SPORTSKE NAUKE I ZDRAVLJE

SPORTS SCIENCE AND HEALTH

Volume 13 Issue 2

Naučno-stručni časopis iz oblasti sportskih i medicinsko-rehabilitacionih nauka
Scientific Journal in Sports and Medical-Rehabilitation Science

ISSN 2232-8211 (Print)
ISSN 2232-822X (Online)

Godina 13 • Broj 2
Decembar 2023.
Republika Srpska
Bosna i Hercegovina

Volume 13 • Issue 2
December 2023
The Republic of Srpska
Bosnia and Herzegovina

UDC: 612
UDC: 613
UDC: 796

www.siz-au.com

APEIRON

SPORTSKE NAUKE I ZDRAVLJE

SPORTS SCIENCE AND HEALTH

Naučno-stručni časopis iz oblasti sportskih i medicinsko-rehabilitacionih nauka

Scientific Journal in Sports and Medical-Rehabilitation Science

Izdavač/Published by *Panevropski univerzitet "Apeiron" Banja Luka/ Pan-European University "Apeiron" Banja Luka, Bosnia and Herzegovina*

Urednik izdavača/Editor of University Publications Aleksandra Vidović, *Pan-European University "Apeiron" Banja Luka, Bosnia and Herzegovina*

Kancelarija/Office

Panevropski univerzitet "Apeiron"
Pere Krece 13, 78000 Banja Luka,
Bosna i Hercegovina
tel. +387 (0) 51 247 975,
fax +387 (0) 51 430 921
siz@siz-au.com
www.siz-au.com

Pan-European University "Apeiron"
Pere Krece 13, 78000 Banja Luka,
Bosnia and Herzegovina
tel. +387 (0) 51 247 975,
fax +387 (0) 51 430 921
siz@siz-au.com
www.siz-au.com

Sekretar i tehnička podrška/ Secretariat and Technical Support Oliver Krička, Bosnia and Herzegovina
Lektura/Text editing Tanja Aničić, Tijana Vasiljević
Dizajn/Design Sretko Bojić
Web dizajn/Web Design Marko Milovanović
Štampa/Printed by MARKOS, Banja Luka
Tiraž: 300 kom. /Printed in 300 copies/

Tematske oblasti/Themes:

- Predškolsko vaspitanje u funkciji razvoja djece
- Savremeno školsko fizičko vaspitanje u funkciji pravilnog rasta i razvoja djece i omladine
- Savremeno fizičko vaspitanje i zdravlje mladih
- Studentski sport kao faktor zdravog življenja
- Sport u funkciji rekreacije građana- stanovništva i zdravlja
- Sportsko- rekreativne aktivnosti kao faktor borbe protiv stresa
- Primjena sportsko-rekreativnih aktivnosti u promjeni načina života ljudi
- Moderne sportsko-rekreativne aktivnosti (fitnes, ekstremni sportovi i dr.) I zdravlje vježbača
- Korektivna gimnastika i kineziterapija u otklanjanju posturalnih poremećaja
- Sport osoba sa posebnim potrebama u funkciji osposobljavanja za život i rad
- Sport invalida kao faktor zdravlja i resocijalizacije
- Vrhunski sport i zdravlje
- Ostale aktuelne teme vezane za sportske nauke i zdravlje

- Preschool education in the function of child development
- Modern school physical education in the function of proper growth and development of children and youth
- Modern physical education and youth health
- University sports as a factor of healthy living
- Sport in the function of recreation and health of citizens
- Sports and recreational activities as anti-stress factor
- Use of sports and recreational activities in the change of people's lifestyle
- Modern sports and recreational activities (fitness, extreme sports, etc.) and health of exercisers
- Corrective exercises and kinetic therapy in the elimination of postural disorders
- Sport for people with special needs as a function of training for life and work
- Disabled sports as a factor of health and social reintegration
- Top sport and health
- Other current topics related to sports science and health

Indexed in:

ebscohost.com
citefactor.org/contact
scopus.com
scholar.google.com
doisrpska.nub.rs
crossref.org
road.issn.org
cosmosimpactfactor.com
erihplus.nsd.no
worldcat.org
doaj.org
esjindex.org

UDC 612
UDC 613
UDC 796

SPORTS SCIENCE AND HEALTH is registered with the Ministry of Science and Technology of the Republic of Srpska by serial registration code 07.030-053-85-2/11, date 08.02.2011., number 612.
SPORTS SCIENCE AND HEALTH (ISSN 2232-8211) is an international journal published two time a year.

ISSN 2232-8211 (Print)
ISSN 2232-822X (Online)

SPORTSKE NAUKE I ZDRAVLJE

SPORTS SCIENCE AND HEALTH

Vol. 13 (2023) No. 2 (129-260)

Sadržaj / Contents

Godišnja pretplata 30 EUR-a /Annual subscription is 30 EUR
Full-text available free of charge at http://www.siz-au.com

Dear readers,

In the new December issue of our Journal we have a record number of papers and a lot of papers from Asia, the Editorial Board included seventeen works by authors from Algeria, Indonesia, Iraq, Philippines, Lithuania, North Macedonia, Croatia, Serbia and Bosnia and Herzegovina.

In this issue, you will read articles related to age as an indicator of sports success, an eight-week online program of special skills on the body mass index of students, an analysis of students' behavior during physical activity in teaching activities, an analysis of the culture of student behavior, an analysis of the condition of Indonesian beach volleyball players, improvement body mass index using exercise tabata, differences between professional and recreational athletes in habits during the COVID-19 pandemic, how exercise lasts in the plank affects arm muscles and precision in archery, identifying and diagnosing the gap in the application of artificial intelligence in the management of sports organizations, motor skills students with specific learning difficulties and students with normal development, quality of life and physical fitness in women, the connection between physical activity and obesity, analysis of gyaku-zuki assessment in karate, the effect of massage on the work productivity of people with disabilities, the relationship between students' nutrition and their physical activity, the relationship between quality of life and cardiorespiratory fitness, theraband exercise program, the use of intermittent exercises in training to increase maximal aerobic speed and strength in U-19 soccer players and the relationship between physical fitness and the lifestyle of early school-aged children.

We would like to thank all the authors, reviewers and members of the editorial board for their efforts, and on this occasion we invite our previous collaborators, especially new, young colleagues, to contribute their works to the effort to make sports science an increasingly important factor in people's good health. We hope that this issue will meet the expectations of the wider readership.

We wish everyone a happy and successful New Year 2024!

EDITORIAL BOARD OF THE JOURNAL

Dragi čitaoci,

U novom decembarskom izdanju našeg Časopisa imamo rekordan broj radova i dosta radova iz Azije, Uredništvo je uvrstilo sedamnaest radova, autora iz Alžira, Indonezije, Iraka, Filipina, Litvanije, Sjeverne Makedonije, Hrvatske, Srbije i Bosne i Hercegovine.

U ovom broju ćete pročitati članke koji se odnose na starost kao indikator sportskog uspjeha, osmondeljni online program specijalnih vještina na indeks tjelesne mase studenata, analiza ponašanje studenata pri fizičkoj aktivnosti u nastavnim aktivnostima, analiza kulture ponašanja studenata, analiza stanja indonežanskih odbojkaša na pijesku, poboljšanje indeksa tjelesne mase pomoću tabata vježbanja, razlike između profesionalnih i rekreativnih sportsita u navikama tokom pandemije COVID – 19, kako vježba izdržaja u planku utiče na mišiće ruku i preciznost u streličarstvu, identifikovanje i dijagnostikovanje jaza u primjeni umjetne inteligencije u upravljanju sportskim organizacijama, motorne sposobnosti učenika sa specifičnim teškoćama u učenju i učenika urednog razvoja, kvalitet života i fizička kondicija kod žena, povezanost fizičke aktivnosti sa gojaznošću, analiza procjene gyaku-zuki u karateu, učinak masaže na radnu produktivnost osoba sa invaliditetom, odnos između uhranjenosti studenata i njihove fizičke aktivnosti, odnos između kvaliteta života i kardiorespiratorne sposobnosti, theraband program vježbanja, korišćenje povremenih vježbi u treningu za povećanje maksimalne aerobne brzine i snage u U-19 fudbalera i odnos između fizičke spremnosti i načina života djece ranog školskog uzrasta.

Zahvaljujemo svim autorima, recenzentima i članovima uredništva na uloženom trudu i ovom prilikom pozivamo naše dosadašnje saradnike, a posebno nove, mlade koleginice i kolege, da svojim radovima daju doprinos nastojanju da sportske nauke budu sve značajniji faktor dobrog zdravstvenog stanja ljudi. Nadamo se da će i ovaj broj ispuniti očekivanja šire čitalačke populacije.

Želimo svima srećnu i uspješnu novu 2024. godinu!

UREDNIŠTVO ČASOPISA

https://doi.org/10.7251/SSH2302133L
UDC: 796.015.52:005.346
Original scientific paper
Originalni naučni rad

An Examination of an 8-Week Online Activity-Specific Skills Program to BMI of Local College Students

Joseph Lobo[1], Kristia Estilo[2], Lou Margarett Parcon[3], Andrea Audine Bulquerin[4], Jackelyn Delos Santos[5], Mike Jhun Valencia[6], Joanna Marie Sabid[7], Frietzie Inayan[7], Edi Setiawan[8]

[1]Mabalacat City College, Mabalacat City, Philippines
[2]West Visayas State University- Janiuay Campus, Iloilo, Philippines
[3]Pototan National Comprehensive High School, Iloilo, Philippines
[4]Iloilo National High School, Department of Education, Iloilo, Philippines
[5]Panitan National High School, Department of Education, Capiz, Philippines
[6]Malay College, Aklan, Philippines,
[7]Iloilo State University of Fisheries, Science and Technology, Iloilo, Philippines
[8]Faculty of Teacher Training and Education, Universitas Suryakancana, Indonesia

Correspondence:
Joseph Lobo, Mabalacat City College, Mabalacat City, Philippines
joseph.lobo@mec.edu.ph

Abstract: *Requiring college students to participate in basic resistance training movement patterns and locomotor and non-locomotor exercises has decreased and improved BMI. This study aimed to examine the effectiveness of the online activity-specific skills program to college students' BMI. This study has employed an experimental research design in which the students undergo a series of activity-specific skills for eight consecutive weeks. Demographic characteristics such as gender, BMI (pre- and post-test), and the Physical Activity Readiness Questionnaire are all included. Independent Sample T-Test was utilized to determine the significant difference based on the post-test scores of the participants concerning gender. Lastly, the Paired samples T-test was executed to the significant difference in the pre-and-test scores of the participants. It was found that no significant difference was observed in the pre-test scores of the participants; lastly, after performing the Paired samples t-test, it was found that there was no significant difference observed between the pre-and post-test score of the participants after performing a series of activity-specific skills activities for eight weeks. Students' body mass indexes were not affected by the movement patterns taught in PE 1, which included locomotor, non-locomotor, and basic resistance training. The results of this study may encourage teachers to reevaluate the efficacy of the existing physical education practices or to look for alternatives that have better potential to reduce students' BMI. Since the study's findings are inconclusive, more research with a larger sample size is required to establish the reliability of the claims presented herein.*
Keywords: *basic resistance training movement patterns, college student, locomotor movements, non-locomotor movements, online setting, physical education.*

INTRODUCTION

As a preventative measure against the spread of the deadly COVID-19 virus, most colleges in the Philippines and other areas of the world switched to online or distance learning two years ago (Foo et al., 2021; Gabriel & Rhonda, 2020; Prevandos & Martin, 2022). The dramatic shifts in the modern educational system have had far-reaching effects on the lives of most college students, causing problems with their mental and, more importantly, their physical health as a result of decreased participation in a wide range of physical activities (Gewalt et al., 2022; Y. Guo et al., 2021; Idris et al., 2021). Utilizing the online learning mode provided numerous benefits and advantages, which was especially helpful during the assault of COVID-19. As was previously said, various educational institutions around the world have leveraged technology to bring learning into the homes of their students. Surprisingly in the post-pandemic era, this form of instruction will play a vital role in assisting HEIs in providing students with a superior education (Pokhrel & Chhetri, 2021). The primary objective of most physical education courses is to instill in students a lifelong routine of regular physical activity. Although online learning has its uses, it does not appear to be a good fit for this area. While the main advantages of online education are their accessibility and safety, physical education classes have a little impact on students' skill sets and tacit knowledge. Despite this, higher education institutions nevertheless face a wide range of difficulties. Educators from throughout the world have voiced concerns about the use of online physical education courses. These challenges stem from factors like insufficient IT skills, the use of many

platforms, and a general lack of access to home-based technology (Korcz et al., 2021). Due to the repetitive nature of sessions within the constraints of the setting and the ineffectiveness of instructional tools, it can be difficult to convey the true objective and relevance of physical education (Jeong & So, 2020). Furthermore, due to teachers' inexperience in the field, acquired mostly through trial and error, it is challenging to perform comprehensive assessments of physical education sessions online. However, research has also revealed that student engagement is low in virtual classes because of the lack of a physical connection between the teacher and the learner. This is a problem on top of the other challenges online instructors already face while running classes. The lack of real-world experience, flagging motivation, and diminished social opportunities are all potential repercussions. The data shown thus far highlights the challenges that institutions around the world are having with the deployment of e-learning in the wake of the global pandemic. The nature of physical education (PE) may lead some to believe that it is impossible to teach PE online. Despite recent technological advancements, physical education cannot be properly taught in a solitary online format due to the interactive and social aspect of the subject (Moustakas & Robrade, 2022).

Effectiveness of Locomotor, Non-Locomotor, and Basis Resistance Training Movement patterns in a home-based setting

There has been a rise in recent years in the amount of research published on the topic of using the internet and other technology means to motivate individuals to engage in fundamental resistance training movement patterns and locomotor and non-locomotor movements. It is fascinating to observe how different research settings shape the findings presented in academic journals. Students in the Elementary Teacher Education Program at the University of Mataram were surveyed online, and they assessed their own locomotor skills and their non-locomotor mobility very poorly (Safruddin et al., 2021). On the one hand, (Bulca et al., 2020) experimental study assessed the impact of digital physical activity films on the development of locomotor skills in preschoolers. A total of 906 kids, 442 in the intervention group and 464 in the control group, were studied. Locomotor skill improvement was compared between the intervention and control groups using Two 2 × 2 (Group × Time) ANOVAs with repeated measurements. The locomotor subscale exhibited significant ($p < 0.05$) group time interactions. Locomotor skill development was statistically significant in the intervention group but not in the control group. The results imply that performance can be improved with the help of digital tools aimed at enhancing locomotor skills. In addition, (Vikberg et al., 2022) investigated the barriers to and motivations for participation in an online-delivered, home-based RT program for older adults with low muscle mass. Thirty men and women, ages 70 to 71, with low muscle mass were given home-based RT with internet workout videos to perform three times a week for 45 minutes for 10 weeks. Out of a total of 30, 27% completed the study. The increase in chair stand time was 1.6 seconds (95% CI, 0.8-2.3 seconds), while the increase in lean body mass was 0.39 kilograms (95% CI, 0.06-0.72 pounds). The online RT program for elderly people with low muscle mass was practicable as evidenced by high compliance, user satisfaction, increased lean mass, and increased chair-stand duration. Participants' pleasant experiences may be responsible for the intervention's success and favorable outcomes. These results indicate that an RT program provided over the internet may be helpful for elderly people with muscle wastage. Similarly, Daveri et al. (2022) study aimed to compare the efficacy of three training programs, each of which consisted of 15 sessions (three per week): supervised livestreaming (LS), unsupervised following a video recording (VR), and unsupervised following a written curriculum (WP). We also tracked and compared metrics including muscular fitness, cardiovascular health, and total activity. In order to provide useful analysis for statistically significant comparisons between small groups, we also computed mean differences (), 95% confidence intervals (C.I.), and Cohen's effect sizes (E.S.). All three groups saw increases in their levels of physical activity: LS = 93.3%, VR = 86%, and WP = 74%. There was no change in weight, however there was a decrease in waist circumference of 1.3 cm (95% C.I. = 2.1, 0.5; E.S. = 0.170; p 0.004). Resting heart rate (Δ = −7.3 bpm; 95% C.I. = −11.9, −2.7; E.S. = 1.296; $p < 0.001$) and Ruffier's index (Δ = −2.1bpm; 95% C.I. = −3.5, −0.8; E.S. 1.099; $p < 0.001$) were both significantly reduced by LS, but not by VR or WP. It didn't take long to prove that online instruction from a distance was effective. However, the most effective method was supervision, demonstrating the need for an experienced trainer. From what has been discussed so far, it appears that not only can people be enticed to participate in fundamental resistance training movement patterns, but also locomotor and non-locomotor movement activities, but that a broad variety of ways and tools may be used to do so. However, college students are not the intended participants for these scholarly articles. There has probably

been little published research on the efficacy of providing these kinds of activities online. Therefore, it is vital that an investigation along these lines be carried out.

Purpose of the study

This research aims to assess the impact of an activity-specific skills program (including locomotor, non-locomotor, and basic resistance training movement patterns) on the body mass indexes of undergraduate students at a Philippine college in Region III.

MATERIALS AND METHODS

Research Design

The purpose of this experimental study was to evaluate the effectiveness of the activity-specific skills program included in the current Physical Education 1 course offered by the college's department of Physical Education.

Instruments and Data Gathering Procedure

A questionnaire comprised of four (4) sections was used to compile responses from the participants. The Physical Activity Readiness Questionnaire (PAR-Q), Body Mass Index (BMI) [pre- and post-test scores] are included as well as other demographic details (i.e., gender). Those who were found to have a preexisting medical condition were immediately disqualified from taking part in the study.

Study participants were given a list of activity-specific skills to complete, such as those found in the categories of *non-locomotor skills*, *locomotor skills*, and *basic resistance training movement patterns*. The students will complete each of the eight (8) weekly assignments. The instructor-in-charge will convene with students during a set week before to the events below to go over prerequisites and logistics. A video and a module were made available to students as part of the online format of the course to help them with the subsequent assignments. The required workout regimen for the experiment is laid forth in Table 1.

Table 1. *Activity-specific skills activities for the course of eight (8) weeks*

Week	Activities
Week 01	Non-Locomotor Skills • Bracing the core • Dead bug series
Week 02	• Rolling • Bird dog series
Week 03	• Press up, scapular protraction and retraction • Plank series • Squat series
Week 04	Locomotor Skills • Crawl and Creep • Landing and jumping • Throwing
Week 05	• Linear movements (hop, skip, leap or bound, jog, and run) • Lateral movements (slide, crossover, grapevine)
Week 06	Basic Resistance Training movement patterns • Lower body: squat, lunge & hinge
Week 07	• Upper body: Horizontal pull & push; vertical pull & push
Week 08	• Lifting and throwing

Participants of the Study

The selected participants for the study are undergraduate students enrolled in Physical Education 1 at a local college in Mabalacat City, Region III, Philippines. Therefore, *purposive sampling technique* was employed. Researchers use their own judgment to decide who will provide the most valuable data, rather than relying on statistical

probability (Etikan, 2016). To ensure that the data collected from the participants is as reliable as possible, a set of selection criteria has been developed:

1. 1st year student enrolled in Physical Education 1-Movement Competency;
2. Either male or female; and
3. No medical history.

Monitoring procedures activity-specific skills program adherence

The study participants were monitored in two ways to ensure they all completed the exercises: (1) they were required to submit an index card in the college-required format detailing the activities they took and Body Mass Index (post-test); and (2) they were required to submit unaltered and uncut video footage of themselves performing the exercises. Both of these vital monitoring tools were deposited in Google Drive by the participants. To show that they are making progress, students must submit the following weekly. Surprisingly, all of the participants contributed their full attention and turned in their work on time.

Statistical analysis

The data was analyzed using IBM SPSS 27 (IBM Statistical Package for the Social Sciences). Descriptive statistics were utilized to characterize the demographic features of the participants according to gender and body mass index scores (pre-test) using frequency and percentage. In addition, the *Independent Sample T-Test* was used to analyze the difference in participants' sex-based test results after the intervention. This test, classified as a parametric test, compares the dispersion of two independent variables (Gerald, 2018). Finally, the participants' pre- and post-test scores were compared using the *Paired samples T-test* to determine whether or not there was a statistically significant improvement in their performance after engaging in a battery of activity-specific skills exercises (Ross & Willson, 2017).

Ethical considerations

It was made clear to the participants what was being measured and how, as well as what the goals of the experiment were. Benefits to academia and the scientific community as a whole have also been detailed. With this in mind, the questionnaire asked participants to confirm their approval by clicking a box next to the attached agreement.

RESULTS

Table 2 illustrates the demographic characteristics of the participants according to gender [N_{male} = *32*(45.7%) and N_{female} = *38*(54.3%)] and body mass index scores (pre-test) [$N_{underweight}$ = *14*(20.0%), N_{normal} = *45*(64.3%), $N_{overweight}$ = *10*(14.3%) and N_{obese} = *1*(1.4%)].

Table 2. *Demographic Characteristics of the Participants*

Variable	Items	*N*(%)
Gender		
	Male	*32*(45.7%)
	Female	*38*(54.3%)
Body Mass Index (pre-test)		
	Underweight (UW)	*14*(20.00%)
	Normal (N)	*45*(64.3%)
	Overweight (OW)	*10*(14.3%)
	Obese (O)	*1*(1.4%)

Table 3 displays the body mass index (pre-test) classification of the participants according to gender. Based on the table, most male participants fall under the normal classification, followed by underweight and overweight, and lastly, obese [N_{normal} = *19*(59.38%), $N_{underweight}$ = *6*(18.75%), $N_{overweight}$ = *6*(18.75%), and N_{obese} = *1*(3.12%)]. For female participants, most are under the normal classification, followed by the underweight and overweight [N_{normal} = *26*(68.42%), $N_{underweight}$ = *8*(21.05%), $N_{overweight}$ = *4*(10.53%)], respectively.

Table 3. *Contingency table of the participants' gender and Body mass index (BMI) classification*

	Body Mass Index Classification			
Gender	*Underweight/UW* (%)	*Normal/N* (%)	*Overweight/OW* (%)	*Obese/O* (%)
Male	*6*(18.75%)	*19*(59.38%)	*6*(18.75%)	*1*(3.12%)
Female	8(21.05%)	26(68.42%)	4(10.53%)	*0*(0.0%)

Based on the Independent samples t-test findings which can be seen on Table 4, it was found that no significant difference was observed on the pre-test scores of the participants after performing a series of activity-specific skills activities for eight weeks [$t(60.228) = .732$, $p = .467$], even male participants (22.06 ± 4.61) has a slightly higher mean score compared to female participants (21.31 ± 3.81).

Table 4. *Independent samples t-Test results based on post-test scores*

	N	M ± SD	SE	*df*	*t*-test	Sig.	Decision
Post-test Scores							
Male	32	22.06 ± 4.61	.815	60.228	.732	.467	Not significant
Female	38	21.31 ± 3.81	.618				

After performing the Paired samples *t*-test, it was found that there was no significant difference observed between the pre- and post-test score of the participants after performing a series of activity-specific skills activities for eight weeks [$t(69) = -1.249$, $p = .216$], which can also be seen in Table 4 and 5.

Table 4. *Paired samples t-test results*

	Paired Differences				t	*df*	Sig.
	M ± SD	SE	95% Confidence Interval of the Difference				
			Lower	Upper			
[1] Pre-test - post-test	-.152 ± 1.02	.121	-.394	.091	-1.249	69	.216

Table 5. *Body Mass Index (BMI)-based on pre- and post-test scores of participants after completing a series of activity-specific skills activities*

Pre-test						Post-test					
Participants	BMI	Class	Participants	BMI	Class	Participants	BMI	Class	Participants	BMI	Class
1	17.90	1.00	36	20.22	2.00	1	17.90	1.00	36	19.70	2.00
2	21.30	2.00	37	33.57	3.00	2	21.30	2.00	37	32.59	3.00
3	19.70	2.00	38	21.00	2.00	3	20.10	2.00	38	20.70	2.00
4	17.50	1.00	39	21.10	2.00	4	18.00	1.00	39	21.60	2.00
5	17.30	1.00	40	20.40	2.00	5	17.30	1.00	40	20.00	2.00
6	18.67	2.00	41	20.06	2.00	6	16.20	1.00	41	20.06	2.00
7	22.80	2.00	42	19.93	2.00	7	22.80	2.00	42	20.65	2.00
8	33.60	3.00	43	25.60	3.00	8	32.50	3.00	43	24.91	2.00
9	21.00	2.00	44	19.53	2.00	9	20.00	2.00	44	19.00	2.00
10	19.30	2.00	45	21.21	2.00	10	19.30	2.00	45	19.90	2.00
11	25.50	3.00	46	15.75	1.00	11	25.00	3.00	46	15.80	1.00
12	22.90	2.00	47	25.70	3.00	12	24.30	2.00	47	26.00	3.00
13	26.20	3.00	48	21.00	2.00	13	25.83	3.00	48	21.00	2.00
14	24.40	2.00	49	23.40	2.00	14	24.70	2.00	49	22.16	2.00
15	18.50	2.00	50	16.00	1.00	15	19.25	2.00	50	16.25	1.00

16	23.52	2.00	51	19.84	2.00	16	24.10	2.00	51	24.10	2.00
17	16.30	1.00	52	18.38	1.00	17	16.30	1.00	52	20.20	2.00
18	29.80	3.00	53	20.38	2.00	18	29.80	3.00	53	20.77	2.00
19	20.90	2.00	54	21.20	2.00	19	21.30	2.00	54	21.60	2.00
20	21.20	2.00	55	18.67	2.00	20	21.20	2.00	55	22.30	2.00
21	19.61	2.00	56	17.58	1.00	21	19.61	2.00	56	18.60	2.00
22	21.80	2.00	57	22.93	2.00	22	21.80	2.00	57	24.81	2.00
23	35.76	4.00	58	18.60	2.00	23	35.76	4.00	58	18.17	1.00
24	19.90	2.00	59	23.44	2.00	24	20.80	2.00	59	24.54	2.00
25	20.40	2.00	60	18.10	1.00	25	21.80	2.00	60	17.90	1.00
26	22.50	2.00	61	20.00	2.00	26	22.20	2.00	61	18.93	2.00
27	18.50	2.00	62	16.79	1.00	27	18.50	2.00	62	16.79	1.00
28	16.46	1.00	63	23.59	2.00	28	17.31	1.00	63	24.23	2.00
29	19.80	2.00	64	32.87	3.00	29	20.70	2.00	64	33.80	3.00
30	18.60	2.00	65	21.78	2.00	30	19.00	2.00	65	21.92	2.00
31	21.73	2.00	66	17.56	1.00	31	20.77	2.00	66	18.28	1.00
32	24.60	2.00	67	28.30	3.00	32	23.40	2.00	67	27.10	3.00
33	26.39	3.00	68	21.32	2.00	33	27.40	3.00	68	20.46	2.00
34	18.50	2.00	69	20.95	2.00	34	18.50	2.00	69	21.09	2.00
35	18.10	1.00	70	17.50	1.00	35	17.70	1.00	70	17.47	1.00

Class: 1- Underweight, 2- Normal, 3- Overweight, 4- Obese

DISCUSSION

Different findings have surfaced at different points throughout the investigation. No significant differences in performance were found across groups of participants who were tested for a variety of activity-specific skills (including locomotor, non-locomotor, and basic Resistance Training movement patterns). Multiple experiments carried out over the period of several years support this finding. There were no significant variations in performance between the sexes in terms of locomotor skill competency, as determined by an analysis of variance (ANOVA) done in the study by Jiménez Díaz et al. (2015). Similarly, Niemistö et al. (2020) found no difference in performance to locomotor movements based on gender. However, the study by Kit et al. (2017) found that girls averaged higher than boys did on tests of locomotor ability. ANOVA results ($p < .05$) also show that girls outperform boys when it comes to locomotor ability (Bolger et al., 2018). Zheng et al. (2022) also found that girls outpace boys when it comes to locomotor competence (SMD = −0.07 (95 % CI −0.15, 0.01), $p = 0.09$, $I^2 = 66\%$). The age-sex trend model also revealed that girls' locomotor skills grew at a considerably faster rate than boys' ($\beta = 6.3004$ and 4.6782, $p < 0.001$) (Wang et al., 2020). Meanwhile, Robinson (2011) shows that boys, on average, outperform girls when it comes to locomotor skills proficiency. A study by (Xia et al., 2022) found that when comparing the ability levels of boys and girls in hop, skip, and slide, the former group did better ($p < .05$). After searching extensively through academic literature, researchers were unable to locate any research that specifically addressed non-locomotor skills. Furthermore, no substantial difference was identified between the sexes in regards to basic resistance training movement patterns, which contradicts a number of previously published scholarly publications. Women have had a larger increase in relative upper-body strength with resistance training than men, according to a systematic review and meta-analysis by Roberts et al. (2020). In addition, a gender gap was found for increases in knee extensor maximal torque and muscle quality ($p < .05$), with men showing higher gains than women (Da Boit et al., 2016). Increases in maximal torque were 15.8 ± 10.6% for women and 41.7 ± 25.5% for men, while improvements in muscle quality were 8.8 ± 17.5% for women and 33.7 ± 25.5% for men. Males and females may respond differently to resistance training, at least in terms of the degree of adaptability. Finally, Shin et al. (2012) found that there were disparities in absolute strength between the sexes prior to resistance training, but that following training, both men and women saw a rise in absolute strength in the shoulder press, lat pull down, biceps curl, and strength per lean body mass. Squat, leg extension, and leg curl absolute strength were found to be significantly different between the sexes prior to resistance training, but increased for both sexes following resistance training. Prior to resistance training, gender differences in leg extension and leg curl per lean

body mass were visible, while differences in squat per lean body mass were not. All of the foregoing data points to the fact that research have reached diverse conclusions when looking for differences between the sexes. In addition, most studies in this area have been undertaken with students in primary or secondary education. In this regard, it is plausible to conclude that there is a dearth of articles reporting on scholarly research undertaken in universities and colleges. Therefore, it is highly recommended that a comparable study be conducted in the field of HE.

When the participants' body mass index (BMI) was compared before and after the intervention, researchers discovered no statistically significant improvement. The results of this study go counter to those of other studies that have looked at the correlation between physical activity and body mass index. For example, in boys and girls alike, (Cerit et al., 2020) found a correlation between BMI and motor development in the preschool years. Total MS score was significantly correlated with PA body mass index z score (p = .03), as reported by (H. Guo et al., 2018). Despite the results of this study, it is reasonable to assume that people's body mass index will increase if they engage in more locomotor and non-locomotor related activities. Resistance training plus other forms of exercise (like HIIT) and dietary advice was also found to be useful in lowering and improving body mass index (Ahmadi et al., 2020). Equally convincing is the evidence from study (Jin et al., 2018), which shows that a regimen that incorporates both aerobic and anaerobic exercise reduces body mass index. However, the aforementioned studies do not seek out prospective college students, nor do the tasks assigned to participants in the various studies parallel one another. That is what it is recommended to study these methods in greater depth.

CONCLUSION

The different locomotor, non-locomotor, and basic resistance training movement patterns taught in Physical Education 1 did not seem to have a positive effect on students' body mass indexes, even when the course was offered online. Researchers hope their findings will prompt colleges to rethink their current approaches to physical education or to seek out promising new methods of lowering students' BMIs. Although these studies have limitations, they can nevertheless contribute to the promotion of physical fitness on campus if they are combined with other activities and dietary advice created in conjunction with the school's dietitian. It is advised that a similar study be conducted with a bigger sample size to further analyze whether or not the claims stated by this investigation may be accepted or rejected, as the results of this investigation remain inconclusive.

REFERENCES

Ahmadi, A., Moheb-Mohammadi, F., Navabi, Z. S., Dehghani, M., Heydari, H., Sajjadi, F., & Khodarahmi, S. (2020). The effects of aerobic training, resistance training, combined training, and healthy eating recommendations on lipid profile and body mass index in overweight and obese children and adolescents: A randomized clinical trial. *ARYA Atherosclerosis*, *16*(5), 226–234. https://doi.org/10.22122/ARYA.V16I5.1990

Bolger, L. E., Bolger, L. A., O' Neill, C., Coughlan, E., O'Brien, W., Lacey, S., & Burns, C. (2018). Age and Sex Differences in Fundamental Movement Skills Among a Cohort of Irish School Children. *Journal of Motor Learning and Development*, *6*(1), 81–100. https://doi.org/10.1123/jmld.2017-0003

Bulca, Y., Ozdurak, R. H., & Demirhan, G. (2020). The effects of digital physical exercise videos on the locomotor skill learning of pre-school children. *European Early Childhood Education Research Journal*, *28*(2), 231–241. https://doi.org/10.1080/1350293X.2020.1716475

Cerit, E., Özlü, K., Deryahanoğlu, G., Denizci, T., Yamaner, F., Nur, H., Kendirci, P., & Koçak, Ç. V. (2020). Determination of the basic motor skills and its relationship to BMI and physical activity level in preschooler. *African Educational Research Journal*, *8*(1), 115–123. https://doi.org/10.30918/AERJ.8S1.20.018

Da Boit, M., Sibson, R., Meakin, J. R., Aspden, R. M., Thies, F., Mangoni, A. A., & Gray, S. R. (2016). Sex differences in the response to resistance exercise training in older people. *Physiological Reports*, *4*(12), e12834. https://doi.org/10.14814/phy2.12834

Daveri, M., Fusco, A., Cortis, C., & Mascherini, G. (2022). Effectiveness of Different Modalities of Remote Online Training in Young Healthy Males. *Sports*, *10*(11), 170. https://doi.org/10.3390/sports10110170

Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1. https://doi.org/10.11648/j.ajtas.20160501.11

Foo, C. chung, Cheung, B., & Chu, K. man. (2021). A comparative study regarding distance learning and the conventional face-to-face approach conducted problem-based learning tutorial during the COVID-19 pandemic. *BMC Medical Education*, *21*(1), 1–6. https://doi.org/10.1186/s12909-021-02575-1

Gabriel, J., & Rhonda, D. (2020). Students transition from face to face learning to online learning at higher education: A case study in Trinidad and Tobago. *Educational Research and Reviews*, *15*(8), 487–494. https://doi.org/10.5897/err2020.4005

Gerald, B. (2018). A Brief Review of Independent, Dependent and One Sample t-test. *International Journal of Applied Mathematics and Theoretical Physics*, *4*(2), 50. https://doi.org/10.11648/j.ijamtp.20180402.13

Gewalt, S. C., Berger, S., Krisam, R., & Breuer, M. (2022). "Effects of the COVID-19 pandemic on university students' physical health, mental health and learning, a cross-sectional study including 917 students from eight universities in Germany". *PLOS ONE*, *17*(8), e0273928.

https://doi.org/10.1371/journal.pone.0273928

Guo, H., Schenkelberg, M. A., O'Neill, J. R., Dowda, M., & Pate, R. R. (2018). How Does the Relationship Between Motor Skill Performance and Body Mass Index Impact Physical Activity in Preschool Children? *Pediatric Exercise Science*, *30*(2), 266–272. https://doi.org/10.1123/pes.2017-0074

Guo, Y., Liao, M., Cai, W., Yu, X., Li, S., Ke, X., Tan, S., Luo, Z., Cui, Y., Wang, Q., Gao, X., Liu, J., Liu, Y., Zhu, S., & Zeng, F. (2021). Physical activity, screen exposure and sleep among students during the pandemic of COVID-19. *Scientific Reports*, *11*(1), 8529. https://doi.org/10.1038/s41598-021-88071-4

Idris, F., Zulkipli, I. N., Abdul-Mumin, K. H., Ahmad, S. R., Mitha, S., Rahman, H. A., Rajabalaya, R., David, S. R., & Naing, L. (2021). Academic experiences, physical and mental health impact of COVID-19 pandemic on students and lecturers in health care education. *BMC Medical Education*, *21*(1), 542. https://doi.org/10.1186/s12909-021-02968-2

Jeong, H.-C., & So, W.-Y. (2020). Difficulties of Online Physical Education Classes in Middle and High School and an Efficient Operation Plan to Address Them. *International Journal of Environmental Research and Public Health*, *17*(19), 7279. https://doi.org/10.3390/ijerph17197279

Jiménez Díaz, J., Salazar Rojas, W., & Morera, M. (2015). Age and gender differences in fundamental motor skills (original version in English). *Pensar En Movimiento: Revista de Ciencias Del Ejercicio y La Salud*, *13*(2), 1–16. https://doi.org/10.15517/pensarmov.v13i2.18327

Jin, C.-H., Rhyu, H.-S., & Kim, J. Y. (2018). The effects of combined aerobic and resistance training on inflammatory markers in obese men. *Journal of Exercise Rehabilitation*, *14*(4), 660–665. https://doi.org/10.12965/jer.1836294.147

Kit, B. K., Akinbami, L. J., Isfahani, N. S., & Ulrich, D. A. (2017). Gross Motor Development in Children Aged 3–5 Years, United States 2012. *Maternal and Child Health Journal*, *21*(7), 1573–1580. https://doi.org/10.1007/S10995-017-2289-9/METRICS

Korcz, A., Krzysztoszek, J., Łopatka, M., Popeska, B., Podnar, H., Filiz, B., Mileva, E., Kryeziu, A. R., & Bronikowski, M. (2021). Physical Education Teachers' Opinion about Online Teaching during the COVID-19 Pandemic—Comparative Study of European Countries. *Sustainability*, *13*(21), 11730. https://doi.org/10.3390/su132111730

Moustakas, L., & Robrade, D. (2022). The Challenges and Realities of E-Learning during COVID-19: The Case of University Sport and Physical Education. *Challenges*, *13*(1), 9. https://doi.org/10.3390/challe13010009

Niemistö, D., Finni, T., Cantell, M., Korhonen, E., & Sääkslahti, A. (2020). Individual, Family, and Environmental Correlates of Motor Competence in Young Children: Regression Model Analysis of Data Obtained from Two Motor Tests. *International Journal of Environmental Research and Public Health*, *17*(7), 2548. https://doi.org/10.3390/ijerph17072548

Pokhrel, S., & Chhetri, R. (2021). A Literature Review on Impact of COVID-19 Pandemic on Teaching and Learning. *Higher Education for the Future*, *8*(1), 133–141. https://doi.org/10.1177/2347631120983481

Prevandos, F. G., & Martin, J. T. (2022). Development and Validation of Module in Physical Education 4: Team Sports. *International Journal of Human Movement and Sports Sciences*, *10*(6), 1327–1336. https://doi.org/10.13189/saj.2022.100624

Roberts, B. M., Nuckols, G., & Krieger, J. W. (2020). Sex Differences in Resistance Training: A Systematic Review and Meta-Analysis. *Journal of Strength and Conditioning Research*, *34*(5), 1448–1460. https://doi.org/10.1519/JSC.0000000000003521

Robinson, L. E. (2011). The relationship between perceived physical competence and fundamental motor skills in preschool children. *Child: Care, Health and Development*, *37*(4), 589–596. https://doi.org/10.1111/j.1365-2214.2010.01187.x

Ross, A., & Willson, V. L. (2017). Paired Samples T-Test. In *Basic and Advanced Statistical Tests* (pp. 17–19). SensePublishers. https://doi.org/10.1007/978-94-6351-086-8_4

Safruddin, S., Nasaruddin, N., Widodo, A., Sobri, M., & Radiusman, R. (2021). Students' Basic Movement Skills in Physical Education during the Online Learning. *Proceedings of the 2nd Annual Conference on Education and Social Science (ACCESS 2020)*, *556*(Access 2020), 314–317. https://doi.org/10.2991/assehr.k.210525.097

Shin, Y.-A., Kim, K.-H., Suk, M.-H., & Leem, M.-Y. (2012). Effect of Resistance Training on Body Composition, Hormone, and Muscle Strength According to Gender. *The Official Journal of the Korean Academy of Kinesiology*, *14*(2), 23–35. https://doi.org/10.15758/jkak.2012.14.2.23

Vikberg, S., Björk, S., Nordström, A., Nordström, P., & Hult, A. (2022). Feasibility of an Online Delivered, Home-Based Resistance Training Program for Older Adults – A Mixed Methods Approach. *Frontiers in Psychology*, *13*(June), 1–11. https://doi.org/10.3389/fpsyg.2022.869573

Wang, H., Chen, Y., Liu, J., Sun, H., & Gao, W. (2020). A Follow-Up Study of Motor Skill Development and Its Determinants in Preschool Children from Middle-Income Family. *BioMed Research International*, *2020*, 1–13. https://doi.org/10.1155/2020/6639341

Xia, X., Chao, L., Nan, C., Yin, X., Zheng, H., & Zhang, S. (2022). Fundamental motor skills of kindergarten children in different environments and ethnic groups in Northwest China. *BMC Pediatrics*, *22*(1), 423. https://doi.org/10.1186/s12887-022-03497-7

Zheng, Y., Ye, W., Korivi, M., Liu, Y., & Hong, F. (2022). Gender Differences in Fundamental Motor Skills Proficiency in Children Aged 3–6 Years: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, *19*(14), 8318. https://doi.org/10.3390/ijerph19148318

Primljen: 29. jul 2023. / Received: July 29, 2023
Prihvaćen: 20. novembar 2023. / Accepted: November 20, 2023

https://doi.org/10.7251/SSH2302141M
UDC: 006.44:572.087-053.2
Original scientific paper
Originalni naučni rad

Body Mass Index and Waist Circumference Improvement Via Tabata Workout: A 10-Week Repetition Program

Jumel Miller[1], Joseph Lobo[2], Jennifer De Jesus[1], Rafael Celso[3], Jonar Martin[1], Michael Santos[1], Jeronie Baltazar[4], Sharon Baltazar[5], Edi Setiawan[5]

[1]*Institute of Sports, Physical Education, and Recreation, Central Luzon State University, Nueva Ecija, Philippines*
[2]*Mabalacat City College, Mabalacat City, Philippines*
[3]*College of Sports, Exercise, and Recreation, Bulacan State University, Bulacan, Philippines*
[4]*Physical Education, Recreation, and Sports, Pampanga State Agricultural University, Magalang, Philippines*
[5]*Faculty of Teacher Training and Education, Universitas Suryakancana, Indonesia*

Correspondence:
Joseph Lobo, Mabalacat City College, Mabalacat City, Philippines
joseph.lobo@mec.edu.ph

Abstract: *Published scholarly works have accentuated the effectiveness of the TABATA workout for college students. However, no studies were conducted on college students in the context of higher education institutions in the Philippines. Ergo, this study aimed to assess the effectiveness of the TABATA workout for college students. Lastly, it aimed to investigate if such a method may help to improve participants' Body Mass Index and Waist Circumference. This investigation employed an experimental approach to assessing the effectiveness of TABATA training for college students. Moreover, students underwent a 10-week-long workout in repetition. The first part is focused on collecting participants' demographic characteristics such as sex, age, BMI (pre- and post-test), and WC (pre- and post-test). In the second part, the Physical Activity Readiness Questionnaire was used. Paired samples t-test was also used to determine the significant variance after 10-weeks based on participants' BMI and WC scores After the 10-week exercise performed by the participants in general, it was found that there is a reduction and improvement on participants' BMI. Additionally, an improvement in participants' WC. However, based on sex, no significant variance in males' BMI. Fascinatingly, an improvement was observed in the WC of both sexes. Based on the findings, participating in the TABATA program is effective and may partially improve students' BMI and enhance WC. This study did not take into account other factors which may also affect the result of this study. Therefore, comparable experiments may be conducted while taking into account other variables aforementioned to this study's limitation.*

Keywords: *Body Mass Index, College students, HIIT, Tabata Workout Exercise, Waist Circumference.*

INTRODUCTION

Overweightness and obesity have been a predictor of morbidity and mortality from cardiovascular diseases (CVD), diabetes, musculoskeletal disorders, and various types of cancer (Lopez-Jimenez et al., 2022; Piché et al., 2020). In addition, excess abdominal obesity is highly linked to a range of metabolic abnormalities and CVD (Amato et al., 2013; Tran et al., 2018). As a long practice, Body Mass Index (BMI) is widely used in the diagnosis of overweight and obesity (Nuttall, 2015; D. Shah & Sachdev, 2011; Taieb et al., 2022), whilst Waist Circumference (WC) and indices based on WC-such as the waist-to-hip ratio (WHR), and waist-to-height ratio (WThR) are utilized as surrogate indicators of visceral obesity in predicting morbidity and mortality at the population level (Ashwell & Gibson, 2016; Ferreira-Hermosillo et al., 2014; Yoo, 2016). Such anthropometric indices are applied in epidemiological studies for population surveillance of risk factors for chronic diseases because they can be easily measured and are low-cost (Bhatti et al., 2021; Golia et al., 2020). For example, in the study of Tran et al. (2018) in Vietnam, it was found that the measurements of BMI and WC are highly correlated (men r = .80, women, r = .77). For men, WC or an index based on WC is predominantly and highly associated with blood pressure, glucose, and total cholesterol, compared to their counterpart which is highly associated with glucose but highly important for BP and TC. In this regard, avoiding these possibilities by taking into consideration the BMI and WC of individuals at a young age, is highly recommended.

The college environment represents a critical space for young adults regarding the adoption of unhealthy eating habits and a greater risk of overweight and obesity, and even anemia, characterized particularly by an intake of foods rich in saturated fat and deficient in essentials minerals such as iron and folic acid (Quiliche Castañeda et al., 2021).

The prevalence of overweight and obesity has doubled in the last decades and affects almost a third of the world's population, especially among students in developed countries (Chen et al., 2020), such as the Philippines. Additionally, there has been a strike on the percentage of college students who are not physically active (Chaabna et al., 2022; Kljajević et al., 2021) which is highly evident on a global scale due to some reasons such as academic workloads, lack of self-discipline, and poor access to sports facilities (Ferreira Silva et al., 2022; Memon et al., 2021; Winpenny et al., 2018). In this regard, the aforementioned reasons above are considered a public health problem and a pandemic (Meldrum et al., 2017; Tanucan et al., 2022).

Schools such as higher educational institutions have long been identified as important venues for the provision of physical activities, especially during physical education classes (Kahan & McKenzie, 2015; Prevandos & Martin, 2022). As students spend a lot of time in school, most especially those who are pursuing their undergraduate degrees, educational institutions represent an appropriate setting and opportunity to implement interventions that focus on a healthy active lifestyle (Wyszyńska et al., 2020). Various scholars have accentuated those educational institutions, and specifically the course Physical Education, has an important role in the curriculum in mitigating overweight and the 'obesity epidemic' (Kahan & McKenzie, 2015; McKenzie & Lounsbery, 2014; Quennerstedt et al., 2021). Resources for educational purposes, programs, and special teaching strategies have been developed in various nations in an attempt to encourage young adolescents to practice an active healthy lifestyle targeting the reduction of overweightness and obesity problems (Alfrey, 2023; Cale et al., 2014).

One of the activities that are being provided to college students is HIIT activities such as TABATA workouts. In recent years, there have been numerous studies that were already conducted on the effectiveness of TABATA workouts in the improvement of individuals' overall health (Ekström et al., 2019; Li et al., 2023; Popowczak, Rokita, Koźlenia, et al., 2022). TABATA training is highly considered as one of the high-intensity 'interval or intermittent' training (HIIT) methods, which varies in terms of the characteristics of the training exercise (i.e., the exercise mode, intensity, and durations of exercise and rest) (Emberts et al., 2013; Tabata, 2019). This training also aims to yield the most benefits in a short amount of time. Such as for example, in each exercise, an individual may perform eight rounds of 20 seconds of strenuous exercise followed by 10 seconds of rest. HIIT is the 'near maximal' (in another term, 'submaximal') effort which is generally performed at an intensity that elicits > 80% (sometimes 85-95%) of the maximal heart rate (Weston et al., 2014). On the one hand, a broader definition of HIIT was suggested in which it typically involves short bursts of high-intensity exercise to which a short period of rest and recovery will follow which approximately takes < 30 min to execute (Thompson, 2023). In the exercise physiology discipline, the level of intensity of a specific exercise has been defined relative to the VO2max as 'submaximal,' 'maximal,' and 'supramaximal' when the oxygen demand is less than, equal to, and greater than VO2max, respectively. Since TABATA training is higher than the VO_{2max} (i.e., 170% VO_{2max}), the original training is 'supramaximal intensity intermittent training.' Furthermore, in terms of exercise: recovery ratio, TABATA is different from other exercises such as sprint interval training (SIT). In this regard, this training is an original and unique training method that can be described by either the classic but familiar term 'interval training' or the modern and "cool" term 'HIIT,' which includes a variety of training methods using intermittent/interval high-intensity exercise (Tabata, 2019).

Fascinatingly, it was found out that such workouts may be of great benefit in the improvement of body mass index and waist circumference of students (Domaradzki et al., 2020; Lu et al., 2023; Meng et al., 2022; N. Shah & Purohit, 2020). Most notably, in some scholarly articles, the effects of multiweek HIIT such as TABATA workout were observed in overweight young people and in those with normal BMI and WC, the results indicated that improvements are highly effective for overweight and obese individuals (D'Amuri et al., 2021; Domaradzki et al., 2021; Espinoza Silva et al., 2023; Ouerghi et al., 2017). Additionally, there have been recent studies that have mentioned the effectiveness of TABATA training in the virtual environment. It was also that virtual TABATA training is highly effective in the improvement of the level of physical fitness and psychological well-being of student-athletes (Gani et al., 2023). Likewise, another study was conducted were it was also observed that online TABATA workout had a positive effect on the improvement of muscle mass, ankle strength (dorsiflexion), hip strength (abduction, flexion, extension, and external rotation), knee strength (extension and flexion), and balance (Y-balance test) in adolescents (Lee et al., 2021). However, these studies have not focused on the Body Mass Index and Waist Circumference, instead, they have focused on other physical fitness components (i.e., VO_{2max}, endurance, speed, power, and strength), and psychological well-being. On the other hand, after performing a thorough investigation of published scholarly

works that were conducted in relation to this topic in the setting of college students in the Philippines, no studies were detected. Furthermore, inquiries concerning the effectiveness of TABATA workouts for college students in the improvement of their body mass index and waist circumference are still undiscovered. Evaluating its effectiveness is highly beneficial, most especially for physical education teachers in the Philippines in tertiary education, disseminating its importance in the improvement of students' BMI and WC to prevent or lessen the current number of students who are overweight and obese.

Purpose of the Study

In this regard, this current study examined the effectiveness of the 10-week TABATA workout in repetition to college students based on their pre- and post-test scores, and evaluating the difference based on sex.

MATERIALS AND METHODS OF RESEARCH

Research Design

This current investigation employed an experimental design to evaluate the effectiveness of a 10-week TABATA workout in repetition to undergraduate students in the improvement of their Body Mass Indexes (BMI) and Waist Circumference (WC). It is a scientific method to which the study is conducted in a structured and methodical manner, focusing on its goal in achieving accuracy and formulating the most precise conclusion (Miller et al., 2020). As mentioned earlier, this study has used a sampling technique to which the participants are selected based on their characteristics that are highly suitable for this kind of investigation. In this regard, a selection criterion was formulated to obtain the most reliable and accurate data from the participants:

- enrolled in the course Physical Education 2 (Fitness Exercises [Exercise Program-based])
- must be at least 19 years old;
- can be either male or female; and
- no medical history;

Table 1 illustrates the demographic characteristics of the participants. Based on the table, most of the participants are female compared to male [(N_{female} = *22*(73.3%), N_{male} = *8*(26.7%)]. In terms of age, most participants are 20 years old, followed by 19 and 21 years old [(N_{20yo} = *14*(46.7%), N_{19yo} = *13*(43.3%), N_{21yo} = *3*(10.00%)], respectively with a mean of 19.67 years old.

Table 1. *Demographic Characteristics of the participants*

Variables	Items	*N*(%)
Sex	Male	*8*(26.7%)
	Female	*22*(73.3%)
Age (M=19.67)	19 years old	*13*(43.3%)
	20 years old	*14*(46.7%)
	21 years old	*3*(10.0%)

Note: M-Mean

Table 2 below illustrates the TABATA workout program that is designed based on the curriculum of the course to which students are asked to undergo. It also provides the step-by-step process where students are expected to perform in class. The said workout program will be performed by the students in a repetitive manner for the duration of 10-weeks.

Table 2. *10-week repetition TABATA workout program*

Workout	Instructions
High Knees	1. Start standing. 2. Run in place, driving the knees towards the chest. 3. Use arms and try and go as fast as you can. Complete as many reps as possible in 20 seconds at maximum effort, followed by 10 seconds of rest. Repeat eight times. Rest for one minute then continue on to the next move.
Sprawl	1. Start in a plank position. 2. Jump feet toward hands, dropping butt below knees and lifting torso up, and raising hands to chest level. 3. Jump feet back to plank position. That's one rep. Complete as many reps as possible in 20 seconds at maximum effort, followed by 10 seconds of rest. Repeat eight times. Rest for one minute then continue on to the next move.
Skaters	1. Start standing with feet hip-distance apart. 2. Jump to the right, landing on right foot and bringing your left leg behind body. 3. Jump back to the left, landing on left foot and bringing right foot behind body. That's one rep. Complete as many reps as possible in 20 seconds at maximum effort, followed by 10 seconds of rest. Repeat eight times. Rest for one minute then continue on to the next move.
Knee Tuck to Pushup	1. Start in a high plank position. 2. Jump knees between hands (or place sliders under feet, and pull knees forward in line with hands). 3. Return feet to plank position. 4. Bend elbows and lower into a pushup with control. That's one rep. Complete as many reps as possible in 20 seconds at maximum effort, followed by 10 seconds of rest. Repeat eight times. Rest for one minute then continue on to the next move.
Tuck Jumps	1. Start standing. 2. Jump straight up, tucking knees to your chest. 3. Land softly, and immediately repeat that move. That's one rep. Complete 20 seconds at maximum effort, followed by 10 seconds of rest. Repeat eight times. Rest for one minute.
Mountain Climbers	1. Start in a plank position. 2. Drive your knees toward chest, one at a time, as quick as you can. That's one rep. Complete as many reps as possible in 20 seconds at maximum effort, followed by 10 seconds of rest. Repeat eight times. Rest for one minute then continue on to the next move.
Squat Jump	1. Start standing with feet shoulder width apart, toes pointed forward, and weight in heels. 2. Lower down into a squat, and then drive through heels to reverse movement and jump up as high as possible. 3. Land softly back into the squat position. That's one rep. Complete as many reps as possible in 20 seconds at maximum effort, followed by 10 seconds of rest. Repeat eight times. Rest for one minute then continue on to the next move.
Burpees	1. Start standing. 2. Squat down to plant palms on mat. 3. Immediately, jump feet back into a plank position. 4. Perform a pushup. 5. Jump feet toward hands. 6. Push down through heels to rise up and jump into the air, bringing hands over head. 7. Land softly back on mat. That's one rep. Complete as many reps as possible in 20 seconds at maximum effort, followed by 10 seconds of rest. Repeat eight times. Rest for one minute then continue on to the next move.

Instruments and Data Gathering Procedure

The collection of data from the participants was successfully obtained by utilizing a two-parts questionnaire. The first part is focused on gathering the participants' demographic profile both sex, age, body mass index (BMI- for both pre- and post-test scores) and waist circumference (WC-for both pre- and post-test scores). Lastly, the *Physical Activity Readiness Questionnaire* (PAR-Q) was also utilized to determine the participants' current health status in order to identify and exclude the participants based on the selection criterion formulated for the investigation

Participants of the Study

The selected participants for the study are undergraduate students enrolled from two sections in the program of Bachelor of Physical Education in a higher education institution in Angeles City, Region III (Pampanga), Philippines. Additionally, the participants are currently enrolled in the course Movement Competency Training for the 1st Semester, the Academic Year 2022-2023. In this regard, the participants were selected using *Purposive Sampling* technique. This method of selecting participants is not based on statistical likelihood, but rather on the researcher's subjective estimation of which participants will yield the most informative data (Etikan, 2016). Ergo, a selection criterion has been formulated to ensure that the participants' data is as accurate as feasible. The following criteria are as follows:

1. Must be at least 19 years old on the time of the experimental study has been investigated;
2. Either male or female students;
3. Participants' class are held in the orthodox and virtual modality; and
4. No prior medical conditions.

Statistical Analysis

Obtained data from the participants were processed via *IBM Statistical Package for the Social Sciences version 27* (IBM SPSS 27). The demographic characteristics of the participants (i.e., age, gender, BMI and WC) were interpreted using descriptive statistical analyses such as *frequency* (*f*), *mean* (M) and *percentage* (%). Lastly, *Paired samples t-test* was performed to evaluate the significant variance in terms of BMI and WC based on gender after performing a set of TABATA workout in repetition for ten consecutive weeks (Ross & Willson, 2017).

Ethical Considerations

The participants for this experiment were provided a background concerning the study such as its objectives, the instruments to be used, and the variables that will be measured in the entire duration of the investigation. Furthermore, minor risks in participating in the study were also enumerated. Participants were asked to provide their written consent by agreeing on the statement provided on the questionnaire.

RESULTS OF THE RESEARCH

Table 3 depicts the pre-test reports in terms of body mass index and waist circumference of the participants with respect to sex. In terms of body mass index, most male participants are under the normal classification followed by obese [($N_{male(normal)} = 6(75.00\%)$, $N_{male(obese)} = 2(25.00\%)$], while most female participants are under normal classification followed by underweight [($N_{female(normal)} = 14(63.63\%)$, $N_{female(underweight)} = 8(36.36\%)$]. For waist circumference, most male participants are under low risk followed by high risk [($N_{male(low\ risk)} = 7(87.50\%)$, $N_{male(high\ risk)} = 1(12.50\%)$], while most female participants are under low risk followed by moderate risk [($N_{female(low\ risk)} = 21(95.45\%)$, $N_{female(moderate\ risk)} = 1(4.54\%)$].

Table 3. *Pre-test report in terms of sex vis-à-vis Body mass index and waist circumference*

	Body Mass Index (BMI) Classification		
Sex	*Underweight/UW* (%)	*Normal/N* (%)	*Obese/O* (%)
Male	-	6(75.00%)	2(25.00%)
Female	8(36.36%)	14(63.63%)	-
	Waist Circumference (WC)		
Sex	*Low Risk (%)*	*Moderate Risk (%)*	*High Risk (%)*
Male	7(87.50%)	-	1(12.50%)
Female	21(95.45%)	1(4.54%)	-

Table 4 displays the post-test reports in terms of body mass index and waist circumference of the participants with respect to sex. In terms of body mass index, most male participants are under the normal classification followed

by obese [($N_{male(normal)}$ = *7*(87.50%), $N_{male(obese)}$ = *1*(12.50%)]. Fascinatingly, of the original two participants who are obese, one of them achieved the normal classification after performing the TABATA workout. Meanwhile, most of the female participants are under the normal classification followed by underweight [($N_{female(normal)}$ = *12*(54.55%), $N_{female(underweight)}$ = *10*(45.45%)]. On the other hand, of the original fourteen participants who are normal, two of them became underweight after performing the TABATA workout. Furthermore, concerning waist circumference, most of the male participants are under the low-risk followed by high risk [($N_{male(low\ risk)}$ = *7*(87.50%), $N_{male(high\ risk)}$ = *1*(12.50%)]. Comparing these findings from the pre-test report in Table 4, no changes were observed after performing the TABATA workout. Lastly, all participants are under the low risk [($N_{female(low\ risk)}$ = *22*(100.00%)], indicating that out of the 21 original participants under this category, one from the moderate risk successfully improved her waist circumference by performing the TABATA workout.

Table 4. *Post-test report in terms of sex vis-à-vis Body mass index and waist circumference*

	Body Mass Index Classification		
Sex	*Underweight/UW* (%)	*Normal/N* (%)	*Obese/O* (%)
Male	-	7(87.50%)	1(12.50%)
Female	10(45.45%)	12(54.55%)	-
	Waist Circumference		
Sex	*Low Risk (%)*	*Moderate Risk (%)*	*High Risk (%)*
Male	7(87.50%)	-	1(12.50%)
Female	22(100.00%)	-	-

Table 5 illustrates the detailed comparison of all the participant's body mass index/classification and waist circumference/classification before and after performing the 10-week TABATA workout in repetition. As can be seen in the table, there is a slight improvement and reduction in the participants' body mass indexes and waist circumference. Fascinatingly, it can be seen that the male, an obese participant, has a slight reduction in his body mass index and an improvement in his waist circumference. On the one hand, it is alarming that there is a significant decrease in the body mass index and waist circumference for most female participants under the underweight category after performing the workout.

Table 5. *Detailed comparison of participants' BMI/Classification and Waist Circumference/Classification based on pre-test and post-test scores*

Pre-test				Post-test			
Participant	**Sex**	**BMI / Classification**	**Waist Circumference / Classification**	**Participant**	**Sex**	**BMI / Classification**	**Waist Circumference / Classification**
1	F	17.52 (UW)	30.00 (LR)	1	F	18.02 (UW)	32.00 (LR)
2	F	18.35 (UW)	25.00 (LR)	2	F	18.37 (UW)	27.00 (LR)
3	F	22.92 (N)	27.95 (LR)	3	F	23.05 (N)	26.35 (LR)
4	F	18.65 (N)	28.00 (LR)	4	F	19.05 (N)	26.50 (LR)
5	M	23.41 (N)	30.00 (LR)	5	M	23.30 (N)	27.00 (LR)
6	F	20.50 (N)	29.00 (LR)	6	F	21.20 (N)	27.00 (LR)
7	M	23.15 (N)	36.00 (LR)	7	M	23.45 (N)	34.00 (LR)
8	M	26.44 (O)	41.00 (HR)	8	M	25.02 (O)	38.00 (HR)
9	M	23.79 (N)	32.00 (LR)	9	M	22.25 (N)	29.00 (LR)
10	M	18.52 (N)	26.00 (LR)	10	M	18.60 (N)	26.00 (LR)

11	F	19.23 (N)	28.20 (LR)	11	F	18.06 (N)	27.00 (LR)
12	M	20.80 (N)	30.00 (LR)	12	M	21.25 (N)	28.00 (LR)
13	F	19.20 (N)	29.00 (LR)	13	F	18.50 (N)	26.00 (LR)
14	F	18.75 (N)	33.00 (MR)	14	F	18.25 (N)	30.00 (LR)
15	F	17.24 (UW)	24.00 (LR)	15	F	16.45 (UW)	23.00 (LR)
16	F	22.00 (N)	25.25 (LR)	16	F	21.75 (N)	24.50 (LR)
17	F	17.92 (UW)	23.00 (LR)	17	F	17.05 (UW)	23.00 (LR)
18	F	19.80 (N)	27.00 (LR)	18	F	19.00 (N)	26.25 (LR)
19	F	17.33 (UW)	23.00 (LR)	19	F	16.55 (UW)	23.25 (LR)
20	F	19.50 (N)	26.00 (LR)	20	F	18.50 (N)	25.00 (LR)
21	F	21.19 (N)	26.50 (LR)	21	F	20.20 (N)	25.25 (LR)
22	M	20.90 (N)	27.00 (LR)	22	M	19.50 (N)	26.00 (LR)
23	F	18.50 (N)	28.00 (LR)	23	F	17.25 (UW)	26.00 (LR)
24	F	18.59 (N)	29.50 (LR)	24	F	18.01 (UW)	28.00 (LR)
25	F	16.99 (UW)	23.50 (LR)	25	F	17.02 (UW)	23.00 (LR)
26	F	18.90 (N)	27.50 (LR)	26	F	18.50 (N)	27.00 (LR)
27	F	17.24 (UW)	23.50 (LR)	27	F	18.01 (UW)	23.00 (LR)
28	F	18.59 (N)	28.00 (LR)	28	F	18.00 (N)	27.00 (LR)
29	F	15.17 (UW)	23.00 (LR)	29	F	16.22 (UW)	22.00 (LR)
30	M	28.01 (O)	33.00 (LR)	30	M	27.59 (O)	30.00 (LR)

Note: Values are expressed as BMI(Classification): UW- Underweight, N- Normal, O- Obese; Values are expressed as Waist Circumference (Classification): LR- Low risk, MR- Moderate risk, HR- High risk.

Table 6 demonstrates the results of the paired *t*-test analysis. Overall, in the pre-test and post-test scores, a significant variance was observed which indicates that there is a significant reduction and improvement in the Body Mass Index (BMI) of the participants after performing the TABATA workout [$BMI^{a(pre)}$ (19.97 ± 2.87) and $BMI^{b(post)}$ (19.60 ± 2.76), $t(29) = 2.873$, $p = .008$]. Lastly, concerning the waist circumference of the participants, a significant difference was observed which indicates that after performing the TABATA workout, there is a reduction and improvement in the waist circumference of the participants [WC^{a} (28.10 ± 4.05) and WC^{b} (26.87 ± 3.42), $t(29) = 5.124$, $p < .05$]. Moreover, the study has also examined the variance specifically the individuality of each sex. Concerning male participants, no significant variance was observed concerning their pre-test and post-test scores concerning BMI [$BMI^{a(pre)}_{male}$ (23.13 ± 22.62) and $BMI^{b(post)}_{male}$ (22.62 ± 2.92), $t(7) = 1.738$, $p = .126$]; on one hand, a significant variance was observed in terms of their waist circumference, indicating that there is a significant reduction and improvement in their WC after performing the TABATA workout [WC^{a}_{male} (31.88 ± 4.88) and WC^{b}_{male} (29.75 ± 4.23), $t(7) = 5.338$, $p = .001$]. For female participants, a significant difference was observed in their pre-test and post-test scores concerning BMI [$BMI^{a(pre)}_{female}$ (18.82 ± 1.75) and $BMI^{b(post)}_{female}$ (18.50 ± 1.72), $t(21) = 2.238$, $p = .036$]; also, a significant variance was observed in terms of their waist circumference, positing that there is a significant reduction and improvement in their WC after performing the TABATA workout [$WC_{female}{}^{a}$ (26.72 ± 2.70) and $WC_{female}{}^{b}$ (25.82 ± 2.43), $t(21) = 3.410$, $p = .003$].

Table 6. *Difference between pre-test and post-test, and waist circumference of participants*

	Variables	Paired Differences				t	df	Sig.
		M ± SD	SE	95% Confidence Interval of the Difference				
				Lower	Upper			
Overall								
1	BMI[a(pre)] - BMI[b(post)]	.37 ± .71	.130	.10689	.63510	2.873	29	.008
2	WC[a] - WC[b]	1.22 ± 1.31	.240	.73705	1.7162	5.124	29	.000
Male Participants								
1	BMI[a(pre)] - BMI[b(post)]	.51 ± .83	.292	-.18298	1.1979	1.738	7	.126
2	WC[a] - WC[b]	2.13 ± 1.12	.398	1.184	3.066	5.338	7	.001
Female Participants								
1	BMI[a(pre)] - BMI[b(post)]	.32 ± .67	.143	.02269	.62003	2.238	21	.036
2	WC[a] - WC[b]	.90 ± 1.24	.264	.35115	1.4488	3.410	21	.003

Note: Values are expressed as Mean ± Standard Deviation; BMI-Body Mass Index (pre- and post-test) WC- Waist Circumference (pre- and post-test).

DISCUSSION

This study aimed to examine the effectiveness of the ten-week series in repetition of TABATA workouts in the improvement of the Body Mass Index (BMI) and Waist Circumference (WC) of the participants. Based on the findings, it was found that there was a significant difference and improvement in the body mass index of the participants if seen from an overall perspective. The finding of this study has been supported by the study of (Domaradzki et al., 2020) which reported that a significant difference was observed in the BMI of the participants who joined the 10-week TABATA program after performing the two-way ANOVA [BMI(F=120.30,p <0.001)], however, it is only effective for overweight individuals. Likewise, the findings of Meng et al. (2022) also reported that BMI and body fat mass decreased (BMI: −1.8 kg/m^2 vs. – 1.2 kg/m^2, P < 0.01; FM: −1.6 kg, P < 0.05 vs. -3.7 kg, P < 0.01) in HIIT following the TABATA program for twelve weeks. Similarly with the study findings of Lu et al. (2023), it was reported that a 12-week low-volume TABATA style functional HIIT was highly effective to female university students to improve cardiorespiratory fitness, body fat, cardiometabolic health outcomes, and habitual PA. Contrary to the findings of Popowczak, Rokita, and Domaradzki (2022), based on their experimental study focusing on a 10-week PE curriculum supplemented by TABATA training program to secondary school students, it was observed that male students of the intervention group has significantly reduced their body fat (1.77%, p < .05) compared to their counterparts. Additionally, the study of Juránková et al. (2015) has reported that the ten-week program of high-intensity strength interval training has a positive effect that is not statistically significant on the reduction of body fat but has a positive effect that is statistically significant on the increase of muscle mass. Based on the general findings, it can be postulated that participating in the TABATA program is effective and may partially improve students' body mass index.

On the other hand, concerning waist circumference, it was found that a significant difference and improvement were observed as seen in the participants' before and after scores. Alarmingly, for male participants, the results showed no statistically significant change in test scores concerning their Body Mass Indexes before and after the TABATA workout, but there is a slight significant improvement in waist circumference. When compared to female participants' pre and post-test scores for BMI and waist circumference, a statistically significant difference was found. Based on these findings, supported by the study of N. Shah and Purohit (2020), reported that TABATA training shows significant improvement in reducing the waist circumference of the female participants. In this regard, it can be postulated that TABATA training program demonstrated partial effectiveness but should be individualized and sex differences should be highly considered in relation to the improvement of waist circumference. In general, there have also been various studies in relation to the effectiveness of TABATA program as HIIT in decreasing and improving waist circumference. Such as the findings of Saetang and Silalertdetkul (2021), it was found that after training, both the HIIT and Abdominal groups saw a substantial reduction in body fat percentage (p <.05). However, only the HIIT and Abdominal groups saw a reduction in their combined abdominal skinfold, waist circumference,

and waist-to-hip ratio after training (p <.05). Likewise, the study of José De Menezes-Junior et al. (2020) has found that children who are overweight or obese can benefit from HIIT protocols with work-to-rest ratios of 1:1 or 2:1 regardless of the overall amount of time spent exercising. In this regard, it can be posited that the TABATA workout may effectively reduce and improve the waist circumference of the participants for those falls under the overweight and obese. Notably, multiple studies have confirmed that TABATA workouts are extremely beneficial, especially for those who are overweight, or obese. Such as the study of D'Amuri et al. (2021), it was reported that a 12-week HIIT is significantly effective for obese adults. Similarly, with the findings of Taufikkurrachman et al. (2020), observed that TABATA method represents an effective way in reducing body weight and fat, most especially to those overweight and obese individuals. However, based on the results of the study, TABATA training program is not highly suggested to introduce, most especially for students that falls under the underweight category as this may cause detrimental issues concerning their health. On a positive note, the training program may be suggested to underweight students if combined with proper caloric food intake.

CONCLUSION

Based on the findings of the study, it has been observed that a 10-week TABATA training workout in repetition may partially improve students' body mass index and significantly enhance waist circumference. In this regard, PE instructors of the college may continuously utilize this exercise in order to facilitate a positive, healthy, and enjoyable activity that may lead to the improvement of their BMI and WC. Furthermore, it has been found that this HIIT program may be highly effective for female college students compared to their counterparts, specifically for both BMI and WC improvement. However, the findings of this study are based on its significant observation that it is highly applicable for students that falls under the category of overweight and obese, but not recommended for those underweight. Additionally, as have mentioned earlier in the discussion part, this type of workout program should be individualized and difference in terms of sex should be highly evaluated.

Most importantly, this experimental study has some caveats that needs to be taken into consideration. This study only focused on undergraduate students in a college in the Philippines. Therefore, this study may not be able to extrapolate the effectiveness of the workout program to other student population. In this regard, the findings of this investigation indicate that doing a similar study with the participation of other students from other higher educational institutions is strongly recommended. Lastly, this research did not take into account the participants' dietary habits, lifestyle choices, and other factors which may also affect the result of this study. Ergo, it is highly suggested that comparable experiments be conducted while taking into account the other variables that were mentioned previously. In conclusion, this study makes a novel contribution to the existing body of information in the form of knowledge about the efficiency of the 10-week TABATA workout program in repetition to undergraduate students in a college in the Philippines

REFERENCES

Alfrey, L. (2023). An expansive learning approach to transforming traditional fitness testing in health and physical education: student voice, feelings and hopes. *Curriculum Studies in Health and Physical Education*, 1–16. https://doi.org/10.1080/25742981.2023.2183477

Amato, M. C., Guarnotta, V., & Giordano, C. (2013). Body composition assessment for the definition of cardiometabolic risk. *Journal of Endocrinological Investigation*, *36*(7), 537–543. https://doi.org/10.3275/8943

Ashwell, M., & Gibson, S. (2016). Waist-to-height ratio as an indicator of 'early health risk': simpler and more predictive than using a 'matrix' based on BMI and waist circumference. *BMJ Open*, *6*(3), e010159. https://doi.org/10.1136/bmjopen-2015-010159

Bhatti, R., Warshow, U., Joumaa, M., ElSaban, M., Nawaz, F. A., & Khamis, A. H. (2021). Relevance of Anthropometric Measurements in a Multiethnic Obesity Cohort: Observational Study. *Interactive Journal of Medical Research*, *10*(2), e27784. https://doi.org/10.2196/27784

Cale, L., Harris, J., & Chen, M. H. (2014). Monitoring health, activity and fitness in physical education: its current and future state of health. *Sport, Education and Society*, *19*(4), 376–397. https://doi.org/10.1080/13573322.2012.681298

Chaabna, K., Mamtani, R., Abraham, A., Maisonneuve, P., Lowenfels, A. B., & Cheema, S. (2022). Physical Activity and Its Barriers and Facilitators among University Students in Qatar: A Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, *19*(12), 7369. https://doi.org/10.3390/ijerph19127369

Chen, Y., Liu, X., Yan, N., Jia, W., Fan, Y., Yan, H., Ma, L., & Ma, L. (2020). Higher Academic Stress Was Associated with Increased Risk of Overweight and Obesity among College Students in China. *International Journal of Environmental Research and Public Health*, *17*(15), 5559. https://doi.org/10.3390/ijerph17155559

D'Amuri, A., Sanz, J. M., Capatti, E., Di Vece, F., Vaccari, F., Lazzer, S., Zuliani, G., Dalla Nora, E., & Passaro, A. (2021). Effectiveness of high-intensity interval training for weight loss in adults with obesity: a randomised controlled non-inferiority trial. *BMJ Open Sport & Exercise Medicine*, *7*(3), e001021. https://doi.org/10.1136/bmjsem-2020-001021

Domaradzki, J., Cichy, I., Rokita, A., & Popowczak, M. (2020). Effects of Tabata Training During Physical Education Classes on Body Composition, Aerobic Capacity, and Anaerobic Performance of Under-, Normal- and Overweight Adolescents. *International Journal of Environmental Research and Public Health*, *17*(3), 876. https://doi.org/10.3390/ijerph17030876

Domaradzki, J., Rokita, A., Koźlenia, D., & Popowczak, M. (2021). Optimal Values of Body Composition for the Lowest Risk of Failure in Tabata Training's Effects in Adolescents: A Pilot Study. *BioMed Research International*, *2021*, 1–7. https://doi.org/10.1155/2021/6675416

Ekström, A., Östenberg, A. H., Björklund, G., & Alricsson, M. (2019). The effects of introducing Tabata interval training and stability exercises to school children as a school-based intervention program. *International Journal of Adolescent Medicine and Health*, *31*(4), 1–11. https://doi.org/10.1515/ijamh-2017-0043

Emberts, T., Porcari, J., Dobers-Tein, S., Steffen, J., & Foster, C. (2013). Exercise intensity and energy expenditure of a tabata workout. *Journal of Sports Science & Medicine*, *12*(3), 612–613. http://www.ncbi.nlm.nih.gov/pubmed/24137082

Espinoza Silva, J. M., Latorre Román, P. Á., Cabrera Linares, J. C., Párraga Montilla, J. A., & Martínez Salazar, C. (2023). Effects of a High Intensity Interval Training (HIIT) Program on Anthropomorphic and Cardiometabolic Variables in School Children with Overweight and Obesity. *Children*, *10*(2), 317. https://doi.org/10.3390/children10020317

Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1. https://doi.org/10.11648/j.ajtas.20160501.11

Ferreira-Hermosillo, A., Ramírez-Rentería, C., Mendoza-Zubieta, V., & Molina-Ayala, M. A. (2014). Utility of the waist-to-height ratio, waist circumference and body mass index in the screening of metabolic syndrome in adult patients with type 1 diabetes mellitus. *Diabetology & Metabolic Syndrome*, *6*(1), 32. https://doi.org/10.1186/1758-5996-6-32

Ferreira Silva, R. M., Mendonça, C. R., Azevedo, V. D., Raoof Memon, A., Noll, P. R. E. S., & Noll, M. (2022). Barriers to high school and university students' physical activity: A systematic review. *PLOS ONE*, *17*(4), e0265913. https://doi.org/10.1371/journal.pone.0265913

Gani, R. A., Setiawan, E., Achmad, I. Z., Aminudin, R., Purbangkara, T., & Hofmeister, M. (2023). Virtual reality-based tabata training: a professional method for changing levels physical fitness and psychological well-being on student-athletes. *Pedagogy of Physical Culture and Sports*, *27*(2), 91–101. https://doi.org/10.15561/26649837.2023.0201

Golia, N., Krishan, K., & Kashyap, J. R. (2020). Assessment of Obesity by Using Various Anthropometric Measurements among Patients with Coronary Heart Disease Residing in North India. *Cureus*, *12*(5), e7948. https://doi.org/10.7759/cureus.7948

José De Menezes-Junior, F., Correa De Jesus, Í., Ferreira, V. L., Wiens, A., Mota, J., & Leite[1], N. (2020). Effect of Different Interval Training Protocols on Adiposity Indicators in Overweight-Obese Children and Adolescents: a Systematic Review and Meta-Analysis. *J. Phys. Educ. V*, *31*, 3161. https://doi.org/https://doi.org/10.4025/jphyseduc.v31i1.3161

Juránková, M., Bílý, J., & Hrazdíra, E. (2015). Effects of high-intensity strength interval training program on body composition. *Journal of Human Sport and Exercise*, *10*(Proc1), 4–6. https://doi.org/10.14198/jhse.2015.10.Proc1.20

Kahan, D., & McKenzie, T. L. (2015). The Potential and Reality of Physical Education in Controlling Overweight and Obesity. *American Journal of Public Health*, *105*(4), 653–659. https://doi.org/10.2105/AJPH.2014.302355

Kljajević, V., Stanković, M., Đorđević, D., Trkulja-Petković, D., Jovanović, R., Plazibat, K., Oršolić, M., Čurić, M., & Sporiš, G. (2021). Physical Activity and Physical Fitness among University Students—A Systematic Review. *International Journal of Environmental Research and Public Health*, *19*(1), 158. https://doi.org/10.3390/ijerph19010158

Lee, K.-J., Noh, B., & An, K.-O. (2021). Impact of Synchronous Online Physical Education Classes Using Tabata Training on Adolescents during COVID-19: A Randomized Controlled Study. *International Journal of Environmental Research and Public Health*, *18*(19), 10305. https://doi.org/10.3390/ijerph181910305

Li, Z., Liu, Y., Han, X., & Zhou, Z. (2023). Effects of running-based versus body-weight-based high-intensity interval training on physical fitness in healthy adolescents. *Frontiers in Physiology*, *14*(March), 1–11. https://doi.org/10.3389/fphys.2023.1060216

Lopez-Jimenez, F., Almahmeed, W., Bays, H., Cuevas, A., Di Angelantonio, E., le Roux, C. W., Sattar, N., Sun, M. C., Wittert, G., Pinto, F. J., & Wilding, J. P. H. (2022). Obesity and cardiovascular disease: mechanistic insights and management strategies. A joint position paper by the World Heart Federation and World Obesity Federation. *European Journal of Preventive Cardiology*, *29*(17), 2218–2237. https://doi.org/10.1093/eurjpc/zwac187

Lu, Y., Wiltshire, H. D., Baker, J. S., Wang, Q., & Ying, S. (2023). The effect of Tabata-style functional high-intensity interval training on cardiometabolic health and physical activity in female university students. *Frontiers in Physiology*, *14*. https://doi.org/10.3389/fphys.2023.1095315

McKenzie, T. L., & Lounsbery, M. A. F. (2014). The Pill Not Taken: Revisiting Physical Education Teacher Effectiveness in a Public Health Context. *Research Quarterly for Exercise and Sport*, *85*(3), 287–292. https://doi.org/10.1080/02701367.2014.931203

Meldrum, D. R., Morris, M. A., & Gambone, J. C. (2017). Obesity pandemic: causes, consequences, and solutions—but do we have the will? *Fertility and Sterility*, *107*(4), 833–839. https://doi.org/10.1016/j.fertnstert.2017.02.104

Memon, A. R., Gupta, C. C., Crowther, M. E., Ferguson, S. A., Tuckwell, G. A., & Vincent, G. E. (2021). Sleep and physical activity in university students: A systematic review and meta-analysis. *Sleep Medicine Reviews*, *58*, 101482. https://doi.org/10.1016/j.smrv.2021.101482

Meng, C., Yucheng, T., Shu, L., & Yu, Z. (2022). Effects of school-based high-intensity interval training on body composition, cardiorespiratory fitness and cardiometabolic markers in adolescent boys with obesity: a randomized controlled trial. *BMC Pediatrics*, *22*(1), 112. https://doi.org/10.1186/s12887-021-03079-z

Miller, C. J., Smith, S. N., & Pugatch, M. (2020). Experimental and quasi-experimental designs in implementation research. *Psychiatry Research*, *283*(June 2019), 112452. https://doi.org/10.1016/j.psychres.2019.06.027

Nuttall, F. Q. (2015). Body Mass Index. *Nutrition Today*, *50*(3), 117–128. https://doi.org/10.1097/NT.0000000000000092

Ouerghi, N., Fradj, M. K. Ben, Bezrati, I., Khammassi, M., Feki, M., Kaabachi, N., & Bouassida, A. (2017). Effects of high-intensity interval training on body composition, aerobic and anaerobic performance and plasma lipids in overweight/obese and normal-weight young men. *Biology of Sport*, *34*(4), 385–392. https://doi.org/10.5114/biolsport.2017.69827

Piché, M.-E., Tchernof, A., & Després, J.-P. (2020). Obesity Phenotypes, Diabetes, and Cardiovascular Diseases. *Circulation Research*, *126*(11), 1477–1500. https://doi.org/10.1161/CIRCRESAHA.120.316101

Popowczak, M., Rokita, A., & Domaradzki, J. (2022). Effects of tabata training on health-related fitness components among secondary school students. *Kinesiology*, *54*(2), 221–229. https://doi.org/10.26582/k.54.2.2

Popowczak, M., Rokita, A., Koźlenia, D., & Domaradzki, J. (2022). The high-intensity interval training introduced in physical education lessons decrease systole in high blood pressure adolescents. *Scientific Reports*, *12*(1), 1974. https://doi.org/10.1038/s41598-022-06017-w

Prevandos, F. G., & Martin, J. T. (2022). Development and Validation of Module in Physical Education 4: Team Sports. *International Journal of Human Movement and Sports Sciences*, *10*(6), 1327–1336. https://doi.org/10.13189/saj.2022.100624

Quennerstedt, M., Barker, D., Johansson, A., & Korp, P. (2021). The relation between teaching physical education and discourses on body weight – an integrative review of research. *Curriculum Studies in Health and Physical Education*, *12*(3), 287–305. https://doi.org/10.1080/25742981.2021.1894407

Quiliche Castañeda, R. B., Turpo-Chaparro, J., Torres, J. H., Saintila, J., & Ruiz Mamani, P. G. (2021). Overweight and Obesity, Body Fat, Waist Circumference, and Anemia in Peruvian University Students: A Cross-Sectional Study. *Journal of Nutrition and Metabolism*, *2021*, 1–9. https://doi.org/10.1155/2021/5049037

Ross, A., & Willson, V. L. (2017). Paired Samples T-Test. In *Basic and Advanced Statistical Tests* (pp. 17–19). SensePublishers. https://doi.org/10.1007/978-94-6351-086-8_4

Saetang, S., & Silalertdetkul, S. (2021). Comparison of the Effects of High-Intensity Interval Training with Abdominal Training and High-Intensity Interval Training on Body Fat in Overweight Women. *Journal of Sports Science and Technology*, *21*(1), 79–91.

Shah, D., & Sachdev, H. P. . (2011). Measuring undernutrition and overnutrition in children. In *Public health in developing countries* (pp. 108–150). Woodhead Publishing Limited. https://doi.org/10.1533/9780857093905.108

Shah, N., & Purohit, A. (2020). Effect of Tabata Training for Weight Loss in Overweight Middle Age Female of Ahmedabad City: An Experimental Study. *International Journal of Science and Healthcare Research*, *5*(December), 281–284. www.ijshr.com

Tabata, I. (2019). Tabata training: one of the most energetically effective high-intensity intermittent training methods. *The Journal of Physiological Sciences*, *69*(4), 559–572. https://doi.org/10.1007/s12576-019-00676-7

Taieb, A. Ben, Roberts, E., Luckevich, M., Larsen, S., le Roux, C. W., de Freitas, P. G., & Wolfert, D. (2022). Understanding the risk of developing weight-related complications associated with different body mass index categories: a systematic review. *Diabetology & Metabolic Syndrome*, *14*(1), 186. https://doi.org/10.1186/s13098-022-00952-4

Tanucan, J. C. M., Garcia, M. A., & Bojos, M. T. (2022). Housework-based exercise versus conventional exercise on health-related fitness of adolescent learners. *Pedagogy of Physical Culture and Sports*, *26*(6), 364–373. https://doi.org/10.15561/26649837.2022.0602

Taufikkurrachman, T., Wardhati, A., Rusdiawan, A., & Sari, R. (2020). The Effect of Cardio and Tabata Exercises on Decreasing Body Fat, Weight and Increasing Physical Fitness. *Proceedings of the 5th International Seminar of Public Health and Education, ISPHE 2020, 22 July 2020, Universitas Negeri Semarang, Semarang, Indonesia*. https://doi.org/10.4108/eai.22-7-2020.2300320

Thompson, W. R. (2023). Worldwide Survey of Fitness Trends for 2023. *ACSM'S Health & Fitness Journal*, *27*(1), 9–18. https://doi.org/10.1249/FIT.0000000000000834

Tran, N. T. T., Blizzard, C. L., Luong, K. N., Truong, N. L. Van, Tran, B. Q., Otahal, P., Nelson, M., Magnussen, C., Gall, S., Bui, T. Van, Srikanth, V., Au, T. B., Ha, S. T., Phung, H. N., Tran, M. H., & Callisaya, M. (2018). The importance of waist circumference and body mass index in cross-sectional relationships with risk of cardiovascular disease in Vietnam. *PLOS ONE*, *13*(5), e0198202. https://doi.org/10.1371/journal.pone.0198202

Weston, K. S., Wisløff, U., & Coombes, J. S. (2014). High-intensity interval training in patients with lifestyle-induced cardiometabolic disease: a systematic review and meta-analysis. *British Journal of Sports Medicine*, *48*(16), 1227–1234. https://doi.org/10.1136/bjsports-2013-092576

Winpenny, E. M., van Sluijs, E. M. F., White, M., Klepp, K.-I., Wold, B., & Lien, N. (2018). Changes in diet through adolescence and early adulthood: longitudinal trajectories and association with key life transitions. *International Journal of Behavioral Nutrition and Physical Activity*, *15*(1), 86. https://doi.org/10.1186/s12966-018-0719-8

Wyszyńska, J., Ring-Dimitriou, S., Thivel, D., Weghuber, D., Hadjipanayis, A., Grossman, Z., Ross-Russell, R., Dereń, K., & Mazur, A. (2020). Physical Activity in the Prevention of Childhood Obesity: The Position of the European Childhood Obesity Group and the European Academy of Pediatrics. *Frontiers in Pediatrics*, *8*(November), 1–8. https://doi.org/10.3389/fped.2020.535705

Yoo, E.-G. (2016). Waist-to-height ratio as a screening tool for obesity and cardiometabolic risk. *Korean Journal of Pediatrics*, *59*(11), 425. https://doi.org/10.3345/kjp.2016.59.11.425

Primljen: 30. jul 2023. / Received: July 30, 2023
Prihvaćen: 14. oktobar 2023. / Accepted: October 14, 2023

https://doi.org/10.7251/SSH2302152Y
Original scientific paper
UDC: 799.311:796.015
Originalni naučni rad

How Does Circuit Plank Exercise Affect Arm Muscle Strength and Archery Accuracy

Betrix Teofa Perkasa Wibafied Billy Yachsie
Indonesian traditional medicine, sports and health department, Vocational Faculty, Yogyakarta State University, Indonesia

Correspondence:
Betrix Teofa Perkasa Wibafied Billy Yachsie, Indonesian traditional medicine, sports and health department, Vocational Faculty, Yogyakarta State University, Indonesia, betrixbilly@uny.ac.id

Abstract: *Circuit plank training is expected to improve archery accuracy supported by the dominant component in archery. This research was an experiment using a one-group pretest-postest design that provided circuit plank training activities in as many as 18 meetings and was carried out three times a week. The study populations were 22 athletes in Yogyakarta, which were then filtered again to take 12 athletes as the study sample using purposive sampling techniques with the criteria of male athletes aged 16-18 years. The instrument of this study included the holding bow digit test and archery distance of 40 meters. The analytical techniques used were normality, homogeneity, and hypothesis tests. The hypothesis testing used a T-test, a statistical analysis technique that can be used to determine whether there is a significant difference between the two mean samples. The analysis of the arm muscle strength data resulted in a t-count value of (41,894) > t table (1.80) and a p-value of (0.000) < 0.05. Meanwhile, the archery accuracy analysis obtained a t-count value of (34,019) > t-table (1.80), and a p-value of (0.000) < 0.05. The results of the two t-tests showed that the t-count value > t-table showed an increase after being given treatment. There was an increase in the strength and accuracy of archery athletes after having circuit plank training and increased endurance component of the arm muscles.*
Keywords: *Circuit, Plank, Bodyweight Training, Archery Sports.*

INTRODUCTION

Indonesians, especially athletes, participate in a variety of sports. One of them is archery, which is one of the world's best sports, this activity is welcoming to all groups (Y. Prasetyo & Susan, 1999). Children to adults can do this sport for recreational activities and achievement (Sarro et al., 2021). Archery achievements do not prioritize gender because archery is not an absolute thing that determines the superiority of performance, which means that when at the same level, male athletes are not necessarily superior to women (Hasmawati et al., 2020). The world record of 144 arrows for the men's recurve number is held by Kim Woo Jin with a score of 1391, while the women's recurve Park Sung Hyun holds the number with a score of 1405 (Ertan et al., 2021). The data can prove that in the sport of archery, women can compete fiercely with men and even surpass male athletes' achievements.

Archery requires five components, namely: physical, tactical, technical, mental, and proper bow tuning, and archery is a sport that not only requires cognitive skills but requires a dominant physical aspect (Spratford & Campbell, 2017). This aspect supports archery accuracy (Dhawale et al., 2018), which is very important in the support of physical endurance and the strength of the arm muscles (Kolayis et al., 2014).

Muscle strength is the ability of a muscle or muscle group to perform work by bearing the weight it lifts (Mohd Saleh et al., 2022). Strong muscles work efficiently daily and improve the body's shape (Ergen et al., 2021). Muscles that are not trained for some reason, such as an accident, will become weak due to atrophy, and if this is left unchecked, the condition can result in muscle paralysis (Nasihul et al., 2022). Muscle strength is closely related to the neuromuscular system, which tells how much the nervous system can activate muscles to contract, so the more muscle fibers that are activated, the greater the muscle's strength (Sadeghipour et al., 2021). Various physical strength exercises need to be trained to improve the athlete's achievements, from the strength of the arms, shoulders, abdomen, and legs (Susanto et al., 2022). One piece of training that could be applied is plank variation training.

Plank exercises are isometric exercises that train strength, which involves the whole muscle maintaining the same body position, such as push-ups for as long as possible (Devries & Giangregorio, 2023). Isometric contraction is the increase in muscle tension when lengthening so that the length of the muscle is in a fixed or unchanged state (Barclay & Curtin, 2023). Isometric exercise was a popular form of strength training in the 1960 (Hahn et al.,

2023). Strength training in an isometric way is more effective for maximum training strength, muscle hypertrophy, and muscle injury healing programs (Hashim et al., 2011). The results of plank training carried out systematically, continuously, and regularly in several reps and sets will affect the strength and flexibility of coordination and shoulder muscles (Stojanović et al., 2023). The stronger and longer a person can perform plank movements, the better the strength of his shoulder muscles to improve physical condition.

The plank exercise makes the muscles contract strongly as a response to the static loading of the muscles involved (de Souza Ferraz et al., 2023). Such loading results in muscle hypertrophy, whose effect will increase muscle strength (Benavente et al., 2023). Muscle hypertrophy depends on the exercises performed. The muscle which will be large is the slow muscle. Hypertrophy caused due to exercise is usually accompanied by increases in myofibrils, actin filaments, myosins, sarcoplasms, and other supporting tissues (Brightwell et al., 2022),(Lim & Goh, 2022).

Based on the observation results and empirical facts, archery coaches only provided monotonous training and lacked an understanding of the physical condition training variety specifically for archery. Some athletes were bored when participating in training and still felt heavy when pulling bows, and also, athletes experienced tremors in the left hand. The tremor experienced affected the groping of arrows which caused a lack of archery accuracy. Some trainers considered that the physical condition training for archery branches was only on the field by shooting as many arrows as possible. The arm muscle strength data measured by the holding bow digit test showed an average of 8.3. If converted to the norm, these results fall into less. In detail from the data, 20 athletes produced 10% in the good category, 35% in the medium category, 45% in the less category, and 10% in the very less category.

The circuit method consists of several items or kinds of exercises that must be done within a particular time. After completing one exercise, the athlete moves on to another without any recovery time until the training is completed (Sari & Vakili, 2022). Circuit drills are exercises with many items and various posts that move between posts or items until the series of practice items are completed. Sports coaching does not depend on the rapid application of sequential processes but on the quality of the coaches' knowledge (Yachsie et al., 2023). In addition to tactics, techniques, and mentality, physical conditions are indispensable for improving achievement (J. L. Park, 2021). Strength is the dominant component in archery to support bow drawing in the set-up to the full-draw position. However, on the field, the coaches only focus on technique and pay little attention to the physical condition of the athlete. Only understanding technique, mentality, or tactics will not help to obtain high points if the arrow misses. Therefore, to strengthen the tactics, physical training also needs to be done (Friday et al., 2023). From the background above, it can be concluded that there was an effect of circuit plank training on the strength of the arm muscles and the accuracy of archery athletes.

METHOD

This experimental research applied one group pretest-posttest design, carried out in one experimental group without a comparison group. In this study, one group was given a plank variation exercise activity in as many as 18 meetings carried out three times a week. The study sample did a pretest first before later being given activity and a posttest after treatment. The population in this study were archery athletes in Yogyakarta as many as 22 athletes with a sample of 12 athletes who were determined using a purposive sampling technique with the criteria of athletes being male and aged 16-18 years. The instrument of this study was a holding bow digit test for arm muscle strength with arm muscle strength measured in units (Kg), The validity of endurance was 0.895 > r table of 0.344 (H. Prasetyo & Siswantoyo, 2019). The accuracy of archery by a distance of 40 meters distance with validity 0,895 > r tabel 0,344 and reliability 0,944 > 0,60 (Yacshie et al., 2022) was assessed by looking at where the arrows landed and comparing them with the determined target. The way to calculate the accuracy of archery was by performing 36 arrow shots and totaling the number of each arrow that process is called scoring.

The researchers collected data by conducting an arm muscle endurance test with a holding bow digit test instrument and archery at 40 meters. After that was a pretest. The sample was given an exercise treatment by doing a plank variation training with the circuit method.

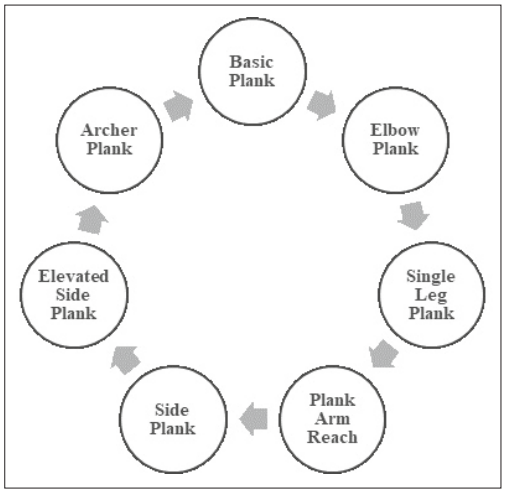


Figure 1. *Circuit Plank Exercise Programs*

The maximum heart rate determined the burden, using a formula to predict the maximum pulse rate. The result showed 220 – age (Z. Huang et al., 2023). The intensity was 70-75% with 30 seconds recovery, 3-6 reps, 3-4 sets, and 3-minute breaks between sets. The analytical techniques used were normality (kolmogorov-Smirnov technique), homogeneity (Levene statistic technique), and hypothesis testing applied a T-test, a statistical analysis technique that can be used to determine whether there is a significant difference between the mean samples.

RESULT

The hypothesis in this study is that there is an effect of Circuit Plank Exercise on Arm Muscle Strength and Archery Accuracy.

Table 1. *Descriptive Statistics Of Archery Strength And Accuracy*

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest Arm Muscle Strength	12	176	633	444.92	142.005
Postest Archery Accuracy	12	425	668	549.00	81.981
Pretest Arm Muscle Strength	12	238	534	413.58	112.642
Postest Archery accuracy	12	270	598	437.08	112.788

Based on the data in table 1, the mean of pretest and posttest arm muscle strength increased, which meant that the data/research group experienced an increase in strength. The mean of pretest and posttest data on archery accuracy had also increased, meaning that the data/group also increased archery accuracy.

Table 2. *Normality Test Calculation*

Data		p	Sig.	Information
Arm Muscle Strength	pretest	0,745	0,05	Normal
	posttest	0,143	0,05	Normal
Archery Accuracy	pretest	0,387	0,05	Normal
	posttest	0,376	0,05	Normal

The results of table 2 this uni normality was obtained from the Shapiro-Wilk test. From the table above results, the pretest and posttest data had a p-value (sig.) > 0.05, which concluded that the variables were normally distributed.

Table 3. *Homogeneity Test Calculation*

Data	Sig.	Information
Arm Muscle Strength	0,397	Homogeneous
Exercise Meditation	0,354	Homogeneous

The results of the homogeneity test table 3 of this study can be seen in table 3 as follows: From table 3 above, the sig value of the pretest and posttest significance was > 0.05, so the data were homogenous.

Table 4. *Hypothesis Test*

Pretest – posttest	Df	T table	T count	P	Sig 5 %
Arm muscle strength	11	1,80	42.884	0,000	0,05
Archery accuracy	11	1,80	35.023	0,000	0,05

The data analysis table 4 of the arm muscle strength obtained a t-count value of (42.884) > t-table (1.80), and a p-value of (0.000) < of 0.05. The results showed that the t-count value was greater than the t-table. Thus, it meant that there was an influence of circuit plank training on arm muscle strength in archery athletes in Yogyakarta. Based on the analysis of archery accuracy above, the t-count value was (35.023) > t table (1.80), and the p-value was (0.000) < 0.05. The results stated that the t-count value was greater than the t-table. Thus, it can be interpreted that there was an influence of circuit plank on the archery accuracy of archery athletes in Yogyakarta. The results of the two t-tests showed that when the value of t-count > t-table, the results showed that the hypothesis was accepted.

ALTERATIONS

This research concluded that the increased arm muscle strength and archery accuracy resulted from circuit plank training exercises. The results were obtained when pulling the bow in the set-up position to the full-draw position. Athletes could pull the bowstrings until they touch the lips and the towing finger touch the chin. Therefore, circuit plank training exercises improved the strength and accuracy of this archery. Body weight training is the same as weight training and is only distinguished by different exercise models and variations. Body weight training can be done without using tools and body weight (Gwinnutt et al., 2022). This body weight exercise is often combined with the circuit method, which is an exercise that uses a form of movement summarized in several posts sorted according to the goals and rules set (Zheng et al., 2022); (Marpaung & Sari, 2022). Weight training with this circuit training system stimulates the muscles (Scoubeau et al., 2023).

Some of the muscle groups that were given stimulation in this study to be increased were: large muscle groups consisting of the pectoralis, hamstring, quadriceps, latticinio Dorsi, low back, biceps, triceps, and abdominal (Bastani et al., 2023). Plank weight training given according to the exercise's dosage, purpose, and dosage can significantly influence arm muscle strength (D'Onofrio et al., 2023). One of the essential elements in archery athletes' physical fitness is the arm muscles' strength (Liao et al., 2022). Excellent muscle strength is the basis for success in sports and the optimization of other physical abilities.

Strong muscles make daily work efficient and shape the body better (Kim & Kim, 2021). Muscle strength is related to the neuromuscular system, namely how much the nervous system can activate the muscles to contract, so the more muscle fibers are activated, the greater the strength the muscle produces (Vendrame et al., 2022); (Mohd Saleh et al., 2022). The plank body weight training program provides exercise movements from the first post to the last, is arranged in a circle, and after the time is up, the researcher gives a sign to stop, and the athlete moves to the next post. Furthermore, the movement of the seven posts is called one circuit. After the athletes do one circuit, they will be given a break for 3 minutes. A good training program increases the score. This can be obtained when the physical condition is supportive or is in shape and balanced with programmatic training (Serrien et al., 2018).

The research showed that archery accuracy was significantly increased along with good muscle strength. Pulling the tremor bow will decrease so that when releasing the arrow, the approval will be right on target so that it will obtain good points: X, 10, and 9. This archery accuracy uses a bow and arrow to aim at objects to stick to the point at which they are shot (Praseтyo et al., 2022). This means that every time the arrow is released, it should not be separated from the intended target (J. Park et al., 2022),(Lombard, 2022). Based on the results above, there was an improvement in archery accuracy due to the condition of the shoulders, strong arms, and good endurance, which caused the athletes not to feel tired. In contrast, the athlete felt light when pulling the bow, so the accuracy increased. From the monthly observations and scoring carried out once every month in Yogyakarta, archery accuracy was increased by looking at the average score obtained at a distance of 40 meters, 322-3 32. On the other hand, muscle endurance also increased, marking a significant increase experienced by the hand when grasping—being trained regularly increased strength and endurance.

Conclusion

Based on the research results and the data analysis, it was concluded that circuit plank body weight training exercises could increase arm muscle strength and archery accuracy, and the endurance component of arm muscles increases significantly.

Acknowledgments

We would like to thank Banyumas Regency for granting permission to carry out the research.

REFERENCES

Barclay, C. J., & Curtin, N. A. (2023). Advances in understanding the energetics of muscle contraction. *Journal of Biomechanics*, 111669.

Bastani, M., Ghasemi, G., & Esmaeili, H. (2023). Core Muscles Activation in Plank with and without Support on Upper Limbs during different Body Angles. *Studies in Sport Medicine*, *14*(34), 95–118.

Benavente, C., Schoenfeld, B. J., Padial, P., & Feriche, B. (2023). Efficacy of resistance training in hypoxia on muscle hypertrophy and strength development: a systematic review with meta-analysis. *Scientific Reports*, *13*(1), 3676.

Brightwell, C. R., Latham, C. M., Thomas, N. T., Keeble, A. R., Murach, K. A., & Fry, C. S. (2022). A glitch in the matrix: the pivotal role for extracellular matrix remodeling during muscle hypertrophy. *American Journal of Physiology-Cell Physiology*, *323*(3), C763–C771.

D'Onofrio, G., Kirschner, J., Prather, H., Goldman, D., & Rozanski, A. (2023). Musculoskeletal exercise: Its role in promoting health and longevity. *Progress in Cardiovascular Diseases*.

de Souza Ferraz, V., Peixoto, C., Resstel, A. P. F., de Paula, Y. T. C., & de Souza Pegorare, A. B. G. (2023). Effect of the pilates method on pain and quality of life in pregnancy: A systematic review and meta-analysis. *Journal of Bodywork and Movement Therapies*.

Devries, M. C., & Giangregorio, L. (2022). Using the specificity and overload principles to prevent sarcopenia, falls and fractures with exercise. *Bone*, 116573.

Devries, M. C., & Giangregorio, L. (2023). Using the specificity and overload principles to prevent sarcopenia, falls and fractures with exercise. *Bone*, *166*, 116573.

Dhawale, T., Yeole, U., & Jedhe, V. (2018). Effect of Upper Extremity Plyometric Training on Strength and Accuracy in Archery Players. *Journal of Medical Science and Clinical Research*, *6*(12), 143–147. https://doi.org/https://dx.doi.org/10.18535/jmscr/v6i12.22

Ergen, E., Hazir, T., Celebi, M., Kin-Isler, A., Aritan, S., Yaylıoglu, V. D., Guner, R., Acikada, C., & Cinemre, A. (2021). Effects of beta-blockers and tuning on archery performance, body sway and aiming behaviour. *BMJ Open Sport & Exercise Medicine*, *7*(2), e001071. https://doi.org/10.1136/bmjsem-2021-001071

Ertan, H., Yagcioglu, S., Yılmaz, A., Ungan, P., & Korkusuz, F. (2021). Accuracy in Archery Shooting is linked to the Amplitude of the ERP N1 to the Snap of Clicker. *Montenegrin Journal of Sports Science and Medicine*, *10*(1), Ahead-of. https://doi.org/10.26773/mjssm.210306

Friday, P. J., Beemer, L. R., Martindale, D., Wassmann, A., Eisman, A. B., Templin, T., Zernicke, R. F., Malinoff, L., Schwartz, A., & Ajibewa, T. A. (2023). A novel policy alignment and enhancement process to improve sustainment of school-based physical activity programming. *International Journal of Environmental Research and Public Health*, *20*(3), 1791.

Gibson, A. L., Smith, J., & Gibson, D. L. (2022). Conducting Adult Client Field-Based Assessments Most Anywhere. *ACSM's Health & Fitness Journal*, *26*(5), 29–44.

Gwinnutt, J. M., Wieczorek, M., Cavalli, G., Balanescu, A., Bischoff-Ferrari, H. A., Boonen, A., de Souza, S., de Thurah, A., Dorner, T. E., & Moe, R. H. (2022). Effects of physical exercise and body weight on disease-specific outcomes of people with rheumatic and musculoskeletal diseases (RMDs): systematic reviews and meta-analyses Informing the 2021 EULAR recommendations for lifestyle improvements in people with. *RMD Open*, *8*(1), e002168.

Hahn, D., Han, S., & Joumaa, V. (2023). The history-dependent features of muscle force production: A challenge to the cross-bridge theory and their functional implications. *Journal of Biomechanics*, 111579.

Hashim, H. A., Hanafi, H., & Yusof, A. (2011). The effects of progressive muscle relaxation and autogenic relaxation on young soccer players' mood states. *Asian Journal of Sports Medicine*, *2*(2), 99–105. https://doi.org/10.5812/asjsm.34786

Hasmawati, F., Samiha, Y. T., Razzaq, A., & Anshari, M. (2020). Understanding Nomophobia Among Digital Natives: Characteristics And Challenges. *Journal of Critical Reviews*, *7*(13), 122–131. https://doi.org/10.31838/jcr.07.13.22

Huang, Q., Wu, M., Wu, X., Zhang, Y., & Xia, Y. (2022). Muscle-to-tumor crosstalk: The effect of exercise-induced myokine on cancer progression. *Biochimica et Biophysica Acta (BBA)-Reviews on Cancer*, 188761.

Huang, Z., Wang, B., Song, K., Wu, S., Kong, H., Guo, L., & Liang, Q. (2023). Metabolic and cardiovascular responses to continuous and intermittent plank exercises. *BMC Sports Science, Medicine and Rehabilitation*, *15*(1), 1.

Kim, J., & Kim, Y. (2021). A Study on the Effects of Turmeric Intake after Weight Training on Blood Alcohol Concentration. *The Korean Journal of Food & Health Convergence*, *7*(3), 33–40.

Kolayis, İ. E., Çilli, M., Ertan, H., & Knicker, J. A. (2014). Assessment of Target Performance in Archery. *Procedia - Social and Behavioral Sciences*, *152*, 451–456. https://doi.org/10.1016/j.sbspro.2014.09.230

Liao, C.-N., Fan, C.-H., Hsu, W.-H., Chang, C.-F., Yu, P.-A., Kuo, L.-T., Lu, B.-L., & Hsu, R. W.-W. (2022). Twelve-Week Lower Trapezius-Centred Muscular Training Regimen in University Archers. *Healthcare*, *10*(1), 171.

Lim, Z. X., & Goh, J. (2022). Effects of blood flow restriction (BFR) with resistance exercise on musculoskeletal health in older adults: a narrative review. *European Review of Aging and Physical Activity*, *19*(1), 1–16.

Lombard, M. (2022). Re-considering the origins of Old World spearthrower-and-dart hunting. *Quaternary Science Reviews*, *293*, 107677.

Marpaung, D. R., & Sari, R. M. (2022). The implementation of plyometrics circuit model to increase jump power. *Journal of Physics: Conference Series*, *2193*(1), 12080.

Mohd Saleh, M., Linoby, A., Abdul Razak, F. A., Abu Kasim, N. A., & Mohamed Kassim, N. A. (2022). The relationship between arm muscle strength, muscle endurance, balance and draw force length on archery performance. *Malaysian Journal of Sport Science and Recreation (MJSSR)*, *18*(1), 83–91.

Nasihul, M., Abcd, W., Acd, P. S., & Bcd, F. X. S. (2022). The effect of water exercise and sand exercise training methods on agility in basketball athletes author : Анотація Аннотация. *Health, Sport, Rehabilitation Здоров'я, Спорт, Реабілітація Здоровье, Спорт,*

Реабилитация, *8*(2).

Park, J. L. (2021). Using group sizes to optimise archery equipment. *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, 17543371211053716.

Park, J., Lee, S., & Chun, S. (2022). Relationship between Accuracy, Speed, and Consistency in a Modern Pentathlon Shooting Event. *Applied Sciences*, *12*(15), 7852.

Prasetyo, H., & Siswantoyo, M. (2019). *Holding Bow Digital Test for Strength and Endurance Arm Muscles of Archery*. *278*(YISHPESS), 409–411. https://doi.org/10.2991/yishpess-cois-18.2018.103

Prasetyo, Y., & Susan, S. (1999). *Analysis Of Physical Exercise And Physical Fitness Level Of Indonesian Ha Health Workers*. *12*(2), 109–119. https://doi.org/doi.org/10.7251/SSH2202109P

Prasetyo, Y., Pamungkas, O. I., Prasetyo, H., & Susan, S. (2022). Analysis Of Anthropometry, Physical Conditions, And Archering Skills As The Basic For Identification Of Talent In The Sport Of Arrow. *Sportske Nauke i Zdravlje*, *12*(2), 183–188. https://doi.org/doi.org/10.7251/SSH2202183P

Sadeghipour, S., Mirzaei, B., Korobeynikov, G. V, & Tropin, Y. (2021). Effects of Whole-Body Electromyostimulation and Resistance Training on Body Composition and Maximal Strength in Trained Women Kharkov State Academy of Physical Culture , Ukraine Анотація Аннотация. *Health, Sport, Rehabilitation Здоров'я, Спорт, Реабілітація Здоровье, Спорт, Реабилитация*, *7*(2), 18–28.

Sari, V., & Vakili, J. (2022). The effect of 8 weeks of circuit training on serum levels of nerve growth factor (NGF) and physical fitness factors in elderly women. *Journal of Applied Health Studies in Sport Physiology*, *9*(1), 72–82.

Sarro, K. J., Viana, T. D. C., & De Barros, R. M. L. (2021). Relationship between bow stability and postural control in recurve archery. *European Journal of Sport Science*, *21*(4), 515–520.

Scoubeau, C., Carpentier, J., Baudry, S., Faoro, V., & Klass, M. (2023). Body composition, cardiorespiratory fitness, and neuromuscular adaptations induced by a home-based whole-body high intensity interval training. *Journal of Exercise Science & Fitness*, *21*(2), 226–236.

Serrien, B., Witterzeel, E., & Baeyens, J.-P. (2018). The Uncontrolled Manifold Concept Reveals That the Structure of Postural Control in Recurve Archery Shooting Is Related to Accuracy. *Journal of Functional Morphology and Kinesiology*, *3*(3), 48.

Spratford, W., & Campbell, R. (2017). Postural stability, clicker reaction time and bow draw force predict performance in elite recurve archery. *European Journal of Sport Science*, *17*(5), 539–545. https://doi.org/10.1080/17461391.2017.1285963

Stojanović, N., Stupar, D., Marković, M., Trajković, N., Aleksić, D., Pašić, G., Koničanin, A., Zadražnik, M., & Stojanović, T. (2023). School-Based Circuit Training Intervention Improves Local Muscular Endurance in Primary School Students: A Randomized Controlled Trial. *Children*, *10*(4), 726.

Susanto, S., Siswantoyo, & Sumaryanto. (2022). Traditional Sport-Based Physical Education Learning Model In Character Improvement And Critical Thinking Of Elementary School Students. *Sportske Nauke i Zdravlje*, *12*(2), 165–172. https://doi.org/doi.org/10.7251/SSH2202165S

Vendrame, E., Belluscio, V., Truppa, L., Rum, L., Lazich, A., Bergamini, E., & Mannini, A. (2022). Performance assessment in archery: a systematic review. *Sports Biomechanics*, 1–23.

Yachsie, B. T. P. W. B., Suharjana, Graha, A. S., & Hartanto, A. (2023). Circuit Game Development: Effects on Balance, Concentration, Muscle Endurance, and Arrow Accuracy. *Physical Education Theory and Methodology*, *23*(1), 92–97. https://doi.org/10.17309/tmfv.2023.1.13

Yacshie, B. T. P. W. B., Prasetyo, Y., & Arianto, A. C. (2022). Walk back tuning and paper tuning: How do they improve archery accuracy? *Journal Sport Area*, *7*(1), 59–68. https://doi.org/10.25299/sportarea.2022.vol7(1).7105

Zheng, Y., Li, H., Gao, K., & Gallo, P. M. (2022). Developing a Home-Based Body Weight Physical Activity/Exercise Program. *ACSM's Health & Fitness Journal*, *26*(2), 20–28.

Primljen: 15. jun 2023. / Received: June 15, 2023
Prihvaćen: 09. novembar 2023. / Accepted: November 09, 2023

https://doi.org/10.7251/SSH2302158O **UDC:** 007.52:004.032.3
Original scientific paper ***Originalni naučni rad***

Identifying and Diagnosing the Gap in Applying Artificial Intelligence Techniques Scale in Managing High-Performance Sports Organizations

Aseel H. Obaid[1], Naeema Zeidan Khalaf[2]
[1]Iraqi Ministry of Education, General Directorate of Education, Rusafa II, Iraq
[2]College of Physical Education and Sports Sciences for Girls, University of Baghdad, Iraq

Correspondence:
Assel H. Obaid, Iraqi Ministry of Education, General Directorate of Education, Rusafa II, Iraq
hassel686@gmail.com

Abstract: *This study seeks to evaluate the technician in the Department of Sports and School Activity in the General Directorate of Education of Baghdad / Al-Rusafa II, according to the requirements of the standard of artificial intelligence techniques in order to diagnose and identify the gap between the technical performance of this section with the requirements of the standard, identify the causes of the gap and propose effective solutions for it. The checklist was used to collect data and information according to the scale of artificial intelligence technologies with five axes (expert systems, virtual reality, smart agents, information technologies, and process automation). The Department of Sports and School Activity in the General Directorate of Education of Baghdad / Al-Rusafa II (case study) have a clear perception of the importance of the measure of artificial intelligence techniques, but the absence of financial and technical capabilities prevents the adoption of this measure in the management of the department, in addition to the lack of management of the department of an administrative unit to follow up the functional work And technology and studying the causes of deviation and the procedures to be followed for the purpose of controlling all factors affecting artificial intelligence techniques, and by examining the results of this study obtained from the checklists, it can be indicated that there are weaknesses in all the requirements that must be available in the sports and school activity section and according to the requirements of the intelligence techniques scale With regard to the axis of expert systems and the axis of smart agents, the percentage of matching dolls was (0%) and the gap for non-conformity amounted to (1). As for the axis of virtual impact, it is not less important than them, as the amount of the gap amounted to (0.9), but the amount of the gap for the axes of information technology and process automation is (0.3), which indicates that the Department of Sports and School Activity applies in its work to most of the paragraphs of these two axes to the requirements of the scale of artificial intelligence technologies.*

Keywords: *Artificial Intelligence techniques, High-Performance Sports Organizations, Checklists, Gap-Size.*

INTRODUCTION

Sports organizations live in a fast-changing environment in the 21st century due to the rapid developments in technology and its various techniques, including Artificial Intelligence (AI) which is a set of digital processes that simulate human intelligence (Gizar, Muhammed, Al-Selmi & Jawoosh, 2022). The adoption of various AI applications by sports organizations has contributed to the speed and ease of interacting with beneficiaries, expanding the scope of this interaction to include large numbers of beneficiaries around the clock (Andrew & Sathesh, 2018). Expert systems, artificial neural networks, genetic algorithms, intelligent agents, simulation systems, robots, and automation systems have replaced human resources in these organizations to achieve outstanding results (Al-Zwainy & Hadal, 2016). This is what high-performance sports organizations with excellent responsive outputs that meet the requirements of competition and are capable of staying, continuing, growing, and developing in a changing environment need (**Aseel, 2018)**. Therefore, their reliance on AI technology applications is increasing significantly for current and future development (Al-Zwainy, Shalal & AbdulQader, 2019).

The research problem lies in the weak implementation and response to the requirements of artificial intelligence (AI) technology application in sports and school activity departments. This is due to the lack of competition among these departments in the general directorates of education in Baghdad, as well as the absence of material and technical resources, which leads to a deficit in their duties. Therefore, the application of the AI technology assessment in sports and school activity departments contributes to ensuring that they acquire the characteristics of high-performance sports organizations.

In modern administrative thinking, topics related to artificial intelligence (AI) technologies and high-performance sports organizations are among the contemporary and relevant topics, whether at the level of professional application or academic theorizing (Lapham & Bartlett, 1995).On the other hand, technological developments and innovations in the field of AI continue to be ongoing and persistent, thus studying these two topics and their connection in the sports field is of utmost importance from the researchers' perspective. Therefore, the importance of the study is manifested in two main aspects:

1. The current study is an extension of previous studies that focus on AI technologies in general, and it adds to the academic accumulation in its field by targeting the knowledge of the applications of AI technologies in sports organizations, which are rarely studied and attempted to be applied in the Iraqi sports environment (Faiq & Al-Zwainy, 2014).
2. Determining the necessary foundations, principles, and requirements for applying AI technology measures to develop the sports and school activity departments in the general directorates of education in Baghdad province as high-performance sports organizations (Jaber, Jasim & Al-Zwainy, 2020).

The main objective of this research is to identify the gap between the current reality of the application of artificial intelligence technologies in the sports and school activity department at the General Directorate of Education in Baghdad / Al-Rusafa II (case study) and the requirements of applying artificial intelligence technology in high-performance sports organizations, while laying foundations for how to apply the requirements of this scale in the sports and school activity department, in order to ensure that this department has the required qualifications to compete internally and externally and increase its material and moral returns.

The current study included three areas. The first area is the human resources, which represents the human resources in the sports and school activity department at the General Directorate of Education in Baghdad / Al-Rusafa II. The second area is the time domain, which extended from January 1st, 2023 to March 30th, 2023. The final area is the spatial domain, as the spatial domain for this study was identified in the sports and school activity department at the General Directorate of Education in Baghdad / Al-Rusafa II in Baghdad Governorate, Iraq.

METHOD AND TOOLS

Choosing the appropriate methodology for the current study is one of the most difficult and important steps that determines the success of scientific research in sports management (Ubaid & Abdul-sattar, 2020), (Najlaa & Nseif, 2022), (Khudhair, Abed & Jasim, 2023). Therefore, the researchers decided to use the descriptive methodology with an analytical approach as it is suitable for the nature of the research problem. It is known that the descriptive methodology provides an accurate picture of the relationships between the community and its sample, and gives the scientific research a picture of the real-life situation, with the ability to predict the future (Ali & Malih, 2022), (Kadhum & Jawad,2021). The study community was deliberately selected from the sports and school activity department in the Directorate General of Education in Baghdad/ Al-Rusafa II in Baghdad province. The community included (57) individuals, such as managers of sports activity departments and their assistants, officials of departments and administrative units, technical supervisors, technicians and administrators. This number represents the research community for the academic year 2022-2023, and table (1) shows the study community and sample. The sample size was chosen to represent the study community because the nature of the research requires a deep understanding and perception in dealing with the questionnaire items designed to study the applications of artificial intelligence in sports and school activity departments and their relationship to principles and foundations of high-performance organizations".

Table 1. *Research Population and Sample Table*

Workplace	Research Population	Research Sample
Department of Sports and School Activity in the General Directorate of Education in Baghdad / Al-Rusafa First	57	57
Percentage	100%	100%

Researchers specializing in sports management require various technologies, tools, and methods to obtain the necessary data and information to carry out their research as required. Thus, the two researchers used a scale for

artificial intelligence techniques built by (Kareem & Uaied, 2021) (Jawoosh, Hatem & Razak, 2021), in addition to reliable scientific references, websites, personal interviews, and field visits to sports and school activity departments (Bayoumi & Zaid,2021).

The field research procedures are the basic foundation on which the two researchers relied on to develop the theoretical framework for their research, starting from theoretical studies, passing through the research methodology, and reaching the conclusions drawn from it. The value of the results obtained by the two researchers in this study lies in the accuracy of the field research procedures that have been chosen to address the subject of building a scale for the applications of artificial intelligence in the sports and school activity department at the General Directorate of Education in Baghdad/Al-Rusafa Al-Thaniya in Baghdad province. The two researchers relied on the method adopted by researcher Gaith (Attallah, 2016) in the field research procedures, which include:

1. The first procedure: identifying the phenomenon that needs to be measured, as this procedure involves examining the actual situation of the sports and school activity department in the General Directorate of Education in Baghdad/Al-Rusafa II (the case study) and studying the actual work context adopted in it, in addition to analyzing the data collected about the performance of this department to identify the gap with the requirements of the scale for artificial intelligence techniques, using checklists.
2. The second procedure: analyzing the characteristics of the research sample, as the two researchers visited the sports and school activity department in the General Directorate of Education in Baghdad/Al-Rusafa II to obtain information about the research sample, such as their academic qualifications, specialties, job experience, and number of years of experience. The researchers were all graduates of various Iraqi universities.
3. The third procedure: analyzing the context of the research, as the researchers examined the context of the sports and school activity department in terms of its administrative structure, policies, and regulations, as well as the extent of the department's implementation of these policies and regulations (Ghazi, Nashmie & Tariq, 2021).

Table 2. *Three-Item Scale and their Weights*

No.	Three-Level Scale Items	Weight
1	Fully Applied	2
2	Partially Applied	1
3	Not Applied	0

A) Calculate the weighted mean for the level of agreement by calculating the values of repetitions for each list of tests according to Equation (1):

$$\text{Weighted Mean} = (\text{Sum of repetitions} * \text{weights}) / \text{Sum of repetitions} \quad (1)$$

B) Calculate the percentage of agreement by dividing the weighted mean by the highest score in the ternary scale according to Equation (2)"

$$\text{Percentage of Agreement} = (\text{Weighted Mean} / \text{Highest score in the ternary scale}) \quad (2)$$

C) Calculate the gap size using Equation (3):

$$\text{Gap size} = 1 - \text{Percentage of Agreement} \quad (3)$$

4. The fourth step involves presenting and analyzing the current situation of the sports and educational activity department in the General Directorate of Education in Baghdad / Al-Rusafa II. Information was collected by conducting personal interviews with a research sample, including the directors of the sports activity departments and their assistants, departmental and administrative unit managers, technical, technological, and administrative supervisors concerned. The aim was to determine the extent of applying the sports and educational activity department in the General Directorate of Education in Baghdad / Al-Rusafa II to the Artificial Intelligence Techniques scale, and to identify the strengths and weaknesses in terms of application, and to calculate the gap size for each axis of the Artificial Intelligence Techniques scale.

RESULTS:

This aspect of the research includes presenting the results for the axes of the artificial intelligence techniques scale and calculating the weighted arithmetic mean of the degree of match, as well as calculating the percentage of the degree of match and then determining the gap, from the perspective of the sample of workers in the sports and school activity department in the General Directorate of Education in Baghdad/Al-Rusafa II. Considering that this department aspires to be a high-performance sports organization, the following are the results of the five axes included in this scale: expert systems axis, virtual reality axis, intelligent agents' axis, information technology axis, and process automation axis. The researcher used a Likert scale with its three levels (applied, partially applied, not applied) to measure the weighted arithmetic mean and the percentage of the degree of match. The individual's answers to the three-point Likert scale items were converted into a quantitative measure by assigning numbers that reflect those answers, which are [2 for (applied), 1 for (partially applied), and 0 for (not applied)] (Salam, Rasheed, Raga & Alwahed, 2018). The results were as follows:

Firstly: Expert systems axis: The checklist for the expert systems axis contains five phrases, as shown in Table (3), which also illustrates the sample individuals' responses to each of the five phrases. It also shows the weighted arithmetic mean of the degree of match and the percentage of the degree of match for each phrase. Then the gap was determined in the sports and school activity department in the General Directorate of Education in Baghdad/Al-Rusafa II. By studying the checklist, it was found that there are weaknesses in all the requirements that should be present in the sports and school activity department according to the requirements of the artificial intelligence techniques scale. The percentage of non-matching items was 0%, indicating a significant gap of 1, which indicates that the sports and school activity department is not fully applied to all the items of the expert systems axis in its work.

Table 3. *Checklist for Expert Systems for the Sports and School Activity Department at the General Directorate of Education in Baghdad/Rusafa II*

Phrase	Applied	Partially Applied	Not Applied
Expert systems rely on rare expertise in solving complex problems.			*
Expert systems act as a consulting expert for top management to contribute to making the right decisions.			*
Expert systems assist in supporting electronic archiving by storing and organizing information and data in sports and school activity departments.			*
Expert systems contribute to acquiring knowledge in various sports fields that support the decisions of top management and the capabilities of employees.			*
Expert systems assist top management by providing information and data to find optimal solutions, alternatives, and conclusions and make decisions.			*
Repetitions	0	0	5
Result	0	0	0
Weighted Mean Score	(5*0)+(0*2)+(0*3)/5=0		
Percentage of Compliance Range	(0/2)=0		
Gap Size	1-0=1		

Secondly: Virtual Reality Axis: The checklist for the Virtual Reality axis includes five phrases, as shown in Table (4), which also shows the responses of the sample individuals to each phrase, along with the mean deviation score and the percentage of conformity for each phrase, as well as identifying the gap for the sports and educational activities department at the Directorate of Education in Baghdad/Al-Rusafa II, it is concluded through the checklist that there are four weak points in the requirements that should be met in the sports and educational activities department according to the Artificial Intelligence Technologies scale. The weighted mean score is (0.2), and the percentage of conformity is (0.1), indicating a significant gap of (0.9) for non-conformity. This indicates that the sports and educational activities department is not fully compliant with most of the phrases in the Virtual Reality axis in its work,

which requires those responsible for the sports and educational activities in the Directorate of Education in Baghdad/ Al-Rusafa II to pay attention to these requirements and address them in the future."

Table 4. *Checklist for Virtual Reality for the Sports and School Activity Department at the General Directorate of Education in Baghdad/Rusafa II*

Phrase	Applied	Partially Applied	Not Applied
Expert systems rely on rare expertise in solving complex problems.			*
Expert systems act as a consulting expert for top management to contribute to making the right decisions.		*	
Expert systems assist in supporting electronic archiving by storing and organizing information and data in sports and school activity departments.			*
Expert systems contribute to acquiring knowledge in various sports fields that support the decisions of top management and the capabilities of employees.			*
Expert systems assist top management by providing information and data to find optimal solutions, alternatives, and conclusions and make decisions.			*
Repetitions	0	1	4
Result	0	1	0
Weighted Mean Score	1/5=0.2		
Percentage of Compliance Range	(0.2/2)=0.1		
Gap Size	0.9		

Thirdly: Intelligent agents' axis: The inspection checklist for the intelligent agent's axis includes five phrases, like the other axes of the artificial intelligence technologies scale, as shown in Table (5). It is also noted that the weighted arithmetic means of the degree of matching equals zero, and the percentage of matching also equals zero. Therefore, the gap value is one. Through studying the inspection checklist, it can be inferred that there are weaknesses in all the requirements that must be met in the sports and educational activity department according to the requirements of the artificial intelligence technologies scale. This indicates that the sports and educational activity department is not fully compliant with all the phrases of the intelligent agent's axis in its work. This requires those responsible for the sports and educational activity department in the General Directorate of Education in Baghdad/ Rusafa II to pay attention to these requirements and address them in the future.

Table 5. *Checklist for Smart agents for the Sports and School Activity Department at the General Directorate of Education in Baghdad/Rusafa II*

Phrase	Applied	Partially Applied	Not Applied
Smart agents assist top management in making the right decisions based on the knowledge base they possess.			*
Smart agents reduce the time employees spend on administrative tasks to achieve their goals.			*
Smart agents perform administrative tasks on behalf of employees and assist them in specific situations.			*
Smart agents contribute to reducing costs and expenses by serving as an alternative to human resources.			*
Smart agent software helps improve and develop the administrative and technical performance of employees.			*
Repetitions	0	0	5
Result	0	0	0
Weighted Mean Score	(5*0)+(0*2)+(0*3)/5=0		
Percentage of Compliance Range	(0/2)=0		
Gap Size	1-0=1		

Fourthly: Information Technology Axis: The inspection checklist for the Information Technology Axis contains five phrases, as shown in Table (6), which also illustrates the sample respondents' responses to each of the five phrases, as well as the weighted mean score and the percentage of conformity for each phrase. After determining the gap value for the sports and school activities section at the Directorate General of Education in Baghdad / Al-Rusafa II, it is noted through the inspection checklist that there are no weaknesses in the requirements that must be available in the sports and school activities section. Instead, there are strengths according to the requirements of the Artificial Intelligence Technologies scale, such as the efficient and speedy contribution of information technologies in accomplishing various administrative tasks and functions. By presenting the results of the inspection checklist in Table (5) for the Information Technology Axis, the percentage of conformity is (0.7%), indicating a relatively small gap of non-conformity of (0.3). This indicates that the sports and school activities section is applied in its work for most of the phrases of the Information Technology Axis.

Table 6. *Checklist for Information technologies for the Sports and School Activity Department at the General Directorate of Education in Baghdad/Rusafa II*

Phrase	Applied	Partially Applied	Not Applied
Information technologies provide useful methods to facilitate the collection, storage, analysis and use of information with high efficiency and effectiveness in organizing work and effectively in decision-making.		*	
Information technologies contribute to the development of human resource skills and improve their level of performance and productivity.		*	
Information technology plays a prominent role in creating values for sports organizations, in addition to assisting them in implementing their strategy, especially in light of the increasing competition.		*	
Information technologies contribute efficiently and quickly to the completion of various business and administrative functions.	*		
The software used in information technologies has multiple purposes and is constantly updated.	*		
Repetitions	2	3	0
Result	4	3	0
Weighted Mean Score	7/5=1.4		
Percentage of Compliance Range	(1.4/2)=0.7		
Gap Size	0.3		

Fifthly: Process Automation Axis: The process automation checklist contains five phrases, as shown in Table (5), which also illustrates the sample responses to each of the five phrases, as well as the weighted average score of the matching range, and the percentage of matching for each phrase. Then, the gap was identified for the sports and educational activity department in the Directorate of Education for Baghdad/Al-Rusafa II. Through studying the checklist, it was found that there is only one weakness point in the requirements that must be available in the sports and educational activity department, according to the requirements of the Artificial Intelligence Techniques Scale, which is the lack of financial and technical resources to prepare for business automation requirements. By presenting the results of the checklist in Table (5), it can be observed that the matching rate is (0.7%), indicating a relatively small gap of non-matching (0.3). This indicates that the sports and educational activity department is applied in its work to most of the process automation axis phrases."

Table 7. *Checklist for Process automation for the Sports and School Activity Department at the General Directorate of Education in Baghdad/Rusafa II*

Phrase	Applied	Partially Applied	Not Applied
The sports and school activity departments seek to improve their technical performance by automating administrative work.		*	
The sports and school activity departments have the financial and technical capabilities that allow them to meet the business automation requirements in managing their various activities.			*
The sports and school activity departments have specialized human resources that contribute to enhancing their role in the transition towards business automation and abandoning traditional management.	*		
Process automation requires specialized human resources with high technical expertise and skills	*		
The sports and school activity departments are interested in automating the internal and external procedures through the website in order to provide all services to the beneficiaries in an easy and fast way and work to improve the work environment.	*		
Repetitions	3	1	1
Result	6	1	0
Weighted Mean Score	7/5=1.4		
Percentage of Compliance Range	(1.4/2)=0.7		
Gap Size	0.3		

DISCUSSIONS:

The main goal of this study is to evaluate the status quo of artificial intelligence technology management according to the Artificial Intelligence Technologies Scale in high-performance sports organizations. This is to ensure high performance in terms of quality, time, and cost. The case study method was used for the purposes of this research, and through field observation in the sports and school activity department at the Directorate General of Education in Baghdad/Al-Rusafa II (the case study), details of all work processes were identified, and all documents related to the work of this department were reviewed to identify any malfunction in the work processes of this department. In addition, interviews were conducted with relevant officials, experts, and specialists in artificial intelligence. Checklists were used to determine the actual performance status of the department's activities compared to the requirements of the Artificial Intelligence Technologies Scale, to highlight the strengths and weaknesses, and to analyze the reasons for the gap between them.

Through the search results, it becomes clear that the majority of the employees in the Department of Sports and School Activities at the Directorate General of Education in Baghdad/Rusafa Al-Rusafa II (educational level) have a clear understanding of the importance of the artificial intelligence techniques scale. However, the lack of financial and technical resources prevents the adoption of this scale in managing the department. In addition, the department lacks an administrative unit to monitor the functional and technical work, study the causes of deviation, and determine the necessary procedures to control all factors affecting artificial intelligence techniques. Through the analysis of the results obtained from the inspection lists, it can be noted that there are weaknesses in all the requirements that should be present in the Department of Sports and School Activities according to the requirements of the artificial intelligence techniques scale. As for the expert systems and intelligent agents' axis, the percentage of conformity is (0%) and the gap amount for non-conformity is (1), indicating that the Department of Sports and School Activities is not fully implementing all the paragraphs of the expert systems and intelligent agents' axis in its work. As for the virtual reality axis, it is no less important than the previous two axes, as the gap amount reached (0.9). However, the gap amount for the information technology and process automation axes is (0.3), indicating that the Department of Sports and School Activities is implementing most of the paragraphs of these two axes according to the requirements of the artificial intelligence techniques scale.

CONCLUSIONS

Through presenting and analyzing the results, the following conclusions can be drawn:

1. The Department of Sports and School Activities in the Directorate of Education in Baghdad/Al-Rusafa II suffers specifically from poor planning and management, as well as a significant weakness in the application of artificial intelligence technologies in all organizational aspects.
2. All workers in the Department of Sports and School Activities in the Directorate of Education in Baghdad/ Al-Rusafa II are in dire need of raising awareness about the importance of applying artificial intelligence technologies in managing high-performance sports organizations.
3. The study found the most important smart applications in artificial intelligence to be expert systems, virtual reality, intelligent agents, information technologies, and process automation.
4. The gap in the Department of Sports and School Activities in the Directorate of Education in Baghdad/ Al-Rusafa II, according to the scale of artificial intelligence technologies applications, reaches (1) for the expert systems and intelligent agents' axis, (0.9) for the virtual reality axis, and (0.3) for the information technologies and process automation axis.

Based on the above conclusions, the following recommendations can be made:

The necessity of adopting a scale for artificial intelligence technologies in Iraqi sports institutions to improve their performance.

1. Conducting similar studies in the Departments of Sports and School Activities in other Directorates of Education in the Republic of Iraq and examining the common points in these studies and the possibility of generalizing them to the country.
2. Involving administrative levels in the Departments of Sports and School Activities in the Directorates of Education in training courses on the concept of artificial intelligence technologies, with the possibility of seeking the help of specialized professors in Iraqi universities to give lectures on the topic.
3. Establishing an administrative unit to manage artificial intelligence technologies within the organizational structure of the Departments of Sports and School Activities in the Directorates of Education to carry out the tasks assigned to it in implementing the requirements of the artificial intelligence technologies scale.

REFERENCES

Al-Zwainy, F. M. S., & Hadal, N. T. (2016). Application artificial forecasting techniques in cost management. *Journal of Engineering*, *22*(8), 1-15.

Al-Zwainy, F. M. S., Shalal, A. M., & AbdulQader, M. A. (2019). *Project Management Office*. Lulu. com.

Al-Zwainy, F. M. S. & Faiq M. S, (2014). Development of the mathematical model for predicating the construction productivity in iraq using the artificial neural perceptron network. *Journal of Engineering and Sustainable Development*, *18*(2), Ar-1.

Ali, I. J., & Malih, D. F. A. (2022). Administrative Skills and Their Role in Distinguishing the Institutional Performance of Directors of Sports Activity in Iraqi Universities. Modern Sport, 21 (1), 0117.

Andrew B. and Sathesh S., "Artificial Intelligence Technology and its Applications in Sport", First Edition, Price water house Coopers, 2018.

Aseel H., "Evaluation of Job Performance According to the 360° Multilateral Technique for Physical Education Teachers in The General Directorates of Education in Baghdad Governorate" Master's Thesis, College of Physical Education and Sports Sciences for Girls, University of Baghdad, Iraq, 2018.

Bayoumi, M. R., & Zaid, N. A. (2021). Analytical study on the extent of the impact of modern technology on the management of sports institutions. *Modern Sport*.

Ghaith M. Attallah, "Building A Quality Management System for Engineering Consulting Burau According to Iso 9001:2015 Requirement in Iraqi Universities (University of Technology Case Study)," M.Sc. thesis, Building and Construction Department of University of Technology, 2016.

Ghazi, H. A., NASHMIE, I. A., & Tariq, A. S. A. A. D. (2021). Modern information technology and its role in improving the performance of sports management Directorates and forums for youth and sports in Iraq. *Modern Sport journal*, *20*(5).

Gizar, M. H., Muhammed, M. A., Al-Selmi, A. D. H., & Jawoosh, H. N. (2022). Using Artificial intelligence to evaluate skill performance of some karate skills. *Modern Sport*, *21*(1), 0001-0001.

Jaber, F. K., Jasim, N. A., & Al-Zwainy, F. M. (2020). Forecasting techniques in construction industry: earned value indicators and performance models. *Przegląd Naukowy. Inżynieria i Kształtowanie Środowiska*, *29*(2 [88]).

Jawoosh, H. N., Hatem, A. D., & Razak, M. A. (2021). Leadership theories in management and psychologist educational filed. *Modern Sport*, *20*(2), 0109-0109.

Kadhum, Z. A., & Jawad, S. M. (2021). An analytical study of organizational confidence from the point of view of physical education teachers in al-rusafa 2 directorate. *Modern Sport journal*, *20*(5).

Kareem, R. A., & Uaied, I. (2021). Smart leadership and its relationship to decision-making for some handball coaches fromthe players' point of view. *Modern Sport*, *20*(2), 0064-0064.

Khudhair, M. O., Abed, S. R., & Jasim, H. T. (2023). Constructing A Measure of Psychological Disability and Its Relationship to Some Basic Skills and Fixed Playing Situations for Youth Football Players Under (19) Years Old. *Revista iberoamericana de psicología del ejercicio y el deporte*, *18*(1), 19-29.

Lapham, A. C., & Bartlett, R. M. (1995). The use of artificial intelligence in the analysis of sports performance: A review of applications in human gait analysis and future directions for sports biomechanics. *Journal of Sports Sciences*, *13*(3), 229-237.

Ubaid, A. H., & Abdul-sattar, L. (2020). Evaluation of the Functional Performance of the Teachers of Physical Education Using Technique 360°. *Modern Sport*, *19*(1), 0140-0156.

Najlaa, S. A. K. S. D., & Nseif, A. (2022). The relationship of three-dimensional intelligence to cognitive achievements in the subject of teaching methods. *Modern Sport*, *21*(4).

Salam H. Rasheed, S.H., Raga, T. H. & Alwahed, S. A., (2018). "Evaluating the administrative performance of the sports talent management of youth and sports institutions in terms of organizational commitment". *Modern Sport journal*, *17*(4).

Primljen: 18. avgust 2023. / Received: August 18, 2023
Prihvaćen: 09. septembar 2023. / Accepted: September 09, 2023

https://doi.org/10.7251/SSH2302167S
UDC: 378.1:005.346]:611.1/.8
Original scientific paper
Originalni naučni rad

Motor abilities of students with specific learning disabilities and a student of regular development

Donata Vidaković Samaržija[1], Lara Trošelj[2]
[1]University of Zadar, Department of Teacher and Preschool Teacher Education, Croatia
[2]Primary school Rijeka, Croatia

Correspondence:
Donata Vidaković Samardžija, University of Zadar, Department of Teacher and Preschool Teacher Education, Croatia
dovidak@unizd.hr

Abstract: *The timely development of motor abilities contributes to the overall development of students, but due to various potential problems, there are often deviations that can affect the quality of daily movement. The aim of the research was to assess the motor abilities of primary education students, and to determine significant differences in individual motor abilities with regard to the existence of a particular learning difficulty or not. The research was conducted on a sample of 101 students (47 students aged 9 years ± 6 months and 54 students aged 10 years ± 6 months). Standardized tests were applied to assess motor abilities: repetitive strength, coordination, speed, explosive power of jumping, agility, flexibility and balance. The basic descriptive indicators were calculated, and the t-test for independent samples was used to determine the significance of differences in motor abilities with regard to the existence of specific learning difficulties. Results: Of the total sample, 75.25% were students without learning disabilities, and 24.75% with specific learning disabilities. Students with no established learning difficulties achieved significantly better results in the variables that assess flexibility (AS1=60.43±18.90 vs.AS2=52.59±12.93; t=1.99; p=0.05), balance (AS1=114.51±107.29 vs. AS2=68.04±75.62; t=2.07; p=0.04), explosive jumping power (AS1=147.09±23.24 vs. AS2=134.15±20.17; t=2.57; p=0.01) and coordination (AS1=20.11±8.78 vs. AS2=26.97±11.84; t=-3.17; p=0.00) from students with specific learning difficulties. Conclusion: Students with specific learning difficulties have less developed individual motor abilities than students with normal development, which encourages thinking about whether it is necessary to adjust the evaluation criteria to their abilities.*
Keywords: *motor abilities, students, specific learning disabilities.*

INTRODUCTION

Many students in their first years of schooling have potential problems that affect their learning ability and overall success in school. The problems that stand out are related to reading, delayed writing skills and/or deficits in math. These are specific learning difficulties which, according to the set of skills in the school area, are grouped into dyslexia (greater difficulties in mastering reading skills), dysgraphia (greater difficulties in mastering writing) and dyscalculia (greater difficulties in learning mathematics) (Bouillet, 2010). The National Center for Learning Disabilities (2014) states that learning disabilities result from neurological differences in the structure and function of the brain and affect a person's ability to receive, store, process, download or communicate information. The stated learning difficulties may be temporary and can be corrected with appropriate interventions, but in 5% to 15% of students the stated difficulties may remain permanent and significant, despite appropriate interventions (American Psychiatric Association, 1994). In addition to learning difficulties, students often encounter other accompanying problems, such as disorientation in space, difficulty determining left and right sides, and poor concentration (Kiš-Glavaš, 2016), which, among other things, is reflected in poorer performance of motor tasks, and weaker development of motor abilities. Motor abilities can be defined as a person's potential in performing simple or complex voluntary movements that are performed by skeletal muscle action (Sekulić and Metikoš, 2007). They are part of the kinanthropological characteristics that significantly change and progress during the period of primary education under the influence of kinesiology activities.

Some research has revealed that students with specific learning disabilities may have less developed motor abilities (Getchell, Pabreja, Neeld & Carrio, 2007; Blanchet & Assaiante, 2022), which is particularly reflected in the implementation of more complex motor tasks. For example, students with dysgraphia and dyscalculia are often accompanied by dyspraxia, which can be explained as a developmental disorder in the planning and execution of motor actions (Kemp, Smith and Segal, 2017), and is manifested first of all by difficulties in fine and gross motor skills,

then by difficulties in maintaining static and dynamic balance and difficulties in coordinated manipulation of objects (Minnis, 2017; Abdulkarim, 2018). Students with dyspraxia are characterized by clumsiness when performing complex movements, they have too pronounced movements, they tire quickly, and there may be difficulties in activities that include playing with a ball caused by poor hand-eye coordination (Minnis, 2017; Kemp, Smith and Segal, 2017).

The aim of this research is to assess the motor abilities of primary education students, and to determine the significance of the difference in individual motor abilities with regard to the existence of a particular learning difficulty or not.

METHODS

Study participants

The research was conducted on a sample of 101 primary education students (47 students aged 9 years ± 6 months and 54 students aged 10 years ± 6 months) who voluntarily participated in the research, and for whom parental consent was obtained. The students do not have any motor aberrations, and the randomly selected sample also includes students who have one or more specific learning difficulties, and who are included in the regular education system. Out of the total sample of respondents, 76 (75.25%) are students without learning difficulties, and 25 students (24.75%) are with specific learning difficulties, of which 7 students have been diagnosed with dyslexia and dysgraphia, 6 students have only been diagnosed with dyslexia , 3 students have dysgraphia, and three students have speech difficulties with dyslexia and dysgraphia. There are two students with attention deficit disorder with dyslexia and dysgraphia, there are also two students with language difficulties and learning difficulties. One is a student with learning disabilities and epilepsy and 1 is a student with speech difficulties and dysgraphia (Figure 1).

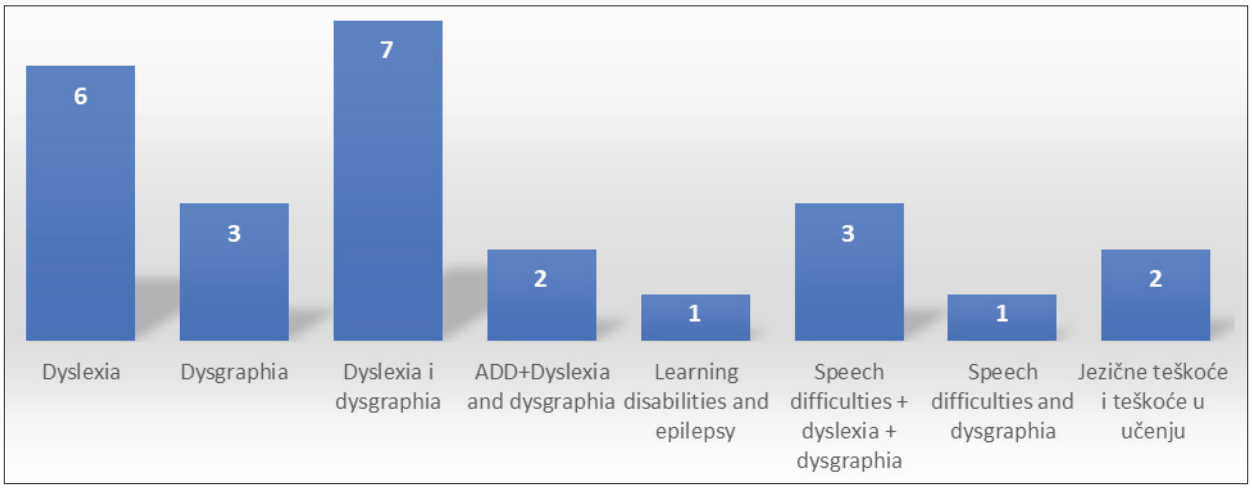


Figure 1. *Share of students with specific learning difficulties according to their diagnoses*

Variables

Standardized tests were used to assess students' motor abilities, which were regularly applied at school with the aim of monitoring students' motor progress. These were tests for evaluating repetitive strength (Sit ups - MRSPTL), coordination (Backward polygon - MREPOL), speed (Plate tapping test - MBFTAP), explosive power of jumping (Standing broad jump - MFESDM), agility (Transferring a sponge by running from side to side -MAGPRP), flexibility (Sit and reach test - MPR) and balance (Balance test on one leg - MFLB).

Statistical analisis

For the purpose of the research, the following descriptive indicators were calculated: arithmetic mean (mean), standard deviation (std. dev.), central value (median), minimum value (minumum), maximum value (maximum), measure of skewness and measure flattening of the distribution (kurtosis). The normality of the distribution was tested with the Kolmogorov-Smirnov test. Since most of the distributions did not deviate significantly from normality, the t-test for independent samples was used to determine the significance of differences in motor abilities with regard to the existence of specific learning difficulties.

RESULTS

Out of the total sample of respondents, 25 students (25%) have specific learning difficulties (12 female students and 13 male students), and 76 students (75%) are of regular development (42 female students and 34 male students) (Figure 2).

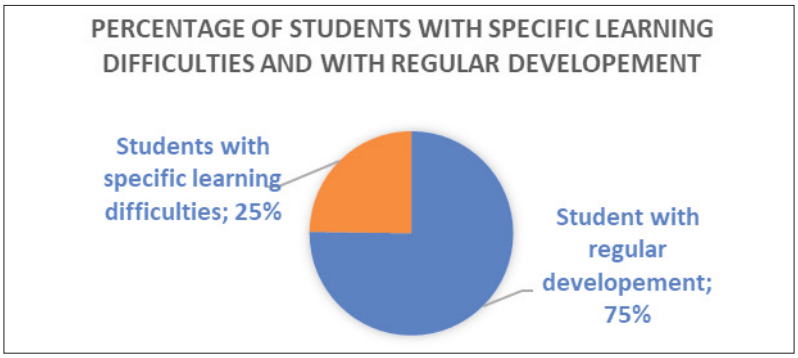


Figure 2. *Percentage of students with specific learning difficulties and students with regular development*

Basic descriptive indicators of motor tests on subsamples were calculated with regard to the presence and absence of specific learning difficulties. Table 1 shows the values of arithmetic means, standard deviations, median, minimum and maximum scores, and measures of curvature and flatness of distributions. Also presented are the results of the Kolmogorov-Smirnov test for assessing the normality of the distribution (Max D and K-S) separately on subsamples with regard to the presence and absence of specific learning disabilities. Comparing the values of the arithmetic means of the measured sample, it is evident that students without specific learning difficulties achieve better results in all motor tests. The greatest dispersion of results is in the Balance test on one leg and Standing broad jump variables. How big the dispersion of the results is is indicated by the values of the minimum and maximum results for both groups of respondents. The Kolmogorov-Smirn test showed that the distributions of the variables Balance test on one leg and Transferring the sponge by running from side to side significantly deviate from normality, while the distributions of the other variables do not deviate. For further processing, the t-test for independent samples was applied.

Table 1. *Descriptive indicators of motor test subjects on subsamples without and with specific learning difficulties (SLD)*

STUDENTS WITHOUT SLD N=76	Mean	SD	MED	MIN	MAX	SKEW	KURT	Max D	K-S test
Sit and reach test (cm)	60.43	18.90	57.50	26.00	105.00	0.36	-0.38	0.09	p > .20
Balance test on one leg (s)	114.51	107.29	88.50	10.00	600.00	2.68	9.62	0.17	p < .05*
Plate tapping test (s)	20.36	2.31	20.00	16.00	26.00	0.19	-0.50	0.11	p > .20
Standing broad jump (cm)	147.09	23.24	145.00	80.00	194.00	-0.43	0.18	0.08	p > .20
Backward polygon (s)	20.11	8.78	18.68	8.06	53.36	1.57	2.86	0.14	p < .10
Transferring the sponge by running from side to side (s)	13.16	2.68	12.20	10.24	24.32	1.73	3.50	0.23	p < .01*
Sit ups (min)	33.26	7.67	35.00	17.00	46.00	-0.51	-0.65	0.12	p > .20
STUDENTS WITH SLD N= 25	**AS**	**SD**	**MED**	**MIN**	**MAX**	**SKEW**	**KURT**	**Max D**	**K-S test**
Sit and reach test (cm)	52.59	12.93	51.00	28.00	80.00	0.14	-0.75	0.11	p > .20
Balance test on one leg (s)	68.04	75.62	52.00	8.00	412.00	3.85	17.49	0.30	p < .01*
Plate tapping test (s)	19.74	5.47	20.00	6.00	37.00	0.93	4.36	0.20	p < .15
Standing broad jump (cm)	134.15	20.17	138.00	77.00	160.00	-1.11	1.10	0.16	p > .20
Backward polygon (s)	26.97	11.84	22.87	16.84	79.00	3.55	14.89	0.28	p < .05*
Transferring the sponge by running from side to side (s)	13.20	2.80	12.19	10.24	19.00	1.19	-0.20	0.33	p < .01*
Sit ups (min)	30.56	8.47	34.00	10.00	40.00	-1.06	0.27	0.18	p > .20

Legend (N- number of students, AS-arithmetic mean, SD- standard deviation, Med- central value, Min- minimum value, MAX- maximum value, Skew- measure of curvature of distribution, Kurt- measure of flatness of distribution)

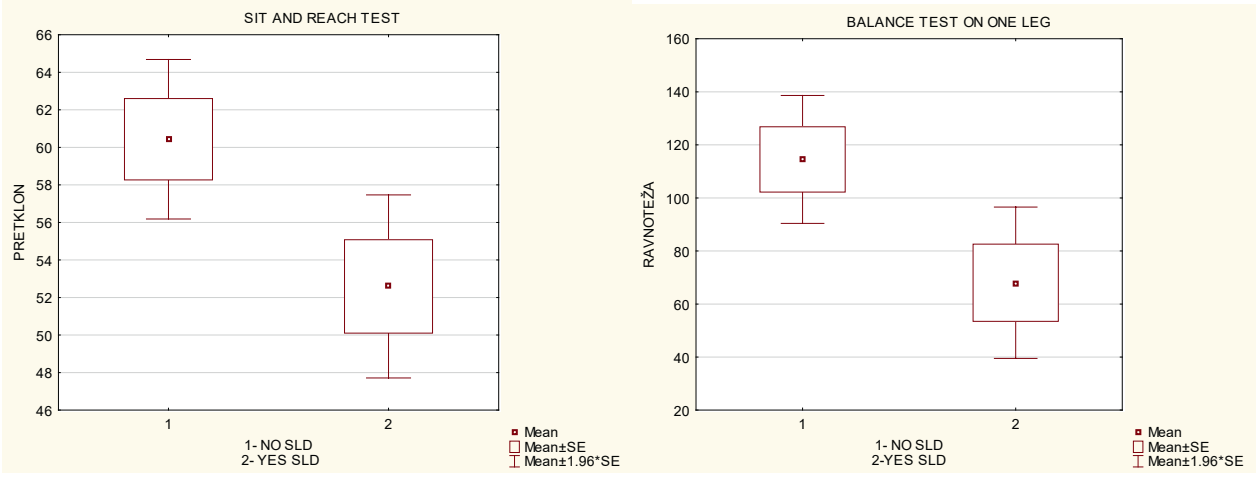
In order to determine the significance of the differences in students' motor abilities with regard to the presence and absence of specific learning difficulties, the t-test for independent samples was applied. Students differ significantly in 4 out of 8 measured variables. More precisely, a statistically significant difference was obtained in the variables *Sit and reach test, Balance test on one leg, Standing broad jump and Backward polygon*. According to the obtained results, students who have no established learning difficulties achieved significantly better results with variables that assess flexibility (Mean1=60.43 ± 18.90 vs.Mean2=52.59 ± 12.93; t=1.99; p= 0.05), balance (Mean1=114.51 ± 107.29 vs. Mean2=68.04 ± 75.62; t=2.07; p=0.04), explosive jumping power (Mean1=147.09 ± 23.24 vs. Mean2= 134.15 ± 20.17; t=2.57; p=0.01) and coordination (Mean1=20.11 ± 8.78 vs. Mean2=26.97 ± 11.84; t=-3.17; p=0.00). In the other motor tests, *Plate tapping test, Transferring the sponge by running from side to side, and Sit and reach test*, students with normal development achieved slightly better results, but not enough to establish statistical significance.

Table 2. *Differences in individual motor tests with regard to the existence of specific learning difficulties (SLD) and without specific learning difficulties (SLD)*

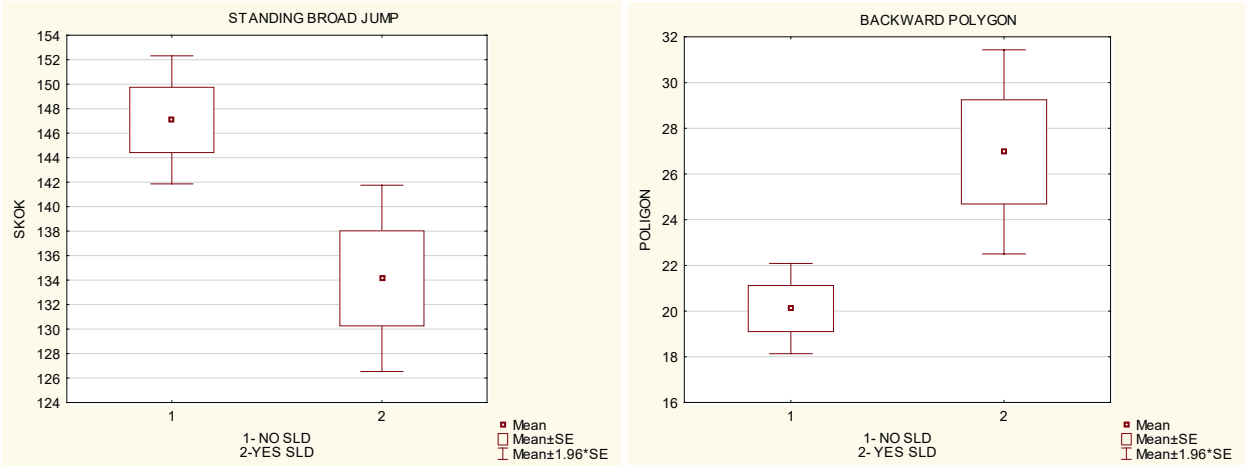
	Mean 1- of students without SLD N=76	Mean 2- of students with SLD N=25	t-value	df	p
Sit and reach test (cm)	60.43	52.59	1.99	101	0,05*
Balance test on one leg (s)	114.51	68.04	2.07	101	0,04*
Plate tapping test (s)	20.36	19.74	0.80	101	0,42
Standing broad jump (cm)	147.09	134.15	2.57	101	0,01*
Backward polygon (s)	20.11	26.97	-3.17	101	0,00*
Transferring the sponge by running from side to side (s)	13.16	13.20	-0.06	101	0,95
Sit ups (min)	33.26	30.56	1.53	101	0,13

Legend: N- number; Mean- arithmetic mean; t-value; df- degrees of freedom; p- level of significance

What is the difference in the results of the variables that proved to be statistically significant, can best be seen in graphs 1, 2, 3 and 4.



Graph 1 and 2. *Presentation of the significance of the differences in the variables Sit and reach test, (flexibility) and Balance test on one leg (balance)*



Graph 3 and 4. *Presentation of the significance of the differences in the variables Standing broad jump (explosive power of jumping) and Backward polygon (coordination)*

DISCUSSION

The values of the arithmetic means of the measured sample indicate that, in comparison with the normative values according to age, students achieve average results in all motor tests (Findak, Metikoš, Mraković, Neljak, 1996; Vidranski, 2020; Tomkinson, et al. 2018). Unfortunately, numerous population studies indicate a decline in motor abilities (Eberhardt, Niessner, Oriwol, Buchal, Worth, & Bös, 2020; Fühner, Kliegl, Arntz, Kriemler, & Granacher, 2021). The vast majority of studies show a steady decline in strength and endurance, and as for agility, speed, balance and coordination, the trend differs between populations (Masanovic et al. 2020). The reasons for the decline of motor abilities can be various, and the most prominent is the modern way of life in which sedentary activities become dominant and physical activity is less and less present. In students with specific learning difficulties, motor changes can occur due to numerous environmental factors that contribute to the delay in the development of the central nervous system and its executive functions, increasing the likelihood of deficiencies in motor development (Coppede, Okuda and Capellini, 2012). Numerous studies indicate that students with specific learning disabilities have less developed motor abilities than their peers (Blanchet & Assaiante, 2022; Okuda, Pinheiro, 2015). And in this research, in all motor tests, students with specific learning difficulties achieve worse results from students with regular development, and in the tests *Sit and reach test, Balance test on one leg, Standing broad jump and Backward polygon*, the differences were statistically significant. Students with specific learning difficulties have less developed flexibility, balance, explosive jumping power and coordination. In the research of Okuda and Pinheiro (2015), the authors observed similar results. In their research, students with specific learning disabilities have significantly less developed fine motor integration, balance, running speed and agility.

Observation of gross motor composites in the study by Hussein, Abdel-Aty, Elmeniawy and Mahgoub (2020) showed that 80% of children with specific learning disabilities are below average in terms of bilateral coordination, 58% below average in terms of balance, 74% below average in running speed and agility, and 68% below average in terms of strength. Some authors indicate that deviations from the average vary with age. For example, a longitudinal study by Westendorp et al. (2011) revealed that children with specific learning disabilities achieved significantly lower results in all motor tests between the ages of 7 and 11, but the difference between the groups changed with age. In that research, a big difference in ball skills between both groups was particularly highlighted, which was more pronounced at the age of 7, and later at the age of 11, the difference between the groups decreased. The authors came to the conclusion that children with specific learning difficulties develop ball skills later in the elementary school period compared to their peers.

Deviations in individual motor abilities are partially differentiated with regard to specific learning difficulties. Students diagnosed with dyslexia most often have less developed coordination, especially of the upper extremities, fine motor skills, strength and agility (Westendorp et al. 2014), as well as static balance (Okuda, Ramos, Santos, Padula, Kirby, Capellini, 2014), while in manipulation objects, especially with a ball, there are almost no deviations (Iversen, Berg, Ellertsen, Tønnessen, 2005). Even in activities that require a fast frequency of movements, despi-

te less developed manual coordination, no significant differences were observed in students with dyslexia (Marchand-Krynski, Morin-Moncet, Bélanger, Beauchamp, Leonard, 2017), which is similar to the results of this study. Students diagnosed with dyscalculia usually have less developed bilateral coordination as well as running speed and agility (Hussein et al. 2020; Smits-Engelsman, Wilson, Westenberg, Duysens, 2003).

As Westendorp et al. (2011) claim, the greater the delay in children's learning, the worse the results of their motor skills, and they emphasize the importance of specific interventions that facilitate both motor and academic abilities. Although there are deviations in the progress of individual motor abilities, students with specific learning difficulties should be encouraged to engage in activities and perform movements correctly. If the child is physically active enough since childhood, this can only have a positive effect on his overall motor development, and on the contrary, if children with learning difficulties distance themselves from such content, it can have an extremely negative effect on them.

CONCLUSON

The research indicates the existence of significant differences in individual motor abilities of students with normal development and students with specific learning difficulties. Students with specific learning disabilities have significantly less developed flexibility, balance, explosive jumping power and coordination. Although students with specific learning difficulties may find it difficult to perform certain complex motor actions, despite the prominent problem, they should be encouraged to engage in such activities. It is necessary to make them aware of how important movement is for their motor development, and how regular physical exercise contributes to the development of their skills and competencies. The results of the conducted research certainly encouraged thinking about how the achievements in certain motor tasks of students with specific learning difficulties should be evaluated, that is, whether the evaluation criteria should be adapted to their abilities. Also, in future assessments of the motor abilities of students with developmental disabilities, it is necessary to include other parameters that can impair motor development, such as the level of physical activity, the prevalence of sedentary activities, and the frequency of participation in organized extracurricular sports activities.

REFERENCES:

Abdulkarim, W. (2018). Autism-Open Access. *Autism*, *8*(2), 1000231.

American Psychiatric Association, A. P., & American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders: DSM-IV* (Vol. 4). Washington, DC: American psychiatric association.

Blanchet, M., & Assaiante, C. (2022). Specific Learning Disorder in Children and Adolescents, a Scoping Review on Motor Impairments and Their Potential Impacts. *Children*, *9*(6), 892.

Bouillet, D. (2010). *Izazovi integriranog odgoja i obrazovanja*. Školska knjiga.

Coppede, A. C., Okuda, P. M. M., & Capellini, S. A. (2012). Performance of children with learning difficulties in fine motor function and handwriting. *Journal of Human Growth and Development*, 297-306.

Eberhardt, T., Niessner, C., Oriwol, D., Buchal, L., Worth, A., & Bös, K. (2020). Secular trends in physical fitness of children and adolescents: a review of large-scale epidemiological studies published after 2006. *International journal of environmental research and public health*, *17*(16), 5671.

Findak, V., Metikoš, D., Mraković, M., & Neljak, B. (1996). Primjenjena kineziologija u školstvu–Norme. *Hrvatski pedagoški-književni zbor. Zagreb. Fakultet za fizičku kulturu Sveučilišta u Zagrebu*.

Fühner, T., Kliegl, R., Arntz, F., Kriemler, S., & Granacher, U. (2021). An update on secular trends in physical fitness of children and adolescents from 1972 to 2015: a systematic review. *Sports Medicine*, *51*, 303-320.

Getchell, N., Pabreja, P., Neeld, K., & Carrio, V. (2007). Comparing children with and without dyslexia on the movement assessment battery for children and the test of gross motor development. *Perceptual and motor skills*, *105*(1), 207-214.

Hussein, Z. A., Abdel-Aty, S. A. R., Elmeniawy, G. H., & Mahgoub, E. A. M. (2020). Defects of motor performance in children with different types of specific learning disability. *Drug Invent. Today*, *14*, 303-307.

Iversen, S., Berg, K., Ellertsen, B., & Tønnessen, F. E. (2005). Motor coordination difficulties in a municipality group and in a clinical sample of poor readers. *Dyslexia*, *11*(3), 217-231.

Kemp, G., Smith, M. i Segal, J. (2017) Learning Disabilities and Disorders. Preuzeto sa: https://www.ctdinstitute.org/sites/default/files/file_attachments/learning-disabilities-and-disorders.pdf

Kiš-Glavaš, L. (2016). Rehabilitacija putem pokreta. *Integrativni pristup poticanju razvoja djece i mladih s teškoćama u razvoju i podizanju kvalitete života osoba s invaliditetom. Sveučilišni udžbenik. Zagreb: Edukacijsko–rehabilitacijski fakultet Sveučilišta u Zagrebu*.

Marchand-Krynski, M. È., Morin-Moncet, O., Bélanger, A. M., Beauchamp, M. H., & Leonard, G. (2017). Shared and differentiated motor skill impairments in children with dyslexia and/or attention deficit disorder: From simple to complex sequential coordination. *PloS one*, *12*(5), e0177490.

Masanovic, B., Gardasevic, J., Marques, A., Peralta, M., Demetriou, Y., Sturm, D. J., & Popovic, S. (2020). Trends in physical fitness among school-aged children and adolescents: a systematic review. *Frontiers in pediatrics*, *8*, 627529.

Minnis, S. (2017). What is Dyspraxia? Preuzeto sa: https://www.medicalnewstoday.com/articles/151951.php

National Center for Learning Disabilities. (2014). The State of Learning Disabilities. Third Edition. https://www.ncld.org/wp-content/uploads/2014/11/2014-State-of-LD.pdf

Okuda, P. M. M., & Pinheiro, F. H. (2015). Motor performance of students with learning difficulties. *Procedia-Social and Behavioral Sciences*, *174*, 1330-1338.

Okuda, P.M.M., Ramos, F.G., Santos, L.C.A., Padula, N., Kirby, A., Capellini, S.A. (2014). Motor profiles of students with dyslexia. *Psychol. Res.*; 4: 31–39. [Google Scholar]

Sekulić, D., Metikoš, D., & Sveučilište, S. (2007). Osnove transformacijskih postupaka u kineziologiji. *Split: Fakultet prirodoslovno–matematičkih znanosti i kineziologije*.

Smits-Engelsman, B. C. M., Wilson, P. H., Westenberg, Y., & Duysens, J. (2003). Fine motor deficiencies in children with developmental coordination disorder and learning disabilities: An underlying open-loop control deficit. *Human movement science*, *22*(4-5), 495-513.

Tomkinson, G. R., Carver, K. D., Atkinson, F., Daniell, N. D., Lewis, L. K., Fitzgerald, J. S., ... & Ortega, F. B. (2018). European normative values for physical fitness in children and adolescents aged 9–17 years: results from 2 779 165 Eurofit performances representing 30 countries. *British journal of sports medicine*, *52*(22), 1445-1456.

Vidranski, T. (2020). Pouzdanost i orijentacijske vrijednosti CROFIT testova u razrednoj nastavi. *Napredak: Časopis za interdisciplinarna istraživanja u odgoju i obrazovanju*, *161*(3-4), 185-202.

Westendorp, M., Hartman, E., Houwen, S., Huijgen, B. C., Smith, J., & Visscher, C. (2014). A longitudinal study on gross motor development in children with learning disorders. *Research in developmental disabilities*, *35*(2), 357-363.

Westendorp, M., Hartman, E., Houwen, S., Smith, J., & Visscher, C. (2011). The relationship between gross motor skills and academic achievement in children with learning disabilities. *Research in developmental disabilities*, *32*(6), 2773-2779.

Primljen: 18. oktobar 2023. / Received: October 18, 2023
Prihvaćen: 03. decembar 2023. / Accepted: December 03, 2023

https://doi.org/10.7251/SSH2302174M
UDC: 613.72/.73-055.2
Original scientific paper
Originalni naučni rad

Quality of Life and Physical Conditioning in Women

Dejan Milenković[1], Ivana Zubić[1], Nataša Nikić[2]
[1]Faculty of Sport, University Union – Nikola Tesla, Belgrade, Serbia
[2]Aerobic studio "NIA", Niš, Serbia

Correspondence:
Dejan Milenković, Faculty of Sport, University Union – Nikola Tesla, Belgrade, Serbia
dejan.milenkovic2309@gmail.com

Abstract: *The aim of this study was to determine the differences in the level of quality of life and physical conditioning between women who are engaged in some form of recreational exercise and women who do not have organized physical exercise. The study involved 60 women of 25 to 45 years old divided into a group engaged in recreational exercise at least a year (30) and a group of non-exercisers (30). A quality of life questionnaire was used to examine the attitudes about the level of quality of life, while a battery of diagnostic tests in the level of physical fitness was assessed. T-test for independent samples was used to compare the two groups. The results showed statistically significant differences in favor of exercisers when it comes to the expression of overall quality of life, as well as the dimensions of mental and physical health and environmental impact. Observing physical performance, women who actively exercise showed a higher degree of physical fitness compared to physically inactive respondents. Therefore, it can be concluded that physical activity has a positive effect on improving quality of life and physical conditioning in women who are engaged in some form of recreational activity.*

Keywords: *physical exercise, mental and physical health, exercisers, non-exercisers.*

INTRODUCTION

Changing the way in thinking about health and health care depends on recognizing the importance of social consequences that can cause diseases, as well as on one's own recognition that health care aims to increase both quantity and quality of survival, so health care is being increasingly focused on "quality of life" (Carr, Higginson & Robinson, 2002). According to the definition of the World Health Organization, quality of life refers to a person's perception of his/her own situation in life through the cultural context and value systems in which he/she lives in relation to life goals, expectations, modalities and interests (WHO).

In the 20th century, the task of health policy was to prolong life expectancy, while in the 21st century it was to improve the quality of life (Ač-Nikolić et al., 2010). In modern life, it is important how a person feels, not how experts (doctors, coaches, etc.) think he/she feels. In the professional literature, it is considered that the quality of life includes one's own assessment of psychological well-being, as well as a wide range of life domains such as physical health and functioning, independence, financial status, efficient use of community social capital (participation in various social activities, recreation, socializing with family and friends), safety of the external environment (Bowling, 2017, 13). Therefore, the quality of life is not only related to the medical aspect of life, but it is observed through social engagement, culture, education, financial status, but also the level of physical activity and mental state of the organism.

Physical activity in modern technologically advanced society has a tendency to decrease. Although there is more free time, due to the life that is facilitated by advanced technology, human movement and physical work are reduced, and sitting is increased. Such a sedentary life has a negative impact on the physical condition of the body because it causes a lower level of muscle strength and cardiovascular endurance (Kudriavtsev et al., 2018), as well as the occurrence of many diseases. Sedentary life negatively affects the occurrence of cardiovascular diseases (Booth et al., 2017) and it may be associated with an increased risk of cancer (Sanchis-Gomar et al., 2015). Physical inactivity primarily contributes to diseases such as obesity and diabetes type 2. Obesity is strongly associated with physical inactivity (Brownson, Boehmer & Luke, 2005; Ekkekakis et al., 2016), because in addition to the consequences, it can also be the cause of physical inactivity due to the influence on the occurrence of the syndrome of impaired dopamine regulation, which in turn contributes to a decrease in physical activity (Ruegsegger& Booth, 2017).The mortality rate from diabetes type 2 can be reduced if the percentage of physically active people increases (Silva et al., 2019), while the occurrence of osteoporosis is the result of bad life habits, including physical inactivity (Bartolozzi, 2015).

In addition to the negative impact on the physical condition of the organism, a sedentary lifestyle also affects mental health. Physical inactivity is significantly associated with a higher level of depression (Bishwajit et al., 2017; Jia et al., 2018). Both physical inactivity and sedentary activity are significantly correlated with symptoms of anxiety (Bélair et al., 2018; Alcántara et al., 2020). People who have elevated levels of tension, anger, rage or who are depressed and anxious use physical activity to solve these psychological problems by increasing muscle work (Schuch et al., 2017; Kandola et al., 2019; Rodriguez-Ayllon et al., 2019).

Physical activity is a key element of overall human health, as it has positive effects on physical health, psychological well-being and quality of life (Bai et al., 2022; Weinberg & Gould, 2019). Thus, the connection between physical activity and psychological well-being was confirmed in a sample of middle-aged people (Granero-Jiménez et al., 2022), as well as in young ones (Pascoe et al., 2020). Samples of older people (65 to 80 years old) also found that moderate physical exercise has positive effects on psychological well-being and quality of life (Shames et al., 2021), as well as on the quality of life and the subjective sense of vitality (Antunes et al., 2022) and on health segment of the quality of life (Chen, Malete & Ling, 2022).

The main intention in this research is to point out the need for regular physical exercise, which, in addition to progress in terms of physical fitness, also contributes to the improvement of mental and physical health. Therefore, the aim of the research is to determine the differences in the level of quality of life and physical conditioning between women who are engaged in some form of recreational exercise and women who do not have organized physical exercise.

MATERIAL AND METHOD

Sample of respondents

The study involved 60 women of 25 to 45 years old divided into a group engaged in recreational exercise (Pilates, step aerobics and tae-bo) for at least a year (n = 30) and a group of non-exercisers (n = 30). Before starting the research, the written consent of all respondents was obtained, as well as the official permission of the aerobics studio „NIA“ in which the research was conducted. The research was approved by the Ethics Committee of the Faculty of Sport, University Union – Nikola Tesla (approval number – 140/22).

Measuring instruments

In this transversal research, a statistical method was used to collect, classify and process data which were then tabulated, interpreted and analyzed. The measurement techniques used in the research are scaling for the purpose of researching attitudes about the level of quality of life and testing through a battery of diagnostic tests that assessed the level of physical abilities.

Quality of Life Questionnaire – shortened and adapted version (WHOQOL-BREF – World Health Organization Quality of Life-Brief). The instrument consists of 26 items to which the respondent responds via a five-point Likert-type self-assessment scale. Based on the items from this version of the questionnaire, data on overall quality of life as well as quality of life in four domains are obtained: physical health (activities, need for drugs and treatment, energy capacity, mobility, pain, sleep quality, health-related work ability); mental health (satisfaction with physical appearance – by herself, negative and positive feelings, self-confidence); social relations (interpersonal relations, social support and sexual activity) and living conditions (financial resources, opportunities for recreation and leisure). 1. Examples of items for the physical health domain: “The extent to which physical pain prevents you from doing what you need to do?”; 2. For mental health domain: “How often do you have negative feelings such as sadness, despair, anxiety, depression?“; 3. Social relations: “What is the level of your satisfaction with the support provided by your friends?”; 4. Living conditions domain: “What is the level of your satisfaction with the conditions you live in?”. The timeline for the questions is “in the last two weeks”. High reliability subscales of the quality of life have been established: physical health α=0,768, mental health α=0,738, social relations α=0,784 and living conditions α=0,780.

Physical fitness. Five tests (Topend Sports) were used in the testing, which have been found to be reliable and valid for the assessment of physical fitness: *Abdominal Endurance – Sit up Test* (Ojeda, Maliqueo, & Barahona-Fuentes, 2020); *Squats Test* (*Blazevich, Gill & Newton, 2002;* Yeh et al., 2018); *Isometric Back Strength Test* (Yang et al., 2020); *Push up Test* (Baumgartner et al, 2002); *2-Minute Step in Place Test* (Haas et al., 2017; Nogueira et al., 2021).

Exercise programs

All exercise programs are realized in the aerobics studio "NIA" in Niš, three times a week (Tuesdays, Thursdays and Saturdays beginning at 6 pm) lasting an hour. Trainings have a three-part structure: introductory (5–10 min), main (45 min) and final part (5–10 min).

Pilates – pilates training consists of low-intensity exercises, which include the muscles of the whole body whose main goal is to stabilize the body and strengthen its central part (core). The trainings were accompanied by music with a tempo of 60 to 80 beats per minute. The introductory part of the training consists of mobility exercises and warm-up exercises – number of repetitions is 6–10 times). In the main part of the training, exercises aimed at strengthening and shaping certain muscle regions are performed (arm muscles, gluteal region, lower extremity muscles, abdominal muscles and back muscles (number of repetitions is 10–12 times). In the final part of the training, stretching exercises of large muscle groups and especially those muscles that were engaged in the main part of the training are applied.

Step aerobic – The introductory part of the training is characterized by the preparation of those muscle groups that will be engaged in the main part of the training with the use of simpler coordination exercises and small range of motion, with a moderate pace (120–134 bpm), which is also preparing the body for more intense exercise. The main part of the training consists of the aerobic part (122–140 bpm) and the part for strength exercises. More complex choreographies with basic steps, lifting steps, outbursts and touch steps are used. The aerobic part is followed by strength exercises on the ground (115–125 bpm). This part of the training includes exercises for the muscles not sufficiently engaged during the aerobic part (for strengthening muscles of the arms and shoulder girdle, gluteal region, abdominal and back muscles. The aim is to increase muscle endurance, repetitive strength and flexibility. The final part of training is characterized by calming down the body by stretching exercises of those muscle groups that were most engaged in the main part, with the music of a slower tempo (50–90 bpm).

Tae-bo – in the introductory part (100–120 bpm), warming up is performed and the organism is prepared for the stresses to follow with simple choreographies composed of the basic steps of walking and running in place and in movement. The main part contains the aerobic part (movements, blocks and sequences of movements aimed at the development of the cardiovascular and respiratory system) and the part with shaping exercises (exercises for shaping and strengthening the body). The tempo of the music is from 100 to 120 bpm. During the realization of this part of the training, the load on the cardio-respiratory system is low. Exercises are used to strengthen the muscles of the arms and shoulder girdle, abdominal wall, back, gluteal region and legs. The final part includes stretching and relaxation exercises with the aim of calming down the body (40–60 bpm). Static stretching exercises are realized. Each exercise is performed in plank for 20 seconds.

Statistical analysis

Among the descriptive parameters in the analysis, the arithmetic mean from the measures of central tendencies and the standard deviation from the measures of dispersion were used. In order to obtain possible differences, the T-test for independent samples was used. The level of significance is $p<0.05$.

RESULTS

Table 1. *Comparison of female exercisers and non-exercisers in quality of life (separate dimensions and overall) and in physical fitness parameters*

		Mean	SD	P
Physical health	exercisers	29.80	2.91	.009*
	non-exercisers	27.47	3.71	
Mental health	exercisers	24.20	2.72	.011*
	non-exercisers	22.33	3.53	
Social relations	exercisers	11.47	1.66	.514
	non-exercisers	11.80	2.24	
Living conditions	exercisers	28.83	4.09	.004*
	non-exercisers	25.57	4.31	

Overall quality of life	exercisers	93.47	8.45	.018*
	non-exercisers	87.17	11.33	
Sit up Test	exercisers	18.75	2.77	.000*
	non-exercisers	13.96	1.79	
Squats Test	exercisers	32.28	2.21	.000*
	non-exercisers	25.93	2.55	
Isometric Back Strength Test	exercisers	98.55	4.90	.000*
	non-exercisers	79.90	6.89	
Push up Test	exercisers	26.55	5.08	.000*
	non-exercisers	17.20	3.10	
2-Minute Step in Place Test	exercisers	107.62	7.84	.000*
	non-exercisers	99.83	8.12	

The results in Table 1 show statistically significant differences between exercisers and non-exercisers when it comes to the accentuation of overall quality of life, as well as the dimensions of mental and physical health and the impact of environment. Namely, female exercisers report a higher level of quality of life than female non-exercisers. Thus, they have a higher overall quality of life, as well as a quality of life related to physical and mental health and the impact of environment compared to female non-exercisers.

Observing the results in the parameters of physical fitness it can be seen that statistically significant differences were found between the group of female exercisers and non-exercisers. Namely, the exercisers have a higher level of physical fitness in all applied tests, which is not surprising given the time period of at least a year that all respondents from the group of physically active women spent in the training process.

DISCUSSION

This research showed that there are statistically significant differences between female exercisers and non-exercisers when it comes to the accentuation of overall quality of life, as well as the dimensions of mental and physical health and environmental impact. Female exercisers have a higher overall quality of life, as well as a quality of life related to mental and physical health and environmental impact compared to female non-exercisers. Besides, observing physical performance, women who actively exercise showed a higher degree of physical fitness compared to physically inactive respondents.

The results of this study confirm the allegations of previous research on this topic. It is considered that there is a positive correlation between the level of physical activity and the quality of life (Prasad, Fredrick & Aruna, 2021), because the highest indicators of quality of life in general, as well as in the physical, mental and social aspects, are showed by the people with high level physical activity intensity (Puciato, Borysiuk & Rozpara, 2017). If a gender analysis is performed, there are no differences in the self-perception of quality of life between men and women, but in both sexes the quality of life is clearly related to physical activity. The domain of physical activity shows the strongest connection with physical inactivity (Porto et al., 2012).

Researches to date suggest that increasing levels of physical activity may contribute to improving the quality of life of older adults (Antunes et al., 2022, Shames et al., 2021). People of both sexes who are more physically active have a higher level of sensory abilities, greater autonomy and independence, with a generally higher overall quality of life, regardless of age, marital status, level of education and socio-economic status. Primarily for women, the indicators of the quality of social life are significantly higher for active and very active subjects compared to sedentary subjects (Guedes et al., 2012). It is also important to include mechanisms of social support for people in order to access various physical exercise programs and in general to create an environment for adults, especially older people, to be as physically as active as possible in order to improve their quality of life (Kang, Park & Wallace, 2018). Physical activity should become a part of everyday life as early as possible, because it is a pledge for psycho-physical health in later years of their lives. So, researches have shown that people who exercised in middle age and continued with these activities during their later life, have a significantly higher level of quality of life associated with health in their old age (Lee et al., 2022).

In women who regularly exercise recreationally, life satisfaction, respect for other people, perception of their own physical appearance, functionality and health status, as well as overall physical self-perception can be improved (Cruz-Ferreira et al., 2011). Ebrahimi, Ghandehari & Veisi (2020) examined the effect of physical exercise organized in the form of sports activities within intergenerational programs (mixed groups of older adults and students) on the quality of life of older people. After 8 weeks, the quality of life of the elderly has significantly increased compared to their results before the test, which indicates the beneficial effects of physical activity, especially when it is supported by the environment of different generations.

The quality of life and high level of mental and physical health depends on physical activity in middle-aged people, as well as in young ones, adolescents and children. It is suggested that physical activity through organized training programs is a promising strategy in terms of promoting mental health in young people (Pascoe et al., 2020). In the last decade great attention has been paid to researches conducted in childhood and monitoring low levels of physical activity, sedentary behavior and mental health problems. It is believed that physical activities in school conditions can reduce anxiety, increase the body's overall resilience, positively affect mental health and thus improve the quality of life in children and adolescents (Andermo et al., 2020). It is also of the utmost importance that middle-aged people, especially women and those with signs of depression and excessive stress, are motivated to adopt more rigorous physically active lifestyle; it has been found that even in this age period physical activity is positively associated with the quality of life (Tement & Selič-Zupančič, 2021).

CONCLUSION

With increasing understanding of the impact of various lifestyle factors, such as sedentary behavior and the level of physical activity on physical and mental health, there is a growing evidence of how physical inactivity correlates with various mental and physical health problems. Quality of life is an important indicator in health assessment, and its improvement contributes to the preservation and improvement of people's physical and mental health. Loss of physical function during the aging process can affect the quality of life. In that sense, physical activity can be an effective means of preventing and treating many psychosomatic disorders that come with aging. So programs that are launched in order to improve the quality of life should inevitably include the domain of physical activity.

The results of this research are based on the studies that have been conducted so far and support the allegations that physical activity contributes to the improvement of both physical and mental health, and thus the overall quality of life. The findings of this and similar studies can help to raise awareness of the need for physical activity, as well as create even more effective health care programs by intensifying physical activity, which leads to improved quality of life, especially for older generations.

Due to the relatively small sample of respondents, which in the case of a group of exercisers was drawn from only one aerobic studio, it can be said that the research has certain limitations. Catching a wider population of women who are regularly exercising and those who are not, would certainly allow a much more reliable analysis of the relationship between the observed phenomena in the form of physical activity, mental and physical health and thus quality of life. Also, a number of parameters that examine the level of physical fitness can be taken into account. However, the research provides information that may indicate the importance of recreational physical activity in women.

REFERENCES

Ač-Nikolić, E., Čanković, S., Draganić, N. & Radić, I. (2010). Ispitivanje validnosti i pouzdanosti WHOQOL-BREF upitnika za populaciju starih u Vojvodini (Validation and reliability testing of WHOQOL-BREF questionnaire for the elderly population in Vojvodina). *Zbornik Matice srpske za društvene nauke*, 131, 211–220. https://www.ceeol.com/search/article-detail?id=600399. [in Serbian]

Alcántara, C., Qian, M., Meli, L., Ensari, I., Ye, S., Davidson, K. W. & Diaz, K. M. (2020). Anxiety sensitivity and physical inactivity in a national sample of adults with a history of myocardial infarction. *International Journal of Behavioral Medicine*, *27*(5), 520–526. https://doi.org/10.1007/s12529-020-09881-w.

Andermo, S., Hallgren, M., Nguyen, T.T.D., Jonsson, S., Petersen, S., Friberg, M., Romqvist, A., Stubbs, B. & Elinder, L.S. (2020). School-related physical activity interventions and mental health among children: a systematic review and meta-analysis. *Sports Medicine – Open*, *6*, 25. https://doi.org/10.1186/s40798-020-00254-x.

Antunes, R., Fonseca, E., Oliveira, D., Matos, R., Amaro, N., Morouco, P., Coelho, L. & Rebelo-Goncalves, R. (2022). Quality of life, vitality and handgrip strength in elderly practitioners of physical exercise. *Cuadernos de Psicologíadel Deporte*, *22*(1), 245–255. https://doi.org/10.6018/cpd.467011.

Bai Y, Hua B., Zhang F., Zhou W. & Deng B. (2022). Effect of different intensity **exercises** intervention on cardiovascular functions and quality of life on patients with chronic heart failure: A protocol for systematic review and meta-analysis. *Medicine*, *14*(101), e28554. https://

doi.org/10.1097/md.0000000000028554.

Bartolozzi, E. (2015). The natural approach to osteoporosis. *Clinical Cases in Mineral and Bone Metabolism*, *12*(2), 111. https://doi.org/10.11138/ccmbm/2015.12.2.111.

Baumgartner, T.A., Oh, S., Chung, H. & Hales, D. (2002). Objectivity, Reliability, and Validity for a Revised Push-Up Test Protocol. *Measurement in Physical Education and Exercise Science*, *6*(4), 225–242. https://doi.org/10.1207/S15327841MPEE0604_2.

Bélair, M.A., Kohen, D.E., Kingsbury, M. & Colman, I. (2018). Relationship between leisure time physical activity, sedentary behaviour and symptoms of depression and anxiety: evidence from a population-based sample of Canadian adolescents. *BMJ Open*, *8*(10), e021119. http://dx.doi.org/10.1136/bmjopen-2017-021119.

Bishwajit, G., O'Leary, D.P., Ghosh, S., Yaya, S., Shangfeng, T. & Feng,Z. (2017). Physical inactivity and self-reported depression among middle- and older-aged population in South Asia: World health survey. *BMC Geriatrics*, *17*(1), 1–8. https://doi.org/10.1186/s12877-017-0489-1.

Blazevich, A.J., Gill, N. & Newton, R.U. (2002). Reliability and validity of two isometric squattests. Journal of Strength & Conditioning Research, 16(2), 298–304. https://journals.lww.com/nsca-jscr/Abstract/2002/05000/Reliability_and_Validity_of_Two_Isometric_Squat.20.aspx.

Booth, F.W., Roberts, C.K., Thyfault, J.P., Ruegsegger, G.N. & Toedebusch, R.G. (2017). Role of inactivity in chronic diseases: evolutionary insight and pathophysiological mechanisms. *Physiological Reviews*, *97*(4), 1351–1402. https://doi.org/10.1152/physrev.00019.2016.

Bowling, A. (2017). *Measuring Health: A Review of Subjective Health, Well-Beeing and Quality of Life Measurement Scales, 4th edition*. London: Open University Press.

Brownson, R.C., Boehmer, T.K. & Luke, D.A. (2005). Declining rates of physical activity in the United States: what are the contributors? *Annual Reviews of Public Health*, *26*, 421–443. https://doi.org/10.1146/annurev.publhealth.26.021304.144437.

Carr, A., Higginson, I. & Robinson, P. (2002). *Quality of Life*. Wiley.

Chen, S., Malete, L. & Ling, J. (2022). An examination of physical activity guidelines and health-related **quality** of **life** among U.S. older adults. *Preventive Medicine*, *156*, 106986. https://doi.org/10.1016/j.ypmed.2022.106986.

Cruz-Ferreira, A., Fernandes, J., Gomes, D., Bernardo, L. M., Kirkcaldy, B. D., Barbosa, T. M., & Silva, A. (2011). Effects of Pilates-based exercise on life satisfaction, physical self-concept and health status in adult women. *Women & Health*, *51*(3), 240–255. https://doi.org/10.1080/03630242.2011.563417.

Ebrahimi, Z., Ghandehari, M.R.E. &Veisi, K. (2020). The Effect of Physical Activity Based on Intergenerational Programs on the Quality of Life of Older Adults. *Iranian Journal of Ageing*, *14*(4), 406–421. http://salmandj.uswr.ac.ir/article-1-1499-en.html.

Ekkekakis, P., Vazou, S., Bixby, W.R. & Georgiadis, E. (2016). The mysterious case of the public health guideline that is (almost) entirely ignored: call for a research agenda on the causes of the extreme avoidance of physical activity in obesity. *Obesity Reviews*, *17*(4), 313–329. https://doi.org/10.1111/obr.12369.

Granero-Jiménez, J., López-Rodrigez, M., Dobarrio-Sanz, I. & Cortés-Roddriguez, A, (2022). Influence of Physical **Exercise** on Psychological Well-Being of Young Adults: A Quantitative Study. *International Journal of Environmental Research and Public Health*, *19*(7), 4282. https://doi.org/10.3390/ijerph19074282.

Guedes, D.P., Hatmann, A.C., Martini, F.A.N., Borges, M.B. & Bernardelli, R. (2012). Quality of Life and Physical Activity in a Sample of Brazilian Older Adults. *Journal of Aging and Health*, *24*(2), 212–226. https://doi.org/10.1177/0898264311410693.

Haas, F., Sweeney, G., Pierre, A., Plusch, T. & Whiteson J. (2017). Validation of a 2 Minute Step Test for Assessing Functional Improvement. *Journal of Therapy and Rehabilitation*, *5*(2), 71–81. https://doi.org/10.4236/ojtr.2017.52007.

Jia, H., Zack, M.M., Gottesman, I.I. & Thompson, W.W. (2018). Associations of smoking, physical inactivity, heavy drinking, and obesity with quality-adjusted life expectancy among US adults with depression. *Value in Health*, *21*(3), 364–371. https://doi.org/10.1016/j.jval.2017.08.002.

Kandola, A., Ashdown-Franks, G., Hendrikse, J., Sabiston, C.M. & Stubbs, B. (2019). Physical activity and depression: Towards understanding the antidepressant mechanisms of physical activity. *Neuroscience & Biobehavioral Reviews*, *107*, 525–539. https://doi.org/10.1016/j.neubiorev.2019.09.040.

Kang, H-W., Park, M. & Wallace, J.P. (2018). The impact of perceived social support, loneliness, and physical activity on quality of life in South Korean older adults. *Journal of Sport and Health Science*, *7*(2), 237–244. https://doi.org/10.1016/j.jshs.2016.05.003.

Kudryavtsev, M., Osipov, A., Kokova, E., Kopylov, Y., Iermakov, S., Zhavner, T., Vapaeva, A., Alexandrov, Y., Konoshenko, L. & Görner, K. (2018). The possibility of increasing cadets' physical fitness level of the educational organizations of the Ministry of Internal Affairs of Russia with the help of optimal training effects via crossfit. *Journal of Physical Education and Sport*, *18*(Suppl. 5), 2022–2028. https://doi.org/10.7752/jpes.2018.s5300.

Lee, M., Lee, H., Song, K.J., & Lee, Y.M. (2022). Benefits of Sustained Physical Activity From Middle-Age To Early Old Age On Quality Of Life In Early Old Age. *Research Square*. https://doi.org/10.21203/rs.3.rs-1219812/v1.

Nogueira, M.A., Almeida, T.D.N., Andrade, G.S., Ribeiro, A.S., Rêgo, A.S., da Silva Dias, R., Ferreira, P.D., Penha, L.R.L.N., de Oliveira Pires, F., Dibai-Filho, A.V. & Bassi-Dibai, D. (2021). Reliability and accuracy of 2-minute step test in active and sedentary lean adults. *Journal of Manipulative and Physiological Therapeutics*, *44*(2), 120–127. https://doi.org/10.1016/j.jmpt.2020.07.013.

Ojeda, A.H., Maliqueo, S.G. & Barahona-Fuentes, G. (2020). Validity and reliability of the Muscular Fitness Test to evaluate body strength-resistance. *Apunts Sports Medicine*, *55*(208), 128–136. https://doi.org/10.1016/j.apunsm.2020.08.002.

Pascoe, M., Bailey, A. P., Craike, M., Carter, T., Patten, R., Stepto, N. & Parker, A. (2020). Physical activity and exercise in youth mental health promotion: A scoping review. *BMJ Open Sport & Exercise Medicine*, *6*(1), e000677. http://dx.doi.org/10.1136/bmjsem-2019-000677.

Porto, D.B., Guedes, D.P., Fernandes, R.A. & Reichert, F.F. (2012). Perceived quality of life and physical activity in Brazilian older adults. *Motricidade*, *8*(1), 33–41. https://doi.org/10.6063/motricidade.8(1).237.

Prasad, L., Fredrick, J. & Aruna, R. (2021). The relationship between physical performance and quality of life and the level of physical activity among the elderly. *Journal of Education and Health Promotion*, *10*, 68. https://doi.org/10.4103/jehp.jehp_421_20.

Puciato, D., Borysiuk, Z. & Rozpara, M. (2017). Quality of life and physical activity in an older working-age population. *Clinical Interventions*

in Aging, *12*, 1627–1634. https://doi.org/10.2147/cia.s144045.

Rodriguez-Ayllon, M., Cadenas-Sánchez, C., Estévez-López, F., Muñoz, N. E., Mora-Gonzalez, J., Migueles, J. H., ... & Esteban-Cornejo, I. (2019). Role of physical activity and sedentary behavior in the mental health of preschoolers, children and adolescents: a systematic review and meta-analysis. *Sports Medicine*, *49*(9), 1383–1410. https://doi.org/10.1007/s40279-019-01099-5.

Ruegsegger, G.N. & Booth, F.W. (2017). Running from disease: molecular mechanisms associating dopamine and leptin signaling in the brain with physical inactivity, obesity, and type 2 diabetes. *Frontiers in Endocrinology*, *8*, 109. https://doi.org/10.3389/fendo.2017.00109.

Sanchis-Gomar, F., Lucia, A., Yvert, T., Ruiz-Casado, A., Pareja-Galeano, H., Santos-Lozano, A., Fuiza-Luces, C., Garatachea, N., Lippi, G., Bouchard, C. & Berger, N. A. (2015). Physical inactivity and low fitness deserve more attention to alter cancer risk and prognosis. *Cancer Prevention Research*, *8*(2), 105–110. https://doi.org/10.1158/1940-6207.CAPR-14-0320.

Schuch, F., Vancampfort, D., Firth, J., Rosenbaum, S., Ward, P., Reichert, T., Bagatini, N.C., Bgeginski, R. & Stubbs, B. (2017). Physical activity and sedentary behavior in people with major depressive disorder: a systematic review and meta-analysis. *Journal of Affective Disorders*, *210*, 139–150. https://doi.org/10.1016/j.jad.2016.10.050.

Shames, A., Nobari, H., Afonso, J., Abbasi, H., Mainer-Pardos, E., Perez-Gomez, J., Bayati, M., Babrami, A. & Carneiro, L. (2021). Effect of Aerobic-Based Exercise on Psychological Well-Being and Quality of Life Among Older People: A Middle East Study. *Frontiers in Public Health*, 9, 764044. https://doi.org/10.3389/fpubh.2021.764044.

Silva, D.A.S., Naghavi, M., Duncan, B.B., Schmidt, M.I., de Souza, M.D.F.M. & Malta, D.C. (2019). Physical inactivity as risk factor for mortality by diabetes mellitus in Brazil in 1990, 2006, and 2016. *Diabetology& Metabolic Syndrome*, *11*(1), 1–11. https://doi.org/10.1186/s13098-019-0419-9.

Tement, M. & Selič-Zupančič, P. (2021). Quality of life and health status in middle-aged presumed healthy Slovenian family practice attendees. *Slovenian Journal of Public Health*, *60*(3), 182–189. https://doi.org/10.2478/sjph-2021-0026.

Weinberg, R.S. & Gould, D. (2019). *Foundations of sport and exercise psychology (7th ed.). Human Kinetics.*

Yang, S., Wu, W., Zhang, C., Wang, D., Chen, C., Tang, Y., Li, K., Xu, J. & Luo, F. (2020). Reliability and validity of three isometric back extensor strength assessments with different test postures. *Journal of International Medical Research*, *48*(2), 1–12. https://doi.org/10.1177/0300060519885268.

Yeh, C-P., Huang, H-C., Chang, Y., Chen, M-D. & Hsu, M. (2018). The Reliability and Validity of a Modified Squat Test to Predict Cardiopulmonary Fitness in Healthy Older Men. *BioMed Research International*, Article ID 4863454. https://doi.org/10.1155/2018/4863454.

Primljen: 06.maj 2023. / Received: May 05, 2023
Prihvaćen: 18. jul 2023. / Accepted: July 18, 2023

https://doi.org/10.7251/SSH2302181S
UDC: 796.015.132:613.24-053.6
Original scientific paper
Originalni naučni rad

Relationship between physical fitness and lifestyle of early school-aged boys and girls

Zorica Stankovska[1], Valon Nikqi[2], Serjoza Gontarev[3], Zharko Kostovski[3]
[1]*University Ss. Cyril and Methodius, Faculty of Pedagogy, St. Kliment Ohridski, Skopje, North Macedonia*
[2]*Faculty of Sports Sciences, University of Prishtina*
[3]*Ss. Cyril and Methodius University, Faculty of Physical Education, Sports and Health, Skopje, North Macedonia*

Correspondence:
Valon Nikqi, Faculty of Sports Sciences, University of Prishtina, Prishtina
valon.nikqi@gmail.com

Abstract: *Monitoring physical fitness is a strong indicator of health status in childhood, adolescence, and adulthood. School provides an ideal environment to assess and monitor the level of physical fitness in children. The research aims to determine the correlation between the physical fitness of early school-aged children (6 to 10 years old) and their lifestyle, particularly the time spent in physical activity. The study was conducted on a sample of 940 participants aged 6 to 10, randomly selected from several primary schools in the Skopje region. The sample was divided into two subgroups by gender, consisting of 466 male participants and 474 female participants. Differences between groups were determined through one-factor multivariate and univariate analysis of covariance (MANCOVA and ANCOVA) with age partialization. The results of this research show a correlation among male participants who engaged in more than 60 minutes of daily physical activity and tests assessing physical fitness (motor skills). For girls, self-reported physical activity was only associated with results on the 20-meter progressive shuttle run test.*
Keywords: *children; physical fitness; lifestyle; physical activity.*

INTRODUCTION

Monitoring physical fitness is a powerful predictor of health status in childhood, adolescence, and adulthood (Guedes et al., 2012; Blair et al., 2001; Williams, 2001; Myers et al., 2004; Warburton et al., 2005; Ortega et al., 2008). Physical fitness relates to academic performance, including cognitive skills and attitudes (attention, memory, understanding), academic behavior (organization, attendance, impulse control), and achievements (better test scores, higher average grades) (Kohl et al., 2013; Grissom, 2005; Welk et al., 2010; Rasberry et al., 2011). School serves as an ideal environment to assess and track children's physical fitness levels (Welk et al., 2010; Condello et al., 2016), enabling the identification of potential low levels and the creation of appropriate interventions to improve it. Additionally, it is important to identify factors that may influence physical fitness levels in childhood or adolescence and study them concurrently (Ortega et al., 2008). Although analyzing risk factors poses a new challenge in various research fields, including health promotion, sociodemographics, kinesiology, and behavioral sciences (Guedes et al., 2012; Condello et al., 2016), few studies have investigated the correlation between physical fitness and risk factors (Grao-Cruces et al., 2014; Castro-Piñero et al., 2012). Information on children's physical fitness from different geographic regions and cultures is crucial for promoting and creating public health strategies aimed at preventing adult disorders.

MATERIAL AND METHODS

Study Participants

This research involved a sample of 940 participants from various primary schools. The sample was further divided by gender, consisting of 466 male and 474 female participants. All students regularly attending physical and health education classes and who were physically and mentally healthy were included in the measurement.

Anthropometric Measures

Measurements were taken in standard school conditions during regular physical and health education classes. Experts in kinesiology, previously trained in specific motor tests, conducted the measurements. The intended tests were conducted following the methodology recommended by the Council of Europe (the EUROFIT test battery). Some tests

were modified and adapted within international scientific projects such as "Nutrition and Assessment of the Nutritional Status of Spanish Adolescents" (AVENA Study), "Healthy Lifestyle in Europe by Nutrition in Adolescence" (HELENA Study) (Ruiz et al., 2006), "Assessment of Fitness in Children and Adolescents" (ALPHA project), and "Identification and Prevention of Health Effects Caused by Nutrition and Lifestyle in Children and Infants" (IDEFICS study).

Variable Sample

The study used 7 criterion variables (fitness tests) and 3 predictor variables. Criterion variables for flexibility, musculoskeletal fitness, motor fitness, and cardiorespiratory fitness included: sit-and-reach (FLE), handgrip dynamometry (HG), standing long jump (SKOK), sit-up for 30 seconds (SIT30), 4 x 10 meters shuttle run test (4X10M), 20-meter shuttle run test with progressive speed increase (Stg), and 20-meter progressive shuttle run test (VO2 max). **Predictor variables**: Time spent in daily physical activity up to 60 minutes, time spent in daily physical activity between 60 and 120 minutes, and time spent in daily physical activity exceeding 120 minutes.

Methodology

For all variables, basic statistical parameters were calculated: mean (X) and standard deviation (SD). Differences between groups were determined through one-factor multivariate and univariate analysis of covariance (MANCOVA and ANCOVA) with age partialization (age was treated as a fixed covariate).

RESULTS

From the obtained results represented in Table 1, with Wilks' Lambda at 0.94 and Rao's F approximation at 2.16 and a statistical significance level of Sig. .008 among younger school-aged boys (Table 1), significant statistical differences in motor status were found between formed groups regarding time spent in physical activity.

In the univariate analysis of covariance, statistically significant differences were found in five variables: handgrip dynamometry (HG) at p = .031, standing long jump (SKOK) at p = .002, 20m shuttle run with progressive speed increase (covered segments) (StG) at p = .001, 20-meter progressive shuttle run test (VO2 max) at p = .000, and sit-up for 30 seconds (SIT30) at p =.012. The partial effect of determinants ranked between 0.01 and 0.03, indicating a small influencing effect.

From the obtained results shown in Table 2, it can be observed that from the analysis of multivariate analysis of covariance and Rao's F-approximation, which is 1.15, and the level of statistical significance Sig, 312, it is evident that there are no statistically significant differences between the groups.

Out of a total of seven analyzed univariate motor tests, significant statistical differences were found in only one test among the analyzed groups of female participants formed based on the time spent in physical activity. Statistically significant differences were found only in the 20-meter progressive shuttle run test (Stg) with a significance level of p= .013.

Table 1. *Differences in motor status between groups of male participants formed based on the time spent in physical activity*

	Value	F	Hypothesis df	Error df	Sig.	n^2
Wilks' lambda	0,94	2,16	14	908	,008	,032

Table 2. *Differences in motor status between groups of female participants formed based on the time spent in physical activity*

	<60 мин		60-120 мин		>120		F	P	n^2	Post hoc pairwaise comparisons		
	Mean	SD	Mean	SD	Mean	SD				1-2	1-3	2-3
FLE	13,74	6,78	15,01	6,06	15,04	6,49	2,58	,077	0,01	ns	ns	ns
HG	13,30	3,43	14,38	4,93	14,17	4,00	3,52	,031	0,02	>	>	ns
SKOK	111,08	23,21	118,25	24,20	121,02	24,73	6,45	,002	0,03	>	>	ns
SIT30	12,75	5,19	13,99	5,49	14,71	5,04	4,45	,012	0,02	>	>	ns
4X10M	14,88	2,02	14,42	2,09	14,74	2,41	2,37	,095	0,01	ns	ns	ns
Stg	3,47	1,45	4,03	1,60	4,04	1,71	7,31	,001	0,03	>	>	ns
VO2max	48,20	3,76	49,38	3,40	49,68	3,50	8,09	,000	0,03	>	>	ns

	Value	F	Hypothesis df	Error df	Sig.	n^2
Wilks' lambda	0,97	1,15	14	916	,312	,017

	<60 мин		60-120мин		>120		F	P	n^2	Post hoc pairwaise comparisons		
	Mean	SD	Mean	SD	Mean	SD				1-2	1-3	2-3
FLE	17,79	6,42	16,95	6,48	17,26	7,45	0,96	,384	0,00	ns	ns	ns
HG	12,71	4,75	12,57	4,26	13,28	3,80	0,51	,601	0,00	ns	ns	ns
SKOK	104,11	22,10	104,00	22,09	109,90	19,98	1,66	,192	0,01	ns	ns	ns
SIT30	12,29	4,85	11,60	5,18	12,22	5,29	0,79	,456	0,00	ns	ns	ns
4X10M	15,41	2,19	15,68	1,91	15,20	1,83	1,32	,268	0,01	ns	ns	ns
Stg	3,19	1,14	2,97	1,06	3,46	1,28	4,40	**,013**	0,02	ns	ns	>
VO2max	47,38	3,44	47,27	2,68	48,13	2,89	2,22	,110	0,01	ns	ns	ns

DISCUSSION

Physical activity is crucial for improving children's health (Rizzo et al., 2007). It reduces the risk of cardiovascular and metabolic diseases, body fat, anxiety, and depression symptoms while enhancing bone health and cardiorespiratory and muscular fitness in children (Huang & Malina, 2002).

Previous cross-sectional studies have shown a positive association between physical activity and physical fitness in children, with greater self-reported physical activity linked to better motor fitness (Dencker et al., 2006). This research indicates that boys engaged in over 60 minutes of daily physical activity show better results in handgrip dynamometry, standing long jump, 30-second sit-ups, and the 20-meter shuttle run test (number of sections and VO2) compared to their peers engaging in less than 60 minutes. However, there was no significant difference between boys participating in 60-120 minutes and over 120 minutes of daily physical activity, suggesting that 60-120 minutes of daily physical activity is sufficient to maintain physical fitness in boys of early school age.

For girls, self-reported physical activity was only associated with the 20-meter step-up test (number of segments). Differences were found among girls engaging in over two hours of daily physical activity. This aligns with the 2008 American and European physical activity guidelines, stating that all children and adolescents should engage in at least 60 minutes of moderate to vigorous physical activity daily (Herrmann et al., 2015). Hence, schools should enhance children's (especially girls') physical activity through suitable sports and games programs, while educational institutions should reinforce supervision to ensure daily physical activity during early school years.

The difference between 60-120 and over 120 minutes of daily physical activity in boys suggests that the threshold for adequate daily physical activity for early school-aged boys for full benefit should be at least 60 minutes but not more than 120 minutes. Extended periods (>120 minutes) won't provide additional benefits for improving muscular and cardiorespiratory fitness. Conversely, for girls, increasing activity intensity might lead to positive changes in physical fitness components and engagement in organized physical activities. This aligns with some studies showing weak or insignificant correlations between physical activity and physical fitness since daily physical activity explains a small portion of aerobic activity, which could independently determine fitness (Morrow et al., 2009; Dencker et al., 2006; Martinez Vizcaino et al., 2008). Conversely, other studies indicate a strong association between physical activity frequency and physical fitness (Hogstrom et al., 2014; Kaminsky et al., 2013). Furthermore, some studies advocate considering physical activity alongside proper nutrition since interventions considering both determinants significantly increase students' fitness levels (Eather et al., 2013; Kriemler et al., 2010; Langford et al., 2015).

CONCLUSION

Boys engaged in over 60 minutes of daily physical activity show better results in handgrip dynamometry, standing long jump, 30-second sit-ups, and the 20-meter shuttle run test (number of segments and VO2 max) compared to peers engaging in less than 60 minutes. For girls, self-reported physical activity was only associated with results in the 20-meter shuttle run test (number of segments).

REFERENCES

Blair, S., Cheng, Y., & Holder, J. S. (2001). Is physical activity or physical fitness more important in defining health benefits? *Medicine and science in sports and exercise*, *33*(6).

Castro-Piñero, J., Padilla-Moledo, C., Ortega, F. B., Moliner-Urdiales, D., Keating, X., & Ruiz, J. R. (2012). Cardiorespiratory fitness and fatness are associated with health complaints and health risk behaviors in youth. *Journal of Physical Activity and Health*, *9*(5), 642-649.

Condello, G., Ling, F. C. M., Bianco, A., Chastin, S., Cardon, G., Ciarapica, D., ... & Gjaka, M. (2016). Using concept mapping in the development of the EU-PAD framework (EUropean-Physical Activity Determinants across the life course): a DEDIPAC-study. *BMC public health*, *16*(1), 1145.

Dencker, M., Thorsson, O., Karlsson, M. K., Lindén, C., Svensson, J., Wollmer, P., & Andersen, L. B. (2006). Daily physical activity and its relation to aerobic fitness in children aged 8–11 years. *European journal of applied physiology*, *96*(5), 587-592.

Eather, N., Morgan, P. J., & Lubans, D. R. (2013). Improving the fitness and physical activity levels of primary school children: Results of the Fit-4-Fun group randomized controlled trial. *Preventive medicine*, *56*(1), 12-19.

Grao-Cruces, A., Fernández-Martínez, A., & Nuviala, A. (2014). Association of fitness with life satisfaction, health risk behaviors, and adherence to the Mediterranean diet in Spanish adolescents. *The Journal of Strength & Conditioning Research*, *28*(8), 2164-2172.

Grissom, J. B. (2005). Physical fitness and academic achievement. *Journal of Exercise Physiology Online*, *8*(1).

Guedes, D. P., Neto, J. M., Lopes, V. P., & Silva, A. J. (2012). Health-related physical fitness is associated with selected sociodemographic and behavioral factors in Brazilian school children. *Journal of Physical Activity and Health*, *9*(4), 473-480.

Herrmann, D., Buck, C., Sioen, I., Kouride, Y., Marild, S., Molnár, D., ... & Ahrens, W. (2015). Impact of physical activity, sedentary behaviour and muscle strength on bone stiffness in 2–10-year-old children-cross-sectional results from the IDEFICS study. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 1-12.

Högström, G., Nordström, A., & Nordström, P. (2014). High aerobic fitness in late adolescence is associated with a reduced risk of myocardial infarction later in life: a nationwide cohort study in men. *European heart journal*, *35*(44), 3133-3140.

Huang, Y. C., & Malina, R. M. (2002). Physical activity and health-related physical fitness in Taiwanese adolescents. *Journal of physiological anthropology and applied human science*, *21*(1), 11-19.

Kaminsky, L. A., Arena, R., Beckie, T. M., Brubaker, P. H., Church, T. S., Forman, D. E., ... & Williams, M. A. (2013). The importance of cardiorespiratory fitness in the United States: the need for a national registry: a policy statement from the American Heart Association. *Circulation*, *127*(5), 652-662.

Kohl III, H. W., & Cook, H. D. (Eds.). (2013). *Educating the student body: Taking physical activity and physical education to school*. National Academies Press.

Kriemler, S., Zahner, L., Schindler, C., Meyer, U., Hartmann, T., Hebestreit, H., ... & Puder, J. J. (2010). Effect of school based physical activity programme (KISS) on fitness and adiposity in primary schoolchildren: cluster randomised controlled trial. *Bmj*, *340*.

Langford, R., Bonell, C., Jones, H., Pouliou, T., Murphy, S., Waters, E., ... & Campbell, R. (2015). The World Health Organization's Health Promoting Schools framework: a Cochrane systematic review and meta-analysis. *BMC public health*, *15*(1), 1-15.

Martínez Vizcaíno, V., Salcedo Aguilar, F., Franquelo Gutiérrez, R., Solera Martínez, M., Sánchez López, M., Serrano Martínez, S., ... & Rodriguez Artalejo, F. (2008). Assessment of an after-school physical activity program to prevent obesity among 9-to 10-year-old children: a cluster randomized trial. *International journal of obesity*, *32*(1), 12-22.

Morrow Jr, J. R., & Ede, A. (2009). Research quarterly for exercise and sport lecture statewide physical fitness testing: A BIG waist or a BIG waste?. *Research quarterly for exercise and sport*, *80*(4), 696-701.

Myers, J., Kaykha, A., George, S., Abella, J., Zaheer, N., Lear, S., ... & Froelicher, V. (2004). Fitness versus physical activity patterns in predicting mortality in men. *The American journal of medicine*, *117*(12), 912-918.

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: a powerful marker of health. *International journal of obesity*, *32*(1), 1-11.

Rasberry, C. N., Lee, S. M., Robin, L., Laris, B. A., Russell, L. A., Coyle, K. K., & Nihiser, A. J. (2011). The association between school-based physical activity, including physical education, and academic performance: a systematic review of the literature. *Preventive medicine*, *52*, S10-S20.

Rizzo, N. S., Ruiz, J. R., Hurtig-Wennlöf, A., Ortega, F. B., & Sjöström, M. (2007). Relationship of physical activity, fitness, and fatness with clustered metabolic risk in children and adolescents: the European youth heart study. *The Journal of pediatrics*, *150*(4), 388-394.

Ruiz, J. R., Rizzo, N. S., Hurtig-Wennlöf, A., Ortega, F. B., W àrnberg, J., & Sjöström, M. (2006). Relations of total physical activity and intensity to fitness and fatness in children: the European Youth Heart Study–. *The American journal of clinical nutrition*, *84*(2), 299-303.

Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2005). Health benefits of physical activity: the evidence. *Cmaj*, *174*(6), 801-809.

Welk, G. J., Jackson, A. W., Morrow Jr, J. R., Haskell, W. H., Meredith, M. D., & Cooper, K. H. (2010). The association of health-related fitness with indicators of academic performance in Texas schools. *Research quarterly for exercise and sport*, *81*(sup3), S16-S23.

Williams, P. T. (2001). Physical fitness and activity as separate heart disease risk factors: a meta-analysis. *Medicine and science in sports and exercise*, *33*(5), 754.

Primljen: 05. maj 2023. / Received: May 05, 2023
Prihvaćen: 04. decembar 2023. / Accepted: December 04, 2023

https://doi.org/10.7251/SSH2302185S
Original scientific paper
UDC: 796.853.26.035:796.01
Originalni naučni rad

Technical Skills Assessment Analysis: Gyaku-Zuki Shots in Karate

Widha Srianto[1], Siswantoyo[1], Rumpis Agus Sudarko[1], Muhammad Wahyu Arga[1], Susanto Susan[2]
[1]Faculty of Sport Science, Yogyakarta State University, Indonesia
[2]Sayyid Ali Rahmatullah State Islamic University Tulungagung, Tulungagung, Indonesia

Correspondence:
Widha Srianto, Faculty of Sports Science, Universitas Negeri Yogyakarta, Indonesia
widhasrianto.2021@student.uny.ac.id

Abstract: *The assessment of sport-specific technical skills is very important and studies on assessment frameworks in sports science are still limited. The Gyaku-zuki is one of the most frequently performed effective punches in Karate, and a set of assessments of its technical skills currently does not exist. Therefore, the establishment of a scoring framework is necessary to provide a standard for measuring athletes' technical skills. This study aims to develop a framework for assessing Gyaku-zuki technique skills that have a high level of validity. This development research was carried out by carrying out three stages of implementation; analysis of existing journals and documents to determine Gyaku-zuki's technical skills assessment, expert judges' assessment of the development of Gyaku-zuki's technical skills assessment using the Delphi method, and analysis of the results of expert judges' assessment by applying Aiken's V to test content validity. This study involved nine expert judges from both academics and practitioners and data analysis showed the relevance of this technical skills assessment material had a coefficient of V 0.96; the systematics of the material relevance assessment procedure has a coefficient value of V 0.93; Gyaku-zuki target direction has a coefficient value of V 0.93; the Gyaku-zuki test score has a coefficient value of V 0.81; distance has a coefficient value of V 0.89; clarity of implementation has a coefficient value of V 0.89. The study concluded that the construction of the Gyaku-zuki technical skill assessment has high content validity with a value of V > 0.8, so that the established framework can be used as a reference in conducting the Gyaku-zuki technical skills assessment.*
Keywords: *Karate, gyaku-zuki, assessment framework, sport science.*

INTRODUCTION

Karate is a Japanese martial art developed on the island of Okinawa and is currently considered a global sport (Clark, 2022; Gonzalez de la Fuente, 2021). In addition, karate is in great demand and is dominated by children and adolescents (Chaabene et al., 2015; Koropanovski et al., 2011; Srianto & Siswantoyo, 2022), and is currently one of the most popular sports since it was competed in at the Tokyo Olympics. 2020 (Rodrigues et al., 2022; Widyastuti & Dimyati, 2019; Zadarko et al., 2019). Peters (2020) explains that karate consists of kata matches and kumite matches; kata consists of a series of movements or moves while kumite consists of fighting. Kata and kumite matches are carried out using dynamic, precise, and well-coordinated techniques, so that a karate athlete is required to have good performance, which is determined by several factors including technique, tactics, and motor skills (Przybylski et al., 2021; Styriak et al., 2020).

Some literature states that the success rate of athletes in kumite matches is higher when athletes use punching techniques rather than kicking techniques (Fendrian & Nurzaman, 2016; Marandi et al., 2010; Zebua & Siahaan, n.d.). Gyaku-zuki is a technique commonly taught in Karate. Gyaku-zuki's punches are mid-range punches and are delivered in short time. This can be interpreted as a reverse punching technique that is often used in kumite tournaments (Ionete et al., 2011; Venkatraman & Nasiriavanaki, 2019). A backwards shot is described with the position of the left foot in front, then the blow is done with the right hand. Vice versa, the position of the right foot is in front, then the stroke is done with the left hand. The Gyaku-zuki punch is an effective punch to use in kumite tournaments because of its speed it may hit the stomach, neck and head. The initial stance of the Gyaku-zuki punch includes the chudan-no-kamae stance. This is a posture that targets the opponent that allows for attack, defense, and a flexible response to the opponent's movement (Shin et al., 2021), followed by a series of movements performed simultaneously including lowering the body's center of mass by extending the dachi and pushing the arms forward by aim at the opponent. Gyaku-zuki is a punch that is performed with a series of body movements rotating the hips and shoulders simultaneously (Venkatraman et al., 2019).

In determining the skill of the Gyaku-zuki technique, a Gyaku-zuki technique skill test is required. This skill test is an important aspect in coaching science which aims to measure the level of success and correctness of a technique (Iermakov et al., 2016). Based on the literature review, there is no test instrument for assessing the skill of the

Gyaku-zuki technique. The study is limited to tests to measure the speed of the Gyaku-zuki technique, analysis of Gyaku-zuki movements, the impact of morphology and motor skills while doing Gyaku-zuki (Doder et al., 2023; Hofmann et al. , 2008; Kadir & Haryanto, 2021), where the test is feasible to use if the Gyaku-zuki player already has punching technique skills. Therefore, it is important to study the preparation of the Gyaku-zuki technique skill test instrument as a first step in assessing the Gyaku-zuki technique. The test instrument was determined and validated by expert judges in carrying out the Gyaku-zuki procedure described by Doder et al. (2023).

METHODS

Research

This research is a development research using quantitative and qualitative analysis approaches to get a high value of validity. The implementation consists of three stages. The first stage is by analyzing existing journals and documents to determine the Gyaku-zuki technique skill test, the second stage is expert jury assessment for the Gyaku-zuki technique skill test which was developed using the Delphi method using a questionnaire (Saud, 2019). The third stage is by analyzing the results of expert judges' assessments by applying Aiken's V to test content validity.

Participants

This study involved nine expert jury participants, including five expert judges from the academic field who work as lecturers with doctoral and master of sports degrees. The four expert judges come from practitioners who have been working as karate trainers for more than ten years and hold a master of sports degree.

Data Analysis

Collecting data using a Likert scale questionnaire with four answer choices, namely: a score of four strongly agree, a score of three agrees, a score of two disagrees, and a score of one strongly disagrees (Awang et al., 2016; Croasmun & Ostrom, 2011). Then, qualitative data in the form of expert judgment suggestions are summarized and realized. Quantitative data were processed using the V-Aiken formulation to test the content validity of the Gyaku-zuki technique skill test. The range of V-Aiken values is zero to one, if the V value <0.6 is considered in the low category, if the V value is 0.6 – 0.8 it is considered in the medium category, if the V value > 0.8 is considered in the high category (Arthur et al. al., 2019). Table 1 shows the V-Aiken formula (Nengsih & Mawardi, 2021) which was implemented in this study.

Table 1. *V-Aiken Formula*

$V =$	$\frac{\sum s}{n(c-1)}$
$s =$	$r - lo$

V: the Aiken scale to find the value for
S: the reduction result of the validator value with the lowest value
N: the number of validators
C: the highest validity value
Lo: the lowest validity value

RESULTS

Based on document analysis, it can be defined that the Gyaku-zuki technique is a punch in karate that is often used in karate tournaments, or it is also known as a backward punch technique when the left foot is in front and the left foot is in front. The punch is done using the right hand, or vice versa. While the Gyaku-zuki technique skill test is a test to assess the quality of Gyaku-zuki's strokes based on instruments that have been constructed and occupied with high validity. Based on the analysis and advice of the expert judges, the Gyaku-zuki technical skill construction was formed. The execution of the Gyaku-zuki procedure adopted from previous studies is described as shown in Figure 1 (Doder et al., 2023).

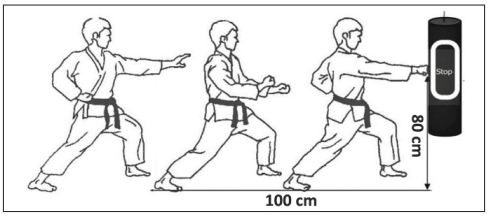


Figure 1. *Execution Procedure of the Gyaku-zuki (Doder et al., 2023)*

Tools

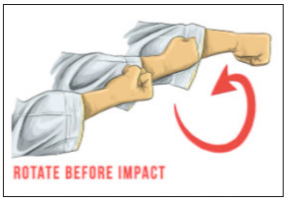
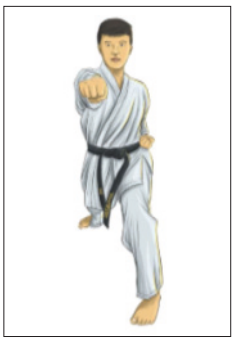
1. Target as a hitting target
2. Whistle as a starting sign of the test
3. Stationery to record test results

Procedure of Test

1. The test can be used for right-handed and left-handed Gyaku-zuki.
2. The target position is in front of the tester.
3. The Gyaku-zuki punch is done 3 times in 1 test.
4. The tester performs the chudan-no-kamae standing position.
6. Target punch can be adjusted (stomach, neck, or head direction)
7. The test is carried out after the tester blows the whistle.
8. The test is carried out 2 times, the best value is taken.

Table 2. *Indicators of Right-Handed Gyaku-zuki Technique Skill Test*

No	Steps	Test Indicators
1	Initial Stance  Figure Initial Attitudes 1 and 2	1. Eyes-view facing forward 2. Upright body position
	 Figure Initial movement attitude 3	3. Chudan-no-kamae position (one hand is in front, and one hand protects the body area).
	 Figure Initial movement attitude 4	4. Zenkutsu dachi, a half stance foot position (to produce a strong push, so the stance should not be low) (Khorasani et al., 2020).

No	Steps	Test Indicators
2	Implementation  Implementation Figure 1	1. Lowering the body mass center by extending the stance towards the target, the feet position is not in one straight line for maximum balance.
	 Implementation Figure 2	2. Rotating the hip and shoulder simultaneously.
	 Implementation Figure 3	3. Performing a straight forward punch while rotating the wrist (hand gripping position)
	 Implementation Figure 4	4. The position of the feet and hands are in opposite, the left foot is in the front and the punch is performed by using the right hand

No	Steps	Test Indicators
3	Continued Movements  Continuation Pictures of Movements 1 and 2	1. Pulling the body back to the original position 2. Pulling punches towards the hips
	 Continuation Pictures of Movement 3 and 4	3. Chudan-no-kamae standing with half stance of zenkutsu dachi. 4. Maintain the body upright and the eyes-view toward the target.

Assessment of the Gyaku-zuki technique

1. Score 4 if 4 of assessment indicators are correct
2. Score 3 if 3 of assessment indicators are correct
3. Score 2 if 2 of assessment indicators are correct
4. Score 1 if 1 of the assessment indicators is correct

Table 3. *Table of Assessment*

No	Steps	Score
1	Initial Stance	
2	Implementation	
3	Continued Movements	
Total Score		

Table 4. *Score Category*

Score	Category
≥ 3.1	High
2.1-3	Average
≤ 2	Low

Remarks: Score = Total Score / 3

The highest score of the Gyaku-zuki technique skill test is four and the lowest score is one. The score ≥ 3.1 is categorized as high, score 2.1-3 is categorized as average, and score ≤ 2 is categorized as low.

Table 5. *Result of Content Validation Test by V-Aiken Formula*

Point	Score																	∑s	n(c-1)	V
	Expert									S										
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9			
1	3	4	4	4	4	4	4	4	4	2	3	3	3	3	3	3	3	3	26	27	0,96
2	4	4	3	4	4	4	4	4	3	3	3	2	3	3	3	3	3	2	25	27	0,93
3	4	4	4	4	3	4	3	4	4	3	3	3	3	2	3	2	3	3	25	27	0,93
4	4	3	3	3	3	4	3	4	4	3	2	2	2	2	3	2	3	3	22	27	0,81
5	3	3	3	4	4	4	4	4	4	2	2	2	3	3	3	3	3	3	24	27	0,89
6	3	4	3	4	4	4	4	4	3	2	3	2	3	3	3	3	3	2	24	27	0,89
	21	22	20	23	22	24	22	24	22												

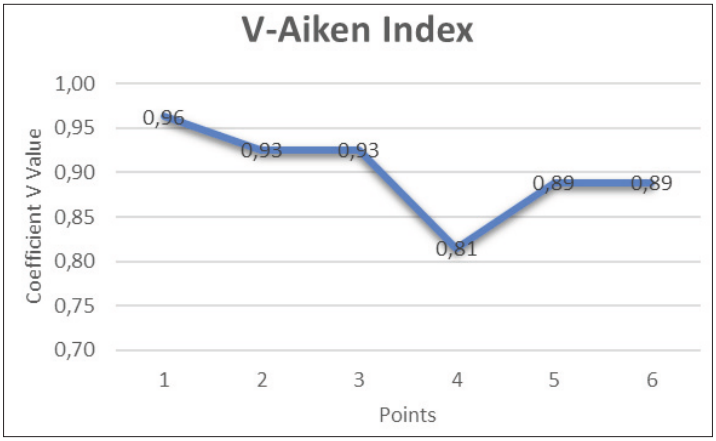


Figure 2. *V-Aiken Index*

The results of the analysis show that the value of the point one coefficient is V = 0.96 which is included in the high category; the value of the two-point coefficient V = 0.93 is included in the high category; the three-point coefficient value V = 0.93 is included in the high category; the fourth coefficient value V = 0.81 is included in the high category; the value of the five point coefficient V = 0.89 is included in the high category; the six point coefficient value is V = 0.89 included in the high category.

DISCUSSION

One of the characteristics of the progress of sports is the utilization of the sport science approach in its implementation which aims to foster athletes who excel physically, technically, tactically and psychologically. Sports science has directions for predicting, comparing results from tests, monitoring training results, making decisions, and setting goals (Zadorozhna et al., 2020). Technique is part of the athlete's psychomotor quality so that the accuracy and precision of the technique is considered a very important factor. This is because the correct technique will affect the performance of athletes. In order to train and develop the Gyaku-zuki technique, a coach must understand the process of moving stages to produce effective punches (Labintsev et al., 2021). One indicator to determine a person's technical quality ability is to carry out an assessment test, then analyze it to formulate improvements holistically (Pinto et al., 2022). The Gyaku-zuki skill test instrument is important to develop because the Gyaku-zuki punch is an effective punch used in karate tournaments (Ionete et al., 2011; Venkatraman et al., 2019). Recently, a test instrument for assessing the skill of the Gyaku-zuki technique did not exist. Therefore, this study aims to establish a construction test of the skill of the occupied Gyaku-zuki technique with a high level of validity.

The results of qualitative data and improvements from the expert jury in the development of the construction of the Gyaku-zuki technique skill test are described as follows: 1) the test is designed simply and easily with one direction of the target in front of the examiner, 2) the target can be the stomach, neck or head target, 3) the number of punch is 3 times according to the average attack in kumite. The results of the data analysis show that the first point regarding the relevance of the technical skills test material for Gyaku-zuki has a coefficient value of V 0.96; the second point is about the relevance of the systematic engineering skills test material for Gyaku-zuki has a coefficient value of V 0.93; the third point about the direction of the target of the Gyaku-zuki technique has a coefficient value of V 0.93; the fourth point about the number of repetitions of the Gyaku-zuki technique skills test has a coefficient value of V 0.81; the fifth point about the distance of the Gyaku-zuki technique skill test has a coefficient value of V 0.89; the sixth point about the clarity of the implementation of the Gyaku-zuki technique skills test has a coefficient value of V 0.89. This study concludes that a set of assessment test frameworks demonstrates a high level of validity.

CONCLUSIONS

Based on the discussion and results of data analysis, the study concluded that the construction of the Gyaku-zuki technique skills test items had high content validity with a value of V > 0.8. Therefore, a set of assessment test frameworks can be used to conduct tests of Gyaku-zuki technique skills.

Acknowledgments

The authors would like to express the gratitude to all the expert judges that have supported in developing the construction of the Gyaku-zuki technique skills test. Authors also thank to all Indonesian Karate; Authors hope that Indonesian Karate will make progress more advanced.

REFERENCES

Arthur, R., Rouf, F. A., Rahmayanti, H., & Maulana, A. (2019). Plumbing work competence instrument in the field of civil engineering. *Journal of Physics: Conference Series*, *1402*.

Awang, Z., Afthanorhan, A., & Mamat, M. (2016). The Likert scale analysis using parametric based Structural Equation Modeling (SEM). *Computational Methods in Social Sciences*, *4*, 13–21.

Chaabene, H., Hachana, Y., Franchini, E., Tabben, M., Mkaouer, B., Negra, Y., Hammami, M., & Chamari, K. (2015). Criterion related validity of karate specific aerobic test (KSAT). *Asian Journal of Sports Medicine*, *6*(3). https://doi.org/10.5812/asjsm.23807

Clark, A. (2022). A Statistical Analysis of the Kata Scoring System in Sport Karate. *Ido Movement for Culture*, *22*(4), 33–40. https://doi.org/10.14589/ido.22.4.5

Croasmun, J. T., & Ostrom, L. T. (2011). Using Likert-Type Scales in the Social Sciences. *Journal of Adult Education*, *40*, 19–22.

Doder, D., Radišić, L., Mujanović, R., & Mojsilović, Z. (2022). Impact of morphological characteristics and motor skills when performing gyaku tsuki. *Revista Brasileira de Medicina do Esporte, 29.* https://doi.org/10.1590/1517- 8692202329012021_0503

Fendrian, F., & Nurzaman, M. (2016). Efektivitas Teknik Serangan Pukulan san Teknik Serangan Tendangan terhadap Perolehan Poin dalam Pertandingan Kumite Cabang Olahraga Karate. *Jurnal Kepelatihan Olahraga*, *8*(2), 35–37.

Gonzalez de la Fuente, E. (2021). Recentering the Cartographies of Karate: artial Arts Tourism in Okinawa. *Ido Movement for Culture*, *21*(3), 51–66. https://doi.org/10.14589/ido.21.3.8

Hofmann, M., Witte, K., & Emmermacher, P. (2008). *Biomechanical analysis of fist punch gyaku-zuki in karate*.

Iermakov, S., Podrigalo, L., Romanenko, V., Tropin, Y., Boychenko, N., Rovnaya, O., & Kamaev, O. (2016). Psycho-physiological features of sportsmen in impact and throwing martial arts. *Journal of physical education and sport*, *16*(2), 433. https://doi.org/10.7752/jpes.2016.02067.

Ionete, G. L., Mereuta Elena, Mereuta Claudia, Tudoran, M. S., & Ganea, D. (2011). *Linear Kinematic Analysis of Gyaku-Tsuki Karate Technique*.

Kadir, S., & Haryanto, A. I. (2021). Development of the Gyaku Tsuki and Mawashi Geri Speed Test. *Competitor: Jurnal Pendidikan Kepelatihan Olahraga*, *13*(2), 130. https://doi.org/10.26858/cjpko.v13i2.19059

Khorasani, A. A., Amiri Khorasani, M. T., & Mohammadipour, F. (2020). Comparison of the Maximum Angular Velocity of Lower Limb Joints in Different Methods of Zenkutsu-dachi in Karate. *Journal of Sport Biomechanics*, *6*(1), 12–21. https://doi.org/10.32598/biomechanics.6.1.3

Koropanovski, N., Berjan, B., Bozic, P. R., Pazin, N., Sanader, A., Jovanovic, S., & Jaric, S. (2011). Anthropometric and physical performance profiles of elite karate kumite and kata competitors. *Journal of Human Kinetics*, *30*(1), 107–114. https://doi.org/10.2478/v10078-011-0078-x

Labintsev, A., Khasanshin, I., Balashov, D., Bocharov, M., & Bublikov, K. (2021). Recognition Punches in Karate Using Acceleration Sensors and Convolution Neural Networks. *IEEE Access*, *9*, 138106–138119. https://doi.org/10.1109/ACCESS.2021.3118038

Marandi, S. M., Zolaktaf, V., & Batavani, M. R. (2010). Analyses of pointing actions of top male competitors in karate at world level. *British Journal of Sports Medicine*, *44*(Suppl_1), i52–i52. https://doi.org/10.1136/bjsm.2010.078725.174

Nengsih, Z. W., & Mawardi, M. (2021). Pengembangan Sistem Pembelajaran Flipped Classroom Berbasis Inkuiri Terbimbing pada Materi Hidrolisis Garam. *Edukatif: Jurnal Ilmu Pendidikan*, *3*(4), 1231-1244. https://doi.org/10.31004/edukatif.v3i4.546.

Peters, M. (2020). Karate-Talk in a Canadian Dojo. *Journal for Undergraduate Ethnography*, *10*(1), 20–34. https://doi.org/10.15273/jue.v10i1.9946

Pinto, F. L., Neiva, H. P., Marques, M. C., Marinho, D. A., Branquinho, L., & Ferraz, R. (2022). Utilizing contextualized skills and coach intervention to optimize the performance of ultimate full-contact fighters. *Ido Movement for Culture*, *22*(4), 22–32. https://doi.org/10.14589/ido.22.4.4

Przybylski, P., Janiak, A., Szewczyk, P., Wieliński, D., & Domaszewska, K. (2021). Morphological and motor fitness determinants of shotokan karate performance. *International Journal of Environmental Research and Public Health*, *18*(9). https://doi.org/10.3390/ijerph18094423

Rodrigues, J. C. C., Penna, E. M., de Azevedo, A. B. C., Meninea, D. S., Magno, A. P., Sant'Ana, J., & Coswig, V. S. (2022). Effects of kiai on jumping performance and striking reaction time in Karate athletes. *Ido Movement for Culture*, *22*(1), 27–35. https://doi.org/10.14589/ido.22.1.5

Saud, A. (2019). Tinjauan Sistematis Tentang Teknik Delphi Dan Kaitannya Terhadap Isu Kefarmasian Terkini. *Majalah Farmasi dan Farmakologi*, *23*(1), 38-47.

Shin, Y.-A., Hong, S.-M., Kim, S.-H., & Lee, B.-K. (2021). The Effect of Kendo's Chudan-no-kamae and Three Striking Movements on Changes in Brainwaves Related to Concentration Index. *The Asian Journal of Kinesiology*, *23*(2), 34–44. https://doi.org/10.15758/ajk.2021.23.2.34

Srianto, W., & Siswantoyo, S. (2022). Biomotor Analysis of Speed and Flexibility in the Karate Talented Athletes Coaching in the Special Region of Yogyakarta. *Proceedings of the Conference on Interdisciplinary Approach in Sports in Conjunction with the 4th Yogyakarta International Seminar on Health, Physical Education, and Sport Science (COIS-YISHPESS 2021)*, 153–156. https://doi.org/10.2991/ahsr.k.220106.029

Styriak, R., Billman, M., & Augustovicova, D. (2020). Karate agility: The new competition category for children's physical development with very high test/re-test reliability. *Ido Movement for Culture*, *20*(3), 32–37. https://doi.org/10.14589/ido.20.3.5

Venkatraman, J., Manwar, R., & Avanaki, K. M. (2019). Development of a punch-o-meter for sport karate training. *Electronics (Switzerland)*, *8*(7). https://doi.org/10.3390/electronics8070782

Venkatraman, J., & Nasiriavanaki, M. (2019). Biomechanics of Kumite Style Gyaku tsuki in Karate. *Copyright@ Nasiriavanaki M| Biomed J Sci &*. https://doi.org/10.26717.BJSTR.2019.14.002550

Widyastuti, C., & Dimyati. (2019). Comparison of Psychological Skills Between Pencak Silat and Karate. *Ido Movement for Culture*, *19*(3), 50–55. https://doi.org/10.14589/ido.19.3.6

Zadarko, E., Mostek, I., Zadarko-Domaradzka, M., Barabasz, Z., Lenik, J., Przednowek, K. H., Huzarski, M., Niziol-Babiarz, E., Szybisty, A., & Przednowek, K. (2019). Diagnostics of selected motor skills of Oyama Karate competitors preparing for the championships. *Ido Movement for Culture*, *19*, 102–106. https://doi.org/10.14589/ido.19.1S.16

Zadorozhna, O., Briskin, Y., Pityn, M., Smyrnovskyy, S., Semeryak, Z., Khomiak, I., & Hlukhov, I. (2020). Multi-functional technical devices for improvement and control of athletes' preparedness in martial arts. *Sport Mont*, *18*(1), 9–14. https://doi.org/10.26773/smj.200202

Zebua, K., & Siahaan, D. (n.d.). Analisis Teknik Pertandingan Kumite Dalam Olahraga Beladiri Karate. *Jurnal Prestasi*, *5*(2), 70–78. https://jurnal.unimed.ac.id/2012/index.php/jpsi/index

Primljen: 17. jul 2023. / Received: July 17, 2023
Prihvaćen: 12. novembar 2023. / Accepted: November 12, 2023

https://doi.org/10.7251/SSH2302191S
Original scientific paper
UDC: 615.823:796.015.52
Originalni naučni rad

The Effectiveness of Massage to Increase the Work Productivity of Persons With Disabilities

Sumarjo Sumarjo[1], Sigit Nugroho[1], Riky Dwihandaka[1], Yudik Prasetyo[1], Susanto Susan[2]
[1]Sports Science Study Program, Faculty of Sports, Yogyakarta State University, Yogyakarta, Indonesia
[2]Sayyid Ali Rahmatullah State Islamic University Tulungagung, Tulungagung, Indonesia

Correspondence:
Sumarjo Sumarjo, Sports Science Study Program, Faculty of Sports, Yogyakarta State University,Yogyakarta, Indonesia
sumarjofik@uny.ac.id

Abstract: *The development of human resources starts from the womb even earlier by paying attention to the level of welfare of expectant mothers, then babies, toddlers, preschool and school age, youth, productive age to old age. The research aims to test and find out the effectiveness of this type of health massage in increasing work productivity which consists of motivation, knowledge, skills, attitudes and independence for people with disabilities with physical disabilities. This study used a quasi-experimental research method with a one group time series design (pretest one post test). The design carried out the first observation (pretest) after that the posttest observation. The treatment group was measured by giving a type of massage therapy to the work productivity of the disabled with physical disabilities which would be known to consist of five (5) influencing factors, namely: (1) motivation, (2) knowledge, (3) skills, (4) attitudes and (5) independence. The research sample was taken from the existing population using a non-random sampling technique with a purposive sampling method. Data collection is obtained through tests and measurements. The test instrument used to measure work productivity uses a questionnaire. The data analysis technique used is analysis of variance. The research results show that there is a significant difference between the initial variable and the final variable with a significance value (2-tailed) <0.05 through paired t-test. Meanwhile, through the ANOVA test results obtained a significance of 0.267. So that it can be interpreted that there is a significant influence on the treatment given with health massage on work productivity variables consisting of motivation, knowledge, skills, attitudes and independence for people with disabilities with physical disabilities. The increase in work productivity that has experienced the greatest or most effective increase is in the motivational variable with a percentage increase of 16.75%.*

Keywords: *Massage, Health, Work productivity, Disability.*

INTRODUCTION

Health development is an integral part of the development of human resources (HR), to achieve the development of an advanced, independent and prosperous nation. Development of human resources starts from the womb and even earlier by paying attention to the level of welfare of prospective mothers, then babies, toddlers, preschool and school age, youth, productive age to old age. Efforts to improve public health are the main program in order to improve the quality of family life through community education. In this connection, the role of the family and school becomes important, as the embodiment of the ideals formulated in the national development goals.

The embodiment of a quality generation for the development of the nation and state, including for persons with disabilities. Persons with disabilities are often socially isolated and face discrimination in access to health, educational services and employment. The root of the language for disability is taken from English, namely from the words dis and ability. Dis means no, and ability means ability. Therefore, if we combine disability or disability, it can be interpreted as a person who has limited abilities in certain things. Meanwhile, disabled people are people with disabilities. So the difference between disability and disability is that disability is a condition of a person's inability to do certain things, while disability is a person with a disability.

It is not uncommon for us to see situations where society cannot fully accept the existence of persons with disabilities, even by their own biological parents. Indeed, parents must try to take care of their baby as much as possible so that they can grow healthy and normal, but all possibilities can happen to anyone and anytime. As the closest person who has relatives or family members with disabilities, we have a very important role to play in increasing their self-confidence. Salceanu (2020) said that when parents feel excessive anxiety, there is a high risk of giving

the same feelings to their children because children who can buy bags will feel that they are a burden to their family. For some families they may accept the existence of children with disabilities, but afterwards they will be faced with other problems such as being ready to accept opinions from people around them, lack of social and psychological support, and problems in being able to join the community. Basically, people with disabilities do not need pity, they only need help, understanding and friendship. If this problem continues, it is possible that it will have a traumatic effect on persons with disabilities.

Even though we all definitely agree that everyone has the same right to play a role in society even though they have a disability. Empowerment of people with disabilities has begun to be intensively implemented by various parties. Both the government and the private sector are starting to pay attention to the welfare of people with disabilities where stereotypes in society think that people with disabilities are unable to do anything when in fact their abilities are limited to a lack of organs, not to anything else. Therefore, we as a society that upholds the values of social justice must support one another regardless of one's physical condition. Guidry-Grimes (2020) conveyed about the disability rights movement, in which this movement is very useful for defending equal rights for people with disabilities. To safeguard the rights of people with disabilities, there needs to be active collaboration from the perspective of persons with disabilities, the community, and policy makers. Therefore, the whole community needs to provide and implement health promotion in order to increase self-confidence and respect for people with disabilities.

Health promotion is the process of enabling people to increase control over the determinants of health and improve their health (WHO, 2005). One of the goals of health promotion is to change behavior or provide information to the target to lead to a better behavior or to provide an overview of the advantages of positive behavior and the disadvantages of negative behavior. Community health status is determined by the health condition of its citizens, including the condition of the elderly, adolescents and children. Law No. 36 of 2009 concerning Health provides a limitation: "health is a healthy state both physically, mentally, spiritually and socially which allows everyone to live productively socially and economically". The definition that refers to the health limit according to the most recent World Health Organization (WHO), is indeed wider and more dynamic than the previous definition which says that health is a state of complete physical, mental and social well-being, and not only the absence of disease and disabled.

According to Law no. 36 of 2009 concerning health, then health includes five aspects namely physical (body), mental (spirit), social, spiritual, economic (productive). A person's health is not only measured from the physical, mental, spiritual and social aspects, but also measured from his productivity in the sense of having a job or producing economically. The five dimensions of health influence each other in realizing the level of health in a person, group or community. That is why, health is holistic or comprehensive.

Physical disability, defined as a patient who has incomplete physical limbs such as amputations, bone defects, muscle joint defects, limbs, arms and paralysis. In line with WHO calculations (2005) estimates that the number of people with disabilities is 10% of Indonesia's population (24 million). Based on Sakernas 2017 data, the national population of working age with disabilities is 21,930,529 people. Of this total, the data includes a workforce of 11,224,673 people (51.18 percent), for the disabled work force there are 10,810,451 (96.31 percent) and open unemployment is 414,222 people (3.69 percent). Meanwhile, 10,705,856 (48.82 percent) are not in the workforce with disabilities. Data on disabilities who were at school were 206,163 people (1.93 percent), who took care of the household were 5,911,017 people (55.21 percent) and others were 4,588,676 people (42.86 percent) (Nurahman, 2018) .

The results of these data show that there is still unemployment for national disabilities of 3.69%, so the role of the government and institutions as well as disability observers is still very much needed to support unemployment alleviation programs. Disabilities need empowerment steps in various abilities for the sake of their future continuity. Empowerment steps to increase community capacity can make them more empowered, in the sense of being able to do something useful in community development. Basically, people with disabilities have the potential and willingness to change in a better direction according to the potential of natural resources and local wisdom around them.

Society's perception of persons with disabilities, which has been ingrained for centuries, is difficult to get rid of. For example, there are students with disabilities who are refused to live in a boarding house, because the owner thinks that the presence of persons with disabilities will bring disaster to their business. When using air transportation by commercial airplanes, persons with disabilities must sign a sick statement so that insurance is not covered. Not only that, we still often encounter discriminatory practices against persons with disabilities in everyday life. Hackett (2020) explains that discrimination against persons with disabilities can occur anywhere, be it on the street, in the

work environment, or in public places. They are faced with an unsafe situation when walking alone against physical attacks or theft because of their limited physical movement. In addition, there is a need for physical development for persons with disabilities on an ongoing basis, so that later their fitness will be maintained to support their next activities (Susanto et al, 2020). There are various types of physical exercise that can be done by persons with disabilities such as playing traditional games (Susanto et al, 2022).

The disabled community can also be interpreted as people with different abilities, namely people who have different abilities from normal people both physically and mentally. All limitations possessed by the community cannot be used as an excuse for them or anyone else to carry out social restrictions, either directly or indirectly. Social restrictions occur when those with physical limitations are grouped into disabled foundations or special schools. These social restrictions are even more real when the environment around us, the public spaces of the city, actually causes every walker to stumble, every wheel chair is stopped, every swing of a white cane for the blind is hampered, and every sign language is ignored by the community (Deswanto, 2004) .

In Indonesia, to develop the independence of people with disabilities can be done in several ways such as entrepreneurial efforts from a number of people with disabilities. In Yogyakarta, a modified motorbike taxi business has been initiated by persons with disabilities for the disabled community and the general public. Tribun Jogja (Anonymous, 2016) revealed that there is a motorcycle taxi service labeled Dhifa CT (City Tour and Transport) which is managed by people with disabilities. This service is a forum for the independence of people with disabilities who want to prove that people with disabilities can enter the world of work and eliminate discrimination of people with disabilities in the world of work.

The term disability community is not limited to those with disabilities, but the term disability has a more flexible and broader meaning, namely people who have temporary or permanent obstacles in carrying out their daily activities, including pregnant women, children, the elderly, wheelchair users, crutches, blind, deaf and quadriplegic. WHO data (2005), about 10 percent or approximately 24 million of the total population of Indonesia are people who have limited capabilities and experience almost the same phenomenon of problems related to the right to the provision of public spaces that do not reach and cannot serve specific needs. their activities (Deswanto, 2004).

Efforts to increase the work productivity of people with disabilities have been carried out by the Government of Indonesia through the provision of various skills. There are various kinds of programs provided by the government to empower people with disabilities, one of which is a program at the Rehabilitation Center for People with Physical Impairment, where people with disabilities are trained to have various skills. Productivity itself is an ability to produce something. To achieve a high level of productivity, there are several factors that support the formation of high productivity for people with disabilities. These supporting factors include: Education, skills, attitudes and work ethics, income level, social security, social level and work climate, motivation, nutrition and health, individual relations, technology, and production. Empowering the productivity of people with disabilities is very useful for maintaining the mental health of people with disabilities because with their participation in life, it will mentally form that they are also useful. Because basically, as mentioned by Kristiyanti (2019) persons with disabilities feel that they are only a burden to other people so that their emotions become uncontrollable to the point where they lose self-confidence.

The provision of skills for people with disabilities is the fulfillment of needs that are in accordance with needs based on their potential and can be further improved towards independence. Through a health massage development program aimed at people with disabilities, it is hoped that people with disabilities will have a better quality of life and can eliminate the perception that people with disabilities will only be a burden on society by begging in several places. As we know that every deficiency will be offset by strengths, massage training for persons with disabilities is a small step but has a big meaning because it can lead persons with disabilities to a more independent life. Apart from that, providing skills training to persons with disabilities is also able to increase their self-confidence and their role is needed in social life. Apart from self-confidence, decision-making skills or accuracy when carrying out activities are also needed (Susanto et al, 2021).

METHOD

This study uses a quasi-experimental research method with a one group time series design (pretest one post test). In this study, the research subjects were persons with disabilities specifically physically disabled who participated in the program at the Integrated Rehabilitation Center for Persons with Disabilities (BRTPD) in Pundong District,

Bantul Regency, Special Region of Yogyakarta. The research subjects before and after treatment were given a work productivity questionnaire consisting of five (5) influencing factors, namely: (1) motivation, (2) knowledge, (3) skills, (4) attitudes and (5) independence. In this study, the population was persons with disabilities, specifically quadriplegic monoplegia, who had the following characteristics: (1) Male sex, (2) Age 20-30 years, (3) Physically disabled/ paralyzed, only one limb was paralyzed at the bottom. The research subjects totaled 28 people. The data analysis technique used was the analysis of variance test (Anova). before the Anova test was carried out, a paired t test was carried out to determine the effectiveness of each independent variable on the dependent variable. After knowing the effectiveness of each treatment, then proceed with the Anova test.

RESULTS

The description of the data before and after the treatment for each variable is as follows:

Table 1. *Data of Mean Pre-test and Post-test of Work Productivity*

Variable	Initial Average	Final Average	Gain Score
Motivation	44,79	52,29	7,5
Knowledge	46,96	52,79	5,83
Skills	44,71	51,64	6,93
Attitude	46,36	52,61	6,25
independence	46,57	50,00	3,43

The results of the pre-test and post-test data analysis on the variables of work productivity consisting of motivation, knowledge, skills, attitudes and independence have all increased. From these results it can be concluded that the use of health massage is effective in increasing work productivity abilities for people with disabilities with physical disabilities.

1. Research Prerequisites Test Results

The requirements test was carried out before analyzing the research data using parametric statistics. Analysis requirements that must be met in the analysis include the normality test and homogeneity test. The results of the analysis prerequisite test are as follows.

a. Normality test

The normality test is carried out to test whether the analyzed variables have a normal distribution of data or not. The data normality test was carried out using the Kolmogorov Smirnov Z. The reading of the data results is said to be normal if the p value (Sig.) > 0.05. The normality test results are shown in the table below.

Table 2. *Normality Test Results*

Treatment	Variable	KSZ	P	Information
Pree test	Motivation	1,200	0,112	Normal
	Knowledge	0,848	0,469	Normal
	Skills	1,035	0,235	Normal
	Attitude	0,628	0,825	Normal
	independence	0,961	0,314	Normal
Post test	Motivation	0,601	0,864	Normal
	Knowledge	0,666	0,767	Normal
	Skills	0,887	0,411	Normal
	Attitude	1,039	0,230	Normal
	independence	0,771	0,591	Normal

Table 2 shows that the results of calculating the normality of the data on all variables both before and after treatment have a significance value greater than 0.05 (p> 0.05), it can be stated that the research data is normally distributed.

b. Homogeneity test

Homogeneity test is used to test the similarity of the variance of the observed data in each treatment group. The homogeneity test was carried out on research data from post-test observations. The statistical test used to test homogeneity uses the Levene test with the F test, namely comparing the largest variance with the smallest variance. The reading of the data results is said to be homogeneous if the p value (Sig.) > 0.05. The homogeneity test results are shown in the following table.

Table 3. *Homogeneity Test Results*

Data	F count	p	Information
Motivation	0,492	0,486	Homogen
Knowledge	0,039	0,844	Homogen
Skills	0,292	0,591	Homogen
Attitude	0,565	0,456	Homogen
independence	3,360	0,072	Homogen

The results of the homogeneity test in Table 3 all data have a calculated F value that is smaller than F table and a significance value greater than 0.05 (p > 0.05), it can be stated that the data on the research variables in the observations are homogeneous.

2. Results of Hypothesis Testing

c. Test Paired T-Test

Test paired t test to determine the effectiveness of each independent variable on the dependent variable. Reading the results of the data it is said that there is a significant difference between the initial variable and the final variable if the p value (Sig.) < 0.05. The results of the paired t test are shown in the following table.

Table 4. *Paired T Test Results*

Work Productivity Variables Pair I	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95 % Confidence Interval of the Difference				
				Lower	Upper			
Motivation (Pre Test) Motivation (Post Test)	-7.50000	4.35890	.82375	-9.19020	-5.80980	-9.105	27	.000
Knowledge (Pre Test) Knowledge (Post Test	-5.82143	3.90682	.73832	-7.33633	-4.30652	-7.885	27	.000
Skills (Pre Test) Skills (Post Test	-6.92857	3.09035	.58402	-8.12688	-5.73026	-11.864	27	.000
Attitude (Pre Test) Attitude (Post Test	-6.25000	3.31802	.62705	-7.53659	-4.96341	-9.967	27	.000
Independence (Pre Test) Independence (Post Test	-3.42857	6.97842	1.31880	-6.13452	-.72262	-2.600	27	.015

The results of the Paired T-Test showed that the significance value (2-tailed) was <0.05, so that the data indicated that there was a significant difference between the initial and final variables.

d. Anova Test

Anova test is used to determine the effectiveness of health massage treatment on work productivity which consists of motivation, knowledge, skills, attitudes and independence. The following in Table 5 explains in more detail the effectiveness of health massage in knowing how much the dependent variable increases and decreases significantly.

Table 5. *Health Massage on Increasing Work Productivity Based on Stimulant Confidence Intervals*

	N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
Motivation	28	52.2857	5.21293	50.2644	54.3071	41.00	60.00
Knowledge	28	52.7857	4.58142	51.0092	54.5622	43.00	59.00
Skills	28	51.6429	5.74272	49.4161	53.8697	38.00	59.00
Attitude	28	52.6071	4.50793	50.8592	54.3551	41.00	59.00
Independence	28	50.0000	5.84998	47.7316	52.2684	41.00	60.00
Total	140	51.8643	5.23300	50.9898	52.7387	38.00	60.00

The minimum increase based on the 95% stimulant Confidence Interval above can be seen that the increase in the lower limit (lower bound) for the variable motivation is 50.2644, knowledge is 51.0092, skill is 49.4161, attitude is 50.8592, independence is 47, 7316, and independence of 50.9898. Meanwhile, the results of the ANOVA test for each variable are shown in Table 6 below.

Table 6. *ANOVA results for each research variable*

	Sum of Squares	df	Mean Square	F	Sig.
Between Group	142.886	4	35.721	1.316	.267
Within Groups	3663.536	135	27.137		
Total	3806.421	139			

The results of the ANOVA test in the significance column obtained P value (P-value) = 0.267 thus at a significant level = 0.05 Ho was rejected, so the conclusion obtained was that there was a significant difference in the average work productivity variable consisting of motivation, knowledge, skills, attitudes and independence.

e. Calculation of Work Productivity Increase

Increased work productivity is known by using the percentage formula. The increase calculation data can be seen in table 7 below.

Table 7. *Results of Increasing Work Productivity*

Work productivity	Mean Pre Test	Mean Post Test	% Enhancement
Motivation	44,79	52,29	16,75
Knowledge	46,96	52,79	12,40
Skills	44,71	51,64	15,50
Attitude	46,36	52,61	13,48
independence	46,57	50,00	7,36

Judging from the calculation of the increase in work productivity, it was found that the variable that experienced the greatest increase was the motivational variable with an increase percentage value of 16.75%. As for the smallest increase in the independent variable with a percentage of 7.36%.

DISCUSION

The results of this study indicate that there are significant differences between the initial variables and the final variables. Meanwhile, from the results of the ANOVA test, a significance of 0.267 was obtained. So that it can

be interpreted that there is a significant influence on the treatment given with health massage on work productivity variables consisting of motivation, knowledge, skills, attitudes and independence for people with disabilities with physical disabilities. The results of this study indicate that there is a significant difference between the initial and final variables and there is the effectiveness of health massage to increase work productivity which is most effective consisting of motivation, knowledge, skills, attitudes and independence. From the results of the training it can be concluded that health massage can increase work productivity. The National Productivity Council has the notion that productivity is a mental attitude that always holds the view that the quality of life today must be better than yesterday and tomorrow must be better than today. The philosophy and spirit of productivity have existed since the beginning of human civilization because the meaning of productivity is the will and effort of humans to always improve the quality of life and livelihood in all fields. In general, productivity is a comparison between the output achieved with the input needed to produce that output (Purnama, 2008). Sedarmayanti (2001) states that various factors that affect work productivity include mental attitudes in the form of work motivation, work discipline and work ethics, education, skills, management, income levels, health, social security, social environment, work climate, production facilities, technology and achievement opportunities.

Growing and improving productivity support factors for persons with disabilities will be very useful for their long term lives. Mora (2020) said that by mentally preparing and increasing work motivation for someone, work results or productivity will increase as well as quality so that they can reduce and avoid various kinds of risks at work. Providing appropriate skills training for persons with disabilities is one way that can be done to increase the productivity of persons with disabilities. If they have physical deficiencies in the hands, they can maximize other limbs such as the legs. Likewise, in physical conditions where they have deficiencies in vision or hearing, they can maximize the function of the limbs in the hands and feet. For example, we often see massage training for people with visual disabilities or commonly called the blind.

To improve the skills of persons with disabilities, of course, there are various kinds of obstacles, as Gayatri (2020) has stated. He explained that there were several obstacles experienced by persons with disabilities such as education in special schools which were unable to meet the readiness of persons with disabilities in facing the world of work. Furthermore, there are still many companies that do not have a work system that is adapted for workers with disabilities. Then persons with disabilities who are looking for jobs do not match the demand. This is also supported by inadequate facilities making it difficult to access for persons with disabilities. Lastly is the unavailability of work designs that are in accordance with the capabilities of people with disabilities.

In order to maximize the potential of persons with disabilities, counseling efforts are needed to improve skills. Mulyati (2019) said that there is a need for counseling on skills to find new product ideas, plan and develop products, conduct entrepreneurship training and how to increase success in entrepreneurship, the ability to manage both finances and marketing so that people with disabilities are able to improve economic quality and productivity independently. Not only for blind people, massage training is also very useful for people with other disabilities. Looking at the benefits of massage itself, we cannot deny that massage is very beneficial for the health of the body and is needed by many people.

This study shows that there are differences in health massage and it has an effect on work productivity consisting of motivation, knowledge, attitude skills and independence. In line with Peter's research (2009) showing that massage can cause relaxation and calm. The massage technique applied is very useful for dealing with health, overcoming complaints of pain and can overcome fatigue. Massage is a fun thing, because it can help the body and mind to produce endorphins which are pain relievers experienced by the body (Juliantri, Nurfianti, and Maulana, 2015: 249). In accordance with the opinion of Kaur (2012) that massage has a mechanical effect that will improve circulation, remove waste products from the body, increase joint mobility and reduce muscle tension. Wahida and Khusniyah, (2012) doing massage will affect the work of the cerebral cortex so as to produce positive perceptions and relaxation, indirectly helping to balance the body's homeostasis through the HPA Axis, to produce Corticotropin Releasing Factor (CRF)

If we look at its history, Arslan (2022) explains that massage has a long history which was found since ancient civilizations in Egypt, China and India where the three nations had health care systems that became role models throughout the world. He also added that massage can make a person able to convey his feelings easily, especially the interaction between the nurse and the patient. With the correct massage technique, it will help improve blood circula-

tion and reduce heart tension and blood pressure. In addition, massage can increase mental and psychological peace and reduce anxiety levels in a person. Talking about anxiety, this will certainly stick with persons with disabilities whose roles have high self-confidence. Not only does it affect their social life, low levels of self-confidence will also affect their work productivity.

Demirel (2019) argues that social anxiety often arises when a person feels that he is different from other people, especially in terms of depiction of the body. This of course greatly affects people with physical disabilities, because at certain times they may feel that they are different from other people in general. Therefore increasing self-confidence in persons with physical disabilities will have a very good impact on their social life. When people with disabilities have more abilities compared to humans who have complete body organs in general, their self-confidence will also increase indirectly. Not only that, he also added that a person's mental health will not only affect their productivity level but will also cause new health problems such as cardiovascular disease, diabetes, hypertension, cancer, osteoporosis, and obesity.

Health massage has various manipulations, including: Techniques used are friction, petrisage, tapotement, walken and effleurage. Each of these massage techniques certainly has its own function and use. Friction technique is a massage manipulation technique by rubbing, while petrisage is a technique by massaging or squeezing. Meanwhile for the tapotement technique is the tapping or tapping movement, for the massage movement with the walken technique means massaging by vibrating, and the last is the massaging movement with the effleurage technique, namely the massaging technique by rubbing. Friction massage is done by rubbing certain parts of the body, either by rotating or sliding the hands to form a certain order. Some of the functions of friction include putting pressure on the skin so that blood flow becomes smooth, skin glands become active, and tightens the skin muscles so that wrinkles will disappear. Prayogo (2022) argues that the friction technique is very useful as a therapeutic technique for sufferers of low back pain. With this movement, the pain will subside and improve activity abilities. He also added that this friction massage technique is able to increase circulation so that the tissues in the body can get adequate amounts of nutrients, oxygen, blood. While the petrisage movement is done by clamping several parts of the skin using the fingertips or palms. With this movement, the skin becomes more stimulated and the muscles become more relaxed.

The basic movement in the next massage is tapotement, which is a tapping movement repeatedly and quickly while paying attention to the rhythm of the beats given. This movement will restore loose muscles and stimulate the nerves in this way blood circulation becomes smoother and fresher. Another type of movement, namely walken, is to move certain areas of the body quickly and continuously. By doing this massage, the tissues will become more limp and relieve tension, but please note that this movement should not be done excessively, just occasionally. As for the last movement, namely effleurage, which is a rubbing movement on certain parts of the body which is done repeatedly while pressing slowly on the part that is being massaged.

The specifications for the form of health massage are body positions consisting of two positions, prone and supine. In the prone position starting from the left starting from the bottom, namely the left leg. The order of the parts of the body to be massaged when in the prone position, including: soles of the feet, ankles, calves, thighs, buttocks and back. Modification of health massage between sport massage and circular massage methods. Sports massage can produce several hormones such as endorphins, adrenaline hormones, and thyroxine. Endorphins are obtained from effleurage and friction techniques. Endorphins are calming hormones. The thyroxine hormone is obtained from the petrisage, tapotement, effleurage, shaking, walken movement techniques. The hormone aims to transport the remains of the body's metabolism. Adrenaline hormone aims to control the nervous system, obtained by tapotement movements. Sport massage stimulates the peripheral nerves obtained from tapotement, stroking, effleurage movements (Wijanarko and Riyadi, 2010).

The mainstay technique in circular massage is friction with circular movements. Tapotement is meant to maximize friction, and effleurage is meant to be calming. At the beginning of the massage, friction is deliberately given immediately to cause a shock and stimulate the release of endorphins which function as sedatives. All members of the body from the soles of the feet to the head will be manipulated in this circulo massage by considering the structure of the muscles and how the organs of the body work. Manipulation or how to hold or grip is a way of using the hands in doing circulo massage in certain areas, as well as giving a certain influence as well. Various types of circulo massage manipulation that are used include: friction, tapotement, walken, effleurage, and skin rolling (Physical Therapy Clinic Team, 2008).

This study shows that there is a significant difference with the level of school and non-school education in increasing work productivity which consists of motivation, knowledge, skills, attitudes and independence. In various studies it has been reported that the sample that received training has a better attitude after attending the training program (Maclaren et al., 2017). Nugroho, Asrin, and Sarwono (2012) suggested that regular massage can reduce systolic and diastolic blood pressure, reduce levels of the stress hormone cortisol, reduce sources of depression and anxiety, so that blood pressure will continue to fall and body function will improve, if the function of the body gets better, then the quality of life and work productivity can improve properly.

Persons with disabilities who are given massage training need not only know the techniques used in massage but also must know the many benefits that can be obtained from the massage itself. The effect of massage is to increase one's work productivity, which is a selling point for people with disabilities who have massage skills.

CONCLUSION

Based on the research results, the following conclusions can be drawn: From the results of the Paired T-Test it was found that the significance value (2-tailed) was <0.05, so that the data indicated that there was a significant difference between the initial and final variables. Meanwhile, from the results of the ANOVA test, a significance of 0.267 was obtained. So that it can be interpreted that there is a significant influence on the treatment given with health massage on work productivity variables consisting of motivation, knowledge, skills, attitudes and independence for people with disabilities with physical disabilities. The increase in work productivity that experienced the greatest increase was in the variable Motivation with a percentage increase of 16.75%.

Acknowledgments
We would like to thank the Faculty of Sport Sciences, Yogyakarta State University, who have given us permission.
Conflict of Interest
The authors declare that there are no conflicts of interest.

REFERENCE

Arslan, G. G., & Yucel, S. C. (2022). Effects of the Hand Massage and Back Massage on Comfort and Anxiety in Older People: A Randomızed Controlled Trial. *Asian Journal of Nursing Education and Research*, *12*(2), 173-179.

Demirel, H. (2019). Social Appearance Anxiety and Rosenberg Self-Esteem Scores in Young Physical Disabled Athletes. *Universal Journal of Educational Research*, *7*(3), 664-667.

Destanto, K. (2004). *Studi Persepsi Masyarakat terhadap Tingkat Kepentingan Penyediaan Ruang Terbuka Publik (RTP) yang Aksessibel Bagi Masyarakat Difabel (Studi Kasus: Alun-Alun Utara Solo)* (Doctoral dissertation, Universitas Diponegoro).

Gayatri, I. A. M., & Suriata, I. N. (2020). Challenges And Opportunities Of Blind Masseurs In Increasing Competency Through Implementation Business Standards Of Massage Parlor. *ADI Journal on Recent Innovation (AJRI)*, *1*(2), 107-120.

Guidry-Grimes, L., Savin, K., Stramondo, J. A., Reynolds, J. M., Tsaplina, M., Burke, T. B., ... & Fins, J. J. (2020). Disability rights as a necessary framework for crisis standards of care and the future of health care. *Hastings Center Report*, *50*(3), 28-32.

Hackett, R. A., Steptoe, A., Lang, R. P., & Jackson, S. E. (2020). Disability discrimination and well-being in the United Kingdom: a prospective cohort study. *BMJ open*, *10*(3), e035714.

Juliantri, V. (2015). Efektivitas Massage Ekstremitas terhadap Perubahan Tekanan Darah pada Pasien Hipertensi di Klinik Pratama Universitas Tanjungpura Tahun 2015. *Jurnal Mahasiswa PSPD FK Universitas Tanjungpura*, *1*(3).

Kaur, J., Kaur, S., & Bhardwaj, N. (2012). Effect of 'foot massage and reflexology'on physiological parameters of critically ill patients. *Nursing & Midwifery Research Journal*, *8*(3), 223-233.

KEMENPPPA. (2019). Pengertian, Jenis dan Hak Penyandang Disabilitas. https://spa-pabk.kemenpppa.go.id/index.php/perlindungan-khusus/anak-penyandang-disabilitas/723-penyandang-disabilitas

Kristiyanti, B., & Rusmawati, D. (2019). Hubungan antara kepribadian hardiness dengan regulasi emosi pada penyandang tunadaksa di balai besar rehabilitasi Bina Daksa (BBRSBD) Prof. Dr. Soeharso Surakarta. *Jurnal Empati*, *8*(2), 431-436.

Kudrin, M. R., Astrakhantsev, A. A., Krasnova, O. A., Klimova, E. S., Kostin, A. V., & Spiridonov, A. B. (2020). Increasment of productivity of first-calf cows by performing udder massage. *International Transaction Journal of Engineering, Management and Applied Sciences and Technologies*, *11*(10), 11-5.

MacLaren, J. E., Cohen, L. L., Larkin, K. T., & Shelton, E. N. (2008). Training nursing students in evidence-based techniques for cognitive-behavioral pediatric pain management. *Journal of Nursing Education*, *47*(8), 351-358.

Mora, Z., Suharyanto, A., & Yahya, M. (2020). Effect of work safety and work healthy towards employee's productivity in PT. Sisirau Aceh Tamiang. *Burns*, *2*(1), 753-760.

Mulyati, T., Rohmatiah, A., & Amadi, D. N. (2019). Pelatihan Dan Pendampingan Penyandang Disabilitas Desa Simbatan, Kecamatan Nguntoronadi Kabupaten Magetan. *Jurnal Terapan Abdimas*, *4*(2), 187-191.

Nugroho, I. A., & Asrin, S. (2012). Efektifitas pijat refleksi kaki dan hipnoterapi terhadap penurunan tekanan darah pada pasien hipertensi. *Jurnal Ilmiah Kesehatan Keperawatan*, *8*(2), 57.

Nurahman (2018). *Dirjen Pembinaan, Penempatan Tenaga Kerja, dan Perluasan Kesempatan Tenaga Kerja Kementrian Tenaga Kerja Repu-*

blik Indonesia. Disamapikan dalam Berdayakan Disabilitas Indonesia Bersama BPJS Ketenagakerjaan di Solo.
Peter, C. (2009). The Theraupetic effect of hands massage. Learning Disability Practice. 12.5 (June 2009): p29.Gale diakses 9 Juni 2017.
Prayogo, D., Sadu, B., Wicaksono, U., & Gunawati, F. (2022). Addition of deep cross-friction massage is better than slow stroke back massage after mckenzie exercise to improve functional ability and work productivity of stone breakers with non-specific low back. *International Journal of Social Science*, *2*(2), 1483-1490.
Purnama, R. (2008). Pengaruh motivasi kerja terhadap produktivitas kerja karyawan pada bagian produksi CV. Epsilon Bandung. *Strategic: Jurnal Pendidikan Manajemen Bisnis*, *8*(2), 58-72.
Salceanu, C., & Luminita, S. M. (2020). Anxiety and depression in parents of disabled children. *Technium Soc. Sci. J.*, *3*, 141.
Sarwono. (2007). *Sosiologi Kesehatan Beberapa Konsep Beserta Aplikas*inya. Yogyakarta: Gadjah Mada University Press
Sedarmayanti, M., & Pd, M. (2001). Sumber daya manusia dan produktivitas kerja. *Bandung: CV. Mandar Maju*.
Susanto, Siswantoyo, Sumaryanto, Adi Wijayanto. (2020). Lung Vital Capacity Levels on disability in Swimming Learning. *Fizjoterapia Polska 20*(5); 122-126.
Susanto, S., Siswantoyo, S., Prasetyo, Y., & Putranta, H. (2021). The effect of circuit training on physical fitness and archery accuracy in novice athletes. *Physical Activity Review*, *1*(9), 100-108.
Susanto, S. Traditional Sport-Based Physical Education Learning Model in Character Improvement and Critical Thinking of Elementary School Students. *Sports science and health*, *24*(2), 165-172.
Tim Klinik Terapi Fisik FIK UNY. (2008). *Pelatihan Circulo Massage*. Yogyakarta: Klinik Terapi Fisik Fakultas Ilmu Keolahragaan Universitas Negeri Yogyakarta.
Tribun Jogja. (2016). *Surwandono Kini Jadi Ojek Difabel: Difa CT Jawab Keraguan Kaum Difabel*. Tribun Jogja, 18 Maret 2016, hal 1 & 11.
Wahida, N., & Khusniyah, Z. (2012). Pengaruh Hipnoterapi Terhadap Nyeri SendiPada Lansia. *Prosiding Seminas Competitive Advantage*, *1*(2).
Wijanarko, B., & Riyadi, S. (2010). Sport Massage: Teori dan Praktek. *Surakarta: Yuma Pustaka*.

Primljen: 29. maj 2023. / Received: May 29, 2023
Prihvaćen: 28. septembar 2023. / Accepted: September 28, 2023

https://doi.org/10.7251/SSH2302201M
UDC: 612.65:796.012.1-057.875
Original scientific paper
Originalni naučni rad

The Relationship Between Students' Nutritional Status and Their Physical Activity

Nazim Myrtaj[1], Fatmir Pireva[1], Branimir Mikić[2]
[1]Faculty of Physical Culture and Sports, AAB College, Prishtina
[2]Faculty of Health Sciences, European University "Kallos" Tuzla, Bosnia and Herzegovina

Correspondence:
Fatmir Pireva, Faculty of Physical Culture and Sport AAB College, Prishtina
fatmir.pireva@universitetiaab.com

Abstract: *The research was carried out on a sample of 1000 (500 male and 500 female) students randomly selected from several faculties within the AAB College in Pristina, Kosovo. Respondents were treated in accordance with the Declaration of Helsinki. For the assessment of physical activity, the international questionnaire (InternationalPhysical Activity Questionnaire IPAQ). To assess the state of nutrition, morphological parameters were applied: body height, body weight and body mass index. Descriptive analysis, non-parametric technique of difference within the group as well as regression analysis were applied to process the results.*

The obtained results show that the average height of the student population is Mean = 174.74±8.6; body weight, mean= 70.88±12.7; body mass index, Mean = 23.1±3.3. The prevalence of overweight is 26.1%, while obesity is 2.8%. The results obtained are almost the same as the countries in the region. The survey for the assessment of physical activity indicates an insufficient involvement of students in physical activities that corresponds to the prevalence of overweight. When asked how much time you usually spend sitting during a working day, the prevalence of 2-7 hours is 84.6%. Regression analysis shows a correlation between inactivity during the day and body mass index.

The data show a trend towards increasing obesity in the student population and this is an extremely powerful reason for: the Ministry of Youth, Culture and Sports, for the Ministry of Education, for Universities and Colleges, tocreate conditions for the highest possible participation of students in sports and recreational activities.

Keywords: *Students, morphological parameters, physical activity, prevalence, IPAQ.*

INTRODUCTION

Physical activity plays a very important role in the health and well-being of children and adolescents. It contributes to psychological, social, emotional and physical development. Also, physical activity promotes the independence and healthy growth of children and adolescents (The European health report 2002). Physical activity is one of the most important factors affecting energy balance. Participating in physical activities is part of a healthy lifestyle as it also affects the prevention of chronic diseases and obesity (Goran, &Treuth, 2001). Regular participation of young people in physical activities is important as it improves health and reduces the risk of developing several chronic diseases, including cardiovascular disease, hypertension, overweight and obesity, osteoporosis, diabetes and some types of cancer. Participating in physical activity is also related to the psychological side of young people, improving symptoms of anxiety or depression in them. Also, participation in these activities helps young people to adopt other health behaviors such as: not smoking, alcohol or drugs (Epstein, & Goldfield, 1999).

Today's late teens participate in many activities that require little or no energy. Sedentary life and unhealthy lifestyles often develop in adolescence (Amisola and Jacobson, 2003). The development of technology in the last decade, as well as the easy access to electronic media (television, video games, internet), have made the leisure activities of teenagers to change substantially, increasing the time they spend in front of electronic media. . Watching TV can affect obesity in two ways: by cutting off young people's participation in physical activity, in which they would spend energy, and on the other hand by increasing the energy received (eating), watching TV or from advertising. different food (Christakis, with bp., 2004).

Given that many factors from the social and physical environments determine the choices of individuals, then the prevention of obesity requires a multisectoral and multidisciplinary approach that combines the promotion of healthy lifestyles with activity that act on socio-economic determinants, as well as on the physical environment.

In the Republic of Kosovo, there is a lack of such research, especially with large research samples that would provide information on the prevalence of overweight (obesity), as well as their impact on the health of students.

Therefore, the main purpose of this research is to prove the level of nutrition among the students of the Republic of Kosovo and the connection between nutrition and physical activity.

The validation of these reports is important from both a scientific and a practical point of view, mainly to understand the impact of physical activity on the body mass index. At the same time, through this research and its results, I aim to help prevent obesity; in preventing the increase in the number of obese people. Such research aims to bring complete information regarding obesity in Kosovo.

METHODS

In order to obtain qualitative data, the student population was selected for ethical reasons.Also, at this age, since growth is intense, there are even more health consequences due to obesity. This age was selected becauseindividuals are productive at work, in studies, are sexually active, have opportunities to engage in physical activity, etc. Likewise, the age after puberty is estimated to be the age at which premature deaths often occur, from coronary heart disease, cancer and heart attack as a result of inactivity and obesity.

Sample of respondents

The research was conducted on a sample of 1000 randomly selected respondents from several faculties within the AAB College. The sample consists of 500 (50%) male respondents (male students) and 500 (50%) female respondents (female students). The average age of respondents of both sexes was 21.59 years. The survey was carried out in the amphitheater using the appropriate work organization, which is typical for such research. Respondents were treated in accordance with the Declaration of Helsinki.

Sample variables

Some of the data were collected by survey method using structured questionnaire. The variables are defined in two groups: Categorical variables (criterion variables): Gender and Level of physical activity. To assess the state of nutrition, I will use these morphological parameters: Body height, Body weight and IMT: body mass index, which shows the ratio of body weight and body height.

Description of measuring instruments

Physical Activity Questionnaire (IPAQ)

For the assessment of physical activity, a questionnaire (P1) from the questionnaire was used International Physical Activity Questionnaire (IPAQ) (according to Hagströmer, Oja , Sjöström, 2006). The structure of the questionnaire allows us an overview of the intensity of some activities that are carried out in any of the three categories mentioned above. In addition, the structure of cells (items) allows to calculate the result of consumption (energy consumption), during walking, during physical activity with moderate intensity and physical activity with high intensity for each category separately. The calculation of the total result means the sum of the duration (in minutes) and frequencies (in days), for all types of activities and for each separate category. It is also possible to calculate the results for each category separately. Craiga and colleagues (Craiga et al. 2003), investigated reliability in 12 countries. Spearman's correlation with the test-retest method also ranged from 0.46 to 0.96, but most often it was 0.80, indicating that the instrument had good reliability.

Statistical analysis

For all quantitative variables, the basic descriptive statistical parameters were calculated and the following: arithmetic mean (Ma), standard deviation (DS), median (ME), quartile range (RQ), skewness (KURT), distribution asymmetry (SKEW), analysis regression and analysis of variance. For all qualitative variables, frequencies, relative frequencies and percentages of individual responses were calculated and the χ^2 test and regression analysis were applied. Data were analyzed using SPSS version 23.0 (SPSS, Chicago, IL, USA).

RESULTS

The results obtained from the statistical processing are presented in 4 tables which clarify the distribution of the results according to the stated purpose.

Table 1. *Classification of results according to body mass index for adults (taken from: World Health Organization, & World Health Organization (1998). Obesity: preventing and managing the global epidemic: report of a WHO consultation. WHO technical report series, 894, 253)*

	MALE		Females		in total	
	Frequency	%	Frequency	%	Frequency	%
Malnutrition 16.00 - 18.50	16	3.2	48	9.6	64	4.6
Normal body weight 18.50 - 24.99	312	62.4	335	67.0	647	64.7
Overweight 25.00 – 29.99	160	32.0	101	20.2	261	26.1
Obesity ≥ 30.00	12	2.4	16	3.2	28	2.8
in total	500	100	500	100	1000	100

The frequencies of male respondents and female respondents are presented in table 1. Malnutrition values of 16.00–18.50 for males show that 16 respondents or 3.2% of them belong to this level, while for females they belong 48 respondents or 9.6% of them, a total of 64 respondents or 4.6%. At the normal body mass level, 312 respondents or 62.4% of them belong to men, 335 respondents or 67.0% of them belong to women, a total of 647 respondents or 64.7%. At the level of overweight body mass, 160 respondents or 32.0% of them belong to men, 101 respondents or 20.2% of them belong to women, a total of 261 respondents or 26.1%. At the level of body mass with obesity, 12 respondents or 24% of them belong to men, 16 respondents or 3.2% of them belong to women, a total of 28 respondents or 2.8%.

Table 2. *Frequency of respondents for both genders for question Q1*

Q1	Frequency	%
30 minutes a day	30	3.0
1 hour a day	124	12.4
2 hours a day	169	16.9
3 hours a day	261	26.1
4 hours a day	193	19.3
5 hours a day	92	9.2
6 hours a day	78	7.8
7 hours a day	47	4.7
½ hour a day	6	0.6
Total	1000	100%
Chi square test	Ash =503.0; df: 8; P = 0.00	1000

Legend: Q1 - During 7 days, how much time did you usually spend sitting during a working day?

The frequencies of the respondents for the two genders in question Q1 are presented in table 2. In the question: Over the course of 7 days, how much time did you usually sit during a working day? , for the option 30 minutes a day , 30 or 3.0% of the respondents declared, 1 hour a day was declared by 124 or 12.4% of the respondents, 2 hours a

day were declared by 169 or 16.9% of the respondents, 3 hours a day are declared 161 or 16.1% of the respondents, 4 hours a day were declared 193 or 19.3% of the respondents, 5 hours a day were declared 92 or 9.2% of the respondents, 6 hours a day were declared 78 or 7.8% of the respondents , 7 hours a day were declared by 47 or 4.7% of the respondents, ½ hour a day were declared by 6 or 0.6% of the respondents. The Chi square test shows that there is a significant statistical difference within the group in the answer given by the respondents of both genders to this question because: Hi = 503.0; df: 8; P = 0.00.

The basic statistical and distribution parameters of the morphological variables and the calendar age of the students of both sexes are presented in table 3. From this table we see that the anthropometric measurements are symmetrical because the coefficients of asymmetry (Skewness) are below the zero value (0). calendar age was an exception because the participation of students in the research was different, namely from 17 to 30 years old. All the applied anthropometric variables have coefficients of positive epicurtic asymmetry (+), which means that the arithmetic means tend towards the highest results, while most of the results are below the arithmetic mean. Only the calendar age has a pronounced asymmetry because most of the tested are leaning towards the younger age. In the kurtosis column, the anthropometric variables, body height, body weight and body mass index have the sign (-) which means that their curve is flat (platokurtic) and the variable, calendar age has the sign (+) which it means that its curve is normal (mesokurtic).

Table 3. *Basic statistical parameters of morphological variables in students of both sexes*

Total	N	Min	the Max	Mean	Std. Dev.	Skew	Kurt
AGE	1000	17.00	31.00	21.59	3.01108	1.199	.708
ABH	1000	142.00	199.00	174.74	8.64417	.064	-.290
ABW	1000	45.00	108.00	70.89	12.72659	.332	-.568
ABMI	1000	17.10	32.99	23.13	3.28387	.377	-.440
P1	1000	1	8	4.30	1.69837	.300	-.430

Table 4. *Correlation of anthropometric predictor variables with the criterion variable for sedentary life in the question: During 7 days, how much time did you usually spend sitting during a working day?*

Pattern		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	595.249	44.4		13.407	0.00
	AGE	0.152	0.104	0.041	1,459	0.14
	ABH	-3.141	0.255	-2.412	-12.329	0.00
	ABW	4.09	0.311	4.625	13.166	0.00
	ABMI	-11.182	0.949	-3.262	-11,784	0.00

a. Dependent variable: P1 During the 7 days, how much time did you usually spend sitting during a working day?

R = 0.541; R Square = 0.293; F = 103.161; Sig. = 0.000

By means of regression analysis among students of both sexes (table 4), the value of the correlation between the group of independent predictor variables (anthropometric variables) and the criterion dependent variable (sedentary life) was determined with the question: During 7 days, How much time do you usually spend sitting down during a work day?The correlation of the entire system of independent predictor anthropometric variables: body weight, body weight and body mass index as well as calendar age with the criterion dependent variable: During 7 days, how much time did you usually spend sitting during a working day,there is a multiple correlation coefficient (multiple) with a value of R = 0.541, which explains the common variability between the system and the criterion variable of about 29% (R Square = 0.293). The coefficient of the F-test that was obtained is high (103.161) and it is confirmed with the height of significance (Sig = 0.000), which shows that there is a statistically significant multiple correlation between

the two calculated systems. The obtained results show that between the anthropometric parameters and the sedentary life expressed by the question: During 7 days, how much time did you usually spend sitting during a working day? there is a significant statistical correlation that conditions each other.

DISCUSSION

The characteristics of the sample as well as the results of the empirical part of the research show a possible conclusion that a small part of the population of young age (after adolescence) in the Republic of Kosovo regularly engages in physical activities, which can be characterized as exercises regular physical. If we know that one of the most important goals of physical and health education is the adoption of healthy habits that make regular physical exercises, then the question is how much this has become part of their daily life. Bearing in mind that research on the physical activities of young people in the Republic of Kosovo has not been carried out before and that the sports and recreational habits of our young people were not known, as well as their quality of life in in general, both at the territorial level and at the national level, the results of our research can provide a good basis for further research, which will be more exploratory and comprehensive. Since they are based on the self-assessment of the respondents, of some important indicators, on the basis of which the "in-depth" identification of the needs and interests of citizens in the field of physical exercises and with it a lifestyle of healthy.

Important factors for students are: success in studies, interpersonal relationships, going out and socializing with friends. So, it is assumed that due to these factors, students are already satisfied enough with life and that physical activity does not have a significant impact on quality of life. Students who engage in physical activity are more likely to engage in it because they enjoy it, and those who do not engage in it have other hobbies and interests that enhance their quality of life in their own way. Another answer to the existing result can be found in the results obtained in the subscales of the individual domains of quality of life, in which the students achieved the highest result in the health subscale, which is not surprising for the student population. Students, being a younger population, are certainly not characterized by major health problems compared to older people. On the other hand, since physical activity has a significant impact on health (Pate et al., 1995; Heimer et al., 2004), the positive contribution of physical activity to the quality of life of patients and the elderly is certainly more highlighted, as observed in most studies that focused on the relationship between the mentioned variables (Anokye et al., 2012; Phillips et al., 2013). Thus, some aspects of life, such as physical activity, are not equally important for everyone. For the students, since they are already satisfied with their health, physical activity does not have any additional impact on them, and consequently not even on the quality of life. With this research, an attempt has been made to establish a connection between physical activity and overweight in young women and men, respectively in students.

The study used body mass index to determine the prevalence of obesity, which is the most widely used indicator of nutritional status at the level of broad population masses, although there is a drawback to measurements at the individual level (Flegal et al., 2009). Some researchers question the use of BMI as an indicator of body fat deposits, believing that it should be replaced by other indicators (Kragelund, &Omland, 2005). Misclassification of nutrition based on BMI can occur in the elderly, who due to the aging process lose muscle mass and increase the content of adipose tissue in the body, and BMI can underestimate body fat stores. The problem may also exist in people with developed muscles who may have a high BMI even though they are not obese (Kragelund, &Omland, 2005). Despite these shortcomings of BMI, several studies have confirmed that BMI is a good indicator of body fat stores (Hu, 2008), so BMI has been accepted as a reliable and valid measure to identify individuals at risk. increasing obesity-related mortality and morbidity (Flegal et al., 2009). The prevalence of obesity in our research,2.4% in men and 3.25% in women, is lower than the prevalence of obesity in the world in 1975, where it was 3% in men and 6% in women, to reach 11% in men and 15% in women in 2014 (NCD-RisC, 2016). The prevalence of overweight in the countries of the European region varies between 32-79% in men and 28-78% in women, which is almost equal to our research 32% in men and 20.2% in women. The prevalence of obesity varies between 5-23% in men and 7-36% in women, which is higher than in the sample studied in Kosovo, in men 2.4% and in women 3.25% (Branca, et al., 2007). Body mass index that shows normal body weight 18. 50–24. 99 was found in men 62.4% and in women 67.0%, which corresponds to data from other authors (Rouzitalab, 2015).

CONCUION

The results of our research show a moderately high prevalence rate in overweight students and a lower prevalence in obese students. Students who have been identified as overweight are distinguished as a group with an increased relative risk of occurrence and development of diseases related to excessive eating and insufficient daily physical activity. Students during their studies often do not pay attention to the way of nutrition to the extent that is recommended and their main diet consists of fast foods, then they consume a lot of sweets, coffee and energy drinks. Students do not take enough care of their health or healthy lifestyle, neglecting physical activity and healthy eating, but giving more priority to the obligations in the faculty as well as entertainment. We can conclude that physical activity, regardless of age and gender, plays a very important role in preventing overweight. Regardless of the stage of overweight, systematically controlled physical activity contributes to maintaining optimal health. It is very important to create habits and influence the change of lifestyle by increasing the daily time for physical activities, as a preventive measure for increasing body weight and thus influencing the quality of life. The data show a trend towards increasing obesity in the student population and this is an extremely powerful reason for: the Ministry of Youth, Culture and Sports, for the Ministry of Education, for Universities and Colleges to create conditions for participation as higher of students in recreational sports activities.

REFERENCES

ACSM (American College of Sports Medicine) (2005). *Health-Related physical fitness Assessment Manual._* Baltimore: Lippincott Williams and Wilkins.

Anokye, NK, Trueman, P., Green, C., Pavey, TG & Taylor, RS (2012). Physical activity and health related quality of life. *Public health, 12,* 1-8.

Benassi, L., Blažević, I., &Janković, D. (202 1). Physical activity and nutrition of children in primary education. *Economic Research - Economic Research, 35* (1), 2654-2667 DOI: 10.1080/1331677X.2021.1974307

Branca, F., Nikogosian, H., &Lobstein, T. (2007). *The Challenge of Obesity in the WHO European Region and the Strategies for Response.* Copenhagen: WHO.

Christakis, D., Ebel, B., Rivara, F., & Zimmerman, F. (2004). Television, video, and computer game usage in children under 11 years of age. *The Journal of pediatrics 145* (5), 652-6 DOI: 10.1016/j.jpeds.2004.06.078

Craig, CL, Marshall, AL, Sjostrom, M., et al. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and science in sports and exercise,35* (8), 1381-95.

Dewi., RC, &Rimawati., N. (2021). Body Mass Index, Physical Activity, and Physical Fitness of Adolescence. *Journal of Public Health Research, 10* (2). doi:10.4081/jphr.2021.2230

Džepina, M., &Čavlek, T. (2004). *Health care students.* Medix, br. (54/55), 151 – 154.

Epstein, LH, & Goldfield, GS (1999). Physical activity in the treatment of childhood overweight and obesity: current evidence and research issues. *Medicine Science of Sports Exercise, 31* (11 suppl), S5532–S559

Flegal KM, Shepherd JA, Looker AC, Graubard BI, Borrud LG, Ogden CL, et al. (2009). Comparisons of percentage body fat, body mass index, waist circumference, and waist-stature ratio in adults. *Am J Clin Nutr. 89* (2) ,500 -8.

Gazibara, T., KisicTepavcevic DB., Popovic, A., et al. (2013). Eating habits and body-weightsof students of the University of Belgrade, *Serbia: a cross-sectional study. 31* (3): 330-3

Goran, MI, &Treuth, MS (2001). Energy expenditure, physical activity, and obesity in children. *Pediatric Clinic North America, 48* (4), 931–953.

Hagströmer, M., Oja, P., &Sjöström, M. (2006). The International Physical Activity Questionnaire (IPAQ): a study of concurrent and construct validity. *Public Health Nutr,* 9(6), 755-62.doi: 10.1079/phn2005898.

Heimer, S., Mišigoj-Duraković, M., Ružić, L., Matković, B., Prskalo, I., Beri, S. &Tonković- Lojović, M. (2004). Fitness level of adult economically active population in the Republic of Croatia estimated by EUROFIT system. *Collegium Anthropologicum,* 28 (1), 223-233.

Hu, F. (2008). *Obesity Epidemiology.* New York: Oxford University Press.

Huddleston S, Mertesdorf J, & Araki K (2002). Physical activity behavior and attitudes towards involvement among physical education, health, and leisure services pre-professionals. *Coll Stu J. 1;36* (4), 555-73.

Jackson-Leach, R., &Lobstein, T. (2006). Estimated burden of pediatric obesity and co- morbidities in Europe. Part 1. The increase in the prevalence of child obesity in Europe is itself increasing. *International Journal of Pediatric Obesity,1* (1), 26-32.

Kragelund, C., &Omland, T. (2005). A farewell to body mass index? *Lancet. 366* :1589-91.

Kuzman M et al. (2004). Cardiovascular disease - vascular risk in children and young adults. *Medix 56/57,* 73-7.

Kuzman, M., Pejnović Franelić, I., & Pavić Šimetin, I. (2004). Ponašanje u vezi sa zdravljem u djece školske dobi 2001./2002. *Zagreb: Hrvatski zavod za javno zdravstvo*. [in Croatian]

Mandac, V., et al (2001). The influence of physical activity and nutrition knowledge on nutritional status of the twelve years old. *In: International Conference EUSHM, Programs and Abstracts Book: P12,* Budapest.

Marques-Vidal, P., Ferreira, R., Oliveira, JM and Paccaud, F. (2008). Is thinness more more prevalent than obesity in Portuguese adolescents? *Clinical Nutrition 27,* 531–536.

Mišigoj-Duraković, M. (2008). *Kinanthropometry.* Faculty of Kinesiology, University of Zagreb.

Mikić, B., Bojić, A., Petrović, N., Šljivić, E., Numanović, E. (2022). Specifičnosti životnih navika srednjoškolaca. Travnik. Međunarodna statistička Konferencija. Univerzitet u Travniku. [in Serbian]

NCD Risk Factor Collaboration (NCD-RisC). (2016). Trends in adult body-mass index in 200countries from 1975 to 2014: a pooled analysis of 1698 population-based measurements studies with 19.2 million participants. *Lancet.387* (10026), 1377-96.

Pate, R., Pratt, M., Blair, S., Haskell, W., Macera, C., & Bouchard, C. (1995). Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA,273,* 402-407.

Peltzer K, Pengpid S, Samuels T, Özcan NK, Mantilla C, Rahamefy OH, et al. (2014). Prevalence of overweight/obesity and its associated factors among university students from 22 countries. Int. J. Environ. *Res. Public Health.11,* 7425.

Phillips, SM, Wójcicki, TR, & McAuley, E. (2013). Physical activity and quality of life in older adults: an 18-month panel analysis. *Quality of Life Research, 22,* 1647-1684.

Rouzitalab, T., Gargar, i BP, Amirsasan, R., Jafarabadi, MA, Naeimi, AF, &Sanoobar, M. (2015). The relationship of disordered eating attitudes with body composition and anthropometric indices in physical education. *Iranian Red Crescent Medical Journal, 17* (11), e20727.

Roshita, A., Riddell-Carre, P., Sjahrial, R., Jupp, D., Torlesse, H., Izwardy, D., & Rah, JH (2021). A qualitative inquiry into the eating behavior and physical activity of adolescent girls and boys in Indonesia. *Food and Nutrition Bulletin,42* (1_suppl), S122-S131. doi:10.1177/0379572121990948

The European health report 2002. *Copenhagen, WHO Regional Office for Europe, 2002 (WHO Regional Publications, European Series, No. 97).*

Wallace, LS, Buckworth, J., Kirby, TE, & Sherman, WM (2000). Characteristics of exercise behavior among college students: Application of social cognitive theory to predicting stage of change. *Preventive Medicine: An International Journal Devoted to Practice and Theory, 31* (5), 494-505.

WHO Expert Consultation (2004). Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet (London, England),363* (9403), 157–163. https://doi.org/10.1016/S0140-6736(03)15268-3

World Health Organization (2011). *Obesity and overweight fact sheet.* Department of Sustainable Development and Healthy Environments.

Primljen: 18. jul 2023. / Received: July 18, 2023
Prihvaćen: 08. oktobar 2023. / Accepted: October 08, 2023

https://doi.org/10.7251/SSH2302208B
UDC: 316.728:616.12-089.168
Original scientific paper
Originalni naučni rad

The relationship between the quality of life and cardiorespiratory fitness

Marko Badrić[1], Leona Roca[1], Nenad Krošnjar[2]
[1]*Faculty of Teacher Education University of Zagreb, Croatia*
[2]*Faculty of Humanities and Social Sciences University of Zagreb, Croatia*

Correspondence:
Marko Badrić, Faculty of Teacher Education University of Zagreb, Croatia
marko.badric@ufzg.hr

Abstract: *Low levels of cardiorespiratory fitness and physical fitness have a negative impact on the health of children and adolescents. The aim of the study is to determine the relationship between the quality of life and cardiorespiratory fitness in elementary school students. The study involved 651 4th grade elementary school students in the Republic of Croatia. The average age of the students was 10.38 ± 0.50 years. Their body height was measured with a height metre (Seca® 213, Hamburg, Germany) and body mass, body mass index (BMI), and adipose tissue (%) with a dual-frequency body composition analyser (TANITA DC -360P). Cardiorespiratory fitness was determined by a multistage 20-metre run test (20MSRT Shuttle Run Test). The quality of life was assessed by a questionnaire for children and adolescents aged 8 to 18 years (KIDSCREEN-10). The results show that students perceived their quality of life as relatively high (4.33) and that the values of maximal oxygen uptake (VO2max) were 45.16 mL/kg/min. The results of a simple regression analysis show that there is a statistically significant relationship (p=0.00) between the quality of life and cardiorespiratory fitness in elementary school students. The results obtained in this research should serve as a stimulus for future researches concerning the relationship of cardiorespiratory fitness, physical activity and quality of life. Raising the level of cardiorespiratory fitness together with a healthy diet should encourage the development of intervention school programs which would considerably improve the overall health of children and adolescents.*

Keywords: *quality of life, cardiorespiratory fitness, health, elementary education, children, ill-being.*

INTRODUCTION

Quality of life is described as part of holistic health and takes into account one's perception Health Related Quality of Life (HRQoL) provides information about a person's feelings about their well-being and provides information about current and future health (Pastor et al., 2022). Inadequate physical activity among children and adolescents is increasingly prominent and is becoming a growing public health problem, particularly among elementary school-aged children (Roca & Badrić, 2019). Quality of life is described as part of holistic health that takes into account the individual's perception of physical, mental, and social functioning (Centres for Disease Control, 2011). The World Health Organization defines health-related quality of life as a multidimensional and integrative construct consisting of physical, psychological, and social well-being and functioning (WHOQOL, 1993). Quality of life is a set of different conditions and needs such as biological needs, safety, love and belonging, respect, self-actualization, desire for knowledge and understanding, and aesthetic needs. (Jurko, Čular, Badrić, & Sporiš 2015). Health-related quality of life measures the impact of health or illness on daily life and is highly influenced by a person's concerns, conditions, and desires, as well as self-perceived health and well-being (Haraldstad et al., 2019).

Physical activity, health, and quality of life are closely linked. The human body is designed for movement and therefore requires regular physical activity to function optimally and prevent diseases (Heimer & Sporiš, 2016). Health-related quality of life is most commonly included in quality of life assessments because it covers a wide range of health issues, including subjective perceptions and thoughts, as well as an individual's functioning and ability to thrive in different areas of life (Wallander & Koot 2016). Cardiorespiratory fitness is a direct indicator of the overall capacity of an person's cardiovascular and respiratory systems to perform physical activities (Zhan et al., 2020). Cardiorespiratory fitness refers to the overall capacity of the cardiovascular and respiratory systems, as well as the ability to perform long-term rhythmic and dynamic exercises involving the large muscles of the body, and its direct measure is aerobic capacity (Lang et al., 2018). Maximum oxygen uptake (VO2max) is the only objective measure of

cardiorespiratory fitness and is exclusively used in exercise, fitness or cardiovascular health research. Cardiovascular capacity also determines aerobic capacity (Jurko et al., 2015). Cardiorespiratory fitness can be measured directly, expressed as maximal oxygen consumption (VO2max), or it can be estimated from the peak speed achieved on a treadmill or cycloergometer, or from non-exercise algorithms (Ross, et al., 2016). Cardiorespiratory fitness, which declines with age, is one of the greater problems of today's population. Insufficient physical activity and sedentary lifestyle undoubtedly contribute to poor cardiorespiratory fitness. (Badrić & Roca, 2020). Evaristo and colleagues (2019) emphasize the importance of developing a system for cardiorespiratory fitness in adolescents and that further research is needed in the future to assess the causal connection between cardiorespiratory fitness and quality of life in adolescents. From a clinical and public health perspective, monitoring children's physical fitness and aerobic skills development provides fundamental information that can be used to maintain and improve children's health. (Kolimechkov, 2017). A higher value of cardiorespiratory fitness in childhood and adolescence is closely related to current health status, but also to a good prediction for the future (Ortega et al., 2011). Therefore, it would be of great benefit to schools to conduct physical fitness tests that are tailored to the age of the participants and would provide the most relevant results on the relationship between physical fitness and health. Information on predictors related to quality of life in children and adolescents is important for public health (Magiera & Pac 2022). Some studies have confirmed a positive association between cardiorespiratory fitness and quality of life (Andersen et al., 2017; Pires-Júnior et al.., 2018; Riiser et al., 2014). These associations suggest that people who are physically active and fit also feel competent, have a positive self-image, and are perceived as competent by others. All these areas can affect social and emotional development and integration into peer groups, which consequently have a great impact on quality of life (Marković, Trbojević Jocić, Horvatin, Pekas, & Trajković, 2022). The aim of this study is to determine the relationship between quality of life and cardiorespiratory fitness in elementary school students.

METHODS

Sample of respondents

In the implementation of this research, a sample of 651 4th grade elementary school students from the Republic of Croatia was used. The average age of the students was 10.38 ± 0.50 years, and the sample was divided into two subsamples according to gender, which consisted of 316 girls (10.30 ± 0.47 years) and 335 boys (10.34 ± 0.49 years). The research was conducted during the second semester of the 2021/2022 school year. All examined students were completely healthy at the time of the research. The research was conducted in accordance with the ethical principles prescribed by the Code of Ethics of the University of Zagreb and the Code of Ethics for Research with Children (Ajduković & Keresteš, 2020).

Variables

Anthropometric measurements were performed according to the International Biological Program (IBP). Body height was measured with a height meter (Seca® 213, Hamburg, Germany), and body mass, body mass index (BMI), and adipose tissue (%) were measured with a dual-frequency body composition analyser (TANITA DC -360P). Cardiorespiratory fitness was determined using the 20MSRT shuttle run test, in which running speed starts at 8.5 km/h−1 and increases by 0.5 km/h−1 every minute. Each stage lasts approximately 60 seconds, with the duration of each interval indicated to the subject by beeps (Leger and Lambert, 1982). Maximal oxygen consumption (VO2max, mL/kg/min) was calculated using the equation: VO2max = 31.025 + 3.238 (S) 2 3.248 (A) + 0.1536 (A 3 S), where S = speed in kilometers per hour at the end of the test and A = age in years (Leger et al., 1988) which is suitable for boys and girls aged 8 to 19 using an online calculator (Wood, 2019). Participants' quality of life was assessed using a questionnaire for children and adolescents aged 8 to 18 years (The KIDSCREEN Group Europe, 2006). To assess adolescents' subjective health and well-being, the Croatian version of the KIDSCREEN-10 quality of life questionnaire was used, which is a short form of the KIDSCREEN-52 questionnaire. The questionnaire assesses the dimensions of physical and psychological well-being, autonomy and parental relationships, peer support and social support, and school environment. The questionnaire consists of 10 questions in which the participants tick on a five-point Likert scale the extent to which they agree with the content of a particular statement in order to obtain an overall rating at the end.The metric properties of the KIDSCREEN-10 questionnaire are satisfactory. The values of Cronbach's alpha are

0.82 and the test-retest coefficient is 0.70, which is a satisfactory result for the internal consistency of the questionnaire (Ravens-Sieberer et al., 2010).

Statistical Analyses

In processing the data for all variables in the study, the basic descriptive parameters were calculated: arithmetic mean, standard deviation, minimum and maximum values, and Skewness and Kurtosis. A simple linear regression analysis was performed to determine the connection between student quality of life as predictors and cardiorespiratory fitness as a criterion. Statistical significance of differences was tested with significance level $p < 0.05$. Data processing was performed using STATISTICA version 14.0.0.15, TIBCO Software Inc.

RESULTS

Table 1. *Descriptive indicators of quality of life assessment, anthropometric characteristics, and cardiorespiratory fitness for the entire sample (N = 651)*

Variables	Mean±Std.Dev	Median	Min	Max	Skewness	Kurtosis
Health assessment	4.30 ± 0.74	4.00	2.00	5.00	-0.80	0.08
Physical form	4.26 ± 0.84	4.00	1.00	5.00	-1.16	1.31
Energy level	4.38 ± 0.75	5.00	1.00	5.00	-1.22	1.61
Mood	1.88 ± 0.92	2.00	1.00	5.00	1.26	1.63
Loneliness	1.47 ± 0.89	1.00	1.00	5.00	2.25	4.80
Personal time	4.15 ± 0.98	4.00	1.00	5.00	-1.14	0.76
Free time	4.22 ± 0.94	4,00	1.00	5.00	-1.12	0.52
Relationship with parents	4.68 ± 0.65	5.00	2.00	5.00	-2.13	4.24
Fun with friends	4.53 ± 0.79	5.00	1.00	5.00	-1.88	3.36
Academic achievement	4.12 ± 0.85	4.00	1.00	5.00	-0.66	-0.14
Learning indicator	4.41 ± 0.86	5.00	1.00	5.00	-1.59	2.34
Overall estimate of quality of life	4.33 ± 0.48	4.40	2.20	5.00	-1.17	1.62
Body height (cm)	147.92 ± 7.23	147.60	124.60	174.00	0.24	0.17
Body weight (kg)	41.03 ± 9.93	39.50	21.90	82.60	0.89	0.77
Body fat (percent %)	19.21 ± 7.57	18.20	4.50	44.40	0.55	-0.29
Body mass index (BMI)	18.57 ± 3.45	17.90	12.70	31.40	0.95	0.68
Maximal oxygen uptake VO2max (mL/kg/min)	45.16 ± 3.78	44.60	37.90	58.30	0.76	0.20

MEAN=arithmetic mean; SD = standard deviation; MIN = minimum result; MAX = maximum result; Skewness =asymmetrical distribution; Kurtosis = tailedness of distribution;

Table 1 shows the descriptive values of the participants' assessment in the dimensions of the KIDSCREEN-10 questionnaire. Students experience their quality of life as relatively high (4.33). The highest assessments of quality of life are related to relationships with parents and family and fun with friends. The lowest scores are found in the dimensions of academic achievement, free time, and loneliness. Self-assessment of health is at a high level. The results of Table 1 also show that the students have an average height of 147.92±7.23 centimeters and a body weight of 41.03±9.93 kilograms. The result for fat percentage (%fat) is 19.21% and body mass index (BMI) is 18.57, indicating that the students had a balanced diet. The results for the values used to estimate maximal oxygen uptake (VO2max) are 45.16 ml/kg/min. The values of the asymmetry of the distribution are in an acceptable range, and the elongation of the distribution shows slightly higher values for individual variables. The values of asymmetry and distributional curvature were taken for samples with more than 300 participants, for those whose values met the threshold: (Kim, 2013) greater than 2 and greater than 7, and parametric statistical analyses were used for the variables in the study.

Table 2. *Results of the regression analysis used to determine the correlation between quality of life and cardiorespiratory fitness in fourth-grade students*

Model	R	R2	Adjusted R	SE	Durbin-Watson	F	p
1	.24	.06	.06	3.67	1.64	39.83	0.00*

*R = multiple correlation coefficient; R2 = coefficient of determination; Adjusted R = corrected coefficient of determination SE = standard error; p = p-value *at the error level p < 0.05*

Table 2 shows the results of the regression analysis, where the statistical significance of the regression model is found in the F-test value (F = 39.83; p = 0.00). Accordingly, this model can be considered as predictively valid. The value of the coefficient of determination (R = 0.24) between quality of life and cardiorespiratory fitness is low but statistically significant. The significant association between predictor and criterion variables explains the 6% of joint variability. The value of the standard error (SE = 3.67), as an indicator of the standard deviation of the dispersion of the measured results around the direction of regression, shows a relatively large imprecision of the regression model. The results of the Durbin-Watson test show that there is no autocorrelation in the residual.

Table 3. *Results of the analysis of variance - ANOVE in the regression model*

	Sums of Squares	df	Mean Squares	F	p
Regression	535.88	1	535.88	39.83	0.00*
Residual	8731.19	649	13.45		
Total	9267.06				

*Df- degrees of freedom; F coefficient of mean squared for regression and residual; p significance level; *at error level p < 0.05*

The results of the analysis of variance in Table 3 based on the results of the F-test (F = 39.83) show the statistical significance (p = 0.00) of the regression model and indicate the suitability of the predictor model for regression analysis.

Table 4. *Test results for determining the significance of the regression coefficient of the predictor variables*

	Standardized coefficient		Unstandardized coefficient			
N = 651	β	Std.Err.	B	Std.Err.	t(649)	p-value
Intercept			36.90	1.32	27.99	0.00*
Quality of life	0.24	0.04	1.91	0.30	6.31	0.00*

*B = beta standardized regression coefficient; B = beta nonstandardized regression coefficient; Std.Err= standard error; t = t-value; p-level of significance; *at error level p < 0.05*

Table 4 shows that the regression coefficient (p = 0.00) of the predictor variables for quality of life is significant. The regression coefficient (b = 0.24) for the predictor variable shows the magnitude or direction of the slope in the sample. An increase of 1 standard deviation in the predictor variable will result in an increase of 0.24 standard deviation.

DISCUSSION

Based on the objective of the study, it can be concluded that there is a statistically significant relationship between quality of life and cardiorespiratory fitness in elementary school students in the Republic of Croatia. A positive correlation between quality of life and cardiorespiratory fitness was found in the participants of this study. The 20mSRT Shuttle running test showed that the maximum oxygen uptake (VO2max) of the students was 45.16 mL/kg/min. This value was higher than the results of the studies by (Bustos-Barahona, Delgado-Floody, &Martínez-Sa-

lazar, 2020; Langer, de Fatima Guimarães, Gonçalves, Guerra-Junior & de Moraes, 2020; Caamaño-Navarrete, Latorre-Román, Párraga-Montilla, Álvarez, & Delgado-Floody, 2021; Tanaka, Tremblay, Okuda, & Tanaka, 2020). The study by Álvarez et al. (2020) showed the same results as this study, while the study by Nqweniso et al. (2020) showed lower values. The participants experience their quality of life as very high. Results from the overall study sample showed a high mean score on the composite variable for assessing overall quality of life (4.33). Quality of life scored high among children living in countries with higher living standards (Dumuid et al., 2017). The dimensions such as relationship with parents and family and fun with friends showed high scores. On the other hand, the dimensions of academic achievement and leisure had the lowest scores. These results are due to school overload and lack of free time to spend on activities of their choice. The study participants rated their health status as high. The coefficient of determination between quality of life and cardiorespiratory fitness is low but statistically significant. Increasing quality of life can significantly influence cardiorespiratory fitness, but the reverse is also true, as increasing cardiorespiratory fitness may well increase quality of life. This fact refers to the feeling of satisfaction, as they create positive values by combining various activities with physical exercise.

In the study by Marković et al. (2022), similar results were obtained. They find that better aerobic capacity contributes to better health and quality of life, while age has the opposite effect. With age, health and thus quality of life decreases. A significant connection between cardiorespiratory fitness and quality of life was also found in the studies by (Andersen et al., 2017; Evaristo et al., 2019; Bottolfs et al., 2020). In addition, a growing number of studies show that cardiorespiratory fitness is associated with better quality of life in children and adolescents (Gu, Chang, & Solmon, 2016; Marques, Mota, Gaspar, & de Matos, 2017; Pires-Júnior et al., 2018). No significant connections were found between aerobic capacity and quality of life in the studies (Basterfield et al., 2021 and Salvini et al., 2018). Lifestyle factors have different effects on physical activity status, so it is important to examine all unifying elements such as physical fitness, sedentary lifestyle, and obesity status (Tambalis, Panagiotakos, Psarra, & Sidossis, 2019). Our study participants have not yet officially entered puberty and at this age it is possible to take preventive measures and improve cardiorespiratory fitness and thus quality of life. As the number of physically active students decreases during adolescence and people become less active over time, it is not surprising that quality of life decreases with age (Marković et al., 2022).

CONCLUSION

The results obtained in this study should stimulate further research on the relationship between cardiorespiratory fitness, physical activity, and quality of life in order to improve the overall health of children and adolescents. Assessing and identifying the level of cardiorespiratory fitness and quality of life of elementary school students should play the key role in monitoring the health of this population. Improving cardiorespiratory fitness together with good nutritional habits should form the basis for school-based intervention programs. In this way, we could have a direct impact on the health of elementary school students. Changing lifestyle habits will impact quality of life and benefit health as we age. The use of exercises that promote the development of cardiorespiratory fitness in children and adolescents could prevent obesity, which is one of the negative components of health status in modern times.

REFERENCES

Ajduković, M. i Keresteš, G. (ur.) (2020). *Etički kodeks istraživanja s djecom (drugo revidirano izdanje)*. Vijeće za djecu Republike Hrvatske. [in Croatian]

Álvarez, C., Cadore, E., Gaya, A.R., Mello, J.B., Reuter, C.P., Delgado-Floody, P., … Ramírez-Vélez, R. (2020). Associations of cardiorespiratory fitness and obesity parameters with blood pressure: fitness and fatness in youth Latin-American ethnic minority. *Ethn Health*. 21:1-17. doi: 10.1080/13557858.2020.1840525.

Andersen, J. R., Natvig, G. K., Aadland, E., Moe, V. F., Kolotkin, R. L., Anderssen, S. A., i Resaland, G.K. (2017). Associations between health-related quality of life, cardiorespiratory fitness, muscle strength, physical activity and waist circumference in 10-year-old children: the ASK study. *Qual Life Res*. doi: 10.1007/s11136-017-1634-1.

Badrić, M. i Roca, L. (2020). Spolne i dobne razlike u nivou kardiorespiratornog fitnesa kod učenika primarnog obrazovanja; U O. Bajrić i V.Srdić (Ur.), *10. međunarodna konferencija ''Sportske nauke i zdravlje";*Banja Luka: Panevropski univerzitet "Apeiron", str. 89-96 [in Croatian]

Basterfield, L., Burn, N. L., Galna, B., Karoblyte, G. i Weston, K. L. (2021). The association between physical fitness, sports club participation and body mass index on health-related quality of life in primary school children from a socioeconomically deprived area of England. *Preventive medicine reports*, *24*, 101557. https://doi.org/10.1016/j.pmedr.2021.101557

Bottolfs, M., Støa, E. M., Reinboth, M. S., Svendsen, M. V., Schmidt, S. K., Oellingrath, I. M. i Bratland-Sanda, S. (2020). Resilience and lifestyle-related factors as predictors for health-related quality of life among early adolescents: a cross-sectional study. *The Journal of*

international medical research, *48*(2), 300060520903656. https://doi.org/10.1177/0300060520903656

Bustos-Barahona, R., Delgado-Floody, P., i Martínez-Salazar, C. (2020). Lifestyle associated with physical fitness related to health and cardiometabolic risk factors in Chilean schoolchildren. *Endocrinologia, diabetes y nutricion*, *67*(9), 586–593. https://doi.org/10.1016/j.endinu.2020.02.005

Caamaño-Navarrete, F., Latorre-Román, P. Á., Párraga-Montilla, J. A., Álvarez, C. i Delgado-Floody, P. (2021). Association between Creativity and Memory with Cardiorespiratory Fitness and Lifestyle among Chilean Schoolchildren. *Nutrients*, *13*(6), 1799. https://doi.org/10.3390/nu13061799

Centers for Disease Control (2011). *Health-related quality of life (HRQOL).* Retrieved from http://www.cdc.gov/hrqol/concept.htm.

Dumuid, D., Olds, T., Lewis, L. K., Martin-Fernández, J. A., Katzmarzyk, P. T., Barreira, T., … International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE) research group (2017). Health-Related Quality of Life and Lifestyle Behavior Clusters in School-Aged Children from 12 Countries. *The Journal of pediatrics, 183*, 178–183.e2. https://doi.org/10.1016/j.jpeds.2016.12.048

Evaristo, S., Moreira. C., Lopes, L., Oliveira, A., Abreu, S., Agostinis-Sobrinho, C., Oliveira-Santos, J., Póvoas, S., Santos, R. I Mota, J. (2019). Muscular fitness and cardiorespiratory fitness are associated with health-related quality of life: Results from labmed physical activity study. *J Exerc Sci Fit*. 20;17(2):55-61

Gu, X., Chang, M. i Solmon, M. A. (2016). Physical activity, physical fitness, and health-related quality of life in school-aged children. *Journal of Teaching in Physical Education*, *35*(2).

Haraldstad, K., Wahl, A., Andenæs, R., Andersen, J. R., Andersen, M. H., Beisland, E., Borge, C. R., Engebretsen, E., Eisemann, M., Halvorsrud, L., Hanssen, T. A., Haugstvedt, A., Haugland, T., Johansen, V. A., Larsen, M. H., Løvereide, L., Løyland, B., Kvarme, L. G., Moons, P., Norekvål, T. M., … LIVSFORSK network (2019). A systematic review of quality of life research in medicine and health sciences. *Quality of life research : an international journal of quality of life aspects of treatment, care and rehabilitation*, *28*(10), 2641–2650. https://doi.org/10.1007/s11136-019-02214-9

Heimer, S., i Sporiš, G. (2016). Kineziološki podražaji i ukupna tjelesna aktivnost u zaštiti zdravlja i prevenciji kroničnih nezaraznih bolesti. U I. Prskalo, i G. Sporiš (ur.), *Kineziologija* (str. 171-190). Zagreb: Školska knjiga, Učiteljski fakultet Sveučilišta u Zagrebu, Kineziološki fakultet Sveučilišta u Zagrebu.

Jurko, D., Čular, D., Badrić, M., Sporiš, G. (2015). *Osnove kineziologije.* Sveučilište u Splitu Kineziološki fakultet, Sportska-knjiga, Gopal Zagreb [in Croatian]

Kolimechkov, S. (2017). Physical fitness assessment in children and adolescents: A systematic review. *European Journal of Physical Education and Sport Science*.

Lang, J. J., Tremblay, M. S., Léger, L., Olds, T. i Tomkinson, G. R. (2018a). International variability in 20 m shuttle run performance in children and youth: who are the fittest from a 50-country comparison? A systematic literature review with pooling of aggregate results. *British journal of sports medicine*, *52*(4), 276. https://doi.org/10.1136/bjsports-2016-096224

Langer, R. D., de Fatima Guimarães, R., Gonçalves, E. M., Guerra-Junior, G. i de Moraes, A. M. (2020). Phase Angle is Determined by Body Composition and Cardiorespiratory Fitness in Adolescents. *International journal of sports medicine*, *41*(9), 610–615. https://doi.org/10.1055/a-1152-4865

Latorre-Román, P. Á., Guzmán-Guzmán, I. P., Antonio Párraga-Montilla, J., Caamaño-Navarrete, F., Salas-Sánchez, J., Palomino-Devia, C., Reyes-Oyola, F. A., Álvarez, C., de la Casa-Pérez, A., Cardona Linares, A. J., & Delgado-Floody, P. (2022). Healthy lifestyles and physical fitness are associated with abdominal obesity among Latin-American and Spanish preschool children: A cross-cultural study. *Pediatric obesity*, *17*(7), e12901. https://doi.org/10.1111/ijpo.12901

Léger, L. A., Mercier, D., Gadoury, C. i Lambert, J. (1988). The multistage 20 metre shuttle run test for aerobic fitness. *Journal of sports sciences*, *6*(2), 93–101. https://doi.org/10.1080/02640418808729800

Leger, L.A. i Lambert, J. (1982). A maximal multistage 20-m shuttle run test to predict VO2max. *European Journal of Applied Physiology*, 49, 1-12.

Magiera, A., & Pac, A. (2022). Determinants of Quality of Life among Adolescents in the Małopolska Region, Poland. *International journal of environmental research and public health*, *19*(14), 8616. https://doi.org/10.3390/ijerph19148616

Marković, L., Trbojević Jocić, J., Horvatin, M., Pekas, D. i Trajković, N. (2022). Cardiorespiratory Fitness and Health-Related Quality of Life in Secondary School Children Aged 14 to 18 Years: A Cross-Sectional Study. *Healthcare (Basel, Switzerland)*, *10*(4), 660. https://doi.org/10.3390/healthcare10040660 [in Croatian]

Nqweniso S., Walter C., du Randt R., Aerts A., Adams L. , Degen J., … Gerber M. (2020) Prevention of Overweight and Hypertension through Cardiorespiratory Fitness and Extracurricular Sport Participation among South African Schoolchildren. *Sustainability* , *12*(16), 6581

Ortega FB, Artero EG, Ruiz JR, Espana-Romero V, Jimenez-Pavon D, Vicente-Rodriguez G et al. (2011). Physical fitness levels among European adolescents: the HELENA study. *Br J Sports Med*; 45: 20–29.

Pastor, R., Bouzas, C., Albertos, I., García, C., García, Á., Prieto, T., … Tur, J. A. (2022). Health-Related Quality of Life in Spanish Schoolchildren and Its Association with the Fitness Status and Adherence to the Mediterranean Diet. *Nutrients*, *14*(11), 2322. https://doi.org/10.3390/nu14112322

Pastor, R., Bouzas, C., Albertos, I., García, C., García, Á., Prieto, T., Velázquez, J., Sánchez-Jiménez, E., Rodríguez, R., Martín, F. J., Campón, A. M., & Tur, J. A. (2022). Health-Related Quality of Life in Spanish Schoolchildren and Its Association with the Fitness Status and Adherence to the Mediterranean Diet. *Nutrients*, *14*(11), 2322. https://doi.org/10.3390/nu14112322

Pires-Júnior, R., Coledam, D., Greca, J., Arruda, G., Teixeira, M., i Oliveira, A. (2018). Physical fitness and health-related quality of life in Brazilian adolescents: a cross-sectional study. *Human Movement, 19*(2), 3-10. https://doi.org/10.5114/hm.2018.74055

Ravens-Sieberer, U. i The KIDSCREEN Group (2006). *The KIDSCREEN questionnaires-Quality of life questionnaires for children and adolescents-Handbook*. Lengerich: Papst Science Publisher.

Ravens-Sieberer, U., Erhart, M., Rajmil, L., Herdman, M., Auquier, P., Bruil, J., & Czemy, L. (2010). Reliability, construct and criterion validity of the KIDSCREEN-10 score: a short measure for children and adolescents' wellbeing and health-related quality of life. *Quality of Life Research, 19*(10), 1487-1500

Riiser, K., Løndal, K., Ommundsen, Y., Småstuen, M. C., Misvær, N., & Helseth, S. (2014). The outcomes of a 12-week Internet intervention aimed at improving fitness and health-related quality of life in overweight adolescents: the Young & Active controlled trial. *PloS one*, *9*(12), e114732. https://doi.org/10.1371/journal.pone.0114732

Roca, L., Badrić, M. (2019). Participating in kinesiology activities in primary-education students' free time, *Sports Science and Health*. 9, 2; 85-91

Ross, R., Blair, S. N., Arena, R., Church, T. S., Després, J. P., Franklin, B. A., … Stroke Council (2016). Importance of Assessing Cardiorespiratory Fitness in Clinical Practice: A Case for Fitness as a Clinical Vital Sign: A Scientific Statement From the American Heart Association. *Circulation*, *134*(24), e653–e699. https://doi.org/10.1161/CIR.0000000000000461

Salvini, M., Gall, S., Müller, I., Walter, C., du Randt, R., Steinmann, P., … Gerber, M. (2018). Physical activity and health-related quality of life among schoolchildren from disadvantaged neighbourhoods in Port Elizabeth, South Africa. *Quality of life research: an international journal of quality of life aspects of treatment, care and rehabilitation*, *27*(1), 205–216. https://doi.org/10.1007/s11136-017-1707-1

Study protocol for the World Health Organization project to develop a Quality of Life assessment instrument (WHOQOL). (1993). *Quality of life research: an international journal of quality of life aspects of treatment, care and rehabilitation*, *2*(2), 153–159.

Tambalis, K.D., Panagiotakos, D.B., Psarra, G. i Sidossis, L.S. (2019). Association of cardiorespiratory fitness levels with dietary habits and lifestyle factors in schoolchildren. *Appl. Physiol. Nutr. Metab*. 44, 539–545.

Tanaka, C., Tremblay, M. S., Okuda, M. i Tanaka, S. (2020). Association between 24-hour movement guidelines and physical fitness in children. *Pediatrics international: official journal of the Japan Pediatric Society*, *62*(12), 1381–1387. https://doi.org/10.1111/ped.14322

Wallander, J. L. & Koot, H. M. (2016). Quality of life in children: A critical examination of concepts, approaches, issues, and future directions. *Clinical psychology review*, *45*, 131–143. https://doi.org/10.1016/j.cpr.2015.11.007

Wood, R. (2019). *„Beep Test Calculators - convert scores to VO2max"* **The Complete Guide to the Beep Test**, https://www.beeptestguide.com/calculator.htm [Accessed 2. 07. 2023.]

Zhan, Z., Ai, J., Ren, F., Li, L., Chu, C. H., & Chang, Y. K. (2020). Cardiorespiratory Fitness, Age, and Multiple Aspects of Executive Function Among Preadolescent Children. *Frontiers in psychology*, *11*, 1198. https://doi.org/10.3389/fpsyg.2020.01198

Primljen: 01. avgust 2023. / Received: August 01, 2023
Prihvaćen: 06. novembar 2023. / Accepted: November 06, 2023

https://doi.org/10.7251/SSH2302215N
UDC: 796.015.132:611.018.83
Original scientific paper
Originalni naučni rad

Theraband Exercise Program: Effective to Improve the Muscle Fitness of the Elderly

Ahmad Nasrulloh[1], Sumaryanti[1], Sigit Nugroho[1], Rina Yuniana[1], Farid Imam Nurhadi[1], Rifky Riyandi Prastyawan[1], Dewangga Yudhistira[2], Gunathevan Elumalai[3]

[1]Department of Sports Science, Faculty of Sport Science, Universitas Negeri Yogyakarta, Indonesia
[2]Department of Sports Coaching Education, Faculty of Sport Science, Universitas Negeri Semarang, Indonesia
[3]Department of Sports Science, Faculty of Sports Science and Coaching University Pendidikan Sultan Idris, Malaysia

Correspondence:
Ahmad Nasrulloh, Department of Sports Science, Faculty of Sport Science, Universitas Negeri Yogyakarta, Indonesia
ahmadnasrulloh@uny.ac.id

Abstract: *Physical activity in the elderly is still primarily focused on cardiorespiratory exercise, with less emphasis placed on muscle fitness. Thus, exercises to promote muscular fitness are required. As a result, in the Covid-19 era, a fun fitness concept was developed to improve muscle fitness. The development process, however, must include validation and effectiveness testing. The research aims were to (1) examine the content's validity and (2) examine the effectiveness of the fun fitness training model. The development of a quantitative and qualitative approach was the research method used. Seven experts took part in the study, including five licenced fitness instructors and two sports academics. The effectiveness test included 30 elderly men and women aged 60 years and weighing 60-80 kg. A 1-4 Likert scale questionnaire, hand grip dynamometer, and leg dynamometer were used as research instruments. SPSS and Excel software was used to help with the Aiken formula data analysis technique and the paired samples t-test. The research was divided into four stages: (1) Developing models through the qualitative analysis of books and e-books; (2) evaluating the model quantitatively using the Delphi method; (3) Examining the findings of the evaluation of seven specialists; and (4) Conducting tests to assess the results. The 12 models were deemed realistic based on the seven experts' collective qualitative findings. According to quantitative findings, the value coefficients for the material's suitability, depth, and practicality range from V 0.76 to V 0.80. A significance value of 0.000<0.05 indicates that the findings of testing the effectiveness of the fun fitness model can significantly improve the strength of the arm and leg muscles. In conclusion, the fun fitness training model shows high content validity and has the potential to improve elderly muscle fitness.*

Keywords: *Exercise models, fun fitness, elderly, muscle fitness.*

INTRODUCTION

Nowadays, exercise has become a need for maintaining immunity. When the immune system is maintained, the body can fight illnesses and stays fit all the time. The Covid-19 virus is not extinct in the modern world. The elderly are particularly vulnerable to Covid-19 exposure. According to Ward et al., (2020) elderly are the ones who are most vulnerable to significant adverse complications from the Covid-19 virus. Grolli et al., (2021) research indicates that the elderly are more susceptible to the Covid-19 virus's adverse effects.

Statistics from the Ministry of Health (Kemenkes,2021) show that as of April 1, 2021, numerous people have been exposed to Covid, with data on 40,349,051 persons who have been vaccinated. The vaccines were allocated to three groups: 1,468,764 for health human resources (HR), 17,327,169 for public officers and 21,553,118 for the elderly. As a result, the elderly are prioritised and given vaccines so that the body's immunity improves and strengthens.

The new order is a challenge and unstable in the new normal period, thus the general population must be prepared to face this transition (Rahmatullah, 2021). The issue at arm is how to keep individuals healthy after receiving immunisations, especially the elderly. Steady body immunity is, of course, tied to fitness; to obtain it, one must engage in sports (Gumantan et al., 2020). Flexibility, body composition, aerobic capacity, and muscle fitness are all required for someone to be called fit (Lokhande et al., 2015). It is critical to remember that the elderly are towards the end of their life cycle, thus efforts to keep healthy are still being made by exercising according to their portion.

The old population in Indonesia has increased from the previous number of 24 million, and it is predicted to expand by 30-40 million people by 2020 (Arini et al., 2020). Humans will undergo social, psychological, and physiological changes as they age (Santoso, 2019). These changes undoubtedly have an impact on health. Earlier research

found a strong link between low muscle fitness and disorders such as dementia, Alzheimer's, and Parkinson's (Boyle et al., 2009). According to Tramontana & Prüller-Strasser, (2018), inadequate muscle fitness is a risk factor for chronic disease and premature death.

According to observations that elderly people exercise in city parks, open fields, and neighbouring sports arenas, showing that the majority of the elderly participate in aerobic sports such as gymnastics, walking, jogging, and cycling (Zheng et al., 2022) . During observations in the sports building, it was discovered that the elderly participated in badminton and tennis activities. Furthermore, the authors conducted interviews with numerous fitness instructors and discovered that the exercise programme included a combination of aerobic exercise and weight training, but for the elderly, aerobic activity was prioritised (Yu et al., 2023).

According to this description, the majority of sports practised by the elderly are still aerobic. Muscle fitness workouts, on the other hand, are required in old age. According to studies, completing muscle fitness activities can lead to a considerable reduction in mortality in old age (Katzmarzyk & Craig, 2002). As a result, a pleasant fitness training model will be designed in the Covid-19 era to promote muscle fitness in the elderly following the dose of exercise, including the suitable model, intensity, and volume of exercise.

To be tested during the development research stage, the constructed model must, of course, go through a validation process. Validation is a critical step in the development research process (Akhiruyanto et al., 2022). In content validity, the initial stage validation is used (Nasrulloh et al., 2022). Content validity is used to assess how well the conceptual design has been produced in comparison to expert judgement (Septian et al., 2022; Yudhistira, Siswantoyo, et al., 2021; Yudhistira, Suherman, et al., 2021; Yudhistira & Tomoliyus, 2020; Yulianto & Yudhistira, 2021). Therefore, the objectives of this research were to (1) examine the content validity of the fun fitness training model and (2) test its effectiveness in improving muscle fitness in the elderly.

MATERIAL & METHODS

Participants

This study is development research, namely developing or validating an existing product to provide answers and solutions to issues encountered (Yulianto & Yudhistira, 2021). This study employed both qualitative and quantitative methods (Noroozi et al., 2020). This study included seven experts: five fitness instructors with national licences and two academics with Doctor of Sports degrees. In addition, 30 elderly men and women between the ages of ±60 and ±60-80 kilos were used in the model testing phase. All samples used in this research stage have had their health checked and are willing to be research samples.

Procedure/Test protocol/Skill test trial/Measure/Instruments

This research has four stages, namely qualitative analysis in the form of eBook documents, books, journal articles, and interviews to construct models and rationalise the difficulties. The model is then poured into the programme; the second stage is quantitative, particularly with the Delphi technique (Wilpers et al., 2021), an assessment of the produced model using a questionnaire; and the authors met directly with seven material experts to evaluate the model and programme. The final stage applied the Aiken formula to the expert assessment results [20]. The fourth stage involved testing effectiveness by performing experiments to evaluate if the model produced might improve muscle fitness, such as arm and leg muscle strength. The effectiveness test was carried out by first administering an initial test, then administering treatment for 8-12 meetings with a training frequency of 1-2 times per week followed by administering a final test. A 1-4 Likert scale questionnaire, hand grip dynamometer muscle strength instruments, and arm leg dynamometer muscle strength instruments were used in this study.

Data collection and analysis / Statistical analysis

SPSS version 23 and Excel applications were used to aid with data analysis procedures. The data analysis technique used in this study was parametric testing, which included prerequisite tests such as homogeneity and normality tests, followed by a paired samples t-test to compare pre-test and post-test outcomes. In addition, the Aiken formula was also used to do content validity analysis. The formula proposed by Aiken (lewis. R. Aiken, 1985) is as follows:

$V = \sum s / [n(c-1)]$
$S = r - lo$
Lo = the lowest validity rating score (e.g. 1)
C = the highest validity rating score (e.g. 5)
R = the number given by the appraiser

RESULTS

Content Validity

Qualitative Analysis Results

Based on document analysis which includes relevant eBooks, books and journal articles, an fun fitness training model for the elderly has been found along with a program that has been compiled and presented as follows:

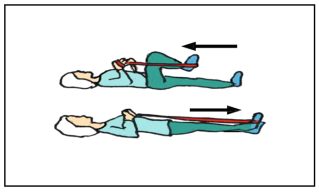


Figure 1. *Leg Press using theraband*

Procedures:

a. Position the feet shoulder-width apart, one knee bent to a 90-degree angle
b. Then the theraband is attached to the bent leg
c. The theraband is held in both hands
d. Both legs push off the terraband until the legs are straight
e. Loosen slowly until the position of the feet forms a 90-degree elbow angle
f. Push back up using the heels to return to the starting position

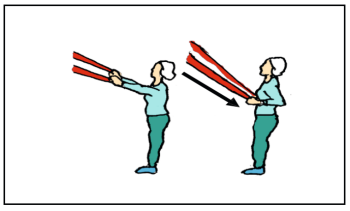


Figure 2. *Pull Down using theraband*

Procedures:

a. In a standing position, hold the theraband with both hands, slightly shoulder width apart
b. Pull the theraband straight down from the front of the head to the front of the chest

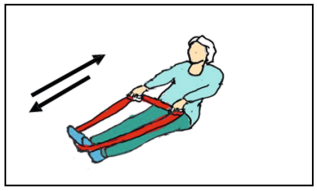


Figure 3. *Krunch using theraband*

Procedures:

a. Sit on the floor and wrap the theraband around your leg, holding it with both hands
b. Roll your spine down onto your back slowly, returning to the starting position slowly and keeping your arms as straight as possible

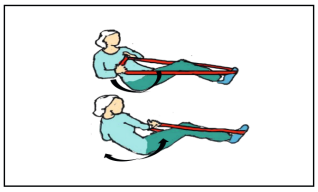


Figure 4. *Russian Twist using theraband*

Procedures:

a. Sit on the mat with the thighs on the floor, with your knees slightly bent.
b. Tighten the abs and hold them so that the buttocks are pressed against the mat.
c. Lean back so that it forms a 45-degree angle. Pull the theraband up to the top of the stomach.
d. Slowly rotate the body to the left side then alternately to the right side

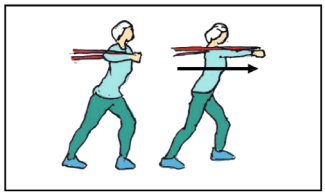


Figure 5. *Chest press using theraband*

Procedures:

a. Standing position, both feet resting on the floor parallel to the shoulders, both hands holding the terraband at shoulder height in front of the chest with elbows bent.
b. Inhale, then pull the theraband straight a little wider than the middle of the chest, moving forward slowly and under control
c. Return to the starting position by touching the terraband to your chest and exhaling.

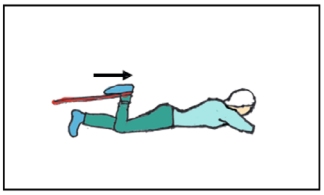


Figure 7. *Lying curl using theraband*

Procedures:

a. The initial position begins by turning the body upside down and is followed by hooking the theraband on the heel just behind the ankle.
b. Take a breath, then lift the leg or bend your leg by pulling the terraband up to the maximum towards the buttocks.

Figure 9. *Bicep curls using theraband*

Procedures:

a. Sit holding the bandage shoulder-width apart, with the elbows bent at a 90-degree angle.
b. Pull the theraband with both hands until it touches the chest. Then return to the starting position.

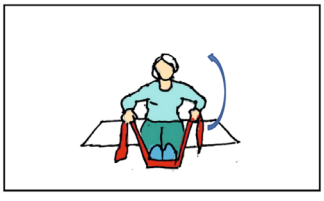


Figure 11. *Rowing using theraband*

Procedures:

a. The initial position is sitting holding on to the theraband which is also attached to the leg.
b. Rowing by pulling the theraband so that the scapulae are close together or pulling the theraband towards the chest. Open both palms when it reaches the chest.

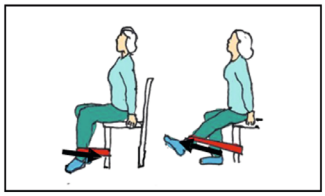


Figure 6. *Leg extension using theraband*

Procedures:

a. Sit on a chair with the feet pointing forward and both hands holding the right and left side of the chair, legs forming a 90-degree angle
b. Pull the theraband until the leg is straight and the rest of the body remains still. The pelvis remains still. During the contraction, hold for a few seconds.
c. Lower slowly until it returns to its original position.

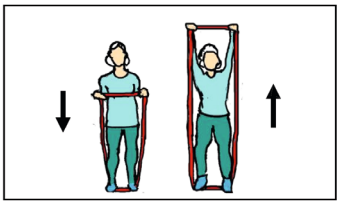


Figure 8*. Shoulder press using theraband*

Procedures:

a. While standing, hold the theraband with the elbows bent in front of the chest, palms facing forward shoulder-width apart, and the theraband hooked on the feet.
b. Push the theraband straight up using both hands then lower it back down to the starting position in front of the chest.

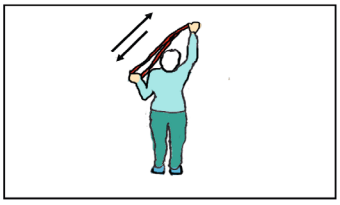


Figure 10. *Triceps ropes using theraband*

Procedures:

a. While standing, hold the theraband with the elbows bent in front of the chest, palms facing forward shoulder-width apart and hook the theraband on the feet.
b. Pushing the theraband straight up using both hands, lower it back down to the starting position in front of the chest.

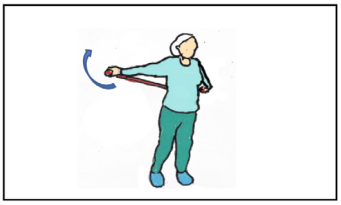


Figure 12. *Butterfly using theraband*

Procedures:

a. The starting position is standing straight with both hands holding the theraband straight in front of the chest.
b. Pull the theraband straight to the side at shoulder height. Hold for a few seconds, then return to the starting position

Table 1. *Fun fitness training program to improve muscle fitness in the elderly*

Week	Meeting	Exercise Items	Exercise Dosage
1-2	1-4	Post 1: Leg press Post 2: Pull Down Post 3: Abdominal Post 4: Leg extension Post 5: Chest press Post 6: Russian twist Post 7: Bicep curl Post 8: Shoulder press Post 9: Laying leg curl Post 10: Triceps Post 11: Rowing Post 12: Butterfly	• **Warming up**: The elderly are given instructions on the exercise programme that is provided. The elderly are instructed to stretch for 7 minutes using static and dynamic stretching variations. • **Core exercises** a. Method: Circuit b. Frequency: 1 time c. Sets: 1 round d. Repetitions: 4-6 times e. Rest between exercise items: 20-30 seconds/according to conditions f. Intensity: Low- Moderate • **Cooling down**: The elderly are instructed to undertake static stretching for 7 minutes with suitable stretching variations, followed by motivation and closing.
3-4	5-8	Post 1: Leg press Post 2: Pull Down Post 3: Abdominal Post 4: Leg extension Post 5: Chest press Post 6: Russian twist Post 7: Biceps curl Post 8: Shoulder press Post 9: Laying leg curl Post 10: Triceps Post 11: Rowing Post 12: Butterfly	• **Warming up:** The elderly are given instructions on the workout programme that is offered to them. The elderly are instructed to stretch for 10 minutes, with sufficient stretching variations. • **Core exercises** a. Method: Circuit b. Frequency: 2 times c. Sets: 1-2 rounds d. Reps: 6 times e. Rest between exercise items: 2-30 seconds / according to conditions f. Rest between sets: 5-6 minutes g. Intensity: Low - Moderate • **Cooling down**: The elderly are instructed to undertake static stretching for 7 minutes with suitable stretching variations, followed by motivation and closing.
5-6	9-12	Post 1: Leg press Post 2: Pull Down Post 3: Abdominal Post 4: Leg extension Post 5: Chest press Post 6: Russian twist Post 7: Biceps curl Post 8: Shoulder press Post 9: Laying leg curl Post 10: Triceps Post 11: Rowing Post 12: Butterfly	• **Warming up:** The elderly are given instructions on the exercise programme that is provided. The elderly are instructed to stretch for 7 minutes using static and dynamic stretching variations. • **Core exercises** a. Method: Circuit b. Frequency: 2 times c. Sets: 2 rounds d. Reps: 6 times e. Rest between exercise items: 20-30 seconds / according to conditions f. Rest between sets: 5-6 minutes g. Intensity: Low-Moderate • **Cooling down:** The elderly are instructed to undertake static stretching for 7 minutes with adequate stretching variations, followed by motivation and closing.

Quantitative Analysis Results

The quantitative analysis results were achieved by the assessment of 7 experts, and all experts completed the authors-prepared questionnaire. The Aiken formula was used to examine the findings of these data. The calculation data is shown below:

Table 2. *The findings of the Aiken formula-based content validity*

Aspect		Assessor								
		1	2	3	4	5	6	7	S	V
1	**Score**	4	3	3	3	4	3	4		
	S	3	2	2	2	3	2	3	17	0.80
2	Score	3	3	3	3	4	3	3		
	S	2	2	2	2	3	2	2	16	0.77
3	Score	3	3	3	3	4	3	3		
	S	2	2	2	2	3	2	2	17	0.80
4	Score	3	4	3	3	4	3	3		
	S	2	3	2	2	3	2	2	16	0.77
5	Score	4	4	3	3	4	3	4		
	S	3	3	2	2	3	2	3	18	0.86
6	Score	3	3	3	3	4	3	4		
	S	2	2	2	2	3	2	3	16	0.77
7	Score	3	4	3	3	4	3	3		
	S	2	3	2	2	3	2	2	17	0.80
8	Score	3	3	3	3	4	3	4		
	S	2	2	2	2	3	2	3	16	0.77
9	Score	4	4	3	3	3	3	4		
	S	3	3	2	2	2	2	3	17	0.80

Data on aspects (1) of compatibility with the objectives to be attained yielded a coefficient value of V 0.80 based on the results of the Aiken formula analysis. Aspect (2), the material's suitability for the needs of the elderly, receives a coefficient of V 0.77. Aspect (3), the material's completeness, receives a coefficient value of V 0.80. (4) The material's suitability concerning elderly fitness receives a coefficient of V 0.77. The depth of the material with the needs of the elderly receives a coefficient of V 0.86 in Aspect (5). Aspect (6) muscle strengthening activities are safe for the elderly, resulting in a V 0.77 coefficient value. Aspect (7), the level of ease in implementing material for the age, receives a coefficient value of V 0.80. The coefficient value for aspect (8) activities planned to pleasure the elderly is V 0.77. Aspect (9) exercises that are simple to understand for the elderly have a coefficient value of V 0.80. According to Aiken's analysis, the content validity value coefficients varied from 0.76 to 0.80, indicating that the developed model and programme have good content validity based on 7 material experts

Homogeneity Test

In this section the authors presents the results of the prerequisite test, namely the homogeneity test, the results are presented as follows:

Table 3. *The homogeneity test findings for the two variables' pre test – post test values*

Variable	Pre test - Post test	Significance	Description
Hand squeeze strength	Pre-test Post-test	0.621	Homogenous
Leg muscle strength	Pre-test Post-test	0.731	Homogenous

Based on the data, the significance value of the variable hand squeeze strength is 0.621> 0.05, and the significance value of the variable leg muscle strength is 0.731> 0.05. If the significance value is more than 0.05, the two variables are considered to be homogenous.

Normality test

In this section, the authors present the results of the prerequisite test, namely the normality test. The results are presented as follows:

Table 4. *The normality test findings for the pre test – post test values of two variables*

Variable	Pre test - post test	Significance	Description
Hand squeeze strength	Pre-test	0.313	Normal
	Post-test	0.662	Normal
Leg muscle strength	Pre-test	0.585	Normal
	Post-test	0.531	Normal

Based on the data acquired, the significant value of the variable hand squeeze strength was found to be 0.313> 0.05 for the pre-test and 0.662> 0.05 for the post-test. It was also discovered that the pre-test was 0.585> 0.05, and the post-test was 0.531> 0.05 in the variable leg muscle strength. The total significance value is more than 0.05. As a result, the data is considered to be normally distributed.

Paired Samples t-test

In this section, the authors present the results of hypothesis testing, namely the paired samples t-test. The findings are presented as follows:

Table 5. *The findings of the paired samples t-test on both variables*

Variable	Pre test – post test	Mean	Significance	Description
Hand squeeze strength	Pre-test	16.53	0.000	Significant
	Post-test	19.12		
Leg muscle strength	Pre-test	11.14	0.000	Significant
	Post-test	11.98		

Based on the data that has been obtained, the significance value of the hand squeeze strength variable is 0.000<0.05 and the significance value of the leg muscle strength variable is 0.000<0.05. Thus, it can be described that the fun fitness model can significantly increase the hand squeeze strength and the strength of the leg muscles. This result is proven by the significance value of the entire variable is 0.000 <0.05.

DICUSSION

The content validation results revealed that the nine questions covered aspects of suitability, completeness, safety, and practicality. The average rating ranged from V 0.76 to 0.80, indicating that the fun fitness training model that was compiled was good and feasible for field testing. Experts agree that content validity coefficients between 0.70 and 1.00, or close to one, indicate good content validity (Yulianto & Yudhistira, 2021)

The data effectiveness test findings revealed that the significant value for the hand squeeze strength variable was 0.000<0.05, followed by the significance value for the leg muscle strength variable being 0.000<0.05. According to studies, a significance value of <0.05 is considered significant (Rizka et al., 2022). As a result, the fun fitness training model packed in an exercise programme can improve elderly hand squeeze strength and leg muscular strength.

Fun fitness is a weight training concept specifically created for the elderly, allowing them to practise activities that are both pleasant and acceptable. Health promotion is associated with fun fitness (Polubinsky & Plos, 2007).

This exercise has the same premise as weight training in that it leverages the surrounding environment with loading techniques based on weight training concepts.

The authors established the notion of fun fitness after discovering that the workouts undertaken by the elderly tended to affect cardio respiratory fitness while ignoring muscle fitness. Weight training in the elderly is crucial for avoiding the risk of bone loss so that the bones get denser and of course can enhance body posture. The circuit training approach is used to construct an fun fitness training model to improve cardio respiratory capacity and muscle strength.

Weight training has traditionally been separated from aerobic exercise, which is typically done two to three days a week (Klika, B., 2013). Also, the recommended weight training is to perform 8 to 12 repetitions at a low to moderate intensity, depending on the participants' needs and level of training (Klika, B., 2013). Circuit training is one approach to combining aerobic exercise and strength training. Circuit training activities planned according to dosage can improve the aerobic and anaerobic systems, as well as increase muscle strength and endurance (Buckley et al., 2015).

Weight training is beneficial for improving individual abilities such as muscle endurance, hypertrophy, and athletic performance. Research conducted by (Ferreira et al., 2012), Weight training is beneficial for improving individual abilities, such as muscular endurance. According to recent research, weight training regularly can enhance body composition, insulin sensitivity, blood glucose levels, and hypertension (Yaacob et al., 2016; Zheng et al., 2022). According to (Krzysztofik et al., 2019; Nguyen et al., 2016) weight training is a structured and planned activity that uses weights to help muscles develop better and stronger. Another viewpoint is that weight training is highly familiar because the exercises performed can be completed in a short period while changing body shape and sports performance (Baker et al., 2013)(Baechle, & Earle, 2014).

Weight training is associated with muscle-building, muscle development, and muscle-maintenance exercises. Strength is defined as the effort exerted by a set of muscles in performing a good contraction, pulling, pushing, or holding a load (Nasrulloh et al., 2020, 2022). The theraband tool is one of the muscle-training instruments. Theraband is a sports item that looks like elastic rubber and is used for strength training. It seeks to improve mobility, balance, joint pain, and muscle strength (Kwak et al., 2016; Lin & Sung, 2012)

Theraband comes in a variety of colour codes based on its thickness and resistance, including red, green, blue, silver, gold, and yellow (Anwer et al., 2021). Recent research has demonstrated that training with terraband media can improve muscle strength in the elderly (Pourtaghi et al., 2017). As a result, a strength training paradigm utilising broadband media as a load must be implemented, and the exercises must be presented in an appealing, varied, and safe manner for the elderly to perform. Furthermore, weight training must adhere to the rules of frequency, intensity, time, and type (Schoenfeld et al., 2021)(Sandler,2010). Furthermore, in the new normal era, it is critical to develop and manage exercise programmes, particularly for the elderly, so that the exercise performed is beneficial. Furthermore, in the new normal era, it is very important to develop and manage exercise programs, especially for the elderly, so that the exercise they do can provide benefits. Strengthening exercises are recommended as one of the main exercises to prevent loss of muscle mass due to aging and improve strength, endurance and muscle function. One of the recommended strengthening exercise models is the theraband exercise program. This program has been proven to be suitable for use in the elderly and has been proven to be very effective in increasing muscle strength and endurance in the elderly. The limitation of this research is that researchers have difficulty in controlling the physical health condition of the elderly, which can decline at any time.

CONCLUSIONS

The fun fitness training model bundled in the training programme has good content validity, according to the assessment of seven experts, as indicated by the validity coefficient ranging from 0.76 to 0.80. Then, based on the effectiveness test, the fun fitness training model can enhance muscle fitness, including squeezing hand strength and arm muscle strength, as demonstrated by a significance value of >0.05 for the entire variable. Fun fitness is a concept developed by the authors to provide awareness and as an acceptable training approach for the old, that not only cardiovascular capability but also muscle fitness, is required to support the health of the aged.

Conflicts of interest

All authors declare no conflict of interest

REFERENCES

Akhiruyanto, A., Pribadi, F. S., & Yudhistira, D. (2022). Developing Android-Based Running Monitor Software to Measure Sprint Speed. *Journal of Hunan University Natural Sciences*, *49*(3), 244–250. https://doi.org/10.55463/issn.1674-2974.49.3.27

Anwer, S., Jeelani, S. I., Khan, S. A., Quddus, N., Kalra, S., & Alghadir, A. H. (2021). Effects of TheraBand and Theratube Eccentric Exercises on Quadriceps Muscle Strength and Muscle Mass in Young Adults. *BioMed Research International*, *2021*. https://doi.org/10.1155/2021/5560144

Arini, Hadju, V., Usman, A. N., & Arundhana, A. I. (2020). Physical activity in affecting hemoglobin changes (Hb) in adolescent females received Moringa oleifera (MO) supplementation in Jeneponto. *Enfermeria Clinica*, *30*, 69–72. https://doi.org/10.1016/j.enfcli.2019.07.033

Baker, J. S., Davies, B., Cooper, S. M., Wong, D. P., Buchan, D. S., & Kilgore, L. (2013). Strength and body composition changes in recreationally strength-trained individuals: comparison of one versus three sets resistance-training programmes. *BioMed Research International*, *2013*, 615901. https://doi.org/10.1155/2013/615901

Boyle, P. A., Buchman, A. S., Wilson, R. S., Leurgans, S. E., & Bennett, D. A. (2009). Association of muscle strength with the risk of Alzheimer disease and the rate of cognitive decline in community-dwelling older persons. *Archives of Neurology*, *66*(11), 1339–1344. https://doi.org/10.1001/archneurol.2009.240

Buckley, S., Knapp, K., Lackie, A., Lewry, C., Horvey, K., Benko, C., Butcher, S., Author, C., & Trinh, J. (2015). *Multi-modal High-Intensity Interval Training Increases Muscle Function and Metabolic Performance in Females 2 Author Affiliations and addresses: 13*.

F Hidayati, D Tirtawirya, D Yudhistira, LA Virama, S. N. (2022). *AND ENDURANCE OF FOOTBALL EXTRACURRICULAR PARTICIPANTS : 6*(1).

Ferreira, M. L., Sherrington, C., Smith, K., Carswell, P., Bell, R., Bell, M., Nascimento, D. P., Máximo Pereira, L. S., & Vardon, P. (2012). Physical activity improves strength, balance and endurance in adults aged 40-65 years: A systematic review. *Journal of Physiotherapy*, *58*(3), 145–156. https://doi.org/10.1016/S1836-9553(12)70105-4

Grolli, R. E., Mingoti, M. E. D., Bertollo, A. G., Luzardo, A. R., Quevedo, J., Réus, G. Z., & Ignácio, Z. M. (2021). Impact of COVID-19 in the Mental Health in Elderly: Psychological and Biological Updates. *Molecular Neurobiology*, *58*(5), 1905–1916. https://doi.org/10.1007/s12035-020-02249-x

Gumantan, A., Mahfud, I., & Yuliandra, R. (2020). Tingkat Kecemasan Seseorang Terhadap Pemberlakuan New Normal Dan Pengetahuan Terhadap Imunitas Tubuh. *Sport Science and Education Journal*, *1*(2), 18–27. https://doi.org/10.33365/ssej.v1i2.718

Katzmarzyk, P. T., & Craig, C. L. (2002). Musculoskeletal fitness and risk of mortality. *Medicine and Science in Sports and Exercise*, *34*(5), 740–744. https://doi.org/10.1097/00005768-200205000-00002

Klika, B., & J. (2013). High-intensity circuit training using body weight: Maximum results with minimal investment. *ACSM's Health & Fitness Journal, 17*(3), 8–13.

Krzysztofik, M., Wilk, M., Wojdała, G., & Gołaś, A. (2019). Maximizing Muscle Hypertrophy: A Systematic Review of Advanced Resistance Training Techniques and Methods. *International Journal of Environmental Research and Public Health*, *16*(24). https://doi.org/10.3390/ijerph16244897

Kwak, C.-J., Kim, Y. L., & Lee, S. M. (2016). Effects of elastic-band resistance exercise on balance, mobility and gait function, flexibility and fall efficacy in elderly people. *Journal of Physical Therapy Science*, *28*(11), 3189–3196. https://doi.org/10.1589/jpts.28.3189

lewis. R. Aiken. (1985). Three Coefficients For Analyzing The Reliability And Validity Of Ratings. *Educational and Psychological Measurement*, *45*, 131–141.

Lin, S.-F., & Sung, H.-C. (2012). The effectiveness of resistance training with thera band on physiological functions for older adults: a systematic review. *JBI Library of Systematic Reviews*, *10*(56), 1–10. https://doi.org/10.11124/jbisrir-2012-265

Lokhande, R., Gedam, B., Shah, Y., Tandon, M., & Bansod, P. Y. (2015). Rationale for near total thyroidectomy in patients with nodular goitre. *International Journal of Biomedical and Advance Research IJBAR International Journal of Biomedical and Advance Research Journal*, *6*(605), 427–430. https://doi.org/10.7439/ijbar

Nasrulloh, A., Apriyanto, K. D., Yuniana, R., Dev, R. D. O., & Yudhistira, D. (2022). Developing Self Body Weight Training Methods to Improve Physical Fitness in the COVID-19 Era: Aiken Validity. *Journal of Hunan University Natural Sciences*, *49*(6), 129–139. https://doi.org/10.55463/ISSN.1674-2974.49.6.14

Nasrulloh, A., Prasetyo, Y., Nugroho, S., Yuniana, R., Pratama, K. W., Mustapha, A., & Idrus, S. Z. S. (2020). Tricet Method to Increase the Hypertrophy Muscle. *Journal of Physics: Conference Series*, *1529*(3), 1–6. https://doi.org/10.1088/1742-6596/1529/3/032006

Nguyen, C., Lefèvre-Colau, M. M., Poiraudeau, S., & Rannou, F. (2016). Rehabilitation (exercise and strength training) and osteoarthritis: A critical narrative review. *Annals of Physical and Rehabilitation Medicine*, *59*(3), 190–195. https://doi.org/10.1016/j.rehab.2016.02.010

Noroozi, F., Eisapareh, K., Bahadori, A., Ghahremani, L., Cousins, R., & Mokarami, H. (2020). Development and validation of dust exposure prevention questionnaire for cardiovascular patients based on the health belief model. *BMC Public Health*, *20*(1), 1–11. https://doi.org/10.1186/s12889-020-09871-3

Polubinsky, R. L., & Plos, J. M. (2007). Building Camaraderie with Fun, Fitness, and Friendly Competition. *Journal of Physical Education, Recreation & Dance*, *78*(2), 25–30. https://doi.org/10.1080/07303084.2007.10597969

Pourtaghi, F., Moghadam, Z. E., Ramazani, M., Vashani, H. B., & Mohajer, S. (2017). Effect of resistance training using thera-band on muscular strength and quality of life among the elderly. *Evidence Based Care Journal*, *7*(3), 7–16. https://doi.org/10.22038/EBCJ.2017.25876.1584

Rahmatullah, M. (2021). Education Management in the New Normal Era: A Literature Study. *Tarbawi: Jurnal Keilmuan Manajemen Pendidikan*, *7*(1), 79–86. https://doi.org/10.32678/tarbawi.v7i01.4195.INTRODUCTION

Rizka, M., Ambardini, R. L., Ode, L., Virama, A., & Yudhistira, D. (2022). *The Effect of Walking Exercise on Blood Pressure and Blood Glucose in the Elderly*. *2015*(c), 30–35.

Santoso, M. D. Y. (2019). Dukungan Sosial Meningkatkan Kualitas Hidup Lansia : Review Article. *Jurnal Kesehatan Mesencephalon*, *5*(1), 33–41. https://doi.org/10.36053/mesencephalon.v5i1.104

Schoenfeld, B. J., Grgic, J., Van Every, D. W., & Plotkin, D. L. (2021). Loading Recommendations for Muscle Strength, Hypertrophy, and Local

Endurance: A Re-Examination of the Repetition Continuum. *Sports (Basel, Switzerland)*, *9*(2). https://doi.org/10.3390/sports9020032

Septian, M., Wibowo, R., Sukamti, E. R., Prasetyo, Y., Ode, L., & Virama, A. (2022). *Content Validity and Reliability Test of Balance Training Program for Archery*. *10*(3), 378–383. https://doi.org/10.13189/saj.2022.100303

Sulistiyono, Andry akhiruyanto, Nawan primasoni, Faturahman arjuna, Nurhadi santoso, D. Y. (2021). Effect of 10 weeks game experience learning (gel) based training on teamwork, respect attitude, skill and physical ability in young football players. *Teoriâ Ta Metodika Fìzičnogo Vihovannâ*, *21*, 173–179. https://doi.org/10.17309/tmfv.2021.2.11

Tramontana, A., & Prüller-Strasser, B. (2018). „Role of Dietary Protein and Muscular Fitness on Longevity and Aging“. *Journal Fur Gynakologische Endokrinologie*, *21*(1), 33–35. https://doi.org/10.1007/S41975-018-0032-6

Ward, C. F., Figiel, G. S., & McDonald, W. M. (2020). Altered Mental Status as a Novel Initial Clinical Presentation for COVID-19 Infection in the Elderly. *American Journal of Geriatric Psychiatry*, *28*(8), 808–811. https://doi.org/10.1016/j.jagp.2020.05.013

Wilpers, A., Bahtiyar, M. O., Wall, D., Kobler, K., Sadler, L. S., Dixon, J. K., & Kennedy, H. P. (2021). Modified Delphi Study on Nursing Practice and Science in Fetal Care. *JOGNN - Journal of Obstetric, Gynecologic, and Neonatal Nursing*, *50*(1), 55–67. https://doi.org/10.1016/j.jogn.2020.09.158

Yaacob, N. M., Yaacob, N. A., Ismail, A. A., Che Soh, N. A. A., Ismail, M. S., Mohamed, H. J. J., & Hairon, S. M. (2016). Dumbbells and ankle-wrist weight training leads to changes in body composition and anthropometric parameters with potential cardiovascular disease risk reduction. *Journal of Taibah University Medical Sciences*, *11*(5), 439–447. https://doi.org/https://doi.org/10.1016/j.jtumed.2016.06.005

Yu, M., Wong, C., Ou, K., Chung, P. K., Yee, K., Chui, K., & Zhang, C. (2023). *The relationship between physical activity , physical health , and mental health among older Chinese adults : A scoping review*. *January*, 1–18. https://doi.org/10.3389/fpubh.2022.914548

Yudhistira, D., Siswantoyo, Tomoliyus, Sumaryanti, Tirtawirya, D., Paryadi, Virama, L. O. A., Naviri, S., & Noralisa. (2021). Development of agility test construction: Validity and reliability of karate agility test construction in kata category. *International Journal of Human Movement and Sports Sciences*, *9*(4), 697–703. https://doi.org/10.13189/saj.2021.090413

Yudhistira, D., Suherman, W. S., Wiratama, A., Wijaya, U. K., Paryadi, P., Faruk, M., Hadi, H., Siregar, S., Jufrianis, J., & Pratama, K. W. (2021). Content Validity of the HIIT Training Program in Special Preparations to Improve the Dominant Biomotor Components of Kumite Athletes. *International Journal of Human Movement and Sports Sciences*, *9*(5), 1051–1057. https://doi.org/10.13189/saj.2021.090527

Yudhistira, D., & Tomoliyus. (2020). Content validity of agility test in karate kumite category. *International Journal of Human Movement and Sports Sciences*, *8*(5), 211–216. https://doi.org/10.13189/saj.2020.080508

Yulianto, W. D., & Yudhistira, D. (2021). *Content Validity of Circuit Training Program and Its Effects on The Aerobic Endurance of Wheelchair Tennis Athletes*. *9*(c), 60–65.

Zheng, Y., Li, H., Gao, K., & Gallo, P. M. (2022). Developing a Home-Based Body Weight Physical Activity/Exercise Program. *ACSM's Health and Fitness Journal*, *26*(2), 20–28. https://doi.org/10.1249/FIT.0000000000000746

Primljen: 30. maj 2023. / Received: May 30, 2023
Izmjene primljene: 26. septembar 2023. / Changes Received: September 26, 2023
Prihvaćen: 05. oktobar 2023. / Accepted: October 05, 2023

https://doi.org/10.7251/SSH2302225I
Original scientific paper
UDC: 796.015.132:796.332
Originalni naučni rad

Using Intermittent Exercises in Training to Enhance Maximum Aerobic Speed and Power in U-19 Football Players

Hadjab Issam[1], Nasri Mohamed Sherif[2], Benmohamed Ahmed[3]
[1]*Department of Sciences and Techniques of Physical and Sports Activities, Mohamed Cherif Messadia University - Souk Ahras, Algeria*

Correspondence:
Hadjab Issam, Department of Sciences and Techniques of Physical and Sports Activities, Mohamed Cherif Messadia University - Souk Ahras, Algeria, i.hadjab@univ-soukahras.dz

Abstract: *In the present research, various forms of interval exercises, including short, medium, and long intervals, were incorporated into a prescribed training regimen to assess their impact on the development of specific physical attributes, namely Maximum Aerobic Speed and Speed-Related Strength, in football players under the age of 19. This study employed an experimental method with a single-group design, involving a sample of 14 players from IRB SEDRATA. To this aim, pre-tests, including the YO-YO Endurance Intermittent Test Level 2 and a hop test spanning a 10-meter distance for both legs were conducted. Subsequently, the proposed training program was administered, culminating in post-tests to gauge the program's effectiveness, employing appropriate statistical methods. In conclusion, the results indicate that the proposed training program has a positive impact on enhancing Maximum Aerobic Speed and Speed-Related Strength among the sampled players.*

Keywords: *intermittent exercise, training program, physical abilities.*

INTRODUCTION

The technology of sports training sciences has advanced quickly in to achieve high athletic levels in various sports, whether in a team or individual competitions. This level of improvement did not arise out nothing rather, science served as the foundation to do so, and efforts are being made to gain further understanding. In order to improve training status and achieve high levels, it is necessary to study what is included in the science of sports training's foundations and rules in greater detail. So, it is necessary to throw light on everything that is novel and creative in the field of sports training and its applications. (Albassati, 1998) In comparison with other team sports, football has attracted a sizable following and a great deal of practitioners. It is one of the team sports that became well-known throughout the world, but especially in Algeria. Sports practice has clearly shown that high results cannot be achieved without building a solid base during childhood and adolescence, which necessitates long-term, systematic planning in the field of training (Wiencek, 1997).

In order to build excellent planning and carry out the finest training programs, it is necessary to provide a variety of facilities and means, keep up with new technologies, and teach and develop trainers with a focus on both theory and practice. The coach must know the basic principles based on defining the methods and means and developing different plans in preparing and training the players through the various stages. (Kashef, 1994) The coaches, according to Kashif Ezzat Mahmoud and Muhammad Hassan Allaoui, must fully comprehend the foundations of the various concepts and applications of the science of training, master motor skills and play plans in his field of specialization, and have information related to the foundations of developing and developing motor skills and physical characteristics, as well as methods of acquiring and advancing them, with the need for him to be familiar with the distinct theory and practice of each (Allaoui, 1990).

Given that the activity of the modern player in football matches today witnessed a significant increase in the distance traveled, compared to the outcomes of the century, the informed observer of modern football notes that it relies heavily on the rhythm of fast play that requires high physical efficiency and has witnessed continuous development over the years. According to the playing centers, the performance in the past increased from a distance of 3361 meters in 1952 to 10802 meters in 2007 (Dellal, 2008) The modern physical requirements of this game have resulted in an urgent requirement for providing the players with a high level of physical preparation, in particular considering changes in modern football achievement are linked to the acceleration of defensive and offensive activities with a high level of strength as well as the players' high level of skillful performance, as well as the use of the total ball met-

hod, the player began to occupy more than a position in the team, that is, we see the defender actively contributing to the attack and the attacker retreating to defend his team's goal, and despite the player's endurance of this high effort, he must maintain physical fitness throughout the entire game (Allaoui, 1992).

Consequently, trainers and fitness professionals have increasingly adopted scientific and evidence-based training programs, guided by statistical data provided by organizations such as FIFA. This data reveals that football players engage in various activities during matches, including quick sprints, walking, and dribbling. These intermittent efforts, involving periods of work and rest, highlight the unique physical demands of football. In response, training methodologies have evolved to incorporate intermittent training, which has gained prominence due to its ability to enhance players' explosiveness and aerobic capacity, both of which are distinguishing factors for modern soccer players (FIFA) (Turpin, 2002). Intermittent training has gained significant popularity across all levels of sports due to its ability to replicate the dynamic nature of the gameplay, featuring high-intensity periods interspersed with rest intervals that can last several minutes. This training method has undergone continuous development by scholars in the field, starting with the pioneering work of *Fox* and al in 1977, who focused on interval training in athletics. Later, in 1980, *G. Gacon* advanced the concept of modern intermittent training, which incorporates alternating work and recovery periods in controlled intensity zones based on the maximum aerobic speed (*LT AT*). Subsequently, researchers such as *Bangsbo and Commetti* (2007) integrated this training approach with the specific demands of modern football (Dellal, 2008).

In recent years, football has undergone significant changes, including an increase in playing systems and a higher level of skill, physicality, and tactical performance. It has evolved into a sport characterized by intermittent efforts and distinctive stages. A thorough analysis of players' exertion in official matches revealed a wide range of movements, including explosive runs (92-109), stops and changes of direction (40-70), tackles (6), dribbles (13), headers (11), movements without the ball (30), and movements with the ball (27) (Turpin, 2002). This has led to assert that football is a team sport with intermittent physical activity dominance. Many countries around the world, recognizing the importance of physical fitness in football, have prioritized the development of their players' physical abilities to ensure global competitiveness. This emphasis on physical efficiency is evident in modern football, characterized by rapid movements under varying tactical plans (Dellal & Javier, 2017).

The physical capabilities of players have a significant and evident impact on their success or failure, as well as the performance of sports clubs. This impact is particularly prominent in football, which is described as the main driving force and crucial pillar for performance. The individual's physical influence plays a vital role in enhancing their career progression and overall organic development, including body systems and organs. Consequently, physical attributes, skills, movements, abilities, tactical plans, and volitional traits all undergo continuous improvement and development. (Allaoui, 1992). Prominent football figures such as *De Bruyne, Benzema, Kante, Messi, and Ronald*o have demonstrated their artistic potential and tactical prowess, transcending physical limitations. According to Dellal and Javier, players cover a distance of 10 to 13.8 kilometers per match, engaging in 79-146 accelerations with maximum speeds ranging from 22 to 33 km/h. For instance, striker Robben achieved a speed of 37 km/h while carrying the ball when he scored the fifth goal for the Netherlands against Spain during the 2014 World Cup in Brazil. Meanwhile, defender Ramos reached a speed of 30 km/h without the ball (Dellal & Javier, 2017).

Considering the aforementioned factors, along with the theoretical knowledge and practical experience of researchers, it has become evident that interval training is underutilized despite its suitability for accurately simulating competitive conditions. The importance of training conditions closely resembling actual competition is emphasized, as well as the significance of training at the same intensity as in competitive matches (Hamad, 2001). Therefore, the researchers were motivated to develop a training program aimed at investigating the impact of intermittent training on the development of specific characteristics in football players under 19 years old. This age category is considered optimal due to the players' physiological, morphological, and mental capabilities. Consequently, the researcher must address the following question as a primary concern:

- Do the intermittent exercises within the proposed training program affect in the improvement of speed aerobic maximum (VMA) and the power characteristic of speed for soccer players under 19 years old?

MATERIALS AND METHODS

Research Design

A single-group experimental design was employed in this study to investigate the impact of a training program incorporating intermittent exercises on the physical abilities of football players under 19 years old. This approach was chosen as the most suitable method to achieve the research objectives, which involve examining the effects of the training program on the selected sample.

Research population and sample

The study focused on football players under the age of 19 who were affiliated with the regional association Annaba. The regional association consisted of 61 teams, divided into 7 groups, with each group comprising 7 to 10 teams. From this group of teams, the intentional sampling method was employed to select the IRB SEDRATA team from the Sports Federation team of the municipality of Sedrata, which consisted of 14 players.

Characteristics of the study sample:

By age: The sample consists of 03 players aged 18 years, 09 players aged 17 years, and two players aged 16 years. The following table shows the sample members according to the age variable.

Table 1. *The distribution of the respondents according to the age variable*

Number of individuals	Age
03	18 years
09	17 years
02	16 years

By (Physical variables): (weight - height).

Table 2. *The values of the autosomal variables.*

physical variables	Value
Weight (kg)	63.80
length (centimeters)	177.25

Data collection tools

- ***The maximum aerobic speed test:*** (YO-YO Endurance intermittent test level 2)

This test was developed by the Danish physiologist Jens Bangsbo in 1994, it is characterized as an intermittent, progressive, and maximal assessment method.

Objective of the test: This test was devised with the primary objective of gauging the player's maximum oxygen consumption, maximum aerobic speed, and capacity for rapid recovery. Additionally, it aims to facilitate the execution of a maximal number of shuttle runs between two lines situated 20 meters apart, with progressively escalating speeds.

Description of the test: The athlete initiates the test by positioning themselves at line B. Upon receiving a signal, the athlete proceeds to line C, which is situated 20 meters from the starting point. Subsequently, a 5-second active recovery period is observed within the designated area (A - B), positioned at a distance of 2.5 meters, after every 40 meters covered. The initial velocity is set at 11.5 km/h. (Dellal, 2013)

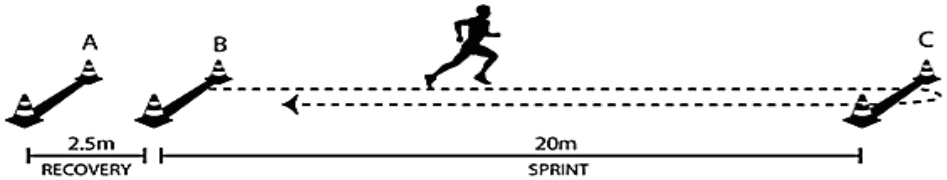


Figure 1. *Test YO-YO Endurance intermittent level 2*

- ***Partridge test for both legs for a distance of 10 meters using photoelectric device cells):***

The aim of the test: to measure the speed-related strength of the leg muscles.

Description of the test: The assessment protocol permits the player to execute two consecutive jumps using their right leg and an additional two using their left leg. Consequently, the testing region is demarcated by two lines: one serving as the starting point and the other as the termination point, separated by a standardized distance of 10 meters. Within this designated region, specialized equipment, namely photoelectric cells, is strategically positioned at both the initiation and culmination points. A dedicated recorder announces the participants' names initially and meticulously documents their respective performance durations subsequently. Simultaneously, an observer closely monitors the precision and accuracy of the execution of the jump sequences. The most favorable outcome derived from all the attempted jumps is the one considered for analysis and evaluation. (Taha, 1989)

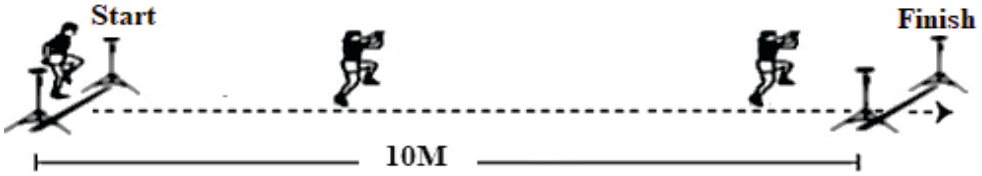


Figure 2. *Test Partridge test for both legs for a distance of 10 meters using a device (Photoelectric cells)*

Scientific basis for the tests

The stability and validity of the tests: The test's stability refers to its ability to produce consistent results when repeated on the same participants under the same conditions. The initial test was administered to a sample of 06 players on 11/16/2021, and the test was repeated on 11/22/2021 using the same sample and conditions. Subsequently, the Pearson correlation coefficient was calculated, and the significance values (sig) were compared with the predetermined significance levels of 0.05 and 0.01, with a degree of freedom of 4. The results indicated that the probability values were lower than the significance levels, confirming a high level of test reliability. Additionally, the self-validity was assessed by calculating the square root of the stability coefficient, which further demonstrated a high degree of self-validity. The findings are summarized in the following table:

Table 3. *the reliability and validity of the physical tests adopted in the study*

physical exams	Sample volume	degrees of freedom	significance level	Stability coefficient	Subjective validity coefficient	probability value sig	the decision
Yo-Yo Endurance intermittent test	06	04	0,05	0,837	0,914	0,038	Statistically D
Partridge test for both The two men are 10 meters apart			0,0 1	0,997	0,998	0,000	

Content of the training program

Following extensive consultations with numerous coaches and esteemed experts in the realm of football, the researchers reached the determination that it was imperative to formulate a comprehensive training regimen spanning eight weeks, encompassing a frequency of two sessions per week. This structure amounted to a total of 16 sessions, commencing from the phase of specialized physical preparation. During the development of this training program, careful consideration was given to the selection of suitable exercises within the training modules, along with meticulous adjustments to the training components and their associated loads.

Typically, the interval training component comprises between 2 to 5 sets, each spanning 6 to 12 minutes in duration. The exertion level during these intervals is maintained at or above 100% of the Maximum Aerobic Speed (VMA). Following each intense interval, participants observe recovery periods spanning 7 to 10 minutes. (Hervé & Cometti, 2007).

Various types of interval exercises (short, medium, long) were used in their various forms (speed interval exercises, strength interval exercises, mixed " strength-speed" exercises). Consideration of the attributes specific to the target age cohort is integral, alongside adhering to established training principles, during the formulation and executi-

on of the envisioned training regimen. This meticulous approach is undertaken with the primary aim of mitigating the risk of injuries that might impede the successful completion of the training program. Notably, these considerations encompass factors such as individual disparities, progressive training regimes, adaptability, program integration, specificity, and the comprehensiveness of the training regimen.

The levels of load, with respect to both intensity and magnitude, are systematically tailored to align with the distinct training phases and the proficiency level of the athletes.

RESULTS

View and analyze study test results:

Table 4. *The test for normality of the normal distribution of the results of anthropometric measurements and physical abilities*

Statistical variables	Kolmogorov-Smirnov		the decision	Shapiro- Wilk		the decision
	statistic	(Sig)		statistic	(Sig)	
Yo-Yo Endurance intermittent test	0,216	0,076	Submit	0,862	0,033	no submit
a test partridge Baklata The two men are 10 m	0,138	0,200	Submit	0,973	0,911	submit

The values obtained from the Yo-Yo Endurance intermittent test did not follow a normal distribution, as evidenced by the non-significant Kolmogorov-Smirnov test (p = 0.076) at the 0.05 level of significance. However, the Shapiro-Wilk test yielded a significant result (p = 0.033), indicating a departure from normality. Consequently, nonparametric tests, specifically Wilcoxon's test, were employed instead of parametric tests. On the other hand, the values of the partridge variable for both legs at a distance of 10 meters were normally distributed. This was supported by the non-significant Kolmogorov-Smirnov test (p = 0.200) and the non-significant Shapiro-Wilk test (p = 0.911) at the 0.05 level of significance. Therefore, parametric tests could be used for further analysis.

Table 5. *Wilcoxon test for differences between pre and post-tests in a variable Yo-Yo Endurance intermittent test*

Appreciation	Total ranks	probability value Sig	value Z	middle ranks	the number N	cases
Statistically D at (0,01)	3,00 75,00	Asymptomatic (bilateral) 0,004	-2,84	3,00 6,82	01 11 02 14	Pre-test > Post-test Pre -test Post- test Pre-test = post-test the total

Based on the table, significant differences were observed between the pre and post-tests of the Yo-Yo Endurance intermittent test. The statistical value (z) was -2.84, indicating a significant result at a 0.01 level of significance. This conclusion is supported by the Asymp. Sig. a (2-tailed) probability value of 0.004, which is lower than the significance level of 0.01. Among the cases, 11 showed higher scores in the post-test with an average score of 6.82, while one case had a higher pre-test score with an average of 3.00. Additionally, two cases maintained the same level, with pre-tests equal to post-tests.To calculate the effect size using the Wilcoxon test for paired samples, the binary correlation coefficient (r_{prb}) known as the Matched-Pairs Rank Biserial Correlation is computed using the following equation: [Please provide the equation for calculating the binary correlation coefficient.] (Safi, 2019).

$$r_{prb} = \frac{4T_{+}}{n(n+1)} - 1$$

Where: $4T_{+}$ The sum of the ranks with a positive sign, *n* the number of pairs of degrees.
explains (r_{prb}) In light of the following simulations:

- The effect size is weak if it is 0,4 > r_{prb}
- The mean effect size was 0.7 > $r_{prb} \geq$ 0,4
- The effect size is significant if it is 0.9 > $r_{prb} \geq$ 0,7
- The effect size is very large $\geq \geq$ 0,9 r_{prb}

According to Table 5, the statistical significance value (Sig) is 0.004. This indicates that there are statistically significant differences between the pre and post-measurements of the Yo-yo test at a significance level of 0.01. These differences can be attributed to the program that was implemented, with the post-test showing favorable results compared to the pre-test.

- Through the previous equation to calculate the effect size when using a test Wilcoxon for the eyes Associated, we find that:

(T_+) = 75,00
(n) = 14 So the value of r_{prb} Equal:

$$r_{prb} = \frac{4 \times 75}{14 \times 15} - 1 = 0{,}42$$

- **effect size:** This indicates that there is an average effect of the training program on the maximum aerobic speed based on the Yo-Yo Endurance intermittent test.

✓ ***Calculate the effect size through the second equation using the Wilcoxon test:***

The effect size R is calculated as Z statistic divided by square root of the sample size (N), (Z/ √ N). (fritz et al.,2012; Ivarsson et al., 2013)

Effect size: R= 2.848/√14 = 0.761

- 0.1-0.3 = small
- 0.3-0.50 = medium
- ≥0.50 = large

- In this case, the effect size is considered large because "r" is higher than 0.50.

From the first and second equations we see that the effect size value when applying the Wilcoxon test ranges from medium to large, and from the percentage of improvement between pretest and posttest we see that the first equation is closest to the application.

Table 6. *Comparison of the pre-test and the post-test results for the study sample in the partridge test for both legs 10 m at the significance level 0.05 at degree of freedom 13*

the test	Arithmetic mean	standard deviation	Sample volume	correlation coefficient	t value calculated	probability value sig	Statistical significance
Pretest	4.06	0.61	14	0.805	5.848	0.000	D
Posttest	3.49	0.52					

Based on Table 6, we observe the comparison of the pre and post-test results of the study sample in the Partridge test (Baklata) for a distance of 10 meters. In the pre-test, the study sample achieved an average score of 4.06 with a standard deviation of 0.61. In the post-test, they achieved an average score of 3.49 with a standard deviation of 0.52. The calculated "t" value was 5.84, and the probability value "sig" was 0.000, which is less than the significance level of 0.05. These findings indicate that there are statistically significant differences between the pre- and post-measurements in favor of the post-test results for this sample. Therefore, the proposed training program, which incorporated intermittent exercises and was applied to the study sample, had a positive contribution to the development of the speed-strength characteristic.

✓ ***Calculate the effect size using Cohen's d equation:***

$$d = \frac{t}{\sqrt{n}}$$

where: (T) = 5.84, (N) = 14, (√ N) = 3.741.

$$d = \frac{5.84}{\sqrt{14}} = 1.56$$

- d = 0.2, small effect
- d = 0.5, medium effect
- d = 0.5, large effect
- d = 1.3, very big effect (Sullivan, & Feinn, 2012)

- Through the following measure: we conclude that the effect size value of (1.56) is very large.

Table 7. *The results of the percentage differences between the pre and post-measurements in the partridge test for both men 10 m*

variants	df	value (tc) calculated	Eta square value (Eta²)	rate variance	difference ratio
Partridge test for both men 10 m	13	7,97	0,8301	83.01%	16,99%

From the table, it is evident that the effect size, measured by the "Eta squared" (η^2) value, is 0.8301. This indicates that 83.01% of the observed variation in the individuals' performance in the Partridge test for both legs at a distance of 10 meters can be attributed to the effect of the proposed program. This is a substantial percentage, demonstrating a clear and significant impact of the program. The remaining 16.99% represents the residual variation. Furthermore, the calculated value of "tc" is 7.97, indicating statistical significance and demonstrating the accuracy and objectivity of utilizing training programs incorporating intermittent exercises for enhancing the physical attribute of speed-related strength.

DISCUSSION

During the statistical analysis of the collected data in this study, a notable statistical dispersion was observed between the initial and final measurements in the Yo-Yo Endurance intermittent test, as indicated in Schedule 5. This finding can be attributed to the implementation of the training program, which incorporated various forms of intermittent exercises. These exercises included running, shuttle runs, and different durations of intervals (long, medium, short, and very short). This observation aligns with previous studies and research in the field, such as the thesis *by Hervé Assadi* in 2012 titled *"Physiological responses during the performance of interval training exercises,*" which found that various interval training exercises enhance maximum aerobic speed. Other studies by Kharoubi Mohamed Faisal (2016), Sadouki Bilal (2016), also support this notion, as indicated by (Billat et al., 2001).

Intermittent training, alongside other training methods, has been recognized as an effective approach to developing maximum aerobic capacity (Cazorla, 2012). states that short, high-intensity intermittent exercises, such as running at 110-120% of the maximum aerobic speed with short recovery periods (15-20-30 seconds) repeated 30-40 times, are the most effective for developing maximum aerobic speed without excessive lactate production. Several studies have provided evidence to support this claim. Overall, the findings of this study and the existing literature emphasize the efficacy of incorporating intermittent exercises, particularly high-intensity short intervals, in improving maximum aerobic speed. This was confirmed by both studies (Sara Aliberti et al., 2021) which is titled" Three workouts compared: interval training, intermittent training and steady state training for the improvement of VO2max and BMI" Intermittent training and interval training contribute effectively to improving aerobic capacity. Based on the statistical analysis of the study results, it is evident that the training program utilizing various forms of intermittent exercises has proven effective in developing maximum aerobic speed (VMA) in football players under 19 years old.

Furthermore, significant improvements were observed in the partridge test for both legs at a distance of 10 meters, as indicated in Tables 6 and 7. These findings consistently support the positive impact of the training program. The researchers assert that the implementation of the training program, which incorporates different types of intermittent exercises, has contributed to the development of power, specifically speed, which is a crucial physical capacity in football. This can be further explained by the insights of (Gacon, 1983, 1990), who suggests that interval training emphasizes exercises involving plyometric contractions. This type of training helps improve the speed of recruiting motor units in muscles, increases neural stimulation frequency, and enhances the synchronization of motor units. These factors collectively contribute to the enhancement of explosive power and the power characteristic of speed. Overall, the findings support the notion that the training program utilizing intermittent exercises effectively enhances maximum aerobic speed and power, particularly speed, in young football players.

The findings of the study align with the results of Mansouri's thesis titled *"A comparative study between the long and short interval training methods and their impact on both the maximum Aerobic speed and the Speed characteristic of senior Football players*" (2019). Mansouri's study also concluded the effectiveness of a training program incorporating long and short-interval training in developing the power characteristic of speed in senior football players. These consistent findings further support the notion that training programs utilizing different forms of intermittent exercises have proven effective in enhancing the power and speed characteristics in football players. Therefore, based on the results of your study and the supporting evidence from Mansouri's thesis, it can be confidently stated that the proposed training program utilizing various forms of intermittent exercises has demonstrated its effectiveness in developing the power characteristic of speed.

CONCLUSION

The study aimed to investigate the effectiveness of incorporating intermittent exercises (specifically focusing on strength and speed) within a proposed training program in improving the maximum aerobic speed and the power characteristic of speed in soccer players under 19 years old. The experimental approach was employed, using a one-group design with a sample of 14 players from IRB SEDRATA. The study included pre-tests, followed by the implementation of a 16-session training program with two sessions per week, starting from the special physical preparation stage and concluding with post-tests. Upon analyzing and processing the collected data, it was observed that the application of intermittent exercises within the proposed training program had a positive impact on enhancing both the maximum aerobic speed (VMA) and the power characteristic of speed in soccer players under 19 years old. These findings suggest that the utilization of intermittent exercises, specifically focusing on strength and speed, can be an effective approach to improving the physical performance of young soccer players in terms of their aerobic capacity and speed-related abilities.

REFERENCES

Albassati, A. A. (1998). *Rules and foundations of sports training and its applications.* Knowledge facility.

Allaoui, M. H. (1992). *The science of sports training* (th12 ed.). Knowledge House.

Allaoui, M. H. (1990). *The science of sports training* (th11 ed.). Knowledge House.

Billat, L. V. (2001). Interval training for performance: a scientific and empirical practice: special recommendations for middle-and long-distance running. Part I: aerobic interval training. *Sports medicine*, *31*, 13-31.

Bernard, T. (2002). *Training and training of the footbaleur*. Ed Amphora.

Bangsbo, J. (1994). The physiology of soccer with special reference to intense intermittent exercice. *Acta Physiol Scand Suppl*. 619 1-155. 48, 53.

Dellal, A. (2008). *Performance training in football*. Legal Deposit.

Dellal, A. (2013). *A season of physical preparation in football*. De boeck

Dellal, A., & Javier, M. (2017). *A season of intermittent work* (4th ed.). Trainer

Dellal, A. (2020). *A chapter on physiotherapy in football* (3rd ed.). de boeck .

Georges, C. (2012). *Biology of development, growth, maturation and motor performance. Courses of Physical Practitioners FFF Clairefontaine*. http://dspace.univ-bouira.dz.

Hervé, A. (2012). *Physiological responses during intermittent running exercises* [Doctoral thesis]. University of Burgundy. https://tel.archives-ouvertes.fr/tel-00817851.

Gacon, G. (1983). The endurance race. Dijon: CRDP University of Dijon.

Gacon, G. (1990). Towards a new definition of maximal aerobic work in middle-distance runners. A new training concept: weighting. AEFA review. 115-116:55-69.

Kashif, A. M. (1994). *planning in training*. Egyptian Renaissance.

Kharoubi, M. F. (2016). A study of the effect of short and long intermittent training on the maximum aerobic speed among of middle class players. *Journal of the Science and Practice of Artistic and Sport Physical Activities, 13*(9).

Mansouri, A. (2019). A *study comparison between ways of short and long intermittent training and their impact on maximum aerobic speed And Power speed among Senior football players* [PhD dissertation is published]. University of Algiers 3.

Mufti, I. H. (2001). *Modern sports training Planning, implementation and leadership* (2nd ed.). Arab Thought House.

Safi, S. K. (2019). *Inferential educational statistics course*. The *seventh lecture*. *Non - parametric tests (parametric-1)*. Islamic University. http://site.iugaza.edu.ps/ssafi/files.pdf

Sadouki, B. (2016). *The impact of training intermittent and mini-game training on the maximum aerobic speed of middle class football players* [Unpublished master's thesis] university Algeria 3.

Sara A., Antonio, C., Giovanni, E., Gaetano A., & Gaetano, R. (2021). Three workouts compared: interval training, intermittent training and steady state training for the improvement of VO2max and BMI. *Sports Science and Health*, *11*(2), 197-204.

Taha, I. (1989). *Football between theory and practice*. Arab Thought House.

Weineck, J. (1997). *Training manual* (4th ed.). Edition vigot.

Fritz, C. O., Morris, P. E., & Richler, J. J. (2012). Effect size estimates: current use, calculations, and interpretation. *Journal of experimental psychology: General*, *141*(1), 2.

Ivarsson, A., Andersen, M. B., Johnson, U., & Lindwall, M. (2013). To adjust or not adjust: Nonparametric effect sizes, confidence intervals, and real-world meaning. *Psychology of sport and exercise*, *14*(1), 97-102.

Sullivan, G. M., & Feinn, R. (2012). Using effect size-or why the P value is not enough. *Journal of Graduate Medical Education*, *4*(3), pp. 279-282.

Fox, E.L., Bartels, R.L., Klinzing, J., & Ragg, K. (1977). Metabolic responses to interval training programs of high and low power output. *Med Sci Sports*. *9*(3): 191-6. https://pubmed.ncbi.nlm.nih.gov/593083/

Hervé, A., & Cometti, G. (2007). *The intermittent*. UFR STAPS University of Dijon.

Primljen: 12. jun 2023. / Received: June 12, 2023
Izmjene primljene: 03. oktobar 2023. / Changes Received: October 03, 2023
Prihvaćen: 08. decembar 2023. / Accepted: December 08, 2023

https://doi.org/10.7251/SSH2302233N UDC: 612.015.3.087:796.325
Short notice *Kratko saopštenje*

Analysis of the Physical Conditions of Indonesian Beach Volleyball Players in 2022

Ahmad Nasrulloh[1], Betrix Teofa Perkasa Wibafied Billy Yachsie[2], Amry Hartanto[3]
[1]*Sports Science Study Program, Faculty of Sports, Yogyakarta State University, Yogyakarta, Indonesia*
[2]*Indonesian Traditional Medicine Study Program, Sports and Health Department, Vocational Faculty, Yogyakarta State University, Indonesia*

Correspondence:
Ahmad Nasrulloh, Sports Science Study Program, Faculty of Sports, Yogyakarta State University Yogyakarta State University, Indonesia, ahmadnasrulloh@uny.ac.id

Abstract: *This research is preliminary research which aims to determine the results of the dominant physical condition components in beach volleyball athletes. This type of research is quantitative descriptive. The sampling technique used was purpose sampling. A sample of 12 volleyball players was obtained which was divided into two subsamples, namely 6 men and 6 women. The instruments used are the push up test, vertical jump, and bleep test. The data analysis technique uses descriptive analysis expressed in percentage form. with results (1) The arm muscle endurance of men's beach volleyball athletes at Pelatnas in 2021 is in the "Adequate" category at 66.67% (4 athletes), while female athletes are in the "Adequate" category at 66.67% (4 athletes) . (2) The cardiorespiratory endurance (VO2 Max) of the 2021 National Pelatnas men's beach volleyball athletes is in the "Adequate" category at 50.00% (3 athletes), while the female athletes are in the "Adequate" category at 50.00% (3 athlete). (3) The leg muscle strength of male beach volleyball athletes at Pelatnas in 2021 is in the "Good" category at 50.00% (3 athletes), while the female athletes are in the "Poor" category at 33.33% (2 athletes), "Fair " by 33.33% (2 athletes), "Good" by 33.33% (2 athletes). From these dominant components, it can be concluded that Indonesian sand volleyball players have less than optimal results, so it is necessary to vary the training program by the coach.*
Keywords: *arm muscle endurance, cardiorespiratory endurance (VO2 max), leg muscle power, sand volleyball.*

INTRODUCTION

Volleyball is a sport that is very popular with Indonesian people (Irawan et al., 2023). That is currently ranked second after football, it is no wonder that this game, which mostly uses hands, is played by almost all people in rural communities, urban communities, and even elementary schools to tertiary institutions (Dragosavljević et al., 2020; Young et al., 2023). Sand volleyball is one of many volleyball variations that is practiced, as evidenced by the fact that there are only two players per team and that the game is played on a sandy beach field (Choi et al., 2023).

Excellent physical condition and fundamental volleyball technical abilities are necessary for success in sand volleyball. Body condition and fitness in the world of sports are incredibly closely entwined since an athlete will always want to make the most of his technical talents. If the physical capacity is sufficient and the physical state is closely related to the body's capacity to carry out the work duties being carried out, skilled movement can be performed(Da Costa et al., 2023; Kadhim & Atea, 2023; Martínez et al., 2023; Teixeira et al., 2023). The components of physical condition that affect sand volleyball performance are strength, speed, flexibility, endurance, leg muscle power, and coordination (Sabillah et al., 2022).

Arm muscle endurance and VO2Max endurance are a person's ability to use their muscles to contract continuously for a relatively long time with certain loads with different targets. The ability to do work with long intensity and continuously is called stamina. Meanwhile, leg muscle strength in sand volleyball is useful for jumping, smashing and blocking (Khalafi et al., 2022). This is supported by research that (Panda et al., 2022) endurance, strength, power and speed are elements of energy that are really needed in the sand volleyball game, because the sand volleyball game only has 2 players so the intensity of the players jumping is greater.

The importance of the state of physical condition should be realized by coaches and athletes themselves (De Smet et al., 2023; Wu et al., 2023). The coach should always control the athlete's physical condition, so that it can be known early on if the players experience interference which will later affect the performance and performance of these players in competition (Amal et al., 2022). Based on the problems above, it can be said that there is a disbalance between expectations and reality that occurs, this means that achievement is not solely determined by technical

proficiency alone, but from several factors, one of which is through systematic and continuous maximum training. So the purpose of this study was to determine the state of arm muscle endurance, VO2Max endurance, and leg muscle power of Pelatnas beach volleyball athletes in 2021.

METHOD

This research is a quantitative descriptive research with descriptive research methods. A sampling technique was used with certain criteria (purpose sampling), which included: volleyball athletes, height 170-185 and ideal body weight, age 21-25 years, active training, good health condition. Next, based on the criteria, A sample of 12 volleyball players was obtained which was divided into two subsamples, namely 6 men and 6 women. Next, to obtain reference data, a test from the realm of physical fitness was used with the instrument used is arm muscle endurance (push up test), vertical jump leg power, and VO2Max endurance (bleep test) research was carried out in Indonesia. The data analysis technique used is descriptive percentage.

RESULTS

Below we will explain the results of physical condition tests on volleyball players. The results of the analysis are as follows:

Table 1. *Statistical description of arm muscle endurance in men's and women's beach volleyball players*

No	intervals	Category	Frequency	Percentage	intervals	Category	Frequency	Percentage
1	53.23 < X	Very good	0	0.00%	33.36 < X	Very good	1	16.67%
2	43.63 < X ≤ 53.23	Good	1	16.67%	29.12 < X ≤ 33.36	Good	0	0.00%
3	34.03 < X ≤ 43.63	Enough	4	66.67%	24.88 < X ≤ 29.12	Enough	4	66.67%
4	24.43 < X ≤ 34.03	Not enough	1	16.67%	20.64 < X ≤ 24.88	Not enough	1	16.67%
5	X ≤ 24.43	Very Not enough	0	0.00%	X ≤ 20.64	Very Not enough	0	0.00%
Amount			6	100%	Amount		6	100%

Based on the results above, it shows that the arm muscle endurance of Pelatnas men's beach volleyball athletes in 2021 is in the „Very Insufficient" category of 0.00% (0 player), "Less" of 16.67% (1 player), „Enough" " by 66.67% (4 player), "Good" by 16.67% (1 player), and "Very Good" by 0.00% (0 player). Based on the results above, it shows that the arm muscle endurance of Pelatnas women's beach volleyball athletes in 2021 is in the „Very Insufficient" category of 0.00% (0 player), „Less" of 16.67% (1 player), „Enough" " by 66.67% (4 player), "Good" by 0.00% (0 player), and "Very Good" by 16.67% (1 player).

Table 2. *Descriptive statistics on the VO2Max endurance of men's and women's beach volleyball players*

No	intervals	Category	Frequency	Percentage	intervals	Category	Frequency	Percentage
1	46.27 < X	Very good	1	16.67%	44.04 < X	Very good	0	0.00%
2	43.09 < X ≤ 46.27	Good	1	16.67%	41.45 < X ≤ 44.04	Good	2	33.33%
3	40.09 < X ≤ 43.09	Enough	3	50.00%	38.86 < X ≤ 41.45	Enough	3	50.00%
4	37.00 < X ≤ 40.09	Not enough	1	16.67%	36.27 < X ≤ 38.86	Not enough	0	0.00%
5	X ≤ 37.00	Very Not enough	0	0.00%	X ≤ 38.86	Very Not enough	1	16.67%
Amount			6	100%	Amount		6	100%

Based on the results above, it shows that the VO2Max endurance of Pelatnas men's beach volleyball athletes in 2021 is in the „Very Insufficient" category of 0.00% (0 player), „Less" of 16.67% (1 player), „Enough" of 50.00% (3 player), „Good" of 16.67% (1 player), and „Very Good" of 16.67% (1 player). Based on the results above, it shows that the VO2Max endurance of Pelatnas women's beach volleyball athletes in 2021 is in the „Very Insufficient" category of 16.67% (1 player), „Less" of 0.00% (0 player), „Enough" of 50.00% (3 player), „Good" of 33.33% (1 player), and „Very Good" of 0.00% (0 player).

Table 3. *Statistical description of Leg Muscle Power in Men's and women's Beach Volleyball player*

No	intervals	Category	Frequency	Percentage	intervals	Category	Frequency	Percentage
1	83.13 < X	Very good	0	0.00%	60.00 < X	Very good	0	0.00%
2	77.93 < X ≤ 83.13	Good	3	50.00%	56.00 < X ≤ 60.00	Good	2	33.33%
3	72.73 < X ≤ 77.93	Enough	1	16.67%	52.00 < X ≤ 56.00	Enough	2	33.33%
4	67.53 < X ≤ 72.73	Not enough	2	33.33%	48.00 < X ≤ 52.00	Not enough	2	33.33%
5	X ≤ 67.53	Very Not enough	0	0.00%	X ≤ 48.00	Very Not enough	0	0.00%
Amount			6	100%	Amount		6	100%

Based on the results above, it shows that the leg muscle power of Pelatnas men's beach volleyball athletes in 2021 is in the category „Very Insufficient" of 0.00% (0 player), „Less" of 16.67% (1 player), „Enough" of 50.00% (3 player), „Good" of 16.67% (1 player), and „Very Good" of 16.67% (1 player). Based on the results above, it shows that the leg muscle power of Pelatnas women's beach volleyball athletes in 2021 is in the „Very Insufficient" category of 0.00% (0 player), „Less" of 33.33% (2 player), „Enough" of 33.33% (2 player), „Good" of 33.33% (2 player), and „Very Good" of 0.00% (0 player).

DISCUSSION

Volleyball athletes really need good physical condition (Cheng & Ebrahimi, 2023)stated that physical condition not only influences technical improvement, but also improves tactics. Improving tactics will not be successful if you do not master the technique well and are supported by good physical condition (Qiao et al., 2023). Physical condition is very determining for a person to optimize the techniques learned, good physical condition is the main requirement for mastering and developing a sports technical skill(Zhao et al., 2023). Physical condition is an important element and is the basis for developing techniques, tactics and strategies in playing volleyball. The dominant physical condition components for sand volleyball players include arm muscle endurance, VO2Max endurance, and leg muscle power.

Muscular endurance is the ability to withstand muscle fatigue during physical activity (Hanish et al., 2023; Yachsie, Suharjana, et al., 2023) Based on research results(Ribeiro et al., 2022)Arm muscle endurance is needed by male or female sand volleyball athletes who aim to combine it with speed where players get hard smashes (Bright et al., 2023). Study (Kang et al., 2023)stated that the average arm muscle endurance of men and women tends to be different. Research backed (Miguel-Ortega et al., 2023) Men's muscle endurance is on average higher than women's, so male volleyball athletes are easier to train than women, but not all female volleyball players have the same results. However, there is a gap in the arm muscle endurance component. If a volleyball player only has good arm muscle endurance, not supported by speed, the ball shot will not be accurate (Yudi & Anggara, 2021). Based on the results (Fatih, 2023) On average, male or female volleyball players have arm muscle endurance in the poor category, so it is best to do exercises to strengthen arm muscle endurance, one of which is by using a GYM machine. With the hope of improving the dominant physical condition components of the Indonesian team's beach volleyball players. So it can be interpreted that arm muscle endurance is needed to maintain a stable arm condition, with the hope that it will not get tired easily when competing (Yachsie, Pranata, et al., 2023). The uses of arm muscle endurance include a stance for receiving passes, as well as for the accuracy of serves or smashes, so the endurance of the arm muscles will greatly influence this, if the muscle endurance is good, the serve will be harder and better. and also smashes (Marpaung & Priyonoadi, 2020).

Fatigue is a factor that causes defeat in sand volleyball games where sandy terrain conditions require players to maintain their stamina, however in this study male and female sand volleyball players had less than optimal results. So there is a gap that causes fatigue during matches and training (Aliberti et al., 2021). Based on research (Rasmin et al., 2023) Low VO2Max conditions are the result of an unhealthy lifestyle, where lack of rest hours, smoking and having fun at night can cause VO2Max conditions to decrease. So it is necessary to hold activities as a form of relaxation, such as outbound activities and other activities. Based on research (Yu et al., 2023) Male and female athletes have an average level of saturation that is higher than non-athletes. And based on research (Griban et al., 2023) The smoking lifestyle is not only experienced by men but women also follow it, be it vaping or smoking tobacco. This means that coaches must understand that it is not only training activities that are maximized, but recreational activities also need to be carried out, with the hope of reducing the impact of unhealthy lifestyles on athletes. Based on research (Carpes et al., 2023). Endurance is a person's body's ability to resist fatigue that arises when carrying out

activities for a long time (Carpes et al., 2023). The culture of smoking and lack of regular rest can affect cardiopulmonary endurance, if interpreted as the ability of the lungs, heart and blood vessels to send sufficient amounts of oxygen to the cells to meet the needs of physical activity for a long time (Stojanović et al., 2022). So if there is an obstacle in the body's system, the body will not respond well, but the body will show a reaction to rest.

The position of the legs in a volleyball game forms a stance with a half-squat process. This is done so that the process of bouncing the ball on the arm can be directed properly. Apart from that, each player must move to pick up the ball, so players who lack good leg power will certainly have unbalanced movements (Shamsuddin et al., 2022). Leg muscle power is the ability of a muscle or group of leg muscles to overcome resistance with fast movements, for example jumping, throwing, hitting and running (González-Badillo et al., 2022). On the other hand, if the explosive power of the leg muscles is still weak, it will affect the player's performance on the field, especially when carrying out attacks and defense (Huang et al., 2023). So this leg power has a big influence on jumping, based on opinion (Schärer et al., 2023) The explosive power of male and female volleyball players has a large gap where men jump higher than women (Roso-Moliner et al., 2023), but As for opinions (Pawlik & Mroczek, 2023) that women's jumps are no less high than men's. This means that leg power can vary depending on body height and the training performed. From the results above, it can be interpreted that male and female sand volleyball players have less than optimal results, so it is necessary to carry out training programs specifically to increase leg power, for example by providing training. Therefore, the explosive power of the leg muscles continues to be trained and improved through training programs that are prepared based on planned and systematic training programs. The weakness in this research is that it cannot control other factors that can influence the test, namely psychological or mental factors.

CONCLUSION

Playing volleyball in a match takes a relatively long time, it can last for hours, and there can even be extra rounds. This requires the ability of volleyball players to do physical work for a relatively long time. These dominant components will provide maximum results. So it can be concluded that it is necessary to carry out special treatment to provide a significant impact, such as exercise to increase arm muscle endurance, relaxation and special treatment to change lifestyle so that VO2Max is maintained as well as, weight training for leg power with each appropriate exercise program.

REFERENCES

Aliberti, S., Calandro, A., Esposito, G., Altavilla, G., & Raiola, G. (2021). Three workouts compared: interval training, intermittent training and steady state training for the improvement of VO2 max and BMI. *Sportske Nauke i Zdravlje*, *11*(2), 197–204. https://doi.org/10.7251/SSH2102197A

Amal, A. I., Sutapa, P., & Ramadhan, T. K. (2022). The relevance of physical conditions to team performance: A case study of PORPROV women's volleyball athletes in Banyumas regency. *Journal of Sports Science and Nutrition*, *3*(1), 95–102.

Bright, T. E., Handford, M. J., Mundy, P., Lake, J., Theis, N., & Hughes, J. D. (2023). Building for the future: A systematic review of the effects of eccentric resistance training on measures of physical performance in youth athletes. *Sports Medicine*, 1–36.

Carpes, L. O., Domingues, L. B., Fuchs, S. C., & Ferrari, R. (2023). Rate of Responders for Post-Exercise Hypotension after Beach Tennis, Aerobic, Resistance and Combined Exercise Sessions in Adults with Hypertension. *Sports*, *11*(3), 58.

Cheng, C., & Ebrahimi, O. V. (2023). A meta-analytic review of gamified interventions in mental health enhancement. *Computers in Human Behavior*, *141*, 107621.

Choi, W., Lee, W., Lee, C., Haugen, M., & Welty Peachey, J. (2023). How do fan engagement and sport participation influence adaptation to campus and life satisfaction? A Comparison between American domestic and Asian international students. *Journal of Leisure Research*, 1–25.

Da Costa, Y. P., Fortes, L., Santos, R., Souza, E., Hayes, L., Soares-Silva, E., & Batista, G. R. (2023). Mental fatigue measured in real-world sport settings: A case study of world class beach volleyball players. *Journal of Physical Education and Sport*, *23*(5), 1237–1243. https://doi.org/10.7752/jpes.2023.05152

De Smet, S., O'Donoghue, K., Lormans, M., Monbaliu, D., & Pengel, L. (2023). Does exercise training improve physical fitness and health in adult liver transplant recipients? A systematic review and meta-analysis. *Transplantation*, *107*(1), e11–e26.

Dragosavljević, S., Mitrović, N., & Stević, D. (2020). The Effects of Plyometric Training on Motor Skills of Top Volleyball Players / Efekti pliometrijskog treninga na motoričke sposobnosti vrhunskih odbojkaša. *Спортске Науке И Здравље - Aпеирон*, *18*(2), 124–138. https://doi.org/10.7251/ssh1902124d

Fatih, E. (2023). Investigation of the Effect of Push-Up Exercises with and without Suspension on Some Motor Skills Applied to Young Volleyball Athletes. *Journal of Education and Recreation Patterns*, *4*(2).

González-Badillo, J. J., Sánchez-Medina, L., Ribas-Serna, J., & Rodríguez-Rosell, D. (2022). Toward a New Paradigm in Resistance Training by Means of Velocity Monitoring: A Critical and Challenging Narrative. *Sports Medicine-Open*, *8*(1), 1–24.

Griban, G. P., Lyakhova, N., Oleniev, D., Kanishcheva, O., Duhina, L., Ostrianko, T., & Skoruy, O. (2023). Dynamics of tobacco smoking prevalence among students and directions of its prevention. *Wiadomości Lekarskie*, *76 (8)*, 1776–1782.

Hanish, S., Muhammed, M., Kelly, S., & DeFroda, S. (2023). Postoperative Rehabilitation for Arthroscopic Management of Femoroacetabular

Impingement Syndrome: a Contemporary Review. *Current Reviews in Musculoskeletal Medicine*, 1–11.

Huang, R., Zhang, M., Huang, L., Chen, Z., Mo, Y., & Gao, Y. (2023). Effects of lower-extremity explosive strength on youth judo athletes adopting different types of power-based resistance training. *Frontiers in Physiology*, *14*, 413.

Irawan, F. A., Permana, D. F. W., & Hadi, S. R. (2023). Kinematics Analysis of Volleyball Open Spike in the Elite Athletes. *ISPHE 2022: Proceedings of the 6th International Seminar on Public Health and Education, ISPHE 2022, 29 June 2022, Semarang, Central Java, Indonesia*, 195.

Kadhim, H. S., & Atea, A. S. (2023). The Effect of Balance Exercises on Some Strength Abilities of The Legs for High-Spiking Players in Volleyball. *The Egyptian Journal of Hospital Medicine*, *90*(2), 2808–2813.

Kang, B., Crilly, N., Ning, W., & Kristensson, P. O. (2023). Prototyping to elicit user requirements for product development: Using head-mounted augmented reality when designing interactive devices. *Design Studies*, *84*, 101147.

Khalafi, M., Sakhaei, M. H., Rosenkranz, S. K., & Symonds, M. E. (2022). Impact of concurrent training versus aerobic or resistance training on cardiorespiratory fitness and muscular strength in middle-aged to older adults: A systematic review and meta-analysis. *Physiology & Behavior*, 113888.

Marpaung, H. I., & Priyonoadi, B. (2020). *The Correlation between Leg-arm Muscle Power and Volleyball Players' Open Smash Ability*.

Martínez, E. L., García, G. M. G., & Molina-Martín, J. J. (2023). Quantification of the competition load of the sets in high-level volleyball in the year 2021. *Journal of Physical Education and Sport*, *23*(1), 134–142.

Miguel-Ortega, Á., Calleja-González, J., & Mielgo-Ayuso, J. (2023). Comparison of Sports Performance and Kinanthropometric Profiles of Elite Female Basketball and Volleyball Players over the Course of a Competitive Season. *Applied Sciences*, *13*(14), 8267.

Panda, M., Rizvi, M. R., Sharma, A., Sethi, P., Ahmad, I., & Kumari, S. (2022). Effect of electromyostimulation and plyometrics training on sports-specific parameters in badminton players. *Sports Medicine and Health Science*, *4*(4), 280–286.

Pawlik, D., & Mroczek, D. (2023). Influence of jump height on the game efficiency in elite volleyball players. *Scientific Reports*, *13*(1), 8931.

Qiao, J., Wang, S., Yu, C., Yang, X., & Fernandez, C. (2023). A chaotic firefly-Particle filtering method of dynamic migration modeling for the state-of-charge and state-of-health co-estimation of a lithium-ion battery performance. *Energy*, *263*, 126164.

Rasmin, M., Faiza, H. N., Suryoadji, K. A., Zain, N. H., Utami, S. S., Taufik, F. F., Friska, D., Sudarsono, N. C., & Syahrudin, E. (2023). Relationship Between Nutritional Status, Physical Activity, Type of Work and Smoking Activity with Fitness Level Measured by 6-Minute Walking Test on Non-staff Employees of Universitas Indonesia, Depok. *Respiratory Science*, *3*(2), 103–115.

Ribeiro, J., Silva Dias, T., Dias, C., & Fonseca, A. M. (2022). Mental imagery use: the perspective of national team coaches in the U-19 beach volleyball world championship. *Sports Coaching Review*, 1–21.

Roso-Moliner, A., Lozano, D., Nobari, H., Bishop, C., Carton-Llorente, A., & Mainer-Pardos, E. (2023). Horizontal jump asymmetries are associated with reduced range of motion and vertical jump performance in female soccer players. *BMC Sports Science, Medicine and Rehabilitation*, *15*(1), 80.

Sabillah, M. I., Tomoliyus, Nasrulloh, A., & Yuniana, R. (2022). The effect of plyometric exercise and leg muscle strength on the power limb of wrestling athletes. *Journal of Physical Education and Sport*, *22*(6), 1403–1411. https://doi.org/10.7752/jpes.2022.06176

Schärer, C., Reinhart, L., & Hübner, K. (2023). Age-Related Differences between Maximum Flight Height of Basic Skills on Floor, Beam and Vault and Physical Condition of Youth Female Artistic Gymnasts. *Sports*, *11*(5), 100.

Shamsuddin, D. S. N. A., Fekeri, A. F. M., Muchtar, A., Khan, F., Chin, K. B., Huah, L. B., Rosli, M. I., & Takriff, M. S. (2022). Computational Fluid Dynamics Modelling Approaches of Gas Explosion in the Chemical Process Industry: A review. *Process Safety and Environmental Protection*.

Stojanović, N., Stojanović, D., Zadražnik, M., Bešić, Đ., & Stojanović, T. (2022). The Effects of Short-Term Preseason Skill-Based Conditioning on Physiological Characteristics in Elite Female Volleyball Players. *SportLogia*, *18*(1).

Teixeira, M., Júnior, A., & Sesinando, A. (2023). Sport Events as a Catalyst for Economic, Socio-Cultural, Tourism, and Environmental Sustainability in Portugal. *Sport Management in the Ibero-American World: Product and Service Innovations*, 258–273.

Wu, S. W., Wan, D. T., Jiang, C., Liu, X., Liu, K., & Liu, G. R. (2023). A finite strain model for multi-material, multi-component biomechanical analysis with total Lagrangian smoothed finite element method. *International Journal of Mechanical Sciences*, *243*, 108017.

Yachsie, B. T. P. W. B., Pranata, D., Hita, I. P. A. D., Kozina, Z., & Suhasto, S. (2023). How Does Circuit Plank Exercise Affect Arm Muscle Strength and Archery Accuracy? *International Journal of Human Movement and Sports Sciences*, *11*(5), 1114–1120. https://doi.org/10.13189/saj.2023.110520

Yachsie, B. T. P. W. B., Suharjana, Graha, A. S., & Hartanto, A. (2023). Circuit Game Development: Implications On Balance, Concentration, Muscle Endurance, And Arrow Accuracy. *Physical Education Theory and Methodology*, *23*(1), 92–97. https://doi.org/10.17309/tmfv.2023.1.13

Young, W. K., Briner, W., & Dines, D. M. (2023). Epidemiology of common injuries in the volleyball athlete. *Current Reviews in Musculoskeletal Medicine*, *16*(6), 229–234.

Yu, Q., Kong, Z., Zou, L., Chapman, R., Shi, Q., & Nie, J. (2023). Comparative efficacy of various hypoxic training paradigms on maximal oxygen consumption: A systematic review and network meta-analysis. *Journal of Exercise Science & Fitness*.

Yudi, A. A., & Anggara, D. (2021). Plyometrics exercise effects vollyball athlete smash ability. *1st International Conference on Sport Sciences, Health and Tourism (ICSSHT 2019)*, *35*, 24–30.

Zhao, K., Zhang, M., Shen, W., Liu, X., Ji, J., Dai, B., & Zhang, R. (2023). Automatic body condition scoring for dairy cows based on efficient net and convex hull features of point clouds. *Computers and Electronics in Agriculture*, *205*, 107588.

Primljen: 11. jul 2023. / Received: July 11, 2023
Prihvaćen: 07. oktobar 2023. / Accepted: October 07, 2023

https://doi.org/10.7251/SSH2302238K UDC: 612.015.3.087:[616.98:578.834
Short notice *Kratko saopštenje*

Differences Between Professional and Recreational Athletes in Psychological Characteristics And Habits During the Covd-19 Pandemic

Danijela Kuna[1], Lana Škorić[2], Terezija Buljan[2]
[1]Faculty of Kinesiology, Osijek, Croatia
[2] Clinical Hospital Center, Zagreb, Croatia

Correspondence:
Danijela Kuna, Faculty of Kinesiology, Osijek, Croatia
danijela.kuna@gmail.com

Abstract: *This study was conducted with the aim of investigating differences between recreational and professional athletes in perfectionism, distress, coping strategies, and changes in sports activities during the COVID-19 pandemic. Participants in the study consisted of a sample of 389 professional and recreational athletes. The results of the conducted analysis indicate the existence of certain differences between the two considered groups. On average, professional athletes score higher on the perfectionism scale than recreational athletes (t=-2,92, p<,01). Also, professional athletes were on average more likely to use relaxation techniques before (t=-8,30, p<,01) and during lockdown (t=-6,20, p<,01) compared to recreational athletes. Furthermore, professional athletes estimated that on average they missed training (t=-6,52, p<,01) and sports performances more (t=-11,30; p<,01) compared to recreational athletes. On average, professional athletes report a significantly larger reduction in training compared to recreational athletes (t=4,23, p<,01). Considering our results, we think it would be beneficial to focus on this topic in future studies.*

Keywords: *coping with stress, changes in sports activities, perfectionism tendencies.*

INTRODUCTION

Since mid-March 2020, starting from the proclamation of the pandemic in Croatia and Bosnia and Herzegovina, the pandemic caused by the virus COVID-19 has affected all social life aspects. To prevent the spread of infection, quarantine, isolation, social distancing, and a reduced maximum number of people in households were introduced by prescribing protective measures. However, quarantine recognized as the best tool to prevent the spread of viruses and to protect the population (WHO, 2020), can cause detrimental mental health implications over extended periods (Hossain et al., 2020). Brooks et al. (2020) reported on the impact of uncertainty related to anticipation, isolation from loved ones, boredom, and loss of freedom on individuals' mental health.

The lockdown has impacted sports and sports events tremendously. Samuel, Tenenbaum, and Galily (2020) argue that the viral pandemic COVID-19 has imposed the most profound changes the world of sports has ever seen. In addition to the aforementioned stressors caused by the pandemic, athletes of all categories had to cope with a sudden and unexpected disruption of their daily activities (Kurdić, 2020). Measures taken in March 2020 in the Republic of Croatia included the suspension of all sports competitions and organized training, as well as the closure of gyms, sports centers, gymnasiums, and recreation centers (Kurdić, 2020). Consequently, athletes of all categories were distracted from the usual training and preparations. The cancelation of global competitions such as the Olympic and Paralympic Games also deprived some elite athletes of the opportunity to achieve long-expected success (Håkansson et al., 2021).

A sudden and unexpected interruption and change in the training schedule and the impossibility to train in an adequate environment can represent an additional psychological burden for athletes (Leguizamo et al., 2021). Besides, when the season is interrupted unexpectedly and without the athlete's own decision, as is the case during the pandemic, the transition process is considered more difficult (Stambulova et al., 2020; Stambulova et al., 2021). The change in the sports calendar has led to a situation where changes in goals, evaluation of current progress and career path, as well as attitudes toward sports life itself are required. Moreover, such changes may lead to uncertainty impacting not only career plans, professional health, and engagement (González-Hernández et al., 2021), but also personal life (Schinke et al., 2020). Facer-Childs et al. (2020) have linked such a decrease in training frequency and volume to poorer mental health status in athletes, i.e., increased levels of depression, anxiety, and stress.

The perception of how stressful this difficult period is could also depend on the level of competition in which athletes participate. For example, Di Fronso et al. (2020) state that elite athletes experience lower stress levels and more functional psychobiosocial conditions compared to novice athletes. Similar results were reported by Clemente-Suarez et al. (2020). They found that training and competition constraints have little or minimal influence on anxiety levels among Olympic and Paralympic athletes, whereas German recreational and amateur athletes reported increased stress levels and lower training motivation (Lautenbach et al., 2020). Accordingly, Şenışık et al. (2021) have shown that athletes of all ability levels differed from nonathletes concerning their levels of depression during the pandemic. Also, Vidović (2021) has shown, using a sample of young Croats, greater stress resilience in athletes compared with nonathletes. Furthermore, elite athletes showed less burnout due to the COVID-19 crisis than recreational athletes and non-athletes (Vidović, 2021). Similarly, Iancheva et al. (2020) found that Russian and Bulgarian sports students who achieved higher rates were able to better cope with stress and generally adapt more easily to the situation. Leguizamo et al. (2020) indicated a negative relationship between coping strategies and undesirable psychological states, namely anxiety, stress, depression, and fatigue.

According to research Oliveira et al. (2015), Mouratidis et al. (2011), another characteristic that distinguishes athletes from the general population is perfectionism. This term is defined as the tendency to demand an exceptionally high or even flawless level of performance from others or from oneself, beyond what the situation requires (APA, 2022). Due to strict training schedules and in order to reduce the number of errors in competitions, athletes improve their technique through training and causing their performance more and more meticulous (Leguizamo et al., 2021). Accordingly, Bradham (2000) indicates a relationship between perfectionism and successful performance in athletes. Nevertheless, studies that have examined variations in the demonstration of perfectionism between athletes of different categorization levels have not reached unambiguous conclusions (Mehri et al., 2017; Stirling and Kerr, 2006; Shmits et al., 2022). Stirling and Kerr (2006) found no significant differences in the expression of perfectionism between groups of recreational and elite athletes, while Shmits et al. (2022) showed that higher-rated athletes had lower expression of perfectionism during hospitalization than individuals who did not participate in sports. Conversely, Hopkinson and Lock (2004) indicated higher levels of perfectionism in elite athletes compared with recreational athletes. Furthermore, Schwarz et al. (2005) found significantly higher levels of perfectionism in female athletes compared with women who do not participate in sports.

Some research (Di Fronso et al., 2020; Clemente-Suarez et al. 2020) shows that elite athletes can cope more suitable with challenging situations. Coping presents a constant alternation of behaviors and cognitive efforts to overcome internal and external demands considered too great for an individual's capabilities (Lazarus and Folkman, 2004). Although the pandemic is a major stressor for the entire population, athletes have developed better coping skills due to the high mental and physical effort required daily (Pété et al., 2020). Szczypińska et al. (2021) report on the most frequent use of cognitive and behavioral coping strategies among Polish kinesiology students and elite athletes, with the frequency of active coping and reevaluation strategies being significantly higher among elite athletes. Correspondingly, the results, gathered by the research of Pété and colleagues (2020), show that engaged and active coping methods, such as relaxation techniques, lead to lower anxiety levels in athletes and that the problems caused by the pandemic are perceived as a challenge that is more manageable to them.

Hence, we aimed to investigate whether there are differences in perfectionism, psychological distress, coping strategies and sports habits between professional and recreational athletes during the COVID-19 pandemic. Specifically, the goal of this research is to examine whether professional and recreational athletes differ in the characteristics of perfectionism and general psychological distress. Also, we want to examine whether there are differences between them given the coping strategies used and relaxation techniques before and during the pandemic. In addition, we are interested in whether they differ with regard to the change in the number of training sessions during the pandemic and the extent to which they lacked training and sports performances.

METHOD

Participants

Participants in the study consisted of a sample of 389 athletes split between two groups: recreational and professional athletes. There was 254 participants in the recreational group, aged from 14 to 70 (M=33,91, SD=11,09), with

49,2% male and 50,8% female athletes. The group of 135 professional athletes consisted of 63,7% male and 36,3% female participants, aged from 12 to 55 years (M =22,43, SD=6,28).

Instruments

Sociodemographic characteristics. Participants answered questions about age, gender and the category and type of sport they are engaged in. Also, participants' mental, fitness and health status was assessed and they were asked questions about the use of relaxation techniques and the frequency of training before and during the pandemic.

Brief COPE. A shortened version of COPE questionnaire was used to assess the stress management strategy (*Brief COPE; Coping Orientation to Problems Experienced*; Carver, 1997). The questionnaire consists of 28 particles that are divided into two subscales: adaptive and non-adaptive coping strategies. The subscale of adaptive coping strategies consists of 16 items, and subscales of non-adaptive strategies include 12 items. The answers to the questionnaire range from 1 to 4 (1 = "I didn't do it at all", 4 = "I did it often"). The total score on the questionnaire is calculated as a linear combination of all items, while the results on the subscales are calculated by summing up the results on the corresponding items. A higher score on a particular subscale indicates more frequent use of that coping strategy. In this study, the reliability of the internal consistency type for adaptive ones is α=,78 and for non-adaptive α=,75.

DASS-21. Croatian version of the DASS-21 (Depression, Anxiety and Stress Scale; Lovibond and Lovibond, 1995) consists of 21 items and includes three subscales of 7 items: depression, anxiety and stress. The subjects were tasked with assessing on the Likert scale of 4 degrees (0 = "not at all" to 3 = "mostly or almost always"), how they felt in the past week. In this study, based on earlier literature (Zanon et al., 2021) and due to high correlations between subscales, the questionnaire was used as a unidimensional measure of general psychological distress. The results on the scale are calculated as a linear combination of responses on items, with a higher score indicating more pronounced symptoms. In this study, the reliability of the internal consistency type for the overall scale is α=,95.

Perfectionism. To assess perfectionism, the Burns scale of perfectionism was applied (Burns, 1980; Ivanov and Penezić, 2004). The scale consists of 10 5-point Likert-type items (1 = "Disagree at all", 5 = "I completely agree"). Results on the scale are calculated as a linear combination of responses on items, with a higher score pointing to more pronounced perfectionism. The reliability of the scale in this study is α=,70.

Procedure

Participants were contacted via e-mail and social networks. Participants were informed about the purpose of the research, as well as anonymity and confidentiality of the collected data. After giving consent to participate in the survey, they would be redirected to online versions of the questionnaire which they would then fill out. The online questionnaire included the measuring instruments listed earlier.

RESULTS

Descriptive data

Before statistical data analyses, the requisites for the implementation of parametric procedures were verified. The values of symmetry and flatness have been calculated, which, for the use of these statistical analyses, should be within the limit of -3 to 3 (Kline, 2011). Although the Kolmogorov-Smirnov test indicates that variable data are not distributed normally, the criteria for the flattened and symmetrical index explicitly suggest that the criteria for normality are met (Kline, 2011). Also, with a large enough sample, the models of regression analysis are robust to the impaired assumption of normality and it is possible to conduct a regression analysis, i.e. the use of planned parametric statistical procedures is justified (Schmidt and Finan, 2018). For all measured variables in the survey, descriptive data (Table 1) were calculated and presented.

Table 1. *Descriptive data on samples of recreational and professional athletes*

	Recreational				Professional			
	N	**M**	**SD**	**SE**	**N**	**M**	**SD**	**SE**
Age	254	33.91	11.09	0.70	135	22.43	6.28	0.54
Perfectionism	254	29.84	5.92	0.37	135	31.67	5.85	0.50
DASS	254	15.57	13.48	0.85	134	15.37	14.77	1.28
Adaptive strategies	226	46.54	6.20	0.41	83	47.40	6.92	0.76
Non-adaptive strategies	226	23.54	4.57	0.30	83	24.20	5.19	0.57
Relaxation techniques (before)	254	8.49	2.81	0.18	133	11.66	3.91	0.34
Relaxation techniques (during)	254	8.30	2.78	0.17	131	10.73	4.01	0.35
Changing the number of trainings	254	-0.12	0.62	0.04	133	-0.56	1.10	0.10
Missing training	254	3.31	1.15	0.07	133	4.03	0.96	0.08
Missing performances	254	2.87	1.27	0.08	133	4.06	0.80	0.07

Table 2. *Correlation table for Recreational (N=254)*

	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Age	.2**	-.09	-.05	-.05	-.04	-.07	.09	-.17**	-.05
Perfectionism	1	.28**	.16*	.28**	.02	.03	-.04	.20**	.08
DASS		1	.13	.58**	.11	.07	-.01	.12	.14*
Adaptive strategies			1	.22**	.18**	.24**	-.14*	.12	.00
Non-adaptive strategies				1	.01	.01	-.04	.10	.07
Relaxation techniques (before)					1	.78**	-.22**	.17**	.24**
Relaxation techniques (during)						1	-.11	.05	.12
Changing the number of trainings							1	-.23**	-.17**
Missing training								1	.34**
Missing performances									1

**p<.05; **p<,01*

Table 3. *Correlation table on a sample of professional athletes (N=135)*

	2	3	4	5	6	7	8	9	10
Age	-.11	-.01	.00	.10	.02	-.03	-.06	-.23**	-.24**
Perfectionism	1	.24**	.12	.37**	-.01	-.03	.20*	.08	.20*
DASS		1	-.06	.54**	-.10	-.08	.15	.06	.07
Adaptive strategies			1	.06	.25*	29**	.08	.16	.13
Non-adaptive strategies				1	-.30**	-.39**	.14	-.08	.09
Relaxation techniques (before)					1	.86**	-.16	-.04	-.06
Relaxation techniques (during)						1	-.05	-.06	-.05
Changing the number of trainings							1	-.05	-.02
Missing training								1	.67**
Missing performances									1

**p<.05; **p<,01*

By examining the correlation of the measured variables on each of the samples (recreational and professional athletes), certain differences were noticed. In professional athletes, age is negatively correlated with missing training and performances. In recreational athletes age is negatively correlated with missing training and positively associated with perfectionism. In addition, it is noticeable that recreational athletes who miss training more are also higher on the scale of perfectionism.

Also, in recreational athletes, a decrease in the number of training sessions was associated with a lack of training and sports performances.

Non-adaptive coping strategies are insignificantly associated with use of relaxation techniques before and during lockdown in recreational, and significantly negative in professional athletes. In other words, professional athletes who are less inclined to use non-adaptive coping strategies, used relaxation techniques more before and during lockdown.

Table 4. *Differences between professional and recreational athletes*

	The Lewen test		t-test				
	F	p	t	Df	p	ΔM	ΔSE
Age	59.26	<.05	13.04	385.46	<.01	11.48	0.88
Perfectionism	0.22	>.05	-2.92	387.00	<.01	-1.84	0.63
DASS	0.82	>.05	0.14	386.00	>.05	0.20	1.49
Adaptive strategies	1.22	>.05	-1.04	307.00	>.05	-0.85	0.82
Non-adaptive strategies	1.08	>.05	-1.10	307.00	>.05	-0.67	0.61
Relaxation techniques (before)	24.94	<.05	-8.30	205.15	<.01	-3.17	0.38
Relaxation techniques (during)	23.61	<.05	-6.20	196.45	<.01	-2.43	0.39
Changing the number of trainings	56.60	<.05	4.23	177.25	<.01	0.43	0.10
Missing training	9.60	<.05	-6.52	312.47	<.01	-0.72	0.11
Missing performances	50.01	<.05	-11.30	372.69	<.01	-1.19	0.11

The results of the conducted analysis indicate the existence of certain differences between the two considered groups, professional and recreational athletes. Based on the results shown in Tables 1 and Table 5, it is evident that the age differences between these groups are statistically significant (t=14,04, p<,01), with recreational athletes on average being older than professional athletes. On average, professional athletes score higher on the perfectionism scale than recreational athletes *(*t=-2,92, p<,01). Also, professional athletes were on average more likely to use relaxation techniques before (t=-8,30, p<,01) and during lockdown (t=-6,20, p<,01) compared to recreational athletes. Furthermore, professional athletes estimated that on average they lacked training (t=-6,52, p<,01) and sports performances (t=-11,30; p<,01) compared to recreational athletes. On average, professional athletes report a significantly larger reduction in training compared to recreational athletes (t=4,23, p<,01). No statistically significant differences between recreational and professional athletes were observed on the other examined variables.

DISCUSSION AND CONCLUSION

This study examines any potential distinctions between professional and recreational players, with a focus on the COVID-19 pandemic's effects on athletes' psychophysical condition. A few assumptions on the distinctions between competitive and recreational athletes have been confirmed. Firstly, statistically significant differences in the age of the two groups are noticeable. Namely, professional recreational are typically younger than amateur athletes. This is reasonable due to the fact that professional athletes' sports preparation and abilities start to diminish evidently during their thirties, while they usually retire even before their forties (Faulkner et al., 2008).

Contrary to estimations, there were no discernible distinctions between recreational and professional athletes regarding the stress and anxiety levels they experienced throughout the examination period as well as in terms of their coping methods.

Nevertheless, professional athletes utilized relaxation techniques more often before and during the lockdown. Numerous studies to date have confirmed the beneficial effect of relaxation techniques on reducing anxiety and stress, blood pressure, and improving concentration, performance, and self-confidence (Vincent & Yahaya, 2012; Weinberg & Gould, 2011). Research has shown that athletes who used relaxation techniques, such as imagination, progressive muscle relaxation, and breathing techniques, achieved better sports achievements than those who did not use them (Parnabas et al., 2014), which, consequently, contributed to the education and encouragement of athletes to use them. This is also supported by the results of this research, which shows that professional athletes, significantly more than recreational athletes, used relaxation techniques before the pandemic, but also during the lockdown, i.e., during a period filled with uncertainty, changes, and stress.

According to earlier studies (Hopkinson and Lock, 2004; Schwarz et al., 2005), professional athletes showed significantly higher levels of perfectionism. The main characteristics of professional athletes are consistency, persistence, and focus on attaining the greatest results possible. They also need to constantly push past their limits. Therefore, they generally have developed a perfectionist mindset. Researchers Hewitt and Flett (1991) identified two types of perfectionism: self- and society-oriented. The first one, which is typically seen as a positive quality, refers to the athlete's efforts to reach a high degree of performance. Conversely, society-oriented perfectionism has a negative connotation since it originates from the athlete's environment (meaning parents, coaches, etc.). Here, the pressure is placed on the athlete in order to be perfect.

Considering that our study found a substantial difference between professional and recreational athletes' perfectionism, use of relaxation techniques before and during lockdown and missing training and performances, we think it would be beneficial to focus on these topics in future studies. Since the research was conducted online, there was significantly less control, thus, there is no guarantee that all participants completed it under the same conditions. Besides, the online research produces a sample with reduced representativeness alongside the uncertainty regarding the participants' identities. Moreover, only self-report scales were utilized, which increases subjectivity, and may also lead to a tendency of providing socially acceptable responses. Therefore, different research techniques and data sources are recommended for future research. Furthermore, a research nature is an association, hence, it prevents making conclusions beyond the variables' relationships. Our study aimed to document the condition of athletes during COVID-19. However, due to this fact, its ecological validity is downsized, and the generalization is limited. Therefore, we recommend repeating this examination when "returning to the old normal". Thus, that will create the opportunity to compare new results with previously obtained ones.

REFERENCES

Bradham, J. (2000). Achievement motivation and perfectionism as predictors of athletic performance. *The Science & Engineering, 61*(5), 2740.

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N. i Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The lancet*, *395*(10227), 912-920.

Carver, C. S. (1997). You want to measure coping but your protocol too long: Consider the brief cope. *International journal of behavioral medicine*, *4*(1), 92-100.

Clemente-Suárez, V. J., Fuentes-García, J. P., de la Vega Marcos, R., & Martínez Patiño, M. J. (2020). Modulators of the personal and professional threat perception of Olympic athletes in the actual COVID-19 crisis. *Frontiers in psychology*, 1985.

Di Fronso, S., Costa, S., Montesano, C., Di Gruttola, F., Ciofi, E. G., Morgilli, L., ... & Bertollo, M. (2020). The effects of COVID-19 pandemic on perceived stress and psychobiosocial states in Italian athletes. *International Journal of Sport and Exercise Psychology*, 1-13.

Facer-Childs, E. R., Hoffman, D., Tran, J. N., Drummond, S. P., & Rajaratnam, S. M. (2021). Sleep and mental health in athletes during COVID-19 lockdown. *Sleep*, *44*(5), zsaa261.

Faulkner, J. A., Davis, C. S., Mendias, C. L., & Brooks, S. V. (2008). The aging of elite male athletes: age-related changes in performance and skeletal muscle structure and function. *Clinical journal of sport medicine: official journal of the Canadian Academy of Sport Medicine*, *18*(6), 501.

González-Hernández, J., López-Mora, C., Yüce, A., Nogueira-López, A., & Tovar-Gálvez, M. I. (2021). "Oh, My God! My Season Is Over!" COVID-19 and Regulation of the Psychological Response in Spanish High-Performance Athletes. *Frontiers in Psychology*, *12*.

Håkansson, A., Moesch, K., Jönsson, C. i Kenttä, G. (2021). Potentially prolonged psychological distress from postponed olympic and paralympic games during COVID-19—career uncertainty in elite athletes. *International journal of environmental research and public health*, *18*(1), 2.

Hewitt, P. L., & Flett, G. L. (1991). Perfectionism in the self and social contexts: Conceptualization, assessment, and association with psychopathology. *Journal of Personality and Social Psychology, 60*(3), 456–470.

Hopkinson, R. A., & Lock, J. (2004). Athletics, perfectionism, and disordered eating. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*, *9*(2), 99-106.

Hossain, M. M., Sultana, A., & Purohit, N. (2020). Mental health outcomes of quarantine and isolation for infection prevention: a systematic umbrella review of the global evidence. *Epidemiology and health*, *42*.

Iancheva, T., Rogaleva, L., GarcíaMas, A., & Olmedilla, A. (2020). Perfectionism, mood states, and coping strategies of sports students from Bulgaria and Russia during the pandemic COVID-19. *Journal of Applied Sports Sciences*, (1), 22-38.

Ivanov, L., & Penezic, Z. (2004). Burnsova skala perfekcionizma.[Burn's Perfectionism Scale]. *Zbirka psihologijskih skala i upitnika*, *2*, 13-18. [in Croatian]

Kline, R.B., 2011. Principles and practice of structural equation modeling (3 rd edn). Guilford publications.

Kurdić, Ž. (2020). *Odluke Stožera civilne zaštite RH u 2020. godini i relevantni propisi u uvjetima epidemije koronavirusa.* Zagreb: IUS – INFO. Dostupno na: https://www.iusinfo.hr/aktualno/u-sredistu/41376#sije%C4%8Danj2020 [18. kolovoza 2022.] [in Croatian]

Lautenbach, F., Leisterer, S., Walter, N., Kronenberg, L., Manges, T., Leis, O., ... & Elbe, A. M. (2021). Amateur and recreational athletes' motivation to exercise, stress, and coping during the corona crisis. *Frontiers in psychology*, 4032.

Lazarus, R. S., Folkman, S., & Krizmanić, M. (2004). *Stres, procjena i suočavanje*. Naklada Slap.

Leguizamo, F., Olmedilla, A., Núñez, A., Verdaguer, F., Gómez-Espejo, V., Ruiz-Barquín, R., & Garcia-Mas, A. (2021). Personality, coping strategies, and mental health in high-performance athletes during confinement derived from the COVID-19 pandemic. *Frontiers in Public Health*, 924.

Lovibond, S.H. i Lovibond, P.F. (1995). *Manual for the Depression Anxiety & Stress Scales.* (2nd Ed.) Sydney: Psychology Foundation.

Mehri, S., Parvazi Shandi, M., & Ajilchi, B. (2017). Comparison of self-esteem, perfectionism and locus of control in athletic and non-athlete students. Journal of Research in Educational Science, 11(38), 219-241.

Mouratidis, A., & Michou, A. (2011). Perfectionism, self-determined motivation, and coping among adolescent athletes. *Psychology of sport and exercise*, *12*(4), 355-367.

Oliveira, L. P. D., Vissoci, J. R. N., Nascimento Junior, J. R. A. D., Ferreira, L., Vieira, L. F., Silva, P. N. D., ... & Vieira, J. L. L. (2015). The impact of perfectionism traits on motivation in high-performance soccer athletes. *Revista Brasileira de Cineantropometria & Desempenho Humano*, *17*, 601-611.

Pété, E., Leprince, C., Lienhart, N., & Doron, J. (2022) Dealing with the impact of the COVID-19 outbreak: Are some athletes' coping profiles more adaptive than others?, *European Journal of Sport Science*, *22*(2), 237-247

Samuel, R. D., Tenenbaum, G., & Galily, Y. (2020). The 2020 coronavirus pandemic as a change-event in sport performers' careers: conceptual and applied practice considerations. *Frontiers in Psychology*, 2522.

Schinke, R., Papaioannou, A., Henriksen, K., Si, G., Zhang, L., & Haberl, P. (2020). Sport psychology services to high performance athletes during COVID-19. *International journal of sport and exercise psychology*, *18*(3), 269-272.

Schmidt A.F., Finan C. (2018) Linear regression and the normality assumption. *J Clin Epidemiol.*; *98*, 146-151.

Schwarz, H. C., Gairrett, R. L., Aruguete, M. S., & Gold, E. S. (2005). Eating attitudes, body dissatisfaction, and perfectionism in female college athletes. *North American Journal of Psychology*, *7*(3).

Şenışık, S., Denerel, N., Köyağasıoğlu, O., & Tunç, S. (2021). The effect of isolation on athletes' mental health during the COVID-19 pandemic. *The Physician and sportsmedicine*, *49*(2), 187-193.

Shimits, A., Reid, W., Petrie, T., Trujillo, N., & Pryor, T. (2022). Eating Disorder Behaviors and Psychological Characteristics: A Comparison Between Athletes and Nonathletes in a Partial Hospitalization Program. *Sport Social Work Journal*, *1*(1), 104-114.

Stambulova, N. B., Ryba, T. V., & Henriksen, K. (2021). Career development and transitions of athletes: The international society of sport psychology position stand revisited. *International Journal of Sport and Exercise Psychology*, *19*(4), 524-550.

Stambulova, N. B., Schinke, R. J., Lavallee, D., & Wylleman, P. (2020). The COVID-19 pandemic and Olympic/Paralympic athletes' developmental challenges and possibilities in times of a global crisis-transition. *International Journal of Sport and Exercise Psychology*, 1-10.

Stirling, A. E., & Kerr, G. A. (2006). Perfectionism and mood states among recreational and elite athletes. *Athletic Insight*, *8*(4), 13-27.

Szczypińska, M., Samełko, A., & Guszkowska, M. (2021). Strategies for coping with stress in athletes during the COVID-19 pandemic and their predictors. *Frontiers in Psychology*, 498.

Vidović, A. (2021). Otpornost na stres uzrokovan pandemijom COVID-19 kod mladih: razlike između sportaša i nesportaša, Diplomski rad. [in Croatian]

Vincent, P & Yahaya, M. (2012). Anxiety and Imagery of Green Space among Athletes. *British Journal of Arts and Social Sciences, 4*(1), 67-72.

Weinberg, R.S. & Gould, D., 2011. *Foundations of Sport and Exercise Psychology*. Champaign, IL: Human Kinetics.

WHO. Mental health and psychosocial considerations during the COVID-19 outbreak. World Health Organization. https://www.who.int/docs/default-source/ coronaviruse/mental-healthconsiderations.pdf. Retrieved 12 April 2020.

Zanon, C., Brenner, R. E., Baptista, M. N., Vogel, D. L., Rubin, M., Al-Darmaki, F. R., Gonçalves, M., Heath, P. J., Liao, H.Y., Mackenzie, C.S., Topkaya, N., Wade, N.G. i Zlati, A. (2021). Examining the dimensionality, reliability, and invariance of the Depression, Anxiety, and Stress Scale–21 (DASS-21) across eight countries. *Assessment*, *28*(6), 1531-1544.

Primljen: 25. maj 2023. / Received: May 02, 2023
Izmjene primljene: 25. septembar 2023. / Changes Received: September 25, 2023
Prihvaćen: 05. novembar 2023. / Accepted: November 05, 2023

https://doi.org/10.7251/SSH2302245P
UDC: 611.018.2:613.25
Short notice
Kratko saopštenje

Relationship of Physical Activity With Obesity

Sandi Prayudho, Ahmad Nasrulloh
Sport Science Study Program, Faculty of Sport Science and Health, Yogyakarta State University, Yogyakarta Indonesia

Correspondence:
Sandi Prayudho, Sport Science Study Program, Faculty of Sport Science and Health, Yogyakarta State University, Yogyakarta Indonesia, sandiiprayudhoo@gmail.com

Abstract: *Physical activity is one way to prevent obesity in the community. Physical activity can be done by anyone, both people who live in urban and rural areas. Paying attention to the physical activity of people in rural areas can help avoid various kinds of diseases even that cause death. The purpose of this study was to determine the relationship between physical activity and obesity seen based on body fat, visceral fat and body mass index. The research method used in this study is associative quantitative method with correlational study. Data collection was preceded by measurements of height, weight, and body fat then continued by filling out the Baecke Physical Activity Questionnaire. The hypothesis testing technique carried out in this study uses simple correlation statistical analysis techniques and multiple correlations followed by t-tests at a significant level of α = 0.05. The results showed: First, there was a meaningful relationship between physical activity and body fat of -0.751, second, there was a meaningful relationship between physical activity and visceral fat of -0.608, and third, there was a meaningful relationship between physical activity and body mass index of -0.72. Bottom Line: Moderate to vigorous intensity physical activity is associated with decreased body fat, visceral fat, and BMI. Light activity or sedentary activity can lead to excessive accumulation of fat which can lead to obesity. This occurred in both male and female genders in this study.*
Keywords: *Physical activity, Obesity, Body fat, Visceral Fat, BMI.*

INTRODUCTION

The development of science and technology in several fields can have a positive or negative impact. One of the negative impacts that occur is a decrease in mobility of movement and physical fitness levels (Woessner et al., 2021) Reduced mobility of movement means reduced physical activity performed, this can improve health (Woessner et al., 2021)

Health is one measure of the level of welfare of a nation. The higher the level of health, the higher the level of welfare of the nation (WHO, 2023). The importance of health is stated in the strategic plan of the Ministry of Health (Renstra Kemenkes) for 2020-2024, that in Presidential Regulation Number 18 of 2020 concerning RPJMN for 2020-2024, mandated nine national development missions, one of which is to improve the quality of Indonesian people. To realize this mission, every Indonesian citizen needs to improve the quality of life by maintaining health.

Health can be reviewed one of them through a person's body composition, body composition is the relative proportion of fat tissue and fat-free tissue contained in the body (Holmes & Racette, 2021). Body composition consists of four main components, namely Total Body Fat, Fat-Free Mass, Bone Minerals and Body Water. Through measuring body composition we can find out whether there is excess fat in the body or not (Duren et al., 2008). The two most commonly measured components of body composition are total body fat tissue and fat-free tissue (Rahayu et al., 2019). Good body composition has an important role in maintaining health and vice versa if the body composition is not good it will bring various diseases (Holmes & Racette, 2021). Good body composition is necessary for a person to increase work capacity and maintain physical fitness in order to complete his daily responsibilities well (Dhankhar, 2022).

In simple terms, body composition can be seen through body mass index (BMI) which has a close relationship with health, this is because BMI is one way to measure and monitor a person's nutritional status simply (Astuti et al., 2021). BMI is categorized into 5 categories, namely, underweight < 18.5, normal 18.5 - 22.9, overweight 23 - 24.9, obesity I 25 - 29.9, and obesity II ≥ 30.0. The main factors that affect BMI are age, sex, lifestyle, genetics, diet, and physical activity (Prameswari et al. 2022).

Changes in BMI can have an impact on a person's health status which can significantly affect his quality of life (Apple et al., 2018). An imbalance between food intake and energy that comes out will cause a person to be malnourished (underweight, overweight, and obesity) (Viasus et al., 2022). Being overweight is an excessive level of nutritional status that will depend on health so that it can reduce a person's quality of life Changes in BMI can have an impact on a person's health status which can significantly affect his quality of life. An imbalance between food intake and energy that comes out will cause a person to be malnourished (underweight, overweight, and obesity) (Lin

& Li, 2021). verweight is a condition where a person weighs more than 120% and has a body mass index above 27. Being overweight is an excessive level of nutritional status that will depend on health so that it can reduce a person's quality of life (Wang et al., 2018).

The problem of obesity is one of the main risk factors for various non-communicable diseases such as cardiovascular disease, cancer, and diabetes militus (Swinburn et al., 2011). Noncommunicable diseases are responsible for > 70% of deaths worldwide, making obesity a major risk factor for morbidity and mortality worldwide as a major risk factor for dangerous diseases, obesity also has a high prevalence with an average prevalence of obesity in adults worldwide of 19.5% (Hidayat & Karjadidjaja, 2022)

The implementation of a healthy lifestyle is still a serious challenge in Indonesia. This is marked by one of them the low participation in sports in Indonesia. According to the results of the Socio-Cultural Education Module (MBPS) survey in 2018, it shows that the participation rate of people exercising nationally is 31.9%. Of the 34 provinces, 12 provinces (35.29%) with scores above the national average and 22 provinces (64.70%) with average scores below the national average (Komisi X DPR, 2018). The decline in sports participation in the community is partly due to the development of technology, this causes someone to be less active. Excessive use of gadgets has a negative side (Alotaibi et al., 2020). High sedentary time in front of layers, lack of physical activity, and poor diet can affect people's nutritional status (Kumala et al., 2019).

Based on data from the Central Statistics Agency (BPS) on the prevalence of obesity in the population aged > 18 years by sex, there was an increase from 2013-2018. In 2013 the prevalence of obesity was 19.6% of men and women 32.9%, in 2016 the prevalence of obesity was 24% of men and women 41.6%, in 2018 the prevalence of obesity was 26.6% of men and women 44.4% (BPS, 2018). Meanwhile, according to data from the Indonesian Ministry of Health (Kemenkes RI) on the obesity epidemic in Indonesia that 13.5% of adults aged 18 years and over are overweight, while 28.7% have obesity (BMI ≥ 25), and based on the 2015-2019 RPJMN indicators as many as 15.4% are obese (BMI ≥ 27) (Ministry of Health, n,d). The problem of obesity does not only occur in urban areas, but the trend of increasing obesity problems in rural areas needs to be considered as a form of input in determining nutrition and health program policies and planning (Effendy et al., 2018).

Looking at the high prevalence of obesity in Indonesia is a serious problem, so obesity prevention is very important. To prevent obesity problems, one of them is by improving lifestyle, Lifestyle plays a very important role for health. In sociology, lifestyle is life for a person (Kumar, 2017). Lifestyle is a long-term choice. There are various efforts to implement a healthy lifestyle, namely by maintaining a healthy food intake pattern with diet and nutrition, exercising regularly, choosing the right supporting nutrition and joining the community to get support from the same people. By making these various efforts and attitudes, a healthy quality of life can be obtained and can create a positive environment (Tiara & Lasnawati, 2022). The application of a healthy lifestyle needs to be applied to all groups ranging from young children, adolescents, adults, and the elderly.

In addition to participating in regular exercise, the application of a healthy lifestyle also needs to be accompanied by maintaining a pattern of healthy and nutritious food intake (Joo et al., 2018). Pineda et al. (2019) showed that changes in the school food environment, such as a ban on drinking overly sweetened beverages and an increase in the availability of fruits and vegetables led to a significant decrease in the prevalence of obesity (Pineda et al. 2019). Salam et al. (2020) showed that a combination of diet along with exercise can reduce BMI z-scores in adolescents (Salam et al. 2020). The application of a healthy lifestyle such as physical activity is one way to maintain physical health and maintain quality of life to stay healthy and fit throughout the day (Kemenkes, 2021). Physical activity is intended to reduce sedentary lifestyle, can increase caloric expenditure, and control weight. However, physical activity needs to be done regularly to get good results (Jeki & Isnaini, 2022).

Based on the above problems, the purpose of this study was to find out how much the relationship between physical activity and the incidence of obesity. Previous research explains that, In particular, rural residents have higher rates of chronic diseases and obesity, evidence supports the effectiveness of environmental policies and strategies to prevent obesity and promote health equity (Renée Umstattd Meyer et al., 2016).

METHODS

The study design used in this study was a cross-sectional observational study. The sample in this cross-sectional observation study was 35 male and 15 women with an age range of 24-65 years from Bojong Koneng village, Ba-

bakan Madang district, Bogor regency. We recruited samples and populations using accidental sampling techniques. Accidental sampling technique is a technique of collecting samples by chance. The sample criteria are as follows.

Physical activity is measured using a physical activity questionnaire, BPAQ (Beacke Physical Activity Questionnaire). This questionnaire contains 16 questions covering 3 categories, such as work activities, sports activities, and leisure activities The questionnaire consists of physical activity scores, namely the light physical activity category <5.6, the moderate physical activity category 5.6-7.9, and the heavy physical activity category >7.9 (Rahayuningsih & Muniroh, 2022).

Body composition is measured using Xiaomi Mi Body Scale 2/ BIA (Bioimpedance Analysis), which consists of weight, body mass index, body fat percentage, bone mass, protein percentage, total body water percentage, visceral fat, body age, muscle mass and BMR (basal metabolic rate).

The data analysis used in this study was univariate analysis, bivariate analysis using pearson product moment and spearman rank correlation tests, and multivariate analysis using simple linear regression equation techniques. To find the relationship between variables use the correlation coefficient and the t-test to find the meaningfulness of the relationship. The analysis of the coefficient of determination is used to determine the contribution of variable X to variable Y by multiplying the correlation coefficient that has been squared by 100%.

Double linear regression equations are used for 2 or more variables. To find a relationship consisting of more than 2 variables use multiple correlation coefficients and an F-test to find the meaningfulness of the relationship. The analysis of the coefficient of determination is used to determine the contribution of variable X to variable Y by multiplying the correlation coefficient that has been squared by 100%.

RESULTS

Below are the results of descriptive analysis of the data obtained, as follows.

Table 1. *Descriptive statistics*

Descriptive Statistics					
Variabel	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Physical Activity	50	4.75	11.00	7.6720	1.64917
Body Fat	50	5.00	47.80	26.8640	11.74735
Visceral Fat	50	1.00	14.00	6.5600	3.76970
BMI	50	15.30	31.40	23.6122	3.90382
Age	50	24	65	46.68	11.765

Table 2. *Sample participation*

Age (Years)	Men (N)	Women (N)	N=40	%
20-30	6	1	7	14
31-40	8	0	8	16
41-50	8	4	12	24
51-60	8	9	17	30
61-70	5	1	6	12

Based on the results of descriptive analysis, it can be seen that the number of data (N) is 50 people, the people of Bojong Koneng village have an average age of 46.68±11.76. In the results of the descriptive analysis, physical activity is known to have an average of 7.67±1.64 which means that physical activity carried out by the people of Bojong Koneng village is classified as moderate physical activity. In addition, it can be known that the average body fat of the people of Bojong Koneng village is 26.86±11.74 with the category of overfat in the male sex and obesity in the female sex. In the variable visceral fat has an average of 6.56±3.76 with normal categories in the male sex and obesity in the female sex. In the variable body mass index has an average of 23.61± 3.90 with normal categories in the male sex and obese in the female sex. In table 2. explain by gender. It can be known that the characteristics of respondents in this study are 70% male and 30% female. People who have the most ages of 51-60 years in this study amounted to 30%.

Table 3. *Characteristics of Respondents*

Characteristics of Respondents	Gender			
	Men		Women	
	Frequency			
	N	%	N	%
Physical Activity				
Light	3	6	8	16
Keep	10	20	6	12
Heavy	22	44	1	2
Average±SD	7,67±1,65			
Body Mass Indeks				
Thin	2	4	0	0
Normal	28	56	4	8
Fat	2	4	3	6
Obesity	3	6	8	16
Average±SD	23,61±3,90			
Body Fat				
Underfat	2	4	0	0
Health	25	50	2	4
Overfat	4	8	2	4
Obese	4	8	11	22
Average±SD	26,86±11,74			
Visceral Fat				
Low	19	38	0	0
Normal	6	12	2	4
High	9	18	3	6
Very High	2	4	9	18
Average±SD	6,56±3,77			
Average weight	60,70±8,67		63,66±10,17	
Average±SD	62,00±9,22			

In table 3. Explaining the characteristics of respondents, it can be seen that in the variable of physical activity, men in rural areas do more heavy physical activity by 44%, while women do more light physical activity by 16%. The mean and standard deviation in the body weight of males was 60.70±8.67 and females was 63.66±10.17. In the variable Body mass index it is known that men who are obese by 6% and women by 16%. Age, sex, and ethnicity were found to have an influence on body fat and BMI in the community of Bojong Koneng Village. Gender can influence the extent to which BMI can predict body fat in the community of Bojong Koneng Village. Women have more total body fat than men (Carpenter et al., 2013).

Body fat in obese men by 8% and women by 22%. A study explains, that light activity has no link with body fat (Winters-VAN Eekelen et al. 2021). The difference in average body fat percentage between men and women was found in this study. Women have a higher body fat average than men. This is in line with research that explains that women's body fat percentage is higher than men's (Goodman-Gruen & Barrett-Connor, 1996).

Visceral fat that falls into the high and very high categories in men by 18% and 4%, while in women by 6% and 18%. . This is in contrast to previous studies that found that the difference in visceral fat in men is higher than in women, besides that there is no difference between visceral fat in men and women (Staiano & Katzmarzyk, 2012). In this study it is known that physical activity carried out by men is classified as heavy physical activity, while in women it is classified as light physical activity. This is what causes differences in visceral fat in men and women. A study says that physical activity for 30 minutes with moderate to strong intensity is associated with a decrease in visceral fat, while light activity is not related (Winters-VAN Eekelen et al., 2021).

Next, it is described in table 4. Related to the relationship between physical activity, body fat, and visceral fat on the body mass index of people in rural areas. To find the correlation value between variables, spearman correlation analysis is used.

Table 4. *Correlation of physical activity, body fat, visceral fat with BMI*

Variabel		Physical Activity	Body Fat	Visceral Fat	BMI
Physical Acativity	R		-0.751	-0.608	-0.725
	Sig. (2-tailed)		0.000	0.000	0.000
Body Fat	R	-0.751		0.672	0.821
	Sig. (2-tailed)	0.000		0.000	0.000
Visceral Fat	R	-0.608	0.672		0.951
	Sig. (2-tailed)	0.000	0.000		0.000
BMI	R	-0.725	0.821	0.951	
	Sig. (2-tailed)	0.000	0.000	0.000	

DISCUSSION

This study discusses the interaction between physical activity, body fat, visceral fat and BMI in rural communities. The results found that obesity that occurs in rural communities is associated with low levels of physical activity as well as high body fat, visceral fat and BMI found in women. Strenuous activity levels are associated with lower body fat, visceral fat and BMI found in males.

Based on the results of the correlation calculation above, it can be explained that, the variable relationship of physical activity with body fat ($R = -0.751$; $\rho = 0.000$) means that physical activity has a strong and significant negative relationship with body fat. A negative sign indicates the direction of the relationship between variables, this can be explained that the higher the physical activity carried out, the less body fat. . This is supported by a study conducted, that someone who has more sedentary activity will have high body fat (DiFrancisco-Donoghue et al., 2022). Other studies report that someone who does more frequent physical activity has low body fat (Zou et al., 2020). Physical activity of moderate to vigorous intensity had a negative association with some body fat and belly fat, while light physical activity had no association with body fat. This is important to prevent abdominal obesity and cardiometabolic disease (Winters-VAN Eekelen et al., 2021).

Based on the results of the correlation calculation above, it can be explained that, the relationship of physical activity variables with visceral fat ($R = -0.608$; $\rho = 0.000$). This means that physical activity has a strong and significant negative association with visceral fat. A negative sign indicates the direction of the relationship between variables, this can be explained that the higher the physical activity carried out, the less visceral fat will be. This is supported by a study that explains that found a relationship between physical activity and abdominal body fat, broadly the same as the relationship between physical activity and total body fat (Bowen et al., 2015). Other studies report that increased visceral fat is a risk factor for metabolic syndrome in postmenopausal women, but high levels of regular physical activity above the threshold of 12,500 steps/day can reduce it substantially (Zając-Gawlak et al., 2017).

Based on the results of the correlation calculation above, it can be explained that, the relationship of physical activity variables with BMI ($R = -0.725$; $\rho = 0.000$). This means that physical activity has a strong and significant negative relationship with BMI. A negative sign indicates the direction of the relationship between variables, this can be explained that the higher the physical activity carried out, the less BMI. This is supported by a study that explains that increased physical activity for 3 three months along with diets carried out by people who are obese shows a decrease in BMI (Rodriguez et al., 2022). The behavior of daily physical activity affects the accumulation of visceral fat and body mass index (Ando et al., 2020). Doing physical activity, such as walking is one way to prevent cardiometabolic disease (Ando et al., 2020).

Based on the results of the correlation calculation above, it can be explained that the variable relationship between body fat and visceral fat ($R = 0.672$; $\rho = 0.000$) shows the direction of a strong and significant positive relationship. This means that, the higher the body fat, the visceral fat. This is supported by research that explains, that there is a positive correlation between body fat and visceral fat (Saraswati et al. 2014).

Based on the results of the correlation calculation above, it can be explained that the variable relationship of body fat with BMI (R = 0.821; ρ = 0.000) shows the direction of a strong and significant positive relationship. This means that, the higher the body fat, the BMI will increase. This is supported by research that explains, that body fat can be predicted well by BMI (Gurrici et al., 1998).

Based on the results of the correlation calculation above, it can be explained that the relationship between visceral fat variables and BMI (R = 0.951; ρ = 0.000) shows the direction of a strong and significant positive relationship. This means that, the higher the visceral fat, the BMI will increase. This is supported by research that explains, that there is a positive correlation between visceral fat and BMI. In addition, it was explained that the correlation between visceral fat and BMI was greater experienced in men (Gadekar et al., 2020). In another study, visceral fat has little to do with BMI. Visceral fat is considered very important for assessing cardiometabolic risk (Shah et al., 2014). The prevalence of abdominal obesity will tend to increase according to BMI and with age usia (Kim et al., 2019).

The study showed that physical activity had a negative association with obesity based on body fat, visceral fat and BMI. In this study, women had a higher average BMI value compared to men, this is because in this study women did more light physical activity, while men had an average BMI value of normal average value conditions due to heavy physical activity. Women with high obesity are associated with risk factors that can cause metabolic syndrome, but high regular physical activity above the threshold of 12,500 steps/day can reduce it substantially (Zając-Gawlak et al., 2017). The findings of this study explain that it is important to engage in moderate-to-vigorous intensity physical activity and is carried out regularly in rural communities. This is important to do to maintain their fitness and health, both physically and mentally. The need to plan government programs related to physical fitness and health in rural areas as an effort to prevent obesity in rural areas.

CONCLUSION AND SUGGESTION

Based on the discussion above, it can be concluded that, the importance of people to do physical activity with moderate to strong intensity, because it can be associated with a decrease in body fat, visceral fat, and BMI. Light activity or sedentary activity can lead to excessive fat accumulation that can lead to obesity. This occurred in both male and female genders in this study. In future studies, more populations and samples are needed to have a better level of accuracy.

Conflict of Interest

The authors declare that there are no confl icts of interest.

REFERENCES

Alotaibi, T., Almuhanna, R., Alhassan, J., Alqadhib, E., Mortada, E., & Alwhaibi, R. (2020). The Relationship between Technology Use and Physical Activity among. *Healthcare*, *8*(488), 1–14.

Ando, S., Koyama, T., Kuriyama, N., Ozaki, E., & Uehara, R. (2020). The Association of Daily Physical Activity Behaviors with Visceral Fat. *Obesity Research and Clinical Practice*, *14*(6), 531–535. https://doi.org/10.1016/j.orcp.2020.10.004

Apple, R., Samuels, L. R., Fonnesbeck, C., Schlundt, D., Mulvaney, S., Hargreaves, M., Crenshaw, D., Wallston, K. A., & Heerman, W. J. (2018). Body mass index and health-related quality of life. *Obesity Science and Practice*, *4*(5), 417–426. https://doi.org/10.1002/osp4.292

Astuti, L. W., Yuliana, N., & Utami, S. (2021). Gambaran Indeks Massa Tubuh (Imt) Mahasiswa Diii Keperawatan Fakultas Kesehatan Universitas Samawa. *Jurnal Kesehatan Samawa*, *1*(1), 24–29. http://www.e-journallppmunsa.ac.id/index.php/jks/article/view/679

Bowen, L., Taylor, A. E., Sullivan, R., Ebrahim, S., Kinra, S., Krishna, K. R., Kulkarni, B., Ben-Shlomo, Y., Ekelund, U., Wells, J. C., & Kuper, H. (2015). Associations between diet, physical activity and body fat distribution: A cross sectional study in an Indian population. *BMC Public Health*, *15*(1). https://doi.org/10.1186/s12889-015-1550-7

Carpenter, C. L., Yan, E., Chen, S., Hong, K., Arechiga, A., Kim, W. S., Deng, M., Li, Z., & Heber, D. (2013). Body fat and body-mass index among a multiethnic sample of college-age men and women. *Journal of Obesity*, *2013*, 19–21. https://doi.org/10.1155/2013/790654

Dhankhar, P. (2022). *A comparative study of body composition difference in teenager boys and girls*. *7*(2), 101–104.

DiFrancisco-Donoghue, J., Werner, W. G., Douris, P. C., & Zwibel, H. (2022). Esports players, got muscle? Competitive video game players' physical activity, body fat, bone mineral content, and muscle mass in comparison to matched controls. *Journal of Sport and Health Science*, *11*(6), 725–730. https://doi.org/10.1016/j.jshs.2020.07.006

Duren, D. L., Sherwood, R. J., Czerwinski, S. A., Lee, M., Choh, A. C., Siervogel, R. M., & Chumlea, W. C. (2008). Body composition methods: Comparisons and interpretation. *Journal of Diabetes Science and Technology*, *2*(6), 1139–1146. https://doi.org/10.1177/193229680800200623

Effendy, S., Gunawan, M. F., Lintang, D., Argoputra, A., Anggraeni, P. D., & Abraham, Y. B. (2018). the Relationship Between Physical Activity and Obesity Based on Body Fat Percentage in Banjaroyo Village. *International Physical Activity Jurnal Farmasi Sains Dan Komunitas*, *15*(1), 29–36. http://dx.doi.org/10.24071/jpsc.151963

Gadekar, T., Dudeja, P., Basu, I., Vashisht, S., & Mukherji, S. (2020). Correlation of visceral body fat with waist–hip ratio, waist circumference and body mass index in healthy adults: A cross sectional study. *Medical Journal Armed Forces India*, *76*(1), 41–46. https://doi.org/10.1016/j.mjafi.2017.12.001

Goodman-Gruen, D., & Barrett-Connor, E. (1996). Sex differences in measures of body fat and body fat distribution in the elderly. *American Journal of Epidemiology*, *143*(9), 898–906. https://doi.org/10.1093/oxfordjournals.aje.a008833

Gurrici, S., Hartriyanti, Y., Hautvast, J. G. A. J., & Deurenberg, P. (1998). Relationship between body fat and body mass index: Differences between Indonesians and Dutch Caucasians. *European Journal of Clinical Nutrition*, *52*(11), 779–783. https://doi.org/10.1038/sj.ejcn.1600637

Hidayat, K. P., & Karjadidjaja, I. (2022). Hubungan Pengetahuan Gaya Hidup Sehat Dengan Kejadian Obesitas Pada Ibu Rumah Tangga di Kecamatan Dayeuhluhur. *BULLET: Jurnal Multidisiplin Ilmu*, *01*(6), 947–952.

Holmes, C. J., & Racette, S. B. (2021). The utility of body composition assessment in nutrition and clinical practice: an overview of current methodology. *Nutrients*, *13*(8), 1–16. https://doi.org/10.3390/nu13082493

Jeki, A. G., & Isnaini, I. F. (2022). Aktivitas Fisik Pada Remaja Dengan Kegemukan ; Sistematik Review Physical Activity in Adolescent With Obesity ; a Systematic Review. *Jurnal Ilmu Kesehatan Masyarakat*, *18*(2). https://doi.org/10.19184/ikesma.v18i1.24902

Joo, J., Williamson, S. A., Vazquez, A. I., Fernandez, J. R., & Bray, M. S. (2018). The Influence of 15-week Exercise Training on Dietary Patterns among Young Adults. *Int J Obes (Lond)*, *11*(1), 509–533. https://doi.org/10.1038/s41366-018-0299-3.The

Kim, H. Y., Kim, J. K., Shin, G. G., Han, J. A., & Kim, J. W. (2019). Association between abdominal obesity and cardiovascular risk factors in adults with normal body mass index: Based on the Sixth Korea National Health and Nutrition Examination Survey. *Journal of Obesity and Metabolic Syndrome*, *28*(4), 262–270. https://doi.org/10.7570/JOMES.2019.28.4.262

Kumar, K. (2017). Importance of Healthy Life Style in Healthy living. *Juniper Online Journal of Public Health*, *2*(5). https://doi.org/10.19080/jojph.2017.02.555596.

Lin, X., & Li, H. (2021). Obesity: Epidemiology, Pathophysiology, and Therapeutics. *Frontiers in Endocrinology*, *12*(September), 1–9. https://doi.org/10.3389/fendo.2021.706978

Rahayu, A., Fahrini, Y., & Setiawan, M. I. (2019). *Dasar-Dasar Gizi*.

Ratna Saraswati, M., Suastika, K., Budhiarta, A., & Made Pande Dwipayana, I. (2014). *Hubungan Massa Lemak Tubuh Dengan Resistensi Insulin Pada Populasi Dengan Faktor Resiko Diabetes*. http://www.dtu.ox.ac.uk/Homacalculator/index.php.

Renée Umstattd Meyer, M., Perry, C. K., Sumrall, J. C., Patterson, M. S., Walsh, S. M., Clendennen, S. C., Hooker, S. P., Evenson, K. R., Goins, K. V., Heinrich, K. M., Tompkins, N. O. H., Eyler, A. A., Jones, S., Tabak, R., & Valko, C. (2016). Physical activity-related policy and environmental strategies to prevent obesity in rural communities: A systematic review of the literature, 2002-2013. *Preventing Chronic Disease*, *13*(1), 1–24. https://doi.org/10.5888/pcd13.150406

Rodriguez, J., Neyrinck, A. M., Van Kerckhoven, M., Gianfrancesco, M. A., Renguet, E., Bertrand, L., Cani, P. D., Lanthier, N., Cnop, M., Paquot, N., Thissen, J. P., Bindels, L. B., & Delzenne, N. M. (2022). Physical activity enhances the improvement of body mass index and metabolism by inulin: a multicenter randomized placebo-controlled trial performed in obese individuals. *BMC Medicine*, *20*(1), 1–20. https://doi.org/10.1186/s12916-022-02299-z

Salam, R. A., Padhani, Z. A., Das, J. K., Shaikh, A. Y., Hoodbhoy, Z., Jeelani, S. M., Lassi Z. S., & Bhutta, Z. A. (2020). Effects of Lifestyle Modification Interventions to Prevent and Manage Child and Adolescent Obesity : *Nutrients*, *12*, 2208.

Shah, R. V., Murthy, V. L., Abbasi, S. A., Blankstein, R., Kwong, R. Y., Goldfine, A. B., Jerosch-Herold, M., Lima, J. A. C., Ding, J., & Allison, M. A. (2014). Visceral adiposity and the risk of metabolic syndrome across body mass index: The MESA study. *JACC: Cardiovascular Imaging*, *7*(12), 1221–1235. https://doi.org/10.1016/j.jcmg.2014.07.017

Staiano, A. E., & Katzmarzyk, P. T. (2012). Ethnic and sex differences in body fat and visceral and subcutaneous adiposity in children and adolescents. *International Journal of Obesity*, *36*(10), 1261–1269. https://doi.org/10.1038/ijo.2012.95

Swinburn, B. A., Sacks, G., Hall, K. D., McPherson, K., Finegood, D. T., Moodie, M. L., & Gortmaker, S. L. (2011). The global obesity pandemic: Shaped by global drivers and local environments. *The Lancet*, *378*(9793), 804–814. https://doi.org/10.1016/S0140-6736(11)60813-1

Viasus, D., Pérez-Vergara, V., & Carratalà, J. (2022). Effect of Undernutrition and Obesity on Clinical Outcomes in Adults with Community-Acquired Pneumonia. *Nutrients*, *14*(15), 1–14. https://doi.org/10.3390/nu14153235

Wang, L., Crawford, J. D., Reppermund, S., Trollor, J., Campbell, L., Baune, B. T., Sachdev, P., Brodaty, H., Samaras, K., & Smith, E. (2018). Body mass index and waist circumference predict health-related quality of life, but not satisfaction with life, in the elderly. *Quality of Life Research*, *27*(10), 2653–2665. https://doi.org/10.1007/s11136-018-1904-6

Winters-VAN Eekelen, E., VAN DER Velde, J. H. P. M., Boone, S. C., Westgate, K., Brage, S., Lamb, H. J., Rosendaal, F. R., & DE Mutsert, R. (2021). Objectively Measured Physical Activity and Body Fatness: Associations with Total Body Fat, Visceral Fat, and Liver Fat. *Medicine and Science in Sports and Exercise*, *53*(11), 2309–2317. https://doi.org/10.1249/MSS.0000000000002712

Woessner, M. N., Tacey, A., Levinger-Limor, A., Parker, A. G., Levinger, P., & Levinger, I. (2021). The Evolution of Technology and Physical Inactivity: The Good, the Bad, and the Way Forward. *Frontiers in Public Health*, *9*(May), 1–7. https://doi.org/10.3389/fpubh.2021.655491

Zając-Gawlak, I., Kłapcińska, B., Kroemeke, A., Pośpiech, D., Pelclová, J., & Přidalová, M. (2017). Associations of visceral fat area and physical activity levels with the risk of metabolic syndrome in postmenopausal women. *Biogerontology*, *18*(3), 357–366. https://doi.org/10.1007/s10522-017-9693-9

Zou, Q., Su, C., Du, W., Ouyang, Y., Wang, H., Wang, Z., Ding, G., & Zhang, B. (2020). The association between physical activity and body fat percentage with adjustment for body mass index among middle-aged adults: China health and nutrition survey in 2015. *BMC Public Health*, *20*(1), 1–12. https://doi.org/10.1186/s12889-020-08832-0

Primljen: 05. septembar 2023. / Received: September 05, 2023
Izmjene primljene: 09. novembar 2023. / Changes Received: November, 09, 2023
Prihvaćen: 11. decembar 2023. / Accepted: December 11, 2023

https://doi.org/10.7251/SSH2302252T
UDC: 796.012.422:572.087
Scientific criticism
Naučna kritika

Age as an Indicator of Sports Success

Edvinas Tenikaitis[1], Luka Androja[2]
[1]*Kaunas University Of Applied Sciences, Lithuania*
[2]*Aspira University Of Applied Sciences, Split, Croatia*

Correspondence:
Luka Androja, Aspira University Of Applied Sciences, Split, Croatia
luka.androja91@gmail.com

Abstract: *This paper examines the relationship between age and sports success, exploring whether age can serve as a reliable indicator of an athlete's performance and achievements in various sports disciplines. The findings and insights presented in this paper can be beneficial to several groups, including sports coaches, talent scouts, sports psychologists, and researchers in the field of sports science. By understanding the role of age in sports success, these professionals can make informed decisions regarding talent identification, athlete development, and performance optimization. The paper initially reviews existing literature on the topic, analyzing studies that have explored the relationship between age and sports performance. It discusses both physiological and psychological factors that can influence an athlete's success at different stages of their career. Additionally, it examines the impact of age-related changes, such as declining physical abilities and increased injury risks, on an athlete's performance and longevity in sports. To improve this paper, several changes can be implemented. First, expanding the number of references and citations will enhance the paper's credibility and provide a broader perspective on the topic. By incorporating studies from different researchers and sources, the paper can present a comprehensive analysis of age as an indicator of sports success. Additionally, the paper can benefit from including more empirical research, moving beyond a review paper to incorporate original studies and data analysis. This would strengthen the paper's argument and contribute to the existing body of knowledge in the field. For other authors writing on the same topic, it is recommended to focus on the following areas for improvement. Firstly, ensuring a thorough review of the literature, covering relevant studies and research papers, will enhance the depth and breadth of the paper. Secondly, conducting original research or including empirical studies will contribute to the scientific understanding of age and sports success. This can involve collecting data from different sports disciplines, analyzing performance metrics, and evaluating the impact of age-related factors on athlete outcomes. So, this paper investigates the relationship between age and sports success, providing insights that can assist various stakeholders in the sports industry.*

Keywords: *sports success, chronological age, biological age, athlete.*

INTRODUCTION

Sports is a highly competitive field where athletes strive to achieve excellence and reach the pinnacle of success in their respective sports. Many factors play a crucial role in determining an athlete's success, such as physical fitness, mental toughness, skill level, and training regimen (Allen & Hopkins, 2015). One of the most discussed and debated factors in recent times is age, and whether it is a determining factor for sports success. Age has long been considered a crucial indicator of athletic performance and a factor that can influence an athlete's ability to compete at a high level (Lorenzo-Calvo et al., 2021). In this context, the relationship between age and sports success has become an intriguing subject of research and discussion among sports stakeholders, experts, and academics.

Age has a significant impact on an athlete's physical capabilities (Suzic Lazic et al., 2017). Athletes differ by age in morphology, as well as in motor and functional abilities (Peña-González et al., 2018). As athletes age, their physical capabilities decline, making it harder for them to perform at their best. This decline is due to various factors, including a decrease in muscle mass, a decrease in bone density, and a decrease in aerobic capacity (Hennis et al., 2022). However, it is essential to note that the rate of decline varies from person to person, and some athletes may maintain their physical capabilities for longer than others.

This paper aims to explore the literature that analyzes the role of age as an indicator of sports success, the challenges associated with competing at different age levels, and the potential factors that can affect an athlete's performance as they age.

SPORT SUCCESS

Sport success can be defined as the achievement of specific goals or objectives in the context of athletic competition (Gould & Maynard, 2009). Research has shown that there are many factors that contribute to sport success, including physical and mental abilities, training, motivation, and social support. Genetic factors may affect athletic ability and add to sport success (Tucker et al., 2014). Despite of that, it is also proven that discrimination between successful and unsuccessful athletes in personality trait factors are common (Rowley et al., 1995). According to a study, athletes were more likely to succeed in their sport if they had greater levels of self-efficacy and confidence (Kim & Eom, 2019). Additionally, a review indicates that a number of variables, such as genetics, training, nutrition, and psychological elements like motivation and goal-setting, can have an impact on a person‘s success in sports (Stanley, 2017).

AGE AS INDICATOR

Age is an important factor in sports success, as it can impact an athlete‘s physical abilities, skill development, and overall performance. Athletes who start training and competing at a young age may have a developmental advantage, as their bodies are still growing and adapting to the demands of their sport (Bompa & Buzzichelli, 2015). However, age can also be a limiting factor in sports, as physical decline and injury risk increase with age. Additionally, older athletes may have accumulated experience and strategic knowledge that can compensate for any physical decline (J. Baker & Horton, 2004). The optimal age for achieving peak athletic performance varies depending on the sport. For instance, studies suggest that endurance athletes tend to peak later in life, with the average age for marathon runners being around 30 years old (Knechtle et al., 2012). On the other hand, team sport athletes tend to peak earlier, with the average age for professional soccer players being around 27 years old (Casal et al., 2017).

Chronological age

Chronological age is a straightforward measure of an individual‘s age, calculated in years from the date of their birth (Kotter-Grühn et al., 2016). It is commonly used as a basic indicator of an athlete‘s potential for success in sports, as younger athletes are sometimes thought to be developing more quickly than their older rivals. However, chronological age does not always accurately reflect an athlete‘s physical, cognitive, or emotional development, which can vary greatly from person to person (Keadle et al., 2019). Additionally, the impact of chronological age on sports success can vary depending on the specific sport in question, as different sports require different physical and mental attributes that may develop at different rates (Vaeyens et al., 2008). Therefore, while chronological age is a useful starting point in assessing an athlete‘s potential for success in sports, it should not be the only factor considered. Other factors such as training, experience, and motor abilities must also be taken into consideration.

Biological age

Biological age is a concept that takes into account an individual‘s physical and physiological health and function, which may be different from their chronological age. Biological age can be influenced by a range of factors, including genetics, lifestyle choices, and environmental factors (Belsky et al., 2015). Biological age, which can represent an athlete‘s physical condition and resiliency among other things, can be a key determinant of their likelihood of success in sports (Figueiredo et al., 2011). For example, an athlete with a younger biological age may have a higher level of physical fitness and be less prone to injuries compared to an athlete with an older biological age. Because it can give a more accurate image of an athlete‘s physical skills and limitations, biological age can be a beneficial complement to chronological age when determining if they have the ability to succeed in sports.

GENDER DIFFERENCES

Gender differences are an important factor to consider when evaluating the impact of age on sports success. On average, males tend to have greater muscle mass and strength than females, which can provide a physical advantage in certain sports that require power and speed. However, females tend to have greater flexibility and endurance, which can be beneficial in sports that require agility and stamina (Giovagnoli, 2021). Additionally, the onset and tempo of puberty can differ between males and females, which can affect their athletic performance and potential (Wing et al., 2020). It can be difficult to compare male and female athletic performance and to create fair and equal competition criteria as a result of these disparities. Research has shown that there is a „sweet spot“ age range for peak performance in vari-

ous sports for both male and female athletes. For example, a study found that in track and field, peak performance was reached between the ages of 26 and 27 for males and between the ages of 24 and 26 for females. In swimming, the peak age range for male athletes was found to be between 20 and 27, while for female athletes it was between 18 and 24 (A. B. Baker & Tang, 2010). As a result, it's critical to encourage gender parity in sports participation and performance evaluation as well as to consider gender-specific aspects when evaluating the effect of age on sports success.

POSITIVE AND NEGATIVE ASPECTS OF AGE FOR SPORTS SUCCESS

Age can be both a positive and negative aspect for sports success (Güllich & Emrich, 2014). On the positive side, younger athletes often have a higher level of energy, faster recovery time, and more flexibility (Makaruk et al., 2022). This makes them more adaptable to new techniques, and better able to push themselves during training sessions (Johnston et al., 2018). Additionally, younger athletes are often fearless and confident, which allows them to take more risks in competitions (Piepiora & Piepiora, 2021). As a result, they can often achieve impressive results in their respective sports, especially in those that require a high level of physical ability and endurance. On the other hand, older athletes tend to have more experience and knowledge of their sport, which can be advantageous. They have developed a better understanding of their own strengths and weaknesses, and know how to optimize their training and performance accordingly ("Relationship between Training Load and Match Running Performance in Men's Soccer," 2021). They are also less prone to injuries, as they have developed greater control over their bodies and movements (Lambert & Evans, 2002). Athletes who are older frequently exhibit greater levels of discipline and commitment, which enables them to sustain their level of physical and mental fitness for longer (Deck et al., 2021). Age, though, can sometimes be a barrier to athletic performance. Younger athletes may have a considerable disadvantage due to their inexperience, particularly in sports that demand a high level of strategic thinking and decision-making (Silva et al., 2020). In addition, younger athletes may struggle to maintain focus and motivation over longer periods, which can hinder their progress. However, older athletes may discover that as they become older, their physical capabilities start to deteriorate, making it more challenging for them to compete at the greatest level (Domingos et al., 2021). They can also have a hard time keeping up with younger rivals who are faster and more energetic. All in all, age is both a positive and negative aspect of sports success. While younger athletes often have more energy and flexibility, older athletes have greater experience and knowledge.

CONCLUSION

In conclusion, age can be both a positive and negative indicator of sports success. Younger athletes often have higher levels of energy, faster recovery time, and more flexibility, which make them more adaptable to new techniques and better able to push themselves during training sessions. They may also be more fearless and confident, allowing them to take more risks in competitions. However, younger athletes may also have a disadvantage due to their inexperience, particularly in sports that demand a high level of strategic thinking and decision-making. On the other hand, older athletes often have a higher level of discipline and dedication, which allows them to maintain their physical and mental fitness for longer periods. They may have more experience and knowledge of the game, allowing them to make better decisions and strategize more effectively. However, older athletes may also find that their physical abilities begin to decline with age, making it more difficult to compete at the highest level, particularly in sports that require a high level of energy and speed. Therefore, it's important to consider both the positive and negative aspects of age when assessing an athlete's potential for success in a particular sport.

Finally, expanding the length of the paper will allow for a more comprehensive exploration of the topic, providing a detailed analysis of different perspectives and addressing potential counterarguments. By incorporating additional references and empirical research, authors can enhance the paper's quality and scientific rigor.

REFERENCES

Allen, S. V., & Hopkins, W. G. (2015). Age of Peak Competitive Performance of Elite Athletes: A Systematic Review. *Sports Medicine (Auckland, N.Z.)*, *45*(10), 1431–1441. https://doi.org/10.1007/s40279-015-0354-3

Baker, A. B., & Tang, Y. Q. (2010). Aging Performance for Masters Records in Athletics, Swimming, Rowing, Cycling, Triathlon, and Weightlifting. *Experimental Aging Research*, *36*(4), 453–477. https://doi.org/10.1080/0361073X.2010.507433

Baker, J., & Horton, S. (2004). A review of primary and secondary influences on sport expertise. *High Ability Studies*, *15*(2), 211–228. https://doi.org/10.1080/1359813042000314781

Belsky, D. W., Caspi, A., Houts, R., Cohen, H. J., Corcoran, D. L., Danese, A., Harrington, H., Israel, S., Levine, M. E., Schaefer, J. D., Sugden,

K., Williams, B., Yashin, A. I., Poulton, R., & Moffitt, T. E. (2015). Quantification of biological aging in young adults. *Proceedings of the National Academy of Sciences*, *112*(30). https://doi.org/10.1073/pnas.1506264112

Bompa, T. O., & Buzzichelli, C. (2015). *Periodization training for sports* (Third Edition). Human Kinetics.

Casal, C. A., Maneiro, R., Ardá, T., Marí, F. J., & Losada, J. L. (2017). Possession Zone as a Performance Indicator in Football. The Game of the Best Teams. *Frontiers in Psychology*, *8*, 1176. https://doi.org/10.3389/fpsyg.2017.01176

Deck, S., Doherty, A., Hall, C., Schneider, A., Patil, S., & Belfry, G. (2021). Perceived Time, Frequency, and Intensity of Engagement and Older Masters Athletes' Subjective Experiences. *Frontiers in Sports and Active Living*, *3*, 653590. https://doi.org/10.3389/fspor.2021.653590

Domingos, C., Correia Santos, N., & Pêgo, J. M. (2021). Association between Self-Reported and Accelerometer-Based Estimates of Physical Activity in Portuguese Older Adults. *Sensors*, *21*(7), 2258. https://doi.org/10.3390/s21072258

Figueiredo, A. J., Coelho e Silva, M. J., & Malina, R. M. (2011). Predictors of functional capacity and skill in youth soccer players: Function and skill in youth soccer. *Scandinavian Journal of Medicine & Science in Sports*, *21*(3), 446–454. https://doi.org/10.1111/j.1600-0838.2009.01056.x

Giovagnoli, A. (2021). The Bayesian Design of Adaptive Clinical Trials. *International Journal of Environmental Research and Public Health*, *18*(2), 530. https://doi.org/10.3390/ijerph18020530

Gould, D., & Maynard, I. (2009). Psychological preparation for the Olympic Games. *Journal of Sports Sciences*, *27*(13), 1393–1408. https://doi.org/10.1080/02640410903081845

Güllich, A., & Emrich, E. (2014). Considering long-term sustainability in the development of world class success. *European Journal of Sport Science*, *14*(sup1), S383–S397. https://doi.org/10.1080/17461391.2012.706320

Hennis, P. J., Murphy, E., Meijer, R. I., Lachmann, R. H., Ramachandran, R., Bordoli, C., Rayat, G., & Tomlinson, D. J. (2022). Aerobic capacity and skeletal muscle characteristics in glycogen storage disease IIIa: An observational study. *Orphanet Journal of Rare Diseases*, *17*(1), 28. https://doi.org/10.1186/s13023-022-02184-1

Johnston, K., Wattie, N., Schorer, J., & Baker, J. (2018). Talent Identification in Sport: A Systematic Review. *Sports Medicine*, *48*(1), 97–109. https://doi.org/10.1007/s40279-017-0803-2

Keadle, S. K., Lyden, K. A., Strath, S. J., Staudenmayer, J. W., & Freedson, P. S. (2019). A Framework to Evaluate Devices That Assess Physical Behavior. *Exercise and Sport Sciences Reviews*, *47*(4), 206–214. https://doi.org/10.1249/JES.0000000000000206

Kim & Eom. (2019). The Managerial Dimension of Open Data Success: Focusing on the Open Data Initiatives in Korean Local Governments. *Sustainability*, *11*(23), 6758. https://doi.org/10.3390/su11236758

Kotter-Grühn, D., Kornadt, A. E., & Stephan, Y. (2016). Looking Beyond Chronological Age: Current Knowledge and Future Directions in the Study of Subjective Age. *Gerontology*, *62*(1), 86–93. https://doi.org/10.1159/000438671

Lambert, C. P., & Evans, W. J. (2002). Effects of aging and resistance exercise on determinants of muscle strength. *AGE*, *25*(2), 73–78. https://doi.org/10.1007/s11357-002-0005-0

Lorenzo-Calvo, J., de la Rubia, A., Mon-López, D., Hontoria-Galán, M., Marquina, M., & Veiga, S. (2021). Prevalence and Impact of the Relative Age Effect on Competition Performance in Swimming: A Systematic Review. *International Journal of Environmental Research and Public Health*, *18*(20), 10561. https://doi.org/10.3390/ijerph182010561

Makaruk, H., Starzak, M., Płaszewski, M., & Winchester, J. B. (2022). Internal Validity in Resistance Training Research: A Systematic Review. *Journal of Sports Science and Medicine*, 308–331. https://doi.org/10.52082/jssm.2022.308

Peña-González, I., Fernández-Fernández, J., Moya-Ramón, M., & Cervelló, E. (2018). Relative Age Effect, Biological Maturation, and Coaches' Efficacy Expectations in Young Male Soccer Players. *Research Quarterly for Exercise and Sport*, *89*(3), 373–379. https://doi.org/10.1080/02701367.2018.1486003

Piepiora, P., & Piepiora, Z. (2021). Personality Determinants of Success in Men's Sports in the Light of the Big Five. *International Journal of Environmental Research and Public Health*, *18*(12), 6297. https://doi.org/10.3390/ijerph18126297

Relationship between training load and match running performance in men's soccer. (2021). *Journal of Men's Health*. https://doi.org/10.31083/jomh.2021.082

Rowley, A. J., Landers, D. M., Kyllo, L. B., & Etnier, J. L. (1995). Does the Iceberg Profile Discriminate between Successful and Less Successful Athletes? A Meta-Analysis. *Journal of Sport and Exercise Psychology*, *17*(2), 185–199. https://doi.org/10.1123/jsep.17.2.185

Silva, A. F., Conte, D., & Clemente, F. M. (2020). Decision-Making in Youth Team-Sports Players: A Systematic Review. *International Journal of Environmental Research and Public Health*, *17*(11), 3803. https://doi.org/10.3390/ijerph17113803

Stanley, J. L. (2017). Teaching ethics in relation to LGBTQ issues in psychology. In T. R. Burnes & J. L. Stanley (Eds.), *Teaching LGBTQ psychology: Queering innovative pedagogy and practice.* (pp. 61–84). American Psychological Association. https://doi.org/10.1037/0000015-004

Suzic Lazic, J., Dekleva, M., Soldatovic, I., Leischik, R., Suzic, S., Radovanovic, D., Djuric, B., Nesic, D., Lazic, M., & Mazic, S. (2017). Heart rate recovery in elite athletes: The impact of age and exercise capacity. *Clinical Physiology and Functional Imaging*, *37*(2), 117–123. https://doi.org/10.1111/cpf.12271

Tucker, A. T., Nowicki, E. M., Boll, J. M., Knauf, G. A., Burdis, N. C., Trent, M. S., & Davies, B. W. (2014). Defining gene-phenotype relationships in Acinetobacter baumannii through one-step chromosomal gene inactivation. *MBio*, *5*(4), e01313-01314. https://doi.org/10.1128/mBio.01313-14

Vaeyens, R., Lenoir, M., Williams, A. M., & Philippaerts, R. M. (2008). Talent Identification and Development Programmes in Sport: Current Models and Future Directions. *Sports Medicine*, *38*(9), 703–714. https://doi.org/10.2165/00007256-200838090-00001

Wing, C. E., Turner, A. N., & Bishop, C. J. (2020). Importance of Strength and Power on Key Performance Indicators in Elite Youth Soccer. *Journal of Strength and Conditioning Research*, *34*(7), 2006–2014. https://doi.org/10.1519/JSC.0000000000002446

Primljen: 25. maj 2023. / Received: May 25, 2023
Prihvaćen: 15. jul 2023. / Accepted: July 15, 2023

Instruction for authors submitting papers

TITLE OF PAPER (TWO LINES AT THE MOST)

First and last name of the first author[1], First and last name of the second author[2]

[1]Name of the Organization, [2]Name of the Organization

Abstract: Every paper must contain the abstract. You should bring basic idea with final results of research to abstract. Paper should be written according the guideline bellow. Abstract may contain up to 250 words.

Keywords: Maximum of five, key words or phrases, separated by commas.

The paper must contain clear introduction, problem statement, method of resolving the problem, results, conclusion, and references. It shoud not contain more than 8 pages of A4 format (21 x 29.7 cm) including figures, tables, references. Paper margins must be: top and bottom 2.5 cm, inside 2.5 cm and outside 2 cm. Pages are not ought to be numbered.

The paper title (use 12 point Times New Roman type of text; the title must be highlighted with Bold option) should be positioned in the middle of the first page, shifted two spaces, font size 10pt, below top margin. After the title, one should leave one space, font size10 pt. The paper must be sent to the Congress Programme Board in electronic form (DOC) via *Paper Submission Form*, or as an email attachment to *siz@apeiron-edu.eu*.

There should be a caption above the table, which says, for example „Table 1. Intercorrelation matrix". Below the figure, there should be the figure number and legend, for example "Figure 3: Work with preschoolers".

The Editorial Board accepts manuscripts written in English (American English or British English) and optionally in Slavic language.

Manuscripts may be rejected if written in poor English or Slavic language. The author is fully responsible for the style (formal, unbiased in any sense), language, and content of the paper. Yet, the Editorial Board has the right to comment on the form and language of the paper before it is accepted for publication. A good, standard command of grammar is expected in written English. Please, avoid non-standard abbreviations.

REFERENCE

It is necessary to cite all sources used for your paper. APA citation style is recommended.

Authors must write the Contact of the corresponding author with his/her full name, academic title, institution, address, e-mail address and phone number (optionally).

REVIEW PROCESS

Submissions to the journal will initially be evaluated by the Editorial Board using several criteria: the appropriateness of the topic and content for the journal; the editing (preparation of the manuscript) and format; and "general" merit. If these criteria are met, the submission will undergo a double-blind review process by at least two acknowledged and independent reviewers, with the review process taking up to 8 weeks.

Only the papers that receive positive reviews will be accepted. One of the crucial reasons for the review is to provide quotations and references of relevant literature. The Editorial Board has the right to comment on the form of the paper before it is accepted for publication. The Editorial Board is not obliged to publish papers in chronological sequence of their receipt or in the sequence in which they have been accepted for publication. No substantial part of the submission should have been published elsewhere. The adducing of the results in extracts, summaries, abstracts, dissertations and Master's theses, reviews and conference papers (up to three pages, containing abstracts, graphical presentations and references) are not considered as publishing. If the manuscript contains the results that have already been published, the author(s) must get the consent of the first publisher and quote the source clearly.

Uputstvo za autore

NASLOV RADA (NAJVIŠE DVA REDA)

Ime i prezime prvog autora[1], Ime i prezime drugog autora[2]

[1]Naziv organizacije, [2]Naziv organizacije

Sažetak: Svaki rad mora sadržati sažetak. Sažetak treba da sadrži osnovnu ideju sa konačnim rezultatima istraživanja. Rad treba pisati u skladu sa uputstvom u nastavku. Sažetak može sadržati do 250 riječi.

Ključne riječi: Najviše pet ključnih riječi ili fraza odvojenih zarezom.

Rad mora sadržati jasan uvod, naveden problem, način riješavanja problema, rezultate, zaključak i literaturu. Rad ne treba da sadrži više od 8 stranica formata A4 (21 x 29.7 cm), uključujući slike, tabele i literaturu. Margine moraju biti: gornja i donja 2,5 cm, unutrašnja 2,5 cm i spoljašnja 2 cm. Stranice ne treba da budu numerisane.

Naslov rada (koristite font Times New Roman 12; naslov mora biti označen opcijom Bold) treba da bude postavljen na sredini prve stranice, pomjeren za dva razmaka, veličina fonta 10 pt, ispod gornje margine. Nakon naslova treba ostaviti jedan razmak, veličina fonta 10 pt. Rad mora biti poslat Programskom odboru Kongresa u elektronskom obliku (PDF ili DOC) putem obrasca za podnošenje radova, ili kao prilog e-mail-u na siz@apeiron-edu.eu.

Trebalo bi da postoji natpis iznad tabele, koji navodi, na primjer, „Tabela 1. Interkorelaciona matrica“. Ispod slike treba da bude broj i legenda, na primjer “Slika 3: Rad sa predškolskim djecom”.

Uredništvo prihvata rukopise napisane na engleskom (američki ili britanski engleski) i opciono na nekom od slovenskih jezika.

Rukopisi mogu biti odbijeni ako su napisani na lošem engleskom ili slovenskom jeziku. Autor je u potpunosti odgovoran za stil (formalan, nepristrasan u bilo kom smislu), jezik i sadržaj rada. Ipak, Urednički odbor ima pravo da komentariše formu i jezik rada prije nego što bude prihvaćen za objavljivanje. Očekuje se dobra, standardna upotreba gramatike u pisanom engleskom jeziku. Izbjegavajte nestandardne skraćenice.

LITERATURA

Potrebno je navesti sve izvore koji se koriste za vaš rad. Preporučuje se APA stil citiranja. Autori moraju da navedu kontakt podatke autora sa njegovim/njenim punim imenom, akademskim nazivom, institucijom, adresom, e-mail adresom i brojem telefona (opciono).

PROCEDURA RECENZIJE

Radovi poslati časopisu će najprije biti ocijenjeni od strane Uredništva imajući u vidu nekoliko kriterijuma: prikladnost teme i sadržaja časopisa; uređivanje (priprema rukopisa) i format; i “opšta” valjanost. Ako su ovi kriteriji ispunjeni, rad će biti poslat na dvostruku anonimnu recenziju od strane najmanje dva priznata i nezavisna recenzenta, a proces recenzije može trajati do 8 sedmica.

Samo radovi koji dobiju pozitivne recenzije će biti prihvaćeni. Jedan od presudnih razloga recenzije je navođenje citata i referenci relevantne literature. Urednički odbor ima pravo da komentariše formu rada prije nego što on bude prihvaćen za objavljivanje. Redakcija nije obavezna da objavljuje radove po hronološkom redosledu njihovog prijema ili po redoslijedu po kom su prihvaćeni za objavljivanje. Nijedan značajan dio rada ne treba da bude objavljen negdje drugdje. Prikazivanje rezultata u izvodima, sažecima, kratkim pregledima, disertacijama i magistarskim tezama, recenzijama i radovima sa konferencija (do tri stranice, koje sadrže sažetke, grafičke prezentacije i literaturu) ne smatra se objavljivanjem. Ako rukopis sadrži rezultate koji su već objavljeni, autor(i) moraju dobiti pristanak prvog izdavača i jasno citirati izvor.

Ethics

Publication ethics, disclosure policy and malpractice statement

Publication and authorship

- All submitted articles are subject to strict peer-review process by at least two reviewers that are experts in the area of the particular paper.
- The factors that are taken into account in review are relevance, soundness, significance, originality, readability and language.
- The paper acceptance is constrained by such legal requirements as shall then be in force regarding libel, copyright infringement and plagiarism.
- For published articles, information on relevant potential conflicts of interest will be made available to the public.

Authors' responsibilities

- Authors must certify that their manuscripts are their original work.
- Authors must certify that the manuscript has not previously been published elsewhere.
- In case a submitted manuscript is a result of a research project, or its previous version has been presented at a conference in the form of an oral presentation (under the same or similar title), detailed information about the project, the conference, etc. shall be provided navesti gde se navode. A paper that has already been published in another journal cannot be reprinted in this journal.
- Authors must certify that the manuscript is not currently being considered for publication elsewhere.
- Authors must identify all sources used in the creation of their manuscript.
- It is the responsibility of each author to ensure that papers submitted in this journal are written with ethical standards in mind.

Reviewers' responsibilities

- Reviews should be conducted objectively, with no personal criticism of the author.
- Reviewers are required to provide written, competent and unbiased feedback in a timely manner on the scholarly merits and the scientific value of the manuscript.
- Reviewers should keep all information regarding articles confidential and treat them as privileged information.
- Reviewers must not have conflict of interest with respect to the research, the authors and/or the funding sources for the research. If such conflicts exist, the reviewers must report them to the Editor without delay.
- Any selected referee who feels unqualified to review the research reported in a manuscript or knows that its prompt review will be impossible should notify the Editor without delay.

Editors' responsibilities

- Editors have complete responsibility and authority to reject/accept an article.
- Editors are responsible for the contents and overall quality of the publication.
- Editors should always consider the needs of the authors and the readers when attempting to improve the publication.
- Editors should preserve the anonymity of reviewers.
- Editors should act if they suspect misconduct, whether a paper is published or unpublished, and make all attempts to persist in obtaining a resolution to the problem.
- Editors should not reject articles based on suspicions.

ETIKA

Etika objavljivanja, pravila objavljivanja i zloupotreba podataka

Objavljivanje i autorska prava

- Svi pristigli članci podliježu strogoj recenziji od strane barem dva recenzenta koji su stručnjaci iz oblasti naučnog rada.
- Faktori koji se uzimaju u obzir prilikom recenzije su relevantnost, ispravnost, značaj, originalnost, čitljivost i jezik.
- Prihvatanje rukopisa je ograničeno takvim zakonskim uslovima koje će se primijeniti u slučaju klevete, zloupotrebe autorskih prava i plagijata.
- Kod objavljenih članka, informacije o relevantnim potencijalnim sukobima interesa biće dostupne javnosti.

Odgovornosti autora

- Autori moraju da potvrde da je njihov rukopis njihovo autorsko djelo.
- Autori moraju da potvrde da njihov rukopis nije prethodno objavljen na nekom drugom mjestu.
- U slučaju da je poslati rukopis rezultat naučnoistraživačkog projekta ili da je, u prethodnoj verziji, bio izložen na skupu u vidu usmenog saopštenja (pod istim ili sličnim naslovom), detaljniji podaci o projektu, konferenciji i slično, navode se u navesti gdje se navode. Rad koji je već objavljen u nekom časopisu ne može biti preštampan u ovom časopisu.
- Autori moraju da potvrde da se njihov rukopis trenutno ne razmatra za objavljivanje negdje drugdje.
- Autori su dužni da navedu sve izvore koje su koristili u pisanju njihovog rukopisa.
- Autori su dužni da se pridržavaju etičkih standarda koji se odnose na naučnoistraživački rad.

Obaveze recenzenta

- Recenzija mora biti objektivna. Komentari koji se tiču ličnosti autora smatraju se neprimjerenim. Sud recenzenata mora biti jasan i potkrepljen argumentima.
- Recenzenti bi trebalo svoje stavove da iskažu jasno, sa pratećim argumentima.
- Recenzenti bi trebalo da čuvaju u povjerenju sve informacije u vezi članka i smatraju ih privilegovanim informacijama.
- Recenzent ne smije da bude u sukobu interesa sa autorima ili financijerom istraživanja. Ukoliko postoji sukob interesa, recenzent je dužan da o tome momentalno obavijesti urednika.
- Recenzent koji sebe smatra nekompetentnim za temu ili oblast kojom se rukopis bavi dužan je da o tome obavijesti urednika.

Obaveze urednika

- Urednici imaju punu odgovornost i ovlaštenje da odbiju/prihvate članak.
- Urednici su odgovorni za sadržaj i ukupni kvalitet publikacije.
- Urednici bi uvijek trebalo da razmotre potrebe autora i čitaoca pri pokušaju da se poboljša publikacija.
- Urednici bi trebalo da sačuvaju anonimnost pregledanog članka.
- Urednici bi trebali da osiguraju da je sav materijal koji objavljuju u skladu sa međunarodno prihvaljivim etičkim smjernicama.
- Urednici bi trebalo da djeluju ukoliko posumnjaju na zloupotrebu, bez obzira da li je rad objavljen ili ne, i preduzmu mjere kako bi uspjeli da riješe problem.
- Urednici ne bi trebalo da odbace članak na osnovu sumnje.

ISSN 2232-8211