PAMUKKALE JOURNAL OF SPORT SCIENCES

dergipark.org.tr/en/pub/psbd

ISSN: 1309-0356
Year: 2023 Volume: 14 Number: 1
Pamukkale University
Faculty of Sport Sciences
Turkey

PAMUKKALE JOURNAL OF SPORT SCIENCES
Pamukkale Spor Bilimleri Dergisi

Volume: 14 Issue: 1 Year: 2023
ISSN: 1309-0356

INDEXING
DOAJ
EBSCO - SPORTDiscus Full Text
Index Copernicus Master List
Scopus, Türkiye Atıf Dizini, CAB Abstracts

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PAMUKKALE JOURNAL OF SPORT SCIENCES
ISSN: 1309-0356
dergipark.org.tr/en/pub/psbd

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doi.org/10.54141/psbd.1198100

PAMUKKALE JOURNAL OF SPORT SCIENCES
ISSN: 1309-0356 dergipark.org.tr/en/pub/psbd

Pamukkale J Sport Sci, 14(1), 1-21, 2023 Research Article

Examination of the Relationship Between Quality of Life and Leisure Satisfaction by Canonical Correlation Analysis

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Keywords
Canonical correlation,
Leisure,
Leisure satisfaction,
Quality of life

Article History
Received 01 November 2022
Revised 09 February 2023
Accepted 14 February 2023
Available Online 27 April 2023

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ABSTRACT

Leisure activities are one of the determinants of quality of life, among others. In this context, this study focuses on all dimensions of satisfaction from leisure activities and quality of life. Canonical correlation analysis was used, and 300 university students were included in the study via convenience sampling method. Data collection tools of the research of "Satisfaction with Life Scale" and "Short-Form-36 Health Survey". According to the research findings, the shared variance between the quality of life and leisure satisfaction data sets was 31.955% for the first canonical function and 19.270% for the second canonical function. In the first canonical function, the physical function variable from the life quality data set and psychological, education, social, and physiologic variables from the leisure satisfaction data set had a relationship in the same direction. In the second canonical function, physical role and emotional functions from the quality of life and relaxation from leisure satisfaction data set had a relationship in the same direction. Leisure satisfaction could be expressed to increase the quality of life in university students. The results indicated that increasing the opportunities for university students to join leisure activities would give beneficial results.

Citation: Tercan Kaas E., Köse E. and Yerlisu Lapa T. (2023). Examination of the Relationship Between Quality of Life and Leisure Satisfaction by Canonical Correlation Analysis. *Pamukkale Journal of Sport Sciences*, *14(1)*, 1-21. doi.org/10.54141/psbd.1198100

INTRODUCTION

The concept of quality of life (QOL) has been subject to much research for decades, and the question of what consists of a good life is tried to be answered by academics (Diener, 2000). QOL is a concept that might be agreed upon by academicians coming from different fields as a vague term that is difficult to be defined (Henderson, 2007; Iwasaki, 2007). In their study, Diener and Suh (1997) mentioned three major philosophical approaches for defining QOL, referring to Brock (1993). These were: 1) Defining the characteristics of the good life dictated by normative ideals; 2) Defining a good life in terms of satisfaction of preferences; 3) Defining a good life based on the experience of individuals. To Diener and Suh (1997), the new approaches to define QOL were objective measurement based on social indicators and subjective measurement according to well-being based on an individual's internal judgment of well-being. Different measurement tools were developed for measuring QOL. One commonly used measurement tool is The Short-Form-36 Health Survey (SF-36), a generic measure that can be used in the general population and among various disease groups. As part of the "International Quality of Life Assessment (IQOLA)" Project, the scale and different versions were translated into more than 40 countries (Ware, 1999). SF-36 measures an individual's functional status and well-being. The eight health-related QOL domains are; "Physical functioning", "Social functioning", "Role limitation due to physical problems", "Role limitation due to emotional problems", "Mental health", "Energy and vitality", "Bodily pain", and "General perception of health" (Demiral et al., 2006). Another commonly used measurement tool of QOL is the "World Health Organization Quality of Life Scale" developed by the "World Health Organization" in 1998. The scale was developed based on an extensive pilot test in 15 centers around the World using 4500 participants. The sub-dimensions of this scale were: "Physical", "Psychological", "Level of independence", "Social relationships", "Environment", and "Spirituality" (Iwasaki, 2007).

Academicians from various fields focused more on defining and measuring factors affecting QOL (Lloyd & Auld, 2002). Among the factors affecting QOL, we can consider factors such as health, working life, friends, family, and leisure (Hagerty et al., 2001). As an essential life domain, leisure is necessary for individuals of different ages (Cheung et al., 2009). Research on leisure and QOL was a complex but remarkable study area by Phillips and Budruk (2011). Bedini et al. (2011) reported the existence of research finding positive relationships between leisure and greater QOL, improved health, and self-esteem and negative relationships between leisure and depression, stress, and risk of dementia. In a study by Gumus and Işık

(2018) conducted on teacher candidates, "leisure-time physical activity" showed a positive correlation with QOL. In a study applied to elderly people in South Korea, leisure activity predicted QOL (Lee et al., 2014). Wang (2022) studied the relationships between leisure involvement and quality of life among users of public sports centres aged 45 years and older. According to the results, leisure involvement provided significant positive quality-of-life outcomes, especially in the physical, psychological, and environmental domains.

The literature abovementioned shows evidence for the positive relationship between leisure and QOL. Besides this, leisure satisfaction exposes positive effects on QOL. In a study examining the relationship between leisure satisfaction (LS), life satisfaction, and QOL, the increase in leisure satisfaction in health professionals increased quality of life (Tokay Argan & Mersin, 2021). In a study, data was collected from 940 adults in China, and multiple regression was utilized to measure the relationship between LS, demographic variables, and QOL. The study's results showed that LS predicted all sub-dimensions of QOL and psychological satisfaction and aesthetical satisfaction had a relationship with all subscales of QOL (Zhou et al., 2021). Çakal and Esentaş Deveci (2022) examined the relationship between LS and QOL in Manisa Mental Hospital health professionals and detected a positive medium-level significant relationship. Leisure satisfaction (LS) is one of the frequently encountered concepts of leisure in the literature, which was defined by Beard and Ragheb (1980) as "the positive perceptions of feelings which individual forms, elicits or gains as a result of engaging leisure activities and choices." One of the studies proving the positive relationship between LS and QOL was conducted by Eifert et al. (2019) in a group of elderly women. In a study conducted on Chinese and British Canadians, overall LS significantly affected happiness, peacefulness, and all nine QOL domains (Spiers & Walker, 2009). In a study applied to Asian countries, among the South Korean population, a positive association was found between leisure satisfaction and QOL (Liang et al., 2013). The contribution of leisure time physical activity was also explored and a study in Taiwan showed that physical activity was positively related to QOL (Ou et al., 2017). In a study investigating the relationship between LS and QOL, all subscales of LS showed a positive correlation with subscales of subjective QOL (Ngai, 2005). In another study applied to residents of a tourism destination a positive correlation between QOL, and LS was detected (Liao et al., 2016). Choe et al. (2020) reported a strong association between LS, social connection/interaction, and QOL was found in the literature. University students were also inquired about the relationship between QOL and LS and the results showed no significant relationship between these two constructs (Yaşartürk et al., 2019).

Although there are studies conducted on university students, when we consider the number of university students in the country's population, more research is required for this group of society. Nowadays, university education is supported by public and private sectors in Turkey and there are 207 universities throughout the country. Currently, the number of university students is reported as 8.240,997 by the Council of Higher Education in Turkey. This number constitutes approximately 10% of Turkey's population, making university students an essential component of society. Besides, the life of young individuals at the university is important as this is a transition period to adulthood (Liu & You, 2015; Özbay, 1997). It is expected that positive physical and mental habits that students gain contribute constructively to the development of the adults of the future. The study is expected to fill the leisure and quality of life literature gap by focusing on university students. As university students are a considerable part of the population in society, gaining meaningful and healthy leisure habits will help them to benefit from leisure activities during their lifetime. Therefore, in the light of the abovementioned literature, the study aims to determine the relationship between QOL and LS in university students using canonical correlation analysis.

METHODS

Research Model

This study was designed with a survey model, and a relational survey model was used. In relational studies, the relationships between two or more variables are examined (Karasar, 1998). This study aims to reveal the relationship between LS and QOL by using canonical correlation analysis. Canonical correlation examines the relationship between two data sets having more than one variable (Tabachnick & Fidell, 2007).

Study Group

The population of the study of university students taking elective physical activity. The sample size was calculated by the formula n = t2pq/d2 (Sümbüloğlu & Sümbüloğlu, 1995). In the formula, t value for alpha = .05 was taken as 1.96 from the t table. The values of p (probability of occurrence) and q (probability of non-occurrence) were taken as .5 to give the highest sample size. d, the accepted level of deviation was taken as .05. By this formula sample size was calculated as n = 385. As a result, feedback from 300 students was reached with a rate of return = 77.9%. The study adhered to the research principles of the Declaration of Helsinki.

Data Collection Tools

In this study, two attitude scales were used as data collection tools.

Leisure Satisfaction (LS) Scale

LS scale was developed by Beard and Ragheb in 1980 and adapted to Turkish by Karlı et al. (2008). The Turkish version of this scale of 39 questions and presents the satisfaction derived from the satisfied leisure needs of individuals. the six-sub dimensions are "Psychological", "Education", "Social", "Relaxation", "Physiologic" and "Aesthetic". In their study, Internal consistency coefficients changed between .79 and .84, and the overall coefficient of the scale was found as .92. In this study the internal consistency coefficient of the Leisure Satisfaction Scale was found to as .935.

Quality of Life (QOL) Scale

QOL was measured by The Short-Form-36 Health Survey (SF-36), which is a generic measure that can be used in both the general population and among various disease groups. SF-36 measures an individual's functional status and well-being. The eight-health related QOL domains are: "Physical functioning", "Social functioning", "Role limitation due to physical problems", "Role limitation due to emotional problems", "Mental health", "Energy and vitality", "Bodily pain", "General perception of health". Turkish adaptation of SF-36 scale was conducted by Koçyiğit et al. (1999). Further validity and reliability studies of this scale were tested in a sample of 1279 adults (Demiral et al., 2006). High points obtained from the subscales show a better perception of QOL. In this study, the internal consistency coefficient of the Quality-of-Life Scale was found to as .849.

Data Collection Procedure

For the data collection process, the permissions of the lecturers were taken in order to reach students in sports fields. Students taking elective physical education lessons were explained the purpose of the study and after their approval, questionnaires with informed consent were distributed to students. Participants were given 20 minutes for filling out the questionnaires right after a brief explanation that their information will be kept confidential.

Data Analysis

For data analysis, Canonical correlation method was used which is an appropriate multivariate statistical technique when the relationship between two variable sets is aimed to be examined (Sherry & Henson, 2005). Before application, the basic assumptions of the canonical correlation were controlled. In this context, normality, linearity of the data, and multicollinearity was tested. Scatter diagrams for multivariate normality and linearity were examined, and every distribution showed a nearly elliptical shape. In order to test univariate normality, skewness, and kurtosis coefficients were checked. As these coefficients changed

between ±2 interval, it could be concluded that the normality assumption was fulfilled (Kunnan, 1998). The details of skewness and kurtosis values are presented in Table 1.

The other assumption of canonical correlation is the non-existence of the multicollinearity problem. In order to check this assumption, VIF and CI values were examined; VIF value was <1.0000 and CI value was <18.225. According to Belsley (1991), when VIF value <10 and CI value is <30 the multicollinearity problem does not exist.

Table 1
Descriptive Statistics of Data Sets

Variable	mean	SD	skewness	Kurtosis	Variable	Mean	SD	skewness	Kurtosis
"X1"	3.9813	.513	-.547	.091	X1	88.03	15.778	-1.324	.685
"X2"	4.0341	.617	-1.229	2.371	X2	76.91	27.326	-1.081	.342
"X3"	4.0379	.509	-.679	.482	X3	71.55	30.452	-.772	-.374
"X4"	4.1333	.626	-.788	1.070	X4	55.46	10.583	.280	1.470
"X5"	4.0511	.606	-1.103	1.772	X5	55.60	9.762	.382	.029
"X6"	4.0992	.670	-.706	-.098	X6	57.41	14.78	.685	.637
					X7	69.60	21.274	-.908	.588
					X8	61.55	13.439	.088	.258

RESULTS

The significance of the canonical model was checked by Pillais, Hotellings, Wilks and Roys tests. As the theoretical bases of these tests were different, the F values were also different. In general, Wilks ƛ was used commonly (Sherry & Henson, 2005).

The results in Table 2 proved the significance of the model. Wilks λ = .48022, F (48, 141130) = 4.72672, p <.001. This result was evidence of the relationship between QOL and LS. As the significance of the model could be impacted by the sample size, the effect size was also suggested to be evaluated (Sherry & Henson, 2005). So, in this study, the Wilks λ was used as inverse effects. This value represented the variance which was not explained by canonical variables.

Table 2
Multivariate Significance Tests

Test	value	Approximate F.	Hypothesis DF.	Error DF.	Significance of F.
"Pillais test"	.4366	4.37113	48.00	1746.00	.000
"Hotellings test"	.84592	5.01088	48.00	1706.00	.000
"Wilks test"	.48022	4.72672	48.00	1411.30	.000
"Roys test"	.31955				

The value "1- λ" showed the common variance shared by canonical variables and could be interpreted as R 2 in regression analysis. In this table "1- λ" value was .51978. So, we could conclude that the shared variance between QOL and LS was 51.978% (Figure 1).

Figure 1
Shared variance between LS and QOL

Canonical correlation examined if the canonical model and each canonical function are significant. According to the results, 6 canonical functions were presented (Table 3).

Table 3
Eigenvalues and Canonical Correlations

root no.	Eigen value	Percentage (%)	Cumulative Percentage (%)	Canonical Correlation	Squared Canonical Correlation
one	.46962	55.51565	55.51565	.56529	.31955
2	.23870	28.21780	83.73345	.43898	.19270
3	.06447	7.62130	91.35475	.24610	.06057
4	.03910	4.62236	95.97711	.19398	.03763
5	.02836	3.35246	99.32958	.16606	.02758
6	.00567	.67042	100.000000	.07509	.00564

Table 3 revealed that the canonical correlation value was .56529. According to this, QOL and LS data sets had a shared variance of 31.955% in the first function. The correlation value in the second canonical function was .43898, and the shared variance between QOL and LS was 19.270%. In the third canonical function, the canonical correlation value was found to be .24610 after excluding the shared variance between QOL and LS data sets in the first two canonical functions. According to this the shared variance between QOL and LS data sets was 6.057. The canonical correlation values and shared variances between two data sets were .19398 and 3.763% for the fourth canonical function, .16606 and 2.758% for the fifth canonical function, .07509 and .0564% for the sixth canonical function, respectively.

Dimension reduction analysis was used to show how canonical functions explained much shared variance. In dimension reduction analysis, canonical functions were ranked hierarchically according to the value of correlation (İlhan et al., 2013). By examining the first line of the dimension reduction table, it could be decided if the canonical model was statistically significant. Also, the shared variance was presented in the first line of the table. The second line of this table showed if the canonical model was statistically significant. Also,

in the second line of the table, the shared variance was presented after the first function was excluded. The dimension reduction analysis results for QOL and LS data sets were presented in Table 4.

Table 4
Dimension Reduction Analysis

root	Wilks λ	F	Hypothesis DF	Error DF	Significance of F
"1 to 6"	.48022	4.72672	48.00	1411.30	.000
"2 to 6"	.70574	2.98554	35.00	1209.73	.000
"3 to 6"	.87419	1.64691	24.00	1005.92	.026
"4 to 6"	.93055	1.40568	15.00	798.20	.137
"5 to 6"	.96694	1.22901	8.00	580.00	.279
"6 to 6"	.99436	.55011	3.00	291.00	.648

The results in Table 4 proved the significance of the canonical model obtained from cumulative values of 6 canonical functions (function 1 to 6). Here (Wilks's λ = .48022, F (48, 1411.30) = 4.72672, p<.001). According to Wilks λ value, which belonged to the relationship formed by cumulative values of 1st and 6th canonical functions, the shared variance between QOL and LS data sets was 51.978% [1-λ = .51978]. The remaining two canonical functions (function 2 to 6) after the deduction of the first canonical correlation, which had the highest correlation between canonical variables, showed a significant correlation between QOL and LS (Wilks's λ = .70574, F (35, 1209.73) = 2.98554, p<.05). According to Wilks λ value which belonged to the relationship formed by cumulative values of 1st and 6th canonical functions, the shared variance between QOL and LS was 29.426% [1-λ = .29426]. The third canonical function (function 3 to 6) exhibited a statistically significant relationship between canonical variables (Wilks's λ = .87419, F (24, 1005.92) = 1.64691, p<.05) after the first two canonical functions were excluded. In this function, the shared variance between QOL and LS was 12.581% [1-λ = .12581]. The relationship was formed by cumulative values of fourth and sixth canonical functions (4 to 6). The remaining ones showed insignificant relationships (p>.05). The explained variances were 6.945%, 3.309%, and .564% for (4 to 6), (5 to 6) and (6 to 6) respectively. When significance levels and shared variances were considered, the 1st and 2nd canonical functions guaranteed the significance. That is why the 1st and 2nd canonical functions that made the highest contribution to variance between two variable sets were decided to be interpreted.

Another important aspect of canonical correlation was the quantity of the contribution of variables in data sets to the relationship between canonical variables. Standardized coefficients of canonical functions and structural coefficients were utilized to analyze this contribution. In this study, to identify the amount of contribution of the variables in the QOL

data set ("Physical function", "Physical role", "Pain score", "General health score", "Vitality score", "Social function score", "Emotional function score", "Mental health score") and the variables in LS data set ("Psychologic", "Education", "Social", "Relaxation", "Physiologic" and "Aesthetic"), standardized and structural coefficients of first and second canonical functions were examined. The findings were presented in Table 5. By the summation of shared variance values in the first and second canonical functions of variables in data sets of QOL and LS, the amount of shared variance with their data set in the canonical model could be known. To decide the significance of shared variance in the data set of the variables, .45 values were taken as criteria. This value was represented as "h2". According to Sherry and Henson (2005), the r s and h 2 values ≥ .45 significantly contributed to the variables' data set.

Table 5
Canonical Analysis of Canonical Functions 1 and 2 for the Relationship Between QOL and LS Data Sets

Variable	1st Canonical Function			2nd Canonical Function			
	Standardized Coefficients	Structural Coefficients (r_s)	Square of Structural Coefficients (r^2_s)	Standardized Coefficients	Structural Coefficients (r_s)	Square of Structural Coefficients (r^2_s)	Communality Coefficient (h^2)
"Physical function"	.37350	.49178*	.24185	.33450	-.22638	.051239	.293086
"Physical role"	.37078	.37758	.14277	.37078	-.69856*	.487986	.630757*
"Pain"	-.17178	.23253	.05407	-.82078	-.15073	.02272	.07679
"General health"	.06993	.06279	.00394	-.04426	-.06812	.00464	.008583
"Vitality"	.54946	.25202	.06351	.18785	-.02849	.000812	.064326
"Social functions"	-.78591	-.59628*	.35555	-.20076	-.35723	.127613	.483163*
"Emotional role"	.11222	.26866	.07218	.32894	-.77696*	.603667	.675845*
"Mental Health"	-.35340	-.21118	.04460	.01595	-.37714	.142235	.186832
Rc ²_			**.31955**			**.19270**	
"Psychological"	.49270	.85096*	.72413	-.77850	-.43428	.188599	.912732*
"Education"	.03679	.65941*	.43482	.34691	.04603	.211876	.646698*
"Social"	.31444	.73723*	.54351	-.06183	-.26339	.069374	.612882*
"Relaxation"	-.23268	.41318	.17072	-.64799	-.48258*	.232883	.403601
"Physiologic"	.47510	.82111*	.67422	.79263	.36760	.13513	.809351*
"Aesthetic"	.05184	.59200*	.35046	.16249	.15741	.024778	.375242

**Structure coefficients (r_s) > .45*

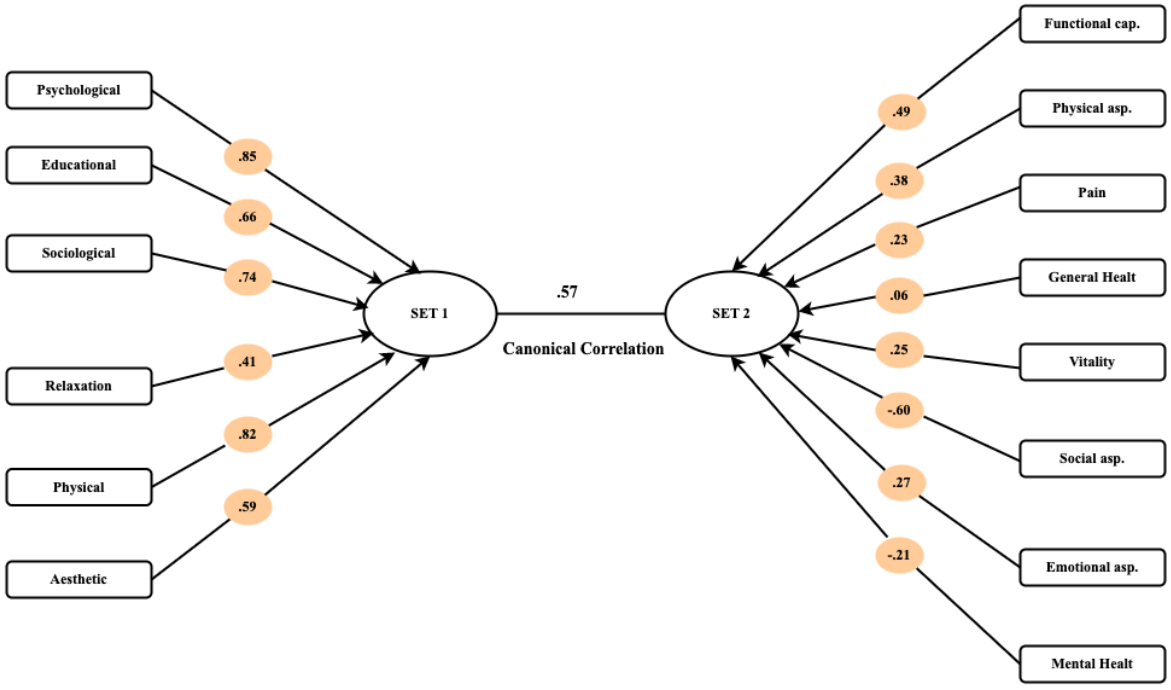
According to Table 5, in the first canonical function, the contribution of the "Physical function" and "Social function" variables to the life quality data set was over .45. These variables showed a higher contribution than other variables. Additionally, in the first canonical function, "Psychological", "Education", "Social", "Physiologic", and "Aesthetic" variables contributed to LS more than .45. They contributed more significantly to the LS data set than the "Relaxation" variable. The signs of variables contributing to their own data set (especially the variables with structural coefficients ≥.45) help us detect the relationship's direction. In the first canonical function, where the structural coefficients of "Physical

function" and "Social function" were significant, the sign of the "Social function" variable was negative. This finding indicated that the two variables had a negative relationship. When variables included in LS data set were examined, it was detected that "Psychological", "Education", "Social", "Physiologic," and "Aesthetic" variables showed positive signs, which denoted that these variables had a positive relationship. When the relationship was examined according to "Social function" variable, it could be expressed that "Psychological", "Education", "Social", "Physiologic" and "Aesthetic" variables in LS data set decreased with the increase in "Social function" variable.

The structural coefficients and the canonical correlation coefficient between QOL and LS data sets regarding to the first canonical function were presented in Figure 2. According to Table 5, for the first canonical function, the value of R c 2 was calculated as .31955. This value indicated that the shared variance between the two data sets was 31.955%.

Figure 2

Structural Coefficients and Canonical Correlation Coefficients Between QOL and LS Data Sets Regarding the First Canonical Function

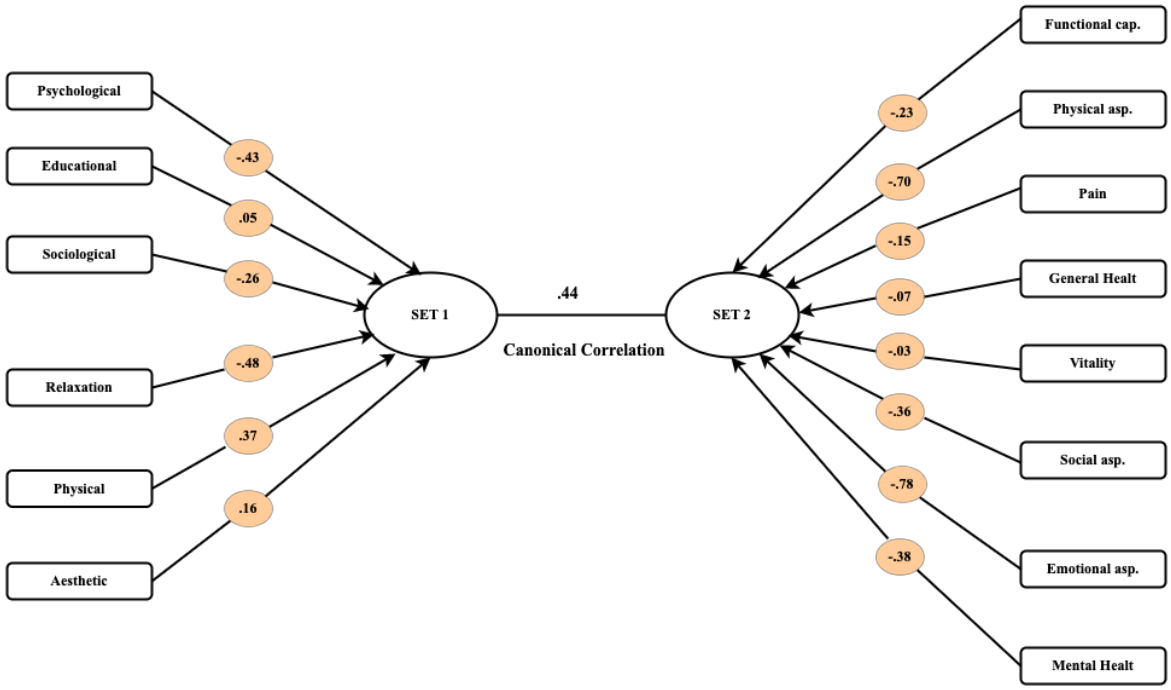


The second canonical function was examined, and the variables that contributed significantly to the second canonical function in the QOL data set showed negative signs. Among them, "Physical role" and "Emotional role" contributed to the QOL data set over .45. Meanwhile, in the LS data set, "Psychological", "Social" and "Relaxation" variables had the same direction, and "Relaxation" variables contributed more than .45 to LS data set. In other words, with their improved "Physical role" and "Emotional role", individuals might get more

LS resulting from the increasing "Relaxation" obtained from leisure activities. Table 5 shows the R c 2 value for the second canonical correlation was .19270. This value indicated that the shared variance between QOL and LS data sets was 19.270%. The structural coefficients and the canonical correlation coefficient between QOL and LS data sets regarding the second canonical function were presented in Figure 3.

Figure 3

Structural Coefficients and Canonical Correlation Coefficients Between QOL and LS Data Sets Regarding to the Second Canonical Function



DISCUSSION

This study examined the relationship between LS and QOL by canonical correlation analysis. The analysis brought out two significant canonical functions between LS and QOL. In the first canonical function, the canonical correlation coefficient was found to as .57, and the shared variance as 31.955%. Meanwhile, the second canonical function put forward a correlation coefficient of .44 and a shared variance of 19.270%. The canonical model consisting of cumulative values obtained by correlation analysis showed that the shared variance between these two data sets was 51.978%.

The relationship between the two data sets revealed that LS aspects had a determining role in the aspects of QOL. As a result, it could be observed from the study's findings that a significant relationship existed between LS and QOL. In a study by Zhou et al. (2021), LS predicted all domains of QOL among 940 urban Chinese individuals. Meanwhile, research conducted in Asian countries showed a significant positive relationship among South Korean

participants (Liang et al., 2013). Another study relating LS and QOL with tourism development found that a positive relationship existed between "LS" and "QOL" (Liao et al., 2016). Health professionals were inquired about their LS, life satisfaction, and QOL, and positive significant relationships were obtained between these two variables (Tokay Argan & Mersin, 2021).

While interpreting the results, it should be considered that the QOL scale shows better health results when the scores increase for each subscale. The satisfaction derived from leisure activities showed a positive relationship with "Physical functioning", "Physical role," and "Emotional role" aspects of QOL. In leisure literature, many presented the positive effects of studies participating in leisure activities on physical health (Mielke et al., 2020; Tian et al., 2016), psychological health (Chun et al., 2012; Goodman et al., 2016; Kim et al., 2018; Lin et al., 2014; McKay, 2012) and cognitive health (Verghese et al., 2003; Wang et al., 2002; Wang et al., 2006; Yates et al., 2016) socialization levels of individuals (Kim et al., 2015b; Schwarzenegger et al., 2005; Zerengok et al., 2018).

One important finding in this study highlighted that satisfaction from leisure activities in terms of "Psychological", "Education", "Social", "Physiologic," and "Aesthetic" was related in the same direction as "Physical functions" and "Physical role" levels of young individuals. In some studies, it was detected that physical activity had a considerable impact on inactivity situations which was an important determinant of mortality, and participating in physical activity improved the physical health condition and life quality of participants (Anokye et al., 2012; DiPietro et al., 2018; O'Dwyer et al., 2017; Villalobos et al., 2019). Meta-analysis studies and systematic reviews handling the effect of physical activity on health expressed that the results of the examined studies showed similar results. According to these results, physical activity had a positive impact on the factors that caused mortality, such as weight or body composition, blood pressure, lipids, glycaemic control, metabolic syndrome, and diabetes. Additionally, it was stated that physical activity protected bone health, and decreased overweight and adiposity risks. The results of the study that Haible et al. (2020) performed on adolescents presented support as it showed that participating in physical activity improved the cardiovascular and muscular fitness levels of the sample. Another considerable result came from a study conducted on disabled individuals. In this study, it was observed that disabled individuals who participated in social activities acquired a high perception of health and life satisfaction, and their level of accepting their disabilities increased (Kim et al., 2015a).

The impact of psychological satisfaction obtained from physical activities that young individuals joined on physical function and physical role restrictions was found to be

considerable. The achieved result highlighted the importance of psychological satisfaction gained in physical activity participation. There were studies presenting evidence of a positive relationship between leisure participation and LS (Huang & Carleton, 2003; Yerlisu Lapa et al., 2012). In other words, some studies revealed that leisure participation increased LS (Ragheb & Griffith, 1982; Ragheb & Tate, 1993); LS leisure increased participation (Sirgy et al., 2010). Therefore, in order to increase leisure participation or the frequency of participation, individuals should acquire a high level of satisfaction from these activities (Beard & Ragheb, 1980). Hence it did not seem likely that an individual repeatedly participating in an activity that he/she did not get psychological satisfaction. According to this result, psychological satisfaction could be important for the continuation of physical activity, and consequently, regular physical activity participation was expected to affect physical functions in a positive way (Vuillemin et al., 2005). A similar situation might be valid for aesthetic satisfaction. Aesthetic satisfaction represented the feelings and views about the fields or places that young individuals used during leisure participation. They could make evaluations of the design, quaintness, and usefulness of these places, and they could change their preferences according to these evaluations.

Another interesting finding in this study was that physical function, which was an important indicator of QOL, changed in the same direction as education and social satisfaction levels. This result might arise from the possibility that regular physical activity participants could gain experiences in time and information on the activities from the informed individuals (such as coaches, instructors, and friends) in their social environment. The increase in awareness and information on physical activity might help maintain and develop physical function levels for young people. Additionally, when the competence in physical activity increased, the motivation to participate in physical activity was expected to increase. The trans-theoretical model explaining why people participate in physical activity highlighted the concept of self-efficacy. According to this model, when individuals participated in physical activity, their self-efficacy increased. Individuals with higher levels of self-efficacy continued to participate in physical activity because self-efficacy was an important source of motivation (Fallon et al., 2005). Individuals with higher levels of motivation participated more in physical activity, which increased QOL and life satisfaction (Chen et al., 2013; Wang, 2008). A grounded theory study on prisoners focused on the benefits of physical activity (Köse, 2021). Prisoners said they achieved physical, psychological, and social benefits and relaxed via physical activities. The relationships between themes obtained supported the findings of the study; the physical benefits achieved by physical activity directly affected the physical health of

prisoners. Additionally, through socialization and education, prisoners gained awareness of their physical health, which indirectly improved them.

Besides the abovementioned positive effects, the impact of physical activity participation on emotional functions, which were important indicators of LS and life quality, was also remarkable. Various studies revealed a decrease in a negative emotional state such as depression (Ma et al., 2020), anxiety (Bélair et al., 2018) and an increase in a positive emotional states such as psychological well-being and motivation (Meira Jr. et al., 2020; Schmiedeberg & Schröder, 2016; Yang et al., 2012) for regular physical activity participants. Herrera et al. (2011) clarified the situation: By productive leisure activities such as handicrafts, computer usage, arts, music, and physical activity, it was possible to contribute to emotional or cognitive health by changing one of the risk factors or a combination of them such as social isolation, emotional or physical function loss which affected QOL negatively. Köse (2021) reported similar findings stating that individuals had psychological relaxation and improved their psychological health through structured leisure activities. The results showed that psychological relaxation might be key to protecting against psychological problems such as depression, anxiety, and anger. It is possible to mention that there is a positive relationship between physical activity participation and QOL, which attracted researchers' attention. Studies are reporting that participating in physical activity increased the life quality of individuals (Anokye et al., 2012; Gu et al., 2016; Marquez et al., 2020). In other words, some studies showed evidence that physically inactive individuals had lower life quality (Blom et al., 2019). LS was helpful for young individuals to participate in leisure activities and increase their life quality. The relationships between leisure participation, LS, and life satisfaction are worthy of attention (Ragheb & Griffith, 1982; Sato et al., 2016).

Additionally, studies show direct relationships between LS and QOL (Chick et al., 2015; Tokay Argan & Mersin, 2021; Zhou et al., 2021). Ngai (2005) found a positive relationship between LS and QOL; and explained that LS could be related to all subjective areas of QOL. Liang et al. (2013) stated that in Asian culture, positive emotions and self-esteem could be developed, social and cultural harmony could be increased, and values such as human development and flexibility could be gained through leisure. As a result, it could be observed that satisfaction derived from leisure could be effective on QOL of young individuals in terms of an emotional situation, physical health, social and cultural adaptation, and mental condition.

CONCLUSION

QOL represents a kind of contentment of individuals as well as it is a general state of well-being. This study aimed to present a perspective on the role of satisfaction obtained from leisure activities on QOL, which is a complete state of well-being having physical, emotional, and social aspects. Results revealed that different sources of satisfaction obtained from leisure activities had a determining role in increasing the QOL. LS could increase QOL directly. Also, the satisfaction derived from leisure activities could increase life quality indirectly by increasing leisure participation. For future studies, are researchers recommended to inquire about mediating variables between LS and QOL (such as participation, perceived freedom, and motivation…) for presenting a more detailed perspective.

This study is limited to university students participating in elective physical education courses. It is impossible to generalize the results to all university students due to the difficulties in randomization. Another limitation was the lack of conditions that could affect the life quality of students, such as chronic diseases, and psychiatric disorders. For future research, other leisure concepts, such as perceived freedom in leisure, leisure negotiation, and leisure benefit, could be studied in relation to university students' quality of life. Also, these concepts could be studied in different populations such as elderly people, disabled people, or immigrants.

Acknowledgments

No financial support was received for this study.

Authors' contributions

The first author contributed to the study design; the first and second authors analyzed the data; the third author helped with review and editing. All authors revised the manuscript and contributed to the interpretation of the results. All authors have read and approved the final version of the manuscript. A consensus was reached on the order of authors.

Declaration of conflict interest

The authors declare that there is no conflict of interests.

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doi.org/10.54141/psbd.1260960

PAMUKKALE JOURNAL OF SPORT SCIENCES
ISSN: 1309-0356 dergipark.org.tr/en/pub/psbd

Pamukkale J Sport Sci, 14(1), 22-42, 2023 Research Article

Professional Athletes' Visual Self-Presentation Strategies: An Investigation on Instagram

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Keywords
Gender, Instagram, Mixed methods, Professional career, Professional sport

Article History
Received 06 March 2023
Revised 12 April 2023
Accepted 16 April 2023
Available Online 27 April 2023

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ABSTRACT

The purpose of this study was to determine how professional athletes in different branches perform their visual self-presentation on Instagram, a social media platform. Embedded design, one of the mixed methods, examined 24 professional athletes. To create the group for study in this research, including football, basketball, tennis and track and field athletes, we used criterion sampling, a purposeful sampling method. Specifically, a total of 5030 posted photos and 854 videos were analysed. In the study, we used thematic coding to conduct content analysis by the subject and purpose of the research (Geurin-Eagleman & Burch, 2016) as well as open coding. Chi-squared was calculated to measure gender differences. Most of the athletes' shared contents and their likes and comments fell under the theme of business life, followed by personal life content. The professional athletes showed differences according to gender and sport in the themes of what they posted on Instagram. The men posted much more actively than the women. Athletes in individual sports also posted less content than team sport athletes. It was striking how little content these professional athletes, especially women and individual athletes, produced about their fans. This research can contribute to the diversification of research on the brand development and strengthening strategies of athletes in the Instagram application and to better understand the use of Instagram by professional athletes. It can also provide a perspective on Instagram usage strategies for professional athletes and athletes with high-performance potential.

Citation: Gönkek, P., and Gencer, R., T. (2023). Professional Athletes' Visual Self-Presentation Strategies: An Investigation on Instagram. *Pamukkale Journal of Sport Sciences*, *14(1)*, 22-42. doi.org/10.54141/psbd.1260960

INTRODUCTION

The sports industry has a highly dynamic structure, consisting of many closely related dimensions (Eschenfelder & Li, 2007) that continue to evolve as societies change. Today, the sports industry has evolved to incorporate Internet-based new media technologies and spreads via digital globalisation, playing a decisive role in societies. New media technologies that enable bidirectional communication significantly affect the production, distribution, and consumption of professional sports (Dart, 2014).

While professional sports have affected the masses socially and culturally, they have gained a feature that has increased competition between individuals and organizations for economic power. Professional sports organizations now command worldwide fan bases and revenues, broadcasting rights, and commercial resources (licensed product sales, sponsorship, etc.) that provide decisive advantages. Undoubtedly, these advantages to organizations are closely related to the performance of the professional athletes on their teams. However, the athlete's name and image recognition also provide critical competitive advantages. Sports organizations work with athletes on recognition, positive brand image, and superior performance to attract large masses (Parmentier & Fischer, 2012).

Professional athletes exhibit the peak technical and tactical skills of their chosen sports, but in addition to representing their professional leagues, they also represent their brands (Babiak et al., 2012). Large audiences follow these athletes closely and get to know them better. Aware of this inclination, professional athletes present themselves to society by exhibiting socially and culturally approved behaviors to control their general impressions. Social media tools offer important opportunities for professional athletes to express themselves online (Sanderson, 2011). These tools, especially social networking sites, and application, attract large masses in a concise time and strengthen interpersonal relations. In this respect, social media tools have an essential place and play strong supporting roles in professional athletes' career development.

Instagram, particularly among social media platforms, maintains a strong position and increases its number of participants daily by providing interpersonal and intercultural socialisation. Professional athletes have increasingly used Instagram to display curated images, interact with their fans, and strengthen their brands. In this respect, Instagram can help us understand the visual self-presentation strategies of professional athletes. This research can contribute to the diversification of research on the brand development and

strengthening strategies of athletes in the Instagram application and to better understand the use of Instagram by professional athletes.

Social Media in Sports

Social media is a field of study given great importance by academics and practitioners, most importantly because nearly half of the world's population uses social media (We Are Social, 2020). Individuals today spend an average of more than 145 minutes a day on social media platforms (Tankovska, 2021). Social media is an important tool in organizational and individual branding efforts because of its cost advantage as well as the rich content it offers (Filo et al., 2015; Shilbury et al., 2020). Indeed, these platforms have become essential parts of organizations' strategic communications (Lamirán-Palomares et al., 2019).

Social media messages from celebrated athletes for unrecognized brands have positive effects on consumers (Brison et al., 2016; Maderer et al., 2018). Achen (2017) stated that could organizations can quickly establish two-way relationships with target audiences using celebrated athletes on social media. For this reason, marketing professionals frequently use professional athletes in branding strategies; marketing activities on social media improve customer perceptions of sponsor companies (Zauner et al., 2012). However, celebrated athletes also use social media for promotional purposes (Hambrick & Mahoney, 2011).

An examination of the social media literature reveals the predominance of Facebook (Leng & Chiu, 2019; Nankervis et al., 2018; Salinda Premadasa et al., 2019; Vale & Fernandes, 2018; Zapata & Ulbinaitė, 2017); Twitter (Carpenter & Krutka, 2014; Fan et al., 2020; Jungherr, 2016; Korzynski & Paniagua, 2016; Lebel & Danylchuk, 2014; Litchfield & Kavanagh, 2019; Pegoraro, 2010; Wang, 2020; Witkemper et al., 2012; Zanini et al., 2019) or both (Achen et al., 2020; Moreau et al., 2021). One of the most apparent reasons for the most popular reason to Facebook is that these applications are historically older. However, Instagram is a unique social networking site for posting and sharing photos with the audience around you (Brown & Tiggemann, 2020), and users between the ages of 25 and 34 make up the largest share of the global Instagram audience (Statista, 2021). With this transformation, Instagram is becoming a popular platform in the sports industry because it provides easy access to the masses.

Instagram is a platform that individuals use to strategically design and display their identities like organizations (Zhou, 2017). Nearly all professional athletes now use Instagram for global communication with fans, sharing their experiences in their fields and their individual lives (Hipke & Hachtmann, 2014). Professional athletes can reach large audiences by sharing about themselves and their social environments. They create coherence between themselves and these audiences by following the trends and increasing their value (Korzynski

& Paniagua, 2016). For these reasons, this research focused on Instagram usage strategies by professional athletes.

There has been considerable research on Instagram in the field of sports focused on sports organizations (Anagnostopoulos et al., 2018; Baena, 2019; Santomier et al., 2016; Siguencia et al., 2017; Toffoletti et al., 2019) and athletes (Arai et al., 2014; Bireline, 2014; Dumont, 2017; Green, 2016; Nankervis et al., 2018; Romney & Johnson, 2020; Thorpe, 2017), though there is short exploration of gender differences in athletes' Instagram use. A few scholars have investigated Instagram use by female athletes only (Barnett, 2017; Toffoletti & Thorpe, 2018). However, no long-term research has been found that specifically approaches the visual self-presentation styles of professional athletes in the Instagram application regarding approaches explicitly gender.

Visual Self-Presentation

Goffman (1978) maintained that individuals calculate their behaviors to create specific reactions and express themselves deliberately and consciously as required by their group and social status. As individuals perform to express themselves, they develop themselves according to the understanding and expectations of society (Goffman, 1978). Professional athletes attempt to sculpt their images to increase their recognition in society, likely partly because they live their professional lives in highly competitive environments. In line with these efforts, the athletes display their experiences while redefining their behaviour, particularly by visually keeping them behavior in the foreground (Bireline, 2014). In line with Goffman's (1978) assertion that we develop ourselves in alignment with societies' expectations, professional athletes consider the expectations of their industries and their societies as they display their experiences. Professional athletes perform in line with the responsibilities required by their professions. However, the masses follow them closely to track their social and personal lives as well as their performances on the field. Thus, athletes model themselves according to societal understanding and expectations, but they also influence the masses who follow them, particularly through exposure on Instagram, which creates vast opportunities for strategic branding. For instance, professional athletes are at the forefront of their physical appearance, and Instagram offers significant opportunities for them to reflect on their appearance in every aspect of their lives. This situation, which can provide critical competitive advantages (Green, 2016), also contributes to strategic branding for the athletes as they share images that reflect their performance, attractive appearance, and marketable lifestyle dimensions (Arai et al., 2014).

Male dominance in sports is steadily decreasing, and media coverage of women and men in male-dominated sports is growing increasingly similar. However, few researchers have studied athletes' self-presentations on Instagram according to gender differences (Gainor, 2017; Geurin-Eagleman & Burch, 2016; Smith & Sanderson, 2015). In the related literature, although a limited number of researchers have examined the visual self-presentations of professional athletes on Instagram according to gender differences, we found no examination of differences in their visual self-presentation based on their chosen sports. Therefore, this study aimed to determine how professional athletes in different sports branches perform their visual self-presentation on Instagram, a social media platform.

METHODS

For the qualitative portion of this mixed-methods research, we examined the visual self-presentations of professional athletes on Instagram, a social networking site. The main problem of the study was how worldwide professional athletes portray themselves visually on Instagram, supported by the following research questions:

RQ-1: With what kind of posts do professional athletes display their brands on Instagram?

RQ-2: What is the relationship between professional athletes' posts on Instagram and their fans' likes and comments?

RQ-3: How do professional athletes' visual self-presentation strategies on Instagram differ according to gender?

Research Model

Embedded design, one of the mixed research methods, was used in this study. In the embedded design, one of the qualitative or quantitative methods is more prominent than the other (Yıldırım & Şimşek, 1999). The qualitative dimension of the research carries more weight. We focused on delving into the qualitative data as a starting point to reveal the differences behind the large volumes of qualitative data collected and then on revealing the gender differences in the data from the qualitative data. The visual self-presentation strategies of professional athletes in the Instagram application were collected with the qualitative research method. Then the quantitative analysis method was used to see the gender differences.

Study Group Selection

For research, Ethical permission was taken from Ege University Social Sciences Scientific Research and Publication Ethics Committee (Protocol No: 48-2018). To create the

group for study in this research, including football, basketball, tennis and track and field athletes, we used criterion sampling, which is a purposeful sampling method. For the study, we applied two separate criteria to select the study group: athletes from the countries ranked in the top three in the world by international federations for each sport and the three female and male athletes who posted the most on Instagram.

Before data collection began, we first studied the Instagram accounts of all the athletes in the national teams of the countries in the top three in the world rankings to determine their suitability for the study. Then, we observed and ranked the athletes who posted the most by the criteria and selected three men and three women for each sport. The final study group consisted of 24 professional athletes (12 female and 12 male) in four sports (Table 1). We studied the Instagram posts of these athletes between 1 January 2017 and 31 December 2017 for evaluation. In addition, the professional athletes examined in this study continue (Date: 01.01.2023) their professional careers and increase the number of their followers, which are millions, day by day, by producing content on their Instagram accounts.

Table 1
Sports of the Professional Athletes in the Study Group

Sport	Gender	Athletes and Their Country Codes
Football	Female	C. Lloyd (USA), L. Dallmann (DEU), J. Scott (GBR)
	Male	L. Podolski (DEU), C. Ronaldo (PRT), W. Pereira da Silva (BRA)
Basketball	Female	A. McCoughtry (USA), L. Pascua (ESP), D. Tchatchouang (FRA)
	Male	J. McGee (USA), W. Hernangomez (ESP), V. Stimac (SRB)
Track and Field	Female	E. Coburn (USA), C. Semenya (ZAF), S. Pearson (AUS)
	Male	M. Farah (GBR), M. E. Barshim (QAT), R. Guliyev (TUR)
Tennis	Female	G. Muguruza (ESP) C. Wozniacki (DNK) K. Pliskova (CZE)
	Male	R. Nadal (ESP) D. Thiem (AUT) D. Goffin (BEL)

Data Collection

Document analysis should be linked to research questions developed in the conceptual framework of a study (Edwards & Skinner, 2009). For this research, we used document analysis of the study group's electronic data posted on Instagram. To ensure the validity of the results, we studied a diverse array of materials, specifically the athletes' photos, videos, and the numbers of likes and comments on their Instagram pages.

Data Analysis

In the study, we used thematic coding to conduct content analysis by the subject and purpose of the research (Geurin-Eagleman & Burch, 2016) as well as open coding. During the coding within the general content analysis framework, we added incomplete or different data

that emerged with an inductive approach to the previously determined code list or revised old codes; we began the data analysis using preexisting codes to guide the process (Creswell & Poth, 2016) but shifted to open coding once it became necessary to add codes. Open coding, questioning, and continuous comparisons enable researchers to overcome subjectivity and bias (Corbin & Strauss, 1990), increasing the research's reliability.

For the open coding, we created codes individually, worked with two researchers to create a standard code list, and then transformed these codes into subthemes, themes, and categories. Content analysis can combine qualitative and quantitative techniques in one study (Creswell & Poth, 2016). In this study, to diversify the data analysis, we examined the data obtained from the sharing categories by chi-squared analysis in SPSS 22.0 to measure the gender differences among the athletes in the study group.

Validity and Reliability

Multiple-analyst triangulation refers to the participation of more than one researcher and more than one analyst in research (Patton, 2014). To ensure the validity of the study findings, we sought support from an expert who conducted communications research on social media. Using a pre-prepared code list increases the validity of the research analysis findings, and as noted earlier, we worked separately to code the categories and themes and then together to produce a final list. We calculated Cohen's kappa to measure the reliability between the coders. We arrived at .89 for the sharing categories and .92 for categories related to an athlete's appearance, findings that indicated excellent inter-rater reliability (McHugh, 2012). Consistency in general patterns derived from the data obtained from different sources contributes to the reliability of the findings (Patton, 2014).

RESULTS

In this study, we analyzed professional athletes' Instagram shares of photos, videos, likes, and comments. Also, we compared the posts according to the athletes' gender and their sports. Tables 2, 3, 4, and 5 present the findings regarding RQ-1, 'With what kind of post do professional athletes display their brands on Instagram?' The table presents the findings according to sport and image themes.

Table 2 presents the themes and subthemes we identified through the thematic and content analysis of the study group's photos and videos within visual self-presentation. As the table shows, the main themes identified were as follows: Athlete's personal life, athlete's business life, athlete's sport, other sport or athlete, reposted fan content, pop culture, landmarks, Internet memes, and screen captures. Among the original personal life subthemes,

we moved charity work to business life because for professional athletes who have become brands, displaying their charity efforts on social media directly affects their professional identities. However, charity work is virtuous; it is also a means for athletes to increase their recognition, reinforce the branding dimension of their professional identity, and strengthen their professional images.

Table 2
Themes and Subthemes of Professional Athletes' Instagram Postings and Content*

Categories of Postings	Content
Athlete's Personal Life	Personal content, e.g., daily routine, weather, parties, family life, hanging out with friends, celebrations
Athlete's Business Life	Business-related content, e.g., training, travelling for competition, game/meet preparation, promoting products, charity work, awards, posters, magazine and newspaper coverage, gala dinners
Athlete's Sport	Content related to the athlete's sport but not directly to the athlete, e.g., other games or athletes in their league/sport, college or minor league games of the same sport, equipment, mascots, veteran athletes
Other Sport or Athlete	Content focused on other sports, including athletes or nonathletes, e.g., coaches, general managers, owners, broadcasters, managers, masseurs, sports doctors, publishers, etc.
Fan Reposts	All posts about the fans
Pop Culture or Landmarks	Content about athletes' favourite TV shows, movies, musicians or groups, actors or actresses, politicians, famous landmarks, entrepreneurs, painters
Internet Meme or Screen Capture	Internet memes or screen captures taken from the Internet (not from Instagram) and reposted on the athlete's Instagram account

** Category definitions have been created using the research of Geurin-Eagleman and Burch (2016)*

Table 3 presents the athletes' appearance-related themes and subthemes.

Table 3
Photo and Video Content Related to Athletes' Appearances*

Themes	Content
Athletic Action	Athlete is actively engaged in a sport and dressed in athletic apparel.
Dressed but Posed	Athlete is dressed in athletic apparel but posed for the image. Athlete is not engaged in athletic activity at the time of the image.
Nonsport Setting	Athlete is dressed in nonathletic apparel and photographed/recorded in a nonathletic setting, such as at home with family.
Sexually Suggestive	Athlete is dressed provocatively or photographed/recorded in such a way as to focus solely on sexual attributes.
Combination	Multiple images of an athlete appear in the photo, such as in a collage, and the images fit more than one category above.
Out-of-Sight	The athlete does not appear in the image.

**Category definitions have been created using the research of Geurin-Eagleman and Burch (2016)*

We initially identified five themes from the photos in which athletes appeared, from following Geurin-Eagleman and Burch (2016). However, we added the theme out of sight to examine the number of likes and comments regarding images in which the athlete was not visible.

Table 4
Study Group Athletes' Instagram Posts (P-n), Likes (L-n), and Comments (C-n) by Sport

Theme		Football	Basketball	Track and Field	Tennis
Athlete's Personal Life	P-n	475	440	361	222
	L-n	428,940,561	2,811,751	2,056,653	6,869,232
	C-n	3,557,571	28,614	11,601	70,401
Athlete's Business Life	P-n	1,016	539	745	491
	L-n	974,109,419	4,080,491	6,706,544	21,680,834
	C-n	5,979,798	39,922	56,504	188,988
Athlete's Sport	P-n	167	99	93	88
	L-n	103,639,621	953,247	756,393	4,186,422
	C-n	641,534	7,668	4,660	26,978
Other Sport or Athlete	P-n	71	48	98	54
	L-n	37,976,279	376,389	567,179	2,180,343
	C-n	177,882	3,099	2,141	9,207
Relating to Fans	P-n	44	52	5	15
	L-n	15,291,657	577,547	24,413	789,893
	C-n	72,341	8,243	214	10,643
Pop Culture or Landmarks	P-n	91	203	91	69
	L-n	33,439,137	542,394	612,182	2,054,034
	C-n	168,904	3,388	4,142	14,032
Internet Meme/Screen Capture	P-n	65	71	150	21
	L-n	10,707,807	318,746	140,668	941,371
	C-n	75,958	4,460	1,717	7,173
TOTAL	P-n	1.929	1,452	1,543	960
	L-n	1,604,104,476	9,660,565	10,861,696	38,802,849
	C-n	10,673,988	95,393	80,984	327,422

Note: P-n: number of posts, L-n: number of likes, C-n: number of comments

As in Table 4, most of the Instagram posts of the professional athletes in this study are related to business life. For the football, track and field, and tennis stars, the least-posted content was under the fan-related theme, and the basketball players' least-posted content was on other sports or athletes. For football and basketball players, the theme with the least liked content was Internet memes and screen capture. Regarding the comments, most related to the athletes' business life content; the themes with the fewest comments were the fan-related content for football and track and field athletes, other sports and athletes in basketball and

Internet memes and screen captures for tennis players. Table 5 presents the comments, likes, and shares related to the study group athletes' postings that specifically related to their appearance by sport.

Table 5
Posts, Likes and Comments by Sport on Posts Related to the Athletes' Appearance

Theme		Football	Basketball	Track and Field	Tennis
Athletic Action	P-n	392	279	340	204
	L-n	429,744,036	2,295,875	3,559,377	8,293,165
	C-n	2,200,167	24,436	23,476	55,306
Dressed, but Posed	P-n	372	225	295	243
	L-n	268,990,777	2,062,841	2,358,064	7,450,088
	C-n	1,503,640	18,269	14,164	62,564
Nonsport Setting	P-n	571	564	411	336
	L-n	620,261,770	3,203,028	3,369,141	13,425,247
	C-n	4,809,794	29,724	25,516	122,766
Sexually Suggestive	P-n	33	14	39	33
	L-n	74,630,878	106,036	813,176	1,216,533
	C-n	590,643	1,577	3,199	16,292
Combination	P-n	259	60	77	42
	L-n	70,529,725	351,262	687,305	3,582,771
	C-n	598,799	4,501	5,611	40,613
Out of Sight	P-n	302	310	381	102
	L-n	139,947,290	1,641,523	956,633	4,835,045
	C-n	970,945	13,886	9,018	29,881
TOTAL	P-n	1,929	1,452	1,543	960
	L-n	1,604,104,476	9,660,565	10,861,696	38,802,849
	C-n	10,673,988	95,393	80,984	327,422

Table 5 indicates high Instagram user engagement, reflected as posts, likes and comments, with athletes' posted content on the themes of athletic action, dressed but posed, and nonsport settings. The most posted content was from the nonsports setting theme, and the least posted was sexually suggestive content; the nonsports content also received the most comments, with sexually suggestive content receiving the fewest.

Regarding RQ-2, 'What is the relationship between professional athletes' posts on Instagram and their fans' likes and comments?' Tables 6 present the findings for each individual athlete by sport.

Table 6
The Number of Posts (P-N), Likes (L-N), and Comments (C-N) of the Content Produced by Professional Athlete

	Athlete's Branch	Photo			Video		
		P-n	L-n	C-n	P-n	L-n	C-n
FOOTBALL	Podolski	493	28.573.567	197.817	89	3.297.978	37.673
	Weverton	179	809.304	9.548	13	42,199	878
	Ronaldo	438	1.443.544.340	9.166.557	63	121.477,60	1.238.144
	Lloyd	193	5.293.419	16.971	28	558.780	1.777
	Dallmann	173	254.621	2.607	19	22.761	436
	Scott	235	225.719	1.526	6	4.187	54
	Total	1.711	1.478.700.970	9.395.026	218	125.403.506	1.278.962
BASKETBALL	McGee	336	4.682.306	51.147	121	1.068.099	19.319
	Hernangomez	154	1.601.353	10.092	19	138.806	3.246
	Stimac	102	443.216	2.367	18	29.082	219
	McCoughtry	276	1.172.969	5.375	99	416.964	2.739
	Pascua	160	44.712	347	10	2.039	10
	Tchatchouang	148	58.090	623	9	2.929	20
	Total	1.176	8.002.646	69.951	276	1.657.919	25.553
TRACK & FIELD	Farah	195	5.204.177	26.642	19	436.250	4.107
	Barshim	211	753.632	5.028	42	210.072	4.315
	Guliyev	111	369.030	4.854	28	49.409	540
	Coburn	220	3.772.007	10.726	45	2.703.573	15.666
	Semenya	300	237.710	3.503	33	11.638	449
	Pearson	267	402.568	3.669	72	111.630	1.485
	Total	1.304	10.739.124	54.422	239	3.522.572	26.562
TENNIS	Nadal	140	19.020.287	128.781	38	4.474.419	54.026
	Thiem	106	2.033.080	15.464	10	139.501	1.524
	Goffin	152	1.312.282	10.741	22	84.381	854
	Muguruza	165	5.078.835	55.563	27	476.828	5.086
	Wozniacki	123	4.376.794	41.104	16	337.898	3.652
	Pliskova	153	1.426.850	10.339	8	41.694	288
	Total	839	33.248.128	261.992	121	5.554.721	65.430

The Table 6 shows more photo posts by football players and video shares by basketball players than other athletes' content shares, and the football players' photo and video posts received the most likes and comments. Although basketball players posted the most videos, the numbers of likes and comments on these videos were low. In contrast, tennis players posted relatively few posts but had the second-most likes and comments on these shares. Meanwhile, the track and field posts showed high shares and like but few comments.

Regarding RQ-3, 'How do professional athletes' visual self-presentation strategies on Instagram differ according to gender?', Table 7 presents the chi-squared test results for gender differences for general content and content specifically related to athletes' appearance.

Table 7
The Results of the Chi-square Tests for the Gender Variable Regarding the "Photo & Video Category" and the "Category of Photo & Video Related to Athlete's Appearance."

Photo&Video Category	Female		Male		X^2	d_f	P	C
	N	%	**N**	%				
Relating to Athlete's Personel Life	821	54,8	677	45,2	45.040	1	.000	,087
Relating to Athlete's Business Life	1196	42,9	1595	57,1	42.742	1	.000	,085
Relating to Athlete's Athlete's Sport	167	37,4	280	62,6	19.295	1	.000	,057
Other Spor tor Athlete	88	32,5	183	67,5	25.162	1	.000	,065
Relating to Fans	21	18,1	95	81,9	40.552	1	.000	,083
Pop Culture or Landmark-Focused Photos/Videos	286	63,0	168	37,0	48.420	1	.000	,090
Internet meme/Screen Capture	206	67,1	101	32,9	50.780	1	.000	,093
Category of Photo& Video Related to the Athlete's Appearance	**Female**		**Male**		X^2	$\mathbf{d_f}$	**P**	**C**
	N	%	**N**	%				
Athletic Action	520	42,8	695	57,2	12.623	1	.000	,046
Dressed, but Posed	496	43,7	639	56,3	7.439	1	.000	,036
Nonsport Setting	933	49,6	949	50,4	5.585	1	.010	,031
Sexually Suggestive	48	40,3	71	59,7	2.384	1	.020	,073
Combination	167	38,1	271	61,9	16.081	1	.000	,052
Out-of-Sight	621	56,7	474	43,3	47.490	1	.000	,089

All sharing categories showed significant statistical differences according to the athletes' genders. Table 7 shows that professional female athletes produced more content than men related to their personal lives, pop culture and landmarks and Internet memes, and screen captures. In contrast, the men shared more posts than the women related to their business lives, own sport, other sports or athletes, and fan-related content.

Table 7 also indicates significant differences by gender in the professional athletes' appearance-related content. Specifically, the men posted more content in all appearance categories, and the women posted the most under the out of sight theme. Overall, except for the "out-of-sight" category, across categories and sports and within the subtheme of content related to appearance, the professional male athletes we studied here produced more Instagram content than the professional female athletes.

DISCUSSION

Professional athletes have the skills to demonstrate their profession at the highest level. In today's globalized structure, they desire to present their superior abilities and other characteristics to the masses through the proper channels in the right areas. Professional athletes, including those we studied here, follow many strategies regarding the use of social media (Sanderson, 2011), including diverse approaches to their visual self-presentation on Instagram.

Fans follow professional athletes with great interest and curiosity. The first research question in this research is ''With what kind of posts do professional athletes display their personal brands on Instagram?'' Song et al. (2018) observed that Instagram users shared images of their personal lives and close social circles, whereas in our study, the professional athletes' posted Instagram content related primarily to their business and personal lives (Table 4). These individuals have high recognition worldwide, and their social media presence and visibility are important for their profession. Because they are brands, also it is rather essential for the economic value of their performances. The fact that their business and personal life posts received more likes and comments than did content from the other themes supports this importance.

Professional athletes' control over their self-presentation has increased with social media (Song et al., 2018), and the athletes we studied here show high Instagram awareness. Although most of the athletes posted large amounts of business-related content, it was noteworthy that they posted the least content related to their fans; the fact that professional athletes posted very little fan-themed content reveals that they are extremely selective in this regard. Goffman (1978) argued that when individuals realize they do not exhibit a self that conforms to ideal standards, they sometimes attempt to hide this. Therefore, in professional team sports, the fact that athletes play for different teams throughout their careers might cause them to limit their fan-themed content. However, we think that athletes in individual sports should produce more fan-themed content for personal brand development.

The fact that most of the professional athletes' posted Instagram content was in the category of nonsports settings indicates their desire to present features of themselves that fans might not easily see (Table 5). Watched by tens of thousands of eyes and hundreds of cameras on the field, professional athletes return to their worlds after each competition, and Instagram allows athletes to present their desired features by reflecting their nonsports lives to their target audiences to support their brands. As stated by Goffman (1978), this situation arises from the fact that individuals seek to present different selves in their daily lives according to the requirements of the environment.

In the content related to the athletes' appearances, they least often shared material under the sexually suggestive theme. This might have been because the athletes we included in our study were at the top in their sports in the world rankings, and they might, therefore, have preferred to post only sports-related and socially approved content; these findings might have been different for athletes who were lower in the rankings. This situation is our possible explanation, and it deserves additional research to confirm or dismiss the hypothesis. Despite

the few sexually suggestive posts, the high number of likes of these relatively rare posts reflects that they do command attention from followers. However, it is quite striking that there were very few comments regarding these posts. This shows that followers hesitate to comment on this theme. The athletes' athletic bodies' presentation in Instagram posts should make to encourage them to respond to the fans' comments and produce more posts like these.

The second research question in this research ''What is the relationship between professional athletes' post on Instagram and their fans' likes and comments? By sport types, the professional football players in this study produced posts the most, followed by the athletes in track and field, basketball, and tennis (Table 6). The high numbers of football players' posts and likes reflect that football has the largest fan base (Biscaia et al., 2016) and is the most-watched sport worldwide (Barnfield, 2013). However, the fact that tennis players received the most likes and comments about their posts after football players indicates that tennis players attract great attention from their followers, revealing the popularity of the sport. This might be because of international tennis organizations' extremely effective use of social media platforms for branding and marketing (Thompson et al., 2018).

The third research question in this research is ''How do professional athletes' visual self-presentation strategies on Instagram differ according to gender?'' Our finding that male athletes posted more than female athletes (Table 7) did not support the findings by Smith and Sanderson (2015), although our finding that the women posted more about their personal lives than the men supported Geurin-Eagleman and Burch (2016). Sun (2008) stated that women enjoy and value different roles, such as motherhood versus professional careers, and they attempt to balance the different aspects of their lives. Although professional sports offer prominent roles for women, many different roles (e.g., mother, wife, homemaker, etc.) and related responsibilities shape their social lives (Sen, 2020). This could be why women share more content on their personal lives.

The fact that men shared more appearance-related content than did women could reflect their desire to be more prominent with their athletic appearance. Although it is consistent with Gainor's (2017) work that the female and male athletes here posted similar amounts of nonsports content, our findings differed from Gainor's in that the men in this study posted more nonsport content.

Social norms could meanwhile explain why the female athletes we studied posted less sexually suggestive content in the materials related specifically to athlete's appearance. Kane et al. (2013) stated that elite female athletes reflect femininity for male audiences in sports media; the fact that media frequently includes such features even along with women's success

as athletes could be the reason for the low number of posts with sexually suggestive content by female athletes. Moreover, the athletes in our research are the best in the world in their sports, and they might not want their target audiences to focus on any aspects other than their athletic success.

Professional athletes have the most important place in the sports field. However, this is not enough. As stated by Aitchison (2007), the sports field is produced by the fans and many stakeholders in the sports system, as well as the athletes. Therefore, the sports field is open to the influence of these other factors. Fans are as important and determining factors in the field of sports as athletes. Therefore, female athletes, in particular, need to interact with fans by producing more content about them.

That professional female athletes share more than professional male athletes on the theme "Out-of-sight" differs from the research results of Geurin-Eagleman and Burch (2016). This suggests that the female athletes in our study attach importance to sharing many different aspects of their daily lives on Instagram.

CONCLUSIONS

In this study, we investigated how professional athletes at the top of their sports in world rankings use Instagram to support their professional careers and personal brands. Although these athletes performed their visual self-presentations on many different themes, they mainly shared posts about their business and personal lives, and the men posted much more actively than the women. Athletes in individual sports also posted less content than did team sport athletes, and it was striking how little content these professional athletes, especially women (Table 7) and individual athletes (Table 4), produced about their fans.

The fact that football players were the most content-producing athletes on Instagram and that their posts had more likes and comments than the posts of other athletes reflect that football is the most popular sport on today's Instagram. Professional athletes who have become brands in sports fields should continue to strengthen their brands in nonsports fields, and Instagram makes great contributions to professional athletes in terms of brand strengthening. Because, in this study, it is seen that every post made by professional athletes receives many likes and comments. More diverse research on social media brand development and strengthening strategies of professional athletes can provide significant contributions.

The research focused only on professional athletes who are good at sports and the most share on Instagram. In line with the results that we obtained here, future findings could increase the effectiveness of social media policies and related training programmes for

athletes. Moreover, in addition to professional athletes, research on social media usage strategies could assist athletes with high-performance potential, and future examinations of content that sports fans frequently like and comment on will contribute to refining future social media strategies. In future research, qualitative research methods can be suggested to gain an in-depth understanding of the causes of social media use in professional athletes' careers for questions. In addition, the same research can be studied again with different athletes.

Acknowledgments

No funding was received for the preparation of the submitted manuscript.

Authors' contributions

The first author who contributed to this research carried out the conceptualization and design of the study. The first author also carried out the data collection and analysis, as well as the writing of the original draft. The second author contributed to consist of the validation of the methodology governing this study, the supervision and critical reviewing of the original draft, as well as the approval of the final draft.

Declaration of conflict interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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doi.org/10.54141/psbd.1182006

PAMUKKALE JOURNAL OF SPORT SCIENCES
ISSN: 1309-0356 dergipark.org.tr/en/pub/psbd

Pamukkale J Sport Sci, 14(1), 43-62, 2023 Research Article

Multi-Criteria Evaluation of Mobile Fitness Applications During COVID-19 Pandemic Based on AHP

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Keywords
Analytic Hierarchy Process (AHP), Fitness applications, Mobile fitness applications

Article History
Received 29 September 2022
Revised 06 March 2023
Accepted 23 March 2023
Available Online 27 April 2023

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ABSTRACT

Fitness centres have been among the first businesses affected by the COVID-19 pandemic. It is clear that with the pandemic, users' choices for sports services and selection criteria for them have changed. During the pandemic, there has been a transition from traditional gym classes to virtual fitness classes. People have started to rapidly adopt these technology-based alternatives worldwide, and there has been an increase in the download and use of these mobile fitness applications. However, there are many alternatives to fitness applications for users. In this study, making the most effective selection among the alternatives in mobile applications where there are conflicting user criteria and identifying customer-oriented platform development proposals in terms of service providers are aimed to contribute to the relevant literature. The study has proposed an Analytic Hierarchy Process (AHP) model, one of the Multi-criteria Decision-Making approaches, for selecting the best choice among mobile fitness application alternatives where there is more than one alternative with more than one criterion and these criteria conflict with each other. The proposed AHP solution has a modular structure that can be easily adapted in case user preferences (criteria) changes and can flexibly be updated when the alternatives change.

Citation: Ercan C. (2023). Multi-Criteria Evaluation of Mobile Fitness Applications during COVID-19 Pandemic Based on AHP. *Pamukkale Journal of Sport Sciences*, *14(1)*, 43-62. doi.org/10.54141/psbd.1182006

INTRODUCTION

The COVID-19 pandemic has drastically changed the consumption habits of people around the world. The pandemic has caused radical social and economic changes all over the world (Bounie et al., 2020; Knotek II et al., 2020; Roggeveen & Sethuraman, 2020). The use of smartphones and smart devices has increased worldwide; mobile applications have made our lives easier at many points and have replaced face-to-face products and services (Devezas, 2020). While the rapid rise of developments in information and communication technologies has led to an increase in the diversity of mobile applications, COVID-19 has also been effective in increasing the use of mobile applications (Heidenreich & Talke, 2020; McLean et al., 2020; Moon, et al., 2021). It is a fact that COVID-19 has made mobile applications more valuable. Therefore, mobile applications now constitute the future of every sector, including health, food and beverage, education, banking, and games (Carlo et al., 2019; Galindo et al., 2020; Jones and Nikolaeva, 2020; Li and Lalani, 2020; Ramdhan & Hamdani, 2021; Stauffer, 2020). The mobile application ecosystem also includes fitness industry (Angosto et al., 2020; Lee & Trimi, 2021). Fitness centres were among the first businesses to close after the outbreak of the COVID-19 pandemic. Although technology has made its presence felt in the fitness industry since 2016, the pandemic has triggered this growth sharply (Ananthakrishnan et al., 2020).

During the pandemic, there has been a transition from the traditional gym to virtual fitness classes. In this process, fitness entrepreneurs have started to identify the demand for virtual training and realize the potential of online services. On the other hand, the growing trend of protecting physical health with COVID-19 has provided technology investors with enormous opportunities to develop fitness applications where users can be more socially isolated and protect their physical health, which has increased the number of fitness applications. During COVID-19, when mobile devices are used extensively, mobile fitness applications are seen by customers as a new marketing channel and an alternative to fitness businesses (Parker et al., 2021). Experts predict that gyms serving before COVID-19 will adopt a unique concept, such as boutiques or high-tech gyms after COVID-19 (Moustakas et al., 2020). There are many fitness applications (free or in-app purchases) on smart devices (Bondaronek et al., 2018). However, there is uncertainty as to whether some applications meet users' expectations. For this reason, fitness applications should be developed with a good user interface, well-designed exercise and nutrition programs that will attract users, cooperation with well-known fitness professionals and health experts, video applications, and providing

feedback. Therefore, what needs to be done for fitness applications is to evaluate this process and the factors that are effective in the process and to follow appropriate strategies.

Users' choices in the purchasing process are essential for both applications and users. The purchasing process includes the emergence of a need, the determination and evaluation of product or service alternatives that will meet this need, the decision to purchase, the purchase, and all actions after the purchase (Schiffman & Kanuk, 2009). Therefore, users' being in the proper purchasing decision process depends on knowing the relative position of these applications in fitness technology.

The healthiest method of determining the strengths and weaknesses of fitness applications, how well they have achieved their goals, and their relative position in the industry is to compare the practices in the fitness industry with each other. Performance measurement serves the purpose of seeing the current status of these applications, providing competitive advantage and differentiation (Alfaro et al., 2007). "The Diffusion of Innovations" model provides benefits for adapting and using rapidly changing technology. This model is an approach that Everett M. Rogers introduced in 1995 to implement the steps and processes involved in the diffusion of new telecommunications technologies (Kavak et al., 2016). The diffusion of innovations model is frequently used by marketers to influence the behavior of large groups of people. This paper provides the effects of the COVID-19 pandemic on the fitness industry, the perspectives of previous research on the subject, and proposes an Analytic Hierarchy Process solution to select among mobile applications by considering the selection as a decision problem.

Literature Survey

Technology is an indispensable part of innovation. In addition, when technology gains the quality of the economy and is transferred to practice, it also gains an innovation dimension (Güneş, 2010). Therefore, the fitness industry must keep up with the times and show an innovative approach through technology. "Rogers' Diffusion of Innovation Theory" focuses on gathering information about the innovation adoption process and reducing uncertainty (Agarwal et al., 1998). The model classifies people according to the criteria of adopting innovations about innovations over a particular time series (Berger, 2005; Park et al., 2004). Therefore, the diffusion of innovations model is an essential tool in interpreting the decisions of users to turn to fitness applications and buy the right one among these applications during the COVID-19 quarantine period. For an innovation to be genuinely new, the information it contains need not be truly new. Therefore, the concept of innovation should be expressed in terms of acquiring knowledge, persuading, or deciding to adopt (Rogers, 1995). In this respect,

the diffusion of innovation provides benefits in adapting and using the model to the ever-changing and evolving fitness technology. Hence, reported information about the fitness applications, such as new installs, average daily active users, and in-app purchase revenue data, are objects considered as the criteria of the problem. There are many factors in choosing a fitness app by user (Cho & Kim, 2020; Rohm et al., 2012; Thompson, 2014). Users prefer a fitness application primarily based on criteria such as ease of use, the usefulness of the application, or personal interests (Grundy et al., 2016; Hermsen et al., 2017). However, health concerns caused by the COVID-19 pandemic have taken priority among the reasons for the preference of these applications (Nyenhuis et al., 2020; Parker et al., 2021; Yang & Koenigstorfer, 2020). The difference between the applications chosen by users during the pandemic period and the applications that are not preferred is related to the innovations used in fitness technology and the trust is given to users (Ueafuea et al., 2020). Lee and Walsh (2011) have concluded sports marketing has become a popular business decision with the possibility of becoming more popular in the future. They have studied sports marketing outsourcing decision-making factors using the Analytic Hierarchy Process (AHP) model. Nisel and Özdemir (2016) have presented a comprehensive literature review of AHP applications in sports. 62 sports-related AHP articles have been selected, categorized, and analyzed in their study. The findings show that the AHP model has successfully been used in the field of sport for variable aims. Lee (2008) has aimed to identify factors affecting sports sponsorship decision-making and develop a sports sponsorship model using AHP. Mirkazemi et al. (2009) have applied the analytic hierarchy process for the performance evaluation criteria of university sports offices. Zadeh et al. (2012) have studied the proper locations of sports spaces using a geographic information system (GIS) and AHP to locate these places in Kahnouj city. Lee and Ross (2012) have identified the decision-making factors of sport sponsorship in the global market context using AHP. Marjani et al. (2013) have studied the selection of the most appropriate sports shoes using the AHP. Nezad and Damaneh (2014) have used AHP to identify the performance evaluation and criteria of the Iranian sports federation. Ebrahimi et al. (2015) have applied AHP to find a suitable location for Ahvaz Sport. Ludi and Yao (2015) have used AHP in the Selection of the Leading Sport Industry in Shanxi Province.

Based on the aforementioned studies, the authors have concluded that with the COVID-19 pandemic, both users' choices for sports services and selection criteria for them have changed. For this reason, it can be assumed that they have developed some reaction situations for preference, download, and purchase of fitness applications. In this context, the

aim of the study is to provide decision support not only for the users of the applications but also for the customer-oriented platform developers.

During and after COVID-19, customers who find it dangerous to go to fitness centers have turned to technological alternatives. This situation has increased the diversity of mobile applications within the scope of fitness applications and increased the usage rates of these mobile applications. In this process, in which mobile devices are used intensively, determining which users should choose mobile applications and the features that should be developed in mobile applications by service providers are discussed in this study as a decision problem. This study suggests a solution based on the Analytic Hierarchy Process. In this study, making the most effective selection among the alternatives in mobile applications where there are conflicting user criteria and identifying customer-oriented platform development proposals in terms of service providers are aimed to contribute to the relevant literature.

METHODS

Research Model

In the study, the Analytic Hierarchy Process model, one of the Multi-criteria Decision Making (MCDM) approaches, has been used for the selection of mobile fitness application alternatives where there is more than one alternative with more than one criterion and these criteria conflict with each other. AHP allows complex problems in a hierarchical structure and in a logical and structural way.

Data Collection Tools

Mobile fitness applications and Multi-Criteria Decision Making (MCDM) Approach

The increasing complexity of the pandemic has multiplied the decision complexity (Ceballos et al., 2016). Marketing can be a general discipline that can provide solutions here (Liu et al., 2019). Decision-making with many criteria is important (Ishizaka & Nemery, 2013). To respond to these needs, multi-criteria decision analysis methods are widely used (Greco, 1997). However, the selection of the proper type of MCDM methods has the utmost importance (Roy & Słowiński, 2013). Wątróbski et al. (2019) have presented a methodological and practical framework for selecting suitable MCDM methods for a particular decision. They present a general framework for selecting an appropriate MCDM method for a given area of decision support, even in cases of data gaps in the decision-making problem description. The proposed framework has been implemented within a web platform available for public use at www.mcda.it. The proposed framework and the web platform by Wątróbski et al. (2019) have

been used to decide which MCDM method is proper for our problem. The application gives the result that AHP is suitable for the selection of mobile fitness application problems.

In MCDM decision problems, goals and criteria leading to these goals are important. Decision criteria play an important role in choosing between alternatives. In mobile fitness applications, six of the top-ranked applications in the USA have been determined as alternatives to the decision problem. In decision problems where there is only one criterion since the selection is made for this purpose, the decision can be easily determined in which the alternative containing the best criterion is selected for the decision problem. However, in mobile fitness applications with many alternatives, there are many conflicting criteria in determining the best alternative for the users. These criteria include;

1. New Installs (M) (often referred to as "downloads," this is the number of new users who are downloading the app for the first time)
2. Average daily active users (K) (the number of users who opened the app at least once in the last 24 hours)
3. In-app Purchase Revenue (M) (the amount of revenue generated by users making purchases within the app)
4. IOS-Samsung applicability
5. User-Friendly/Users can go at their own pace
6. Flexibility with their schedule (Video Downloadable, Online-Offline, etc.).

In determining the values of the first four of these criteria, the numbers in the related report (Apptopia, 2023) have been used, and in the last two, the evaluations have been made in the interviews with users and information systems experts about the applications in question. In MCDM, the final decision is made according to comparisons both between criteria and within criteria. While the aim of the comparison between criteria is to place the criteria in priority order according to the evaluations of the decision maker (DM), the aim of the benchmarking is to determine which of the alternatives is more attractive in the relevant criterion. The final decision is made after the synthesis of these two comparisons. It is necessary to emphasize that the selected alternative will be the most preferred option according to the priority given by the decision maker.

Data Collection Procedure

Multi-Criteria Decision-Making Approach Steps

Firstly, the goals of the users have been determined. For this, both quantitative and qualitative targets have been determined. These also express the expectations of a user from

the mobile Fitness applications used in the Covid pandemic. All six criteria mentioned earlier are 'utility' goals the users want to maximize. However, when the alternatives are examined, it is seen that no alternative is superior to the other alternatives in all criteria. In other words, when switching from one alternative to another, some criteria improve while others worsen. In this case, there can be no talk of the optimal solution for selection. AHP is one of the most widely used methods among MCDM methods. Along with the weighting of the decision-based criteria, the AHP process is also used to choose between alternatives depending on the criteria weights (Aktaş et al., 2015). AHP was developed by Saaty (1980) and can measure the perceptions of users/experts by making use of pairwise comparisons. In AHP, the 1-9 scale is used for pairwise comparisons (Saaty, 1980; 2000). In this study, AHP has been applied since it has been assumed that there is no dependency between the criteria; in other words, there is no mutual interaction between the criteria.

AHP Model Steps

There are four stages in the AHP model; 1) Displaying the criteria in a hierarchical structure. 2) Making pairwise comparisons between Criteria and Alternatives. 3) As a result of pairwise comparisons, determining the priorities of the criteria and the degree of preference of the alternatives according to each criterion. 4) Determination of the order of alternatives as a result of criteria priorities and preference degrees (Aktaş et al., 2015; Saaty, 1994). These four AHP stages are discussed in detail below.

Step 1 (Displaying the criteria in a hierarchical structure)

In this study, all criteria determined have been created as single-level criteria. In order to reach the final goal, six benefit criteria (n=6), whose details are given below, have been determined.

Step 2 (Making pairwise comparisons between Criteria and Alternatives)

In the second step, pairwise comparisons were made. A square matrix represents pairwise comparisons. The following standard AHP scale (Table 1) has been used for pairwise comparison. In our six-element (n=6) problem, n.(n-1)/2=15 pairwise comparisons have been made. These comparisons are shown in Table 2.

The w1/w2 value shows which of the first or second criteria is more important than the other and what the degree of importance is, according to an upper purpose that is the basis for the user's decision. Values on the diagonal are one since each element has a comparison with itself. On the other hand, half of the matrix is the inverse of the other elements. For example, if w3/w2=5 (the first element is more important than the second element), it is clear

that w2/w3 =1/5. Since pairwise comparisons should be consistent, consistency analyses of all comparisons have been performed, and it has been shown in the result tables that they are consistent (Consistency Ratio CR≤0.1).

Table 1
AHP Standard Scale

Scale	Definition	Description
1	Of equal importance	The contribution of both elements to a higher level criterion/purpose is equal.
3	Less important	One element is slightly more important than the other element.
5	Quite important	One element is quietly more important than the other element.
7	Very important	One element is more important than the other element.
9	Absolutely important	One element has absolute superiority over the other element in terms of importance.
2,4,6,8	Intermediate values	It is used as an intermediate value when the above scales do not fully reflect the degree of importance between the two elements.
Inverse Values	1/3, 1/5, 1/7 etc.	These are the values that will be obtained when the order of the elements is changed.

Table 2
AHP Pairwise Comparison Matrix

Criteria	X_1	X_2	X_3	X_4	X_5	X_6
X_1	w_1/w_1	w_1/w_2	w_1/w_3	w_1/w_4	w_1/w_5	w_1/w_6
X_2	w_2/w_1	w_2/w_2	w_2/w_3	w_2/w_4	w_2/w_5	w_2/w_6
X_3	w_3/w_1	w_3/w_2	w_3/w_3	w_3/w_4	w_3/w_5	w_3/w_6
X_4	w_4/w_1	w_4/w_2	w_4/w_3	w_4/w_4	w_4/w_5	w_4/w_6
X_5	w_5/w_1	w_5/w_2	w_5/w_3	w_5/w_4	w_5/w_5	w_5/w_6
X_6	w_6/w_1	w_6/w_2	w_6/w_3	w_6/w_4	w_6/w_5	w_6/w_6

The method of Saaty has been used in determining the values of the weights under error due to its advantages, such as detecting the degree of inconsistency in the evaluations. It is assumed that the decision-makers are completely consistent in their preferences and do not make mistakes.

Step 3 (Determining the priorities of the criteria and the degree of preference of the alternatives according to each criterion)

In determining the criteria prioritization and the preference values of the alternatives, the values in the matrix have been found by normalizing (Baird, 1989). The following expression is used in the normalization:

$$w_i = \frac{a_{ij}}{\sum_{j=1}^{n} a_{ij}} \qquad \text{i=1,2,3,…n} \qquad (1)$$

In the formula a_{ij} is any value in the matrix in binary comparison and $a_{ij} = 1/a_{ji}$, $\forall_{ij} \in$ A and $a_{ij} \neq \infty$.

Step 4 (Determination of the order of alternatives as a result of criteria priorities and preference degrees)

At the last stage in AHP, the ranking of the alternatives has been determined by synthesizing the criteria priorities and preference values. The following formula is used for the ranking value of the first alternative (P: Global priorities of the criterion, A: Alternatives, a: Preference values of the alternatives according to the criteria):

$$\sum_{i=1}^{n} a_{1i} * P_i \quad (2)$$

The following Table 3 has been used to quantify the qualitative values.

Table 3
Quantification of Qualitative Values

Scale	Utility	Cost
9	Very High	Very low
7	High	Low
5	Middle	Middle
3	Low	High
1	Very low	Very High

AHP Model Solution Proposal

Six of the mobile fitness applications which are at the top of the list in the USA in 2020 and whose numerical criterion values are given below have been determined as alternatives to the decision problem and have been coded and included in the problem as A1, A2, A3, A4, A5, and A6.

As the criteria of the decision problem, six criteria for mobile fitness applications are determined below. Since there is only one level in the problem, the local and global weights of the criteria are the same. Criteria;

X_1: New Installs (M) (often referred to as "downloads," this is the number of new users who are downloading the app for the first time).

X_2: Average daily active users (K) (the number of users who opened the app at least once in the last 24 hours).

X_3: In-app Purchase Revenue (M) (the amount of revenue generated by users making purchases within the app).

X_4: IOS-Samsung compatible.

X_5: User-Friendly/Users can go at their own pace.

X_6: Flexibility with their schedule (Video Downloadable, Online-Offline).

While the first three criteria contain quantitative values, the last three include qualitative values according to the decision makers' evaluations. The "Qualitative Values

Converted Decision Matrix" obtained after digitizing the qualitative values is given below in Table 4.

Table 4
Decision Matrix with Converted Qualitative Values

Criteria/ Alternatives	X_1	X_2	X_3	X_4	X_5	X_6
A_1	4.80	1500	4.4	7	7	7
A_2	3.40	500	5.8	7	9	7
A_3	3.40	520	4.5	7	9	9
A_4	2.90	290	4.4	5	7	7
A_5	2.80	650	4.5	7	7	7
A_6	2.70	410	4.2	7	5	5

After the qualitative values have been converted to numerical values, all numerical values have been converted to a standard scale. In determining the criteria priorities and alternative preference values in AHP, the opinions of the experts who made the examination have been taken as a basis.

In Table 5, column totals are presented for calculating the binary criteria weights by using the pairwise comparison of the criteria and the pairwise comparison matrix of the criteria.

Table 5
Binary Comparison of Criteria and Column Totals

Criteria	X_1	X_2	X_3	X_4	X_5	X_6
X_1	1	3	1/2	1/3	2	1/5
X_2	1/3	1	1/4	1/5	1/2	1/9
X_3	2	1/4	1	1/2	3	1/3
X_4	3	5	2	1	4	1/4
X_5	1/2	2	1/3	1/4	1	1/7
X_6	5	9	3	4	7	1
Total	11.833	20.250	7.083	6.283	17.500	2.037

The A_{norm} matrix found by dividing each element by the column sum is presented in Table 6.

Table 6
A_{norm} Matrix

Criteria	X_1	X_2	X_3	X_4	X_5	X_6
X_1	0.085	0.148	0.071	0.053	0.114	0.098
X_2	0.028	0.049	0.035	0.032	0.029	0.055
X_3	0.169	0.012	0.141	0.080	0.171	0.164
X_4	0.254	0.247	0.282	0.159	0.229	0.123
X_5	0.042	0.099	0.047	0.040	0.057	0.070
X_6	0.423	0.444	0.424	0.637	0.400	0.491

After the A_{norm} matrix, the weight matrix has obtained with the formula $w^{(6)} = \lim_{k\to\infty} \frac{A^6 e}{e^T A^6 e}$ for six criteria (k=6). In order for the weights of the binary comparison matrix with n=6 to be consistent, at least the nth power of the A_{norm} matrix must be taken. The A^6e matrix is calculated and presented below:

$$A^6e=\begin{bmatrix} 0.088359 & 0.088361 & 0.088359 & 0.088363 & 0.088359 & 0.088362 \\ 0.04377 & 0.043771 & 0.04377 & 0.043772 & 0.043769 & 0.04377 \\ 0.140104 & 0.140107 & 0.140104 & 0.14011 & 0.140104 & 0.140107 \\ 0.17475 & 0.174747 & 0.174748 & 0.174743 & 0.174753 & 0.174755 \\ 0.059605 & 0.059607 & 0.059605 & 0.059609 & 0.059605 & 0.059607 \\ 0.493411 & 0.493409 & 0.493414 & 0.493402 & 0.493408 & 0.493399 \end{bmatrix}\begin{bmatrix}1\\1\\1\\1\\1\\1\end{bmatrix}=\begin{bmatrix}0.530163\\0.262622\\0.840637\\1.048496\\0.357638\\2.960443\end{bmatrix}$$

Since $e^T.A^6e = 6$;

It is obtained that $w^{(6)}$=[0.08836 0.04377 0.14011 0.17475 0.05961 0.49341].

Consistency Test:

A consistency test is performed to understand whether the w weight matrix is consistent. The Consistency Ratio (CR) is the ratio of the inconsistency index value (CI) to the random index value (RI).

$$CR=\frac{CI\ (Inconsistency\ Index)}{RI\ (Random\ Index)} \quad (3)$$

A value of CR≤0.1 is considered acceptable for the validity of the consistency test (Harker, 1987).

Firstly, the Inconsistency Index (CI) must be calculated to calculate the CR. The CI defined by Satty (1977) by normalizing is calculated as follows:

$$CI=\frac{\lambda maks-n}{(n-1)} \quad (4)$$

In order to be able to calculate CI, λ_{maks} is calculated with the help of the following formula.

$$\lambda_{maks}=\frac{1}{n}\sum_{i=1}^{n}(\sum_{j=1}^{n} a_{ij}w_j/w_i) \quad (5)$$

First, the AwT matrix is calculated.

$$Aw^T=\begin{bmatrix}0.56586\\0.22782\\0.75843\\1.30066\\0.3522\\2.86569\end{bmatrix}$$

Then, λ_{maks} can be obtained as:

$\lambda_{maks} = \left(\frac{1}{6}\right)\left\{\frac{0.56586}{0.08836} + \frac{0.22782}{0.04377} + \frac{0.75843}{0.14011} + \frac{1.30066}{0.17475} + \frac{0.3522}{0.05961} + \frac{2.86569}{0.49341}\right\}$=6.030376

$CI = \frac{\lambda maks - n}{(n-1)} = \frac{6.030376-6}{5} = 0.006075$

$CR = \frac{CI\ (Inconsistency\ Index)}{RI\ (Random\ Index)} = \frac{0.006075}{1.24} = 0.004899$ (for n=6, RI=1.24).

Since CR≤0.1 is required to say that the matrix is consistent, our matrix can be said to be highly consistent. The criteria weights are shown in Table 7 below.

Table 7
Criterion Weights

Criteria	Weights (w_i)
X_1	0.08836
X_2	0.04377
X_3	0.14011
X_4	0.17475
X_5	0.05961
X_6	0.49341

After this stage, pairwise comparison matrixes showing the degree of preference for each criterion are given in Table 8. In addition, the consistency ratios of the comparison made according to each criterion are also given below the Table 8.

Table 8
Preference Values of Alternatives According to Each Criterion (X_1, X_2, X_3, X_4, X_5 and X_6)

CRITERION		A1	A2	A3	A4	A5	A6	PREFERENCE VALUE
CRITERION-1	**A_1**	1	2	2	3	4	5	0.36035
	A_2	1/2	1	1	2	3	4	0.19668
	A_3	1/2	1	1	2	3	4	0.19668
	A_4	1/3	1/2	1/2	1	2	3	0.11486
	A_5	1/4	1/3	1/3	1/2	1	2	0.07612
	A_6	1/5	1/4	1/4	1/3	1/2	1	0.05530
	CI:		0.01983		**CR:**		0.01599	
CRITERION-2	**A_1**	1	3	3	6	2	5	0.39258
	A_2	1/3	1	1	3	1/2	2	0.12904
	A_3	1/3	1	1	3	1/2	2	0.12904
	A_4	1/6	1/3	1/3	1	1/3	1/2	0.05775
	A_5	1/2	2	2	3	1	2	0.20948
	A_6	1/5	1/2	1/2	2	1/2	1	0.08212
	CI:		0.02049		**CR:**		0.01652	
CRITERION-3	**A_1**	1	1/4	1/2	1	1/2	3	0.10018
	A_2	4	1	3	4	3	6	0.42559
	A_3	2	1/3	1	2	1	2	0.15479
	A_4	1	1/4	1/2	1	1/2	3	0.10018
	A_5	2	1/3	1	2	1	2	0.15479
	A_6	1/3	1/6	1/2	1/3	1/2	1	0.06447
	CI:		0.04212		**CR:**		0.03397	

Table 8 (Continued)

CRITERION		A1	A2	A3	A4	A5	A6	PREFERENCE VALUE
CRITERION-4	A_1	1	1	1	2	1	1	0.18182
	A_2	1	1	1	2	1	1	0.18182
	A_3	1	1	1	2	1	1	0.18182
	A_4	1/2	1/2	1/2	1	1/2	1/2	0.09091
	A_5	1	1	1	2	1	1	0.18182
	A_6	1	1	1	2	1	1	0.18182
	CI:		0.00000		**CR:**		0.00000	
CRITERION-5	A_1	1	1/2	1/2	1	1	2	0.13342
	A_2	2	1	1	2	2	3	0.26084
	A_3	2	1	1	2	2	3	0.26084
	A_4	1	1/2	1/2	1	1	2	0.13342
	A_5	1	1/2	1/2	1	1	2	0.13342
	A_6	1/2	1/3	1/3	1/2	1/2	1	0.07805
	CI:		0.00335		**CR:**		0.00270	
CRITERION-6	A_1	1	1	1/2	1	1	2	0.15385
	A_2	1	1	1/2	1	1	2	0.15385
	A_3	2	2	1	2	2	4	0.30769
	A_4	1	1	1/2	1	1	2	0.15385
	A_5	1	1	1/2	1	1	2	0.15385
	A_6	1/2	1/2	1/4	1/2	1/2	1	0.07692
	CI:		0.00000		**CR:**		0.00000	

As seen from the binary comparison matrices above, the consistency ratios of the six matrices ($CR_{X_1} = 0.01599$, $CR_{X_2} = 0.01652$, $CR_{X_3} = 0.03397$, $CR_{X_4} = 0.00000$, $CR_5 = 0.00270$, $CR_{X_6} = 0.00000$) are all below CR≤0.1 and it can be said that the comparisons are extremely consistent.

After the consistency analysis of the pairwise comparisons, in the final stage, the 'combined decision matrix' used to synthesize the criteria priorities and the preference value of the alternatives according to each criterion is presented in Table 9.

Table 9
Combined Decision Matrix

Criteria/ Alternatives	X_1	X_2	X_3	X_4	X_5	X_6
Criterion Weight (w_j)	0.08836	0.04377	0.14011	0.17475	0.05961	0.49341
A_1	0.36035	0.39258	0.10018	0.18182	0.13342	0.15385
A_2	0.19668	0.12904	0.42559	0.18182	0.26084	0.15385
A_3	0.19668	0.12904	0.15479	0.18182	0.26084	0.30769
A_4	0.11486	0.05775	0.10018	0.09091	0.13342	0.15385
A_5	0.07612	0.20948	0.15479	0.18182	0.13342	0.15385
A_6	0.05530	0.08212	0.06447	0.18182	0.07805	0.07692

The criteria weights (w_j) in the decisionta matrix are taken from Table 7, and the preference values of the alternatives according to each criterion (a_{ij}: the value of the i^{th} alternative according to the j^{th} criterion) are taken from the values in Table 8.

The total weight value (A_i) of each alternative equals the sum of the product of the preference value a_{ij} of that alternative for the relevant criteria and the weight of the relevant criteria (w_j) as given in the following formula.

$$A_i=\sum_{j=1}^{6} a_{ij} * w_j \quad \forall_i=1,2,3,\ldots 6 \qquad (6)$$

In this context, the decision matrix prepared for the decision maker is presented in Table 10 below.

Table 10
Decision Matrix

Criteria/ Alternatives	X_1	X_2	X_3	X_4	X_5	X_6	Total Weight	Rank
A_1	0.03184	0.01718	0.01404	0.03177	0.00795	0.07591	0.17869	3
A_2	0.01738	0.00565	0.05963	0.03177	0.01555	0.07591	0.20588	2
A_3	**0.01738**	**0.00565**	**0.02169**	**0.03177**	**0.01555**	**0.15182**	**0.24385**	**1**
A_4	0.01015	0.00253	0.01404	0.01589	0.00795	0.07591	0.12646	5
A_5	0.00673	0.00917	0.02169	0.03177	0.00795	0.07591	0.15322	4
A_6	0.00489	0.00359	0.00903	0.03177	0.00465	0.03795	0.09189	6

RESULTS

The decision matrix, as a result of the comparisons that are considered to be consistent as a result of the consistency analysis, is presented in Table 10. When the results are examined, it is recommended that the user should choose the application coded with A_3 according to the determined criteria and weights. According to the exact comparisons, it is seen that the A_2 application is the second, the A_1 application is the third, the A_5 application is the fourth, the A_4 application is the fifth, and the A_6 application is the sixth. In this model, the user can quickly analyze the changes in the decision matrix by changing the weights of the criteria.

DISCUSSION

The COVID-19 pandemic is rapidly changing consumer habits and reshaping the sports industry. While gyms are negatively affected by the pandemic due to the measures taken and customer preferences, marketers offering virtual application services constantly gain customers by increasing their sales volume. With unexpected situations like the Covid pandemic and ever-changing technology, the fitness industry is expected to keep up with the times and provide a more personalized approach to health. During and after the COVID-19

period, customers who find it dangerous to go to fitness centers have turned to virtual alternatives to applications. This situation has increased the diversity and use of mobile applications within the scope of fitness applications. In this study, determining which mobile applications should be chosen by the users and the features that should be developed in the mobile application by the service providers have been considered a decision problem and modeled with AHP, which is one of the Multi-criteria Decision-Making approaches. AHP analyzes complex problems in a hierarchical system. In order to enable the experts on the subject to participate effectively in decision problems, expert opinions have been taken as the basis for determining the preference values of the AHP criteria priorities and alternatives. One of the strengths of AHP is that it allows the conversion of qualitative variables into quantitative ones.

CONCLUSION

This study has converted qualitative variables into quantitative ones, apart from previous studies. In mobile fitness applications, six top-ranked applications in the USA have been coded and determined as alternatives to the decision problem. As the criteria of the problem, six criteria, three quantitative and three qualitative, have been taken as basis in line with the expert opinions. The proposed solution, modeled with AHP, has a modular structure that can be easily adapted in case of user preferences (criteria) changes and can flexibly update the model in case of an increase or decrease in alternatives. It has also been considered that the proposed model could provide users with quick decision support, as potential users to rarely can focus on the best results and seldom thoroughly examine the search results. In this context, it is evaluated which design features of mobile exercise development applications can affect the quality perception of the users and whether modelled the alternatives in the application stores match the criteria presented will affect the quality perception of the users. To survive in a competitive market, applications must dynamically adapt to needs. This will maintain existing customers, increase its popularity, and not only maintain existing customers, but also increase its popularity and bring in new customers. In this regard, the decision matrix made with AHP also contains important essential data in terms of regarding marketing strategies for marketers who develop mobile applications.

The application developers can gain knowledge on the subject from the table presented, such as where they are in the market, how much importance the users give to any criteria, what criteria they should focus on in order to reach more customers in the market, etc. For example, although the pandemic is predicted to decrease in the following years, increasing

the offline features of the applications may be an essential strategy. Similarly, it is seen that among the important criteria for fitness enthusiasts are the ability to plan and monitor training programs through mobile applications and even to receive services at their own pace and a lower cost. Additionally, it will contribute to the marketing strategies by informing about the preference situations in case the criteria weights change dynamically or if new criteria are added.

Although the effect of the pandemic decreased in 2021 and beyond, it is expected that most people will not return to their old habits in gyms, and it is evaluated that they will continue their mobile fitness and wellness applications. Mobile applications will also minimize the hygiene problems caused by the pandemic and ensure that users stay in shape with the movements they make at home. For this reason, there will inevitably be a significant change in the fitness industry, especially in mobile applications and their content.

Acknowledgments

No funding was received for the preparation of the submitted manuscript.

Authors' contributions

Not applicable.

Declaration of conflict interest

The author has no conflicts of interest to declare.

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doi.org/10.54141/psbd.1183798

PAMUKKALE JOURNAL OF SPORT SCIENCES
ISSN: 1309-0356 dergipark.org.tr/en/pub/psbd

Pamukkale J Sport Sci, 14(1), 63-82, 2023 Research Article

Effects of High-Intensity Interval Training Intervention on Physical Fitness and Body Mass Index of Overweight Primary Schoolchildren

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Keywords
Boys,
Curriculum PE,
Fitness performance,
HIIT,
Overweight prevention

Article History
Received 06 October 2022
Revised 18 December 2022
Accepted 16 January 2023
Available Online 27 April 2023

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ABSTRACT

Being overweight has serious health consequences for schoolchildren. Schools use different physical education (PE) programs for obesity prevention in children, but the overall positive impact of school-based interventions is questionable. This scientific work investigated the effects of high-intensity interval training (HIIT) intervention on physical fitness performance and body mass index (BMI) of overweight primary schoolchildren (seven years old males). Sixty-four boys, who had overweight, participated in this study. All participants practiced 44 PE classes. Control group (G1; n=32; mean age: 7.46±0.32 years; mean height: 123.35±3.28 cm; mean body mass: 27.81±2.32 kg; mean BMI: 17.82±0.11) performed curriculum PE during the investigation. The experimental group (G2; n=32; mean age: 7.54±0.27 years; mean height: 123.26±3.41 cm; mean body mass: 27.84±2.07 kg; mean BMI: 17.78±0.14) performed sixteen-week HIIT intervention in PE classes. Participants' height, weight, BMI, and physical fitness: push-up test, running sprint test, standing long jump test (SLJ), seat-and-reach test (SRT), and six-minute walk test (6MWT) were assessed in pre- and post-PE intervention. There were significant ($p<0.05$) differences between both groups in fitness tests and BMI values in the post-intervention period. Participants (G2), who practiced HIIT intervention, demonstrated a higher value in fitness performance tests, except for SRT. Children (G2) demonstrated significant ($p< 0.05$) lower values of BMI in the post-intervention period. A sixteen-week HIIT intervention in PE classes is effective in increasing of fitness performance and decrease of BMI in overweight primary schoolchildren. Incorporating different HIIT in the PE curriculum could be effective part of overweight prevention in primary schoolchildren.

Citation: Osipov A., Orlova I., Ratmanskaya T. and Lepilina T. (2023). Effects of High-Intensity Interval Training Intervention on Physical Fitness and Body Mass Index of Overweight Primary Schoolchildren. *Pamukkale Journal of Sport Sciences*, *14(1)*, 63-82. doi.org/10.54141/psbd.1183798

INTRODUCTION

Today childhood overweight and obese are growing worldwide health problems (Barros et al., 2022; Ijaz et al., 2021; Wu et al., 2021). Angawi and Gassy (2021) estimated that about 155 million children are overweight globally. It's known that being overweight or obese has serious health consequences, especially for modern children. Smajic et al. (2018) reported that an inactive childhood can pose a severe hazard to health when the child turns into adulthood. Investigators confirmed the association between physical activity (PA) risk behaviours in children (Vukelja et al., 2022) and overweight (Milanović et al., 2021). Lambrinou et al. (2020) reported the significant increase in the prevalence of obesity and the serious public health consequences of childhood overweight and obese is considered one of the most critical public health challenges. In this regard, new qualified/accurate investigations into pediatric obesity are needed (McKenzie & Baard, 2014). Experts point to the need to improve the quality of research related to the problem of childhood obesity. Park et al. (2017) insists on the need to seek diversity in terms of research participants, interventions, research procedures, and evaluation methods, along with overall quality improvement in research methodology. Nagovitsyn et al. (2021) recommend using BMI as an objective parameter for assessing the body mass of schoolchildren. Schwarzfischer et al. (2017) indicated that BMI standards are reliably related to the objectively measured PA level in this population.

It's known that primary and secondary schools are considered essential setting for general intervening in children's overweight/obesity-related behavior. Investigators point out several important reasons for successful intervention: available compulsory primary school education for all children; all schools offer curriculum PE and provide another opportunity for different PA and sports activities; all schools offer a structured educational environment where various interventions can be easily applied and, i.e. (Lambrinou et al., 2020; Pechertseva & Tanaeva, 2021). Lynch et al. (2017) reported that quality PE in primary school is a prerequisite for children's well-being. At this age, serious health threats are known (Oral et al., 2019). Main reasons: increasing levels of urbanization (Melnik, 2018), irrational nutrition (Podrigalo et al., 2020), and lack of daily PA in schoolchildren (Sgro et al., 2019). Today, schools use different programs for obesity prevention in children, but the overall positive impact of school-based interventions, including other PE interventions, is questionable. Their serious problems of increasing body weight and developing obesity in primary schoolchildren were identified (Soler-Lanagrán & Castañeda-Vázquez, 2017). About 20-25% of primary schoolchildren today are overweight or obese (Karki et al., 2019; Milasinovic et al., 2019).

Castro et al. (2018) reported that the high prevalence of overweight/obesity in childhood underscores the need for effective intervention programs capable of reversing this problematic situation. Lee et al. (2006) recommend encouraging children to perform physical exercises to prevent childhood obesity actively. Drenowatz et al. (2021) reported considerable and accurate evidence for beneficial associations of fitness profile and motor competence with body weight in schoolchildren and adolescents.

Preventing obesity requires preschool and primary schoolchildren to do 60-120 minutes of moderate to vigorous physical activity daily (Fernandez-Valero et al., 2021; Mischenko et al., 2021; Sember et al., 2018). Insufficient PA level in schoolchildren leads to a violation of the body's adaptation mechanisms. It reduces the various indicators of their physical fitness profile and motor competence. Casolo et al. (2019) indicate that primary schoolchildren have a sufficient level of PA in between lessons. Health/education professionals need to identify optimal ways to increase the level of PA of schoolchildren in PE classes. PE programs for current schoolchildren should increase children's motor mode to improve their physical condition (Moskalenko et al., 2020). Professionals recommend using various ball games, particularly football (Machado et al., 2018) and volleyball (Nagovitsyn et al., 2020), in the curriculum PE of schoolchildren. Romanov et al. (2017) reported that basic curriculum PE programs for primary schoolchildren in Russian Federation allocate more than half of the total time to motor and sports games. However, simply increasing the volume of play activity for schoolchildren does not guarantee positive results in the fight against overweight and prevention of childhood overweight. In this case, it is necessary to monitor the dynamics of BMI and the level of PA among schoolchildren. Bodnar et al. (2018) recommend solving this problem using according to the schoolchildren's health status PE methods.

Investigators reported that increasing childhood obesity prevalence has shifted the classification of healthy fitness, with 'underfit' as normal for schoolchildren (Yip et al., 2022). Health professionals are defined the physical fitness of schoolchildren as the body's condition resulting from a lifestyle that includes muscle strength, muscle endurance, cardiorespiratory fitness, flexibility, and maintaining an ideal BMI. These parameters are important indicators of children's health, as an integrated measure of the body's ability to perform regular PA. Physicians & investigators founded strong links between physical fitness and BMI status in schoolchildren, in which a high BMI may have a negative impact on some measures of physical fitness of children (Yi et al., 2019).

Scientists & health professionals emphasize the need to use special PA sessions of sufficient duration and frequency (at least three sessions per week) in PE of schoolchildren (Albuquerque et al., 2018). Travill and Wildschutt (2019) reported the lack of intensive PA sessions in PE among most of schoolchildren. Scientists, health professionals & physicians indicated that the insufficient level of development of important physical qualities: speed-power (Orlova et al., 2019; Polevoy, 2020), strength (Iermakov et al., 2020; Khudolii et al., 2019), and coordination abilities (Polevoy, 2020; Snigur, 2017) of preschoolers and primary schoolchildren aged six and eight years. Health/educational professionals & physicians reported the need to use special PE methods to ensure the harmonious physical development of children. These PE methods should have a diverse motor and speed-power basis (Orlova et al., 2019; Osipov et al., 2021). On the other hand, Thomaidou et al. (2021) state that creative dance-based movements and different creative movement PE programs may substantially boost children's creative potential but don't provide children with enough opportunities to develop a wide range of their motor competence and motor skills. There is scientific knowledge that recommends using functional strength training in PE of adolescents who have overweight (Volkova et al., 2018). There is evidence of positive use of high-intensity interval training (HIIT) programs in PE for schoolchildren with obesity (Cvetković et al., 2018). Espinoza-Silva et al. (2019) reported that HIIT interventions caused significant improvements in the cardiorespiratory capacity and BMI levels of overweight/obese schoolchildren (Espinoza-Silva et al., 2019). However, the majority of positive results in schoolchildren aged nine and eleven years were found (Delgado-Floody et al., 2018). Krivolapchuk and Chernova (2018) reported of the positive impact of high-intensity training in PE on preschool children aged five and six years. Unfortunately, there was no found full and robust knowledge about effective PE programs based on motor and speed-power training for seven years old primary schoolchildren with overweight.

The scientific review suggested a lack of knowledge about PE training programs (based on motor and speed-power training) for overweight primary schoolchildren (seven years old males). This scientific work investigated the effects of HIIT intervention on physical fitness performance and BMI of overweight primary schoolchildren. It was hypothesized that this specific HIIT intervention would confer greater improvements in physical fitness and correcting of BMI of overweight primary schoolchildren than curriculum PE.

METHODS

Study Group

Sixty-four primary schoolchildren (boys), who had overweight, participated in this study. Study participation was voluntary. All participants were selected from the four primary classes in two public primary schools, which had a united location and infrastructure (including school gyms). The overall inclusion criteria for all participants were: A) medical qualification for PE classes; B) subject age seven years old; C) overweight (excess of BMI standards for this population). The overweight equivalent to BMI of 17.3-22.0 kg/m2 at seven years old male (World Health Organization BMI for age: five to nineteen years). We confirm that all scientific ethical principles were observed in full. Firstly, all children's parents and primary school administrators were previously informed of the main purposes of the investigation, associated positive benefits, experimental procedures and tests, and future scientific potential. Secondly, informed consent from all parents and primary school administrators to conduct research and publish the results were received before the PE intervention period. Thirdly, this scientific work was implemented after approval by the university ethics committee SibFU (Institute of Physical Culture, Sport and Tourism, Protocol no. 18/2021) following the Helsinki declaration for scientific research with humans.

Data Collection Tools

The overall duration of this investigation conducted about sixteen week (September–December 2021). All children were randomly formed into two equal study groups as control group (G1) and experimental group (G2). Both groups had similar anthropometric and body mass characteristics. Children (G1) had mean age: 7.46±0.32 years; mean height: 123.35±3.28 cm; mean body mass: 27.81±2.32 kg; mean BMI: 17.82±0.11. Children (G2) had mean age: 7.54±0.27 years; mean height: 123.26±3.41 cm; mean body mass: 27.84±2.07 kg; mean BMI: 17.78±0.14. Four primary classes (A, B, C, D) participated in this study, but the number of participants from each class was not equal. Twelve boys from class «A», nine boys from class «B», seven boys from class «C», and four boys from class «D» were included in the control group. Seven boys from class «A», ten boys from class «B», six boys from the class «C», and nine boys from class «D» were included in the experimental group.

All children participated in regular 45-minute PE classes conducted by qualified PE teachers three times a week. These PE classes were held on Mondays, Thursdays, and Saturdays from 11.00 a.m. to 11.45 a.m. at a school gym (except for school holidays for children – one week in October 2021). In total, 44 PE classes (1980 min) were held. All participants

started and completed this study; however, not all participants visited the full PE classes due to respiratory diseases (six participants [G-1] and four participants [G-2] missed from 7 to 10 days, and four participants [G-1] and five participants [G-2] missed from 10 to 14 days during the study).

The control group (n=32) practiced adequate warm-up (walk in place - 30-40 sec, look arounds, arm circles, high reaches, toe touches, side bends, hand claps, knee raises, lateral step reach, ski hops, hip swirls (the duration of each exercise ranged between 12 and 16 reps), jog in place - 30-40 sec) and cool-down (walk in place - 30-40 sec, side stretch reach up, reach up, but don't jump up, ground down, touch your toes, butterfly stretch, quad stretch, calf stretch. The duration of each exercise ranged between 45 and 60 sec); athletics (running and hopping), gymnastics (individual balance, partner balances, shoulder rolls, circle rolls, rotation, and jumping), and different motor and sports games during these PE classes. Motor and sports games are based on different movements with a ball (play in football, handball, and other plays). Experimental group (n=32) practiced adequate warm-up and cool-down, running, hopping, gymnastics exercises, and HIIT exercises instead of sport plays.

The sixteen-week HIIT intervention for the experimental group (G2) was programmed in duration and intensity following scientists' & health professionals' recommendations regarding HIIT in healthy and overweight/obese schoolchildren (Cvetković et al., 2018; Delgado-Floody et al., 2018; Eddolls et al., 2017; Espinoza-Silva et al., 2019). The intervention program had simple high intensity exercises, with the development of basic motor skills, as the main strategy. The exercises lasted 30 sec to 45 sec, with a recovery time of 20 sec to 30 sec, working progressively over a period of 15−20 min of each PE class. The training program had: sprints of 10 m to 20 m; Push-ups; Bench step-ups: step-ups onto a low bench (15-20 cm); Crab walks and Crab toe touches; Inchworms; Dynamic Planks; Burpees. Every HIIT physical exertion was monitored during the investigation. Participants (G2) used heart rate monitors Polar H9 (China) to gather heart rate data while performing intensive physical exceptions. The values of mean heart rate used in HIIT were determined based on data from the assessment and monitoring of submaximal exercise-induced changes in the cardiovascular system of children (Jankowski et al., 2015; Van Camp et al., 2022). In our case, the target pulse rate zone for seven years old males with overweight to improve fitness is 145 to 175 beats per min.

The overall knowledge about HIIT and curriculum training programs in PE classes is outlined in Table 1.

Table 1
Training PE Program for All Participants During the Investigation (September– December 2021)

Training program (45 min)	
G-1 (n=32)	**G-2 (n=32)**
Common Warm-up (5-8 min)	Common Warm-up (5-8 min)
Common Gymnastics (5-10 min)	Common Gymnastics (5-10 min)
Athletics (5-10 min)	HIIT (15-20 min)
Motor and sports games (10-15 min)	Sprints (10-20 m) – 2 min; Rest – 30 sec; Push-ups – 30 sec; Step-ups onto a low bench (15-20 cm) – 2.5 min; Rest – 30 sec; Crab walks – 2 min; Rest – 30 sec; Burpees – 1 min; Rest – 30 sec; Step-ups onto a low bench (15-20 cm) – 2.5 min; Rest – 30 sec; Inchworms – 1.5-2 min; Rest – 30 sec; Dynamic Planks – 1.5-2 min; Rest – 30 sec.
Common Cool-down (5-7 min)	Common Cool-down (5-7 min)

G-1: Control Group
G-2: Experimental Group
HIIT: High-intensity interval training

Data Collection Procedure

Simple and good reliability and validity measurements of the physical fitness performance of participants were used. The variables (fitness tests) for this study were selected according to scientists' recommendations who studied the physical fitness performance of seven years old males. Well known that the normative values of physical fitness (muscle strength, muscle endurance, cardiorespiratory fitness, and flexibility) and BMI are essential references for monitoring the fitness data from schoolchildren. Esmaeilzadeh (2012) recommend standing long jump (SLJ), 30-meter sprint, and push-ups, for the examine the differences in physical fitness among seven to eleven years old males with varying BMI. Yip et al. (2022) recommend the 6-minute walk test (6MWT) to examine exercise tolerance and endurance and the sit-and-reach test (SRT) to examine of the flexibility of the lower back and hamstring muscles for six to seventeen years old males with varying BMI.

Before fitness tests assessments, all participants performed a special warm-up guided by two PE teachers, which consisted of walking and jogging followed by joint exercises (10-15 min). After detailed familiarization (full verbal instruction, high-quality visual demonstration, and quality performing one trial depending on test requirements), participating children used the test procedures. All children completed the test procedures twice (the overall interval between test procedures was sixteen-week). Four qualified test rates performed the test procedures. All test rates were qualified PE teachers.

The push-up test (measurement of upper-body endurance). The correct push-up version (McManis et al., 2000) was explained and demonstrated to all participants. Only correctly performed push-ups were counted in this test. The total number of correctly performed push-ups was measured for the analysis.

The standing long jump test (SLJ) is widely applied to assess lower body strength. The correct SLJ version (Espinosa-Sánchez, 2017) was explained and demonstrated to all participants. Three attempts are allowed for each participant. Recorded the longest distance jumped in best attempting.

The running sprint test (30 m) with standing start (measurement maximum sprint speed). This speed test requires the participant to sprint as fast as possible, over 30 m. The correct sprint test version (Castro-Piñero et al., 2010) was explained and demonstrated to all participants. To measure the exact time of participants, a mechanical stopwatch SOPpr-2a (Russia) with the accuracy of ± 1.0 sec per 30 min was used. An accurate time of 30 m run time was measured for the analysis.

The 6-minute walk test (6MWT) is the most commonly used and well-established test to measure functional exercise capacity. The 6MWT was conducted according to standardized test protocol described by scientific works (Klepper & Muir, 2011; Özcan Kahraman et al., 2019). Standard 6MWT version was explained and demonstrated to all participants. In this case, there was no warm-up before the test procedure. Mechanical stopwatch SOPpr-2a (Russia) with an accuracy of ± 1.0 sec per 30 min was performed to measure of exact time of participants. The accurate time of 6MWT performance for each participant was recorded.

The seat-and-reach test (SRT) is used to evaluate flexibility of the low back and hamstring muscles. The standard SRT version (Cornbleet & Woolsey, 1996) was explained and demonstrated to all participants. The SRT score (in cm) was recorded and used for analysis.

BMI calculator. The participants' height and weight indicators were measured for the BMI calculation procedure. Standard procedures for weight and height measurements for children (Lionti et al., 2013) were performed twice during the investigation (September and December 2021). For these procedures, the electronic weighing scale (Tanita BC-730, China) and certified stadiometer (Seca 264 Wall Mounted Wireless 360, Germany) were used. BMI (kg/m2) indicators were calculated from estimates of heights and weights. The participants' BMI (normal weight or overweight) was assessed with World Health Organization (WHO) BMI standards for this population. Normal weight equivalent to BMI 13.2-17.2 kg/m2 at seven years old male; overweight equivalent to BMI 17.3-22.0 kg/m2 at seven years old male (WHO BMI for age: five to nineteen years).

Data Analysis

Data analysis was performed with the statistical program – IBM SPSS Statistics for Windows 20.0 (Armonk, NY: IBM Corp.). All collected data are presented as means ± standard deviations (Means ± SD). The distribution of each variable was examined using the Kolmogorov-Smirnov normality test. Homoscedasticity of variance was verified with the Levene's test. All variables presented normal distribution. The independent t-test to compare differences between groups for examined variables, and a dependent t-test for pre-test and post-test differences for examined variables in each group, were applied. Complementarily, Cohen's d effect size (ES) was calculated, using Hopkins' spreadsheets (Hopkins et al., 2009). For this investigation, the level of significance was set at $p<0.05$.

RESULTS

We found that there were no significant differences between both groups in variables of fitness tests and BMI status in the pre-intervention period (September 2021). There were trivial (ES < 0.20) magnitude in fitness tests and small (ES – 0.20-0.59) magnitude in the measurement of BMI between groups.

The dependent t-test demonstrated that there were significant ($p<0.05$) differences between all pre- and post-intervention variables in favor of the post-intervention variables for each group. Both groups significantly ($p<0.05$) improved their level of physical fitness and decreased BMI status during the intervention. The independent t-test demonstrated that there were significant ($p<0.05$) differences between both groups in values of fitness tests and BMI status in the post-HIIT period (December 2021) in favor of the experimental group (G-2). Participants (G-2), who performed HIIT in PE, demonstrated a higher value of physical performance in fitness tests, except for SRT. Also, these children demonstrated significant ($p<0.05$) lower values in the measurement of BMI. There were small (ES – 0.20-0.59) magnitude in sprint and 6MWT tests, moderate (ES – 0.60-1.19) magnitude between groups in push-up and SLJ tests, and BMI measurement. There was a trivial (ES < 0.20) magnitude between groups in the measurement of SRT. The overall information about participants' values of fitness performance and BMI status in the investigation period is presented in Table 2.

Table 2
The Overall Findings in Participants' Values of Physical Fitness and BMI During the Investigation Period

Tests	G-1	G-2	$p <$	ES
Pre-intervention period (September 2021)				
Push-up	10.54±3.41	10.45±2.29	0.441	0.015
Sprint – 30 m (sec)	8.02±2.54	8.28±2.43	0.293	0.052
6MWT (m)	365.09±109.67	382.66±107.62	0.233	0.118
SLJ (cm)	109.62±22.44	107.25±15.28	0.301	0.084
SRT (cm)	12.58±2.49	12.55±2.31	0.494	0.002
BMI	17.82±0.11	17.78±0.14	0.091	0.231
Post-intervention period (December 2021)				
Push-up	12.35±2.55	13.54±3.13	0.028*	0.640
Sprint – 30 m (sec)	7.45±1.73	7.05±1.64	0.043*	0.570
6MWT (m)	470.19±106.32	507.18±105.91	0.046*	0.559
SLJ (cm)	130.06±20.63	137.46±18.53	0.033*	0.611
SRT (cm)	18.49±3.82	18.74±3.91	0.344	0.065
BMI	17.73±0.14	17.47±0.22	0.012*	0.872

p: independent-samples t-test
**: statistically significant*
ES: effect size (magnitude of association between the variables)

DISCUSSION

This scientific work investigated the effects of HIIT in PE classes on fitness performance and BMI of overweight primary schoolchildren (seven years old males). We investigated those participants (G-2), who performed HIIT in PE classes, demonstrated a significant ($p<0.05$) higher values in fitness performance, excluding flexibility (SRT), and significant ($p<0.05$) lower value in BMI status, compared to participants (G-1), who performed curriculum PE. These positive findings corroborate the hypothesis that HIIT would confer greater improvements in fitness and correct of BMI status of overweight primary schoolchildren, than curriculum PE. The practical importance of scientific data obtained in this scientific work is accurate knowledge about the strong positive effects of HIIT intervention in PE classes, for improving physical fitness and BMI correcting in primary schoolchildren (seven years old males) with overweight. This investigation complements the topical scientific knowledge about the effects of HIIT on fitness performance and BMI status of overweight seven years old males.

In current, an increasing number of scientific studies have investigated the possible relationship between overweight/obesity and motor competence, physical fitness performance, and the level of adherence to participation in regular PA during primary schoolchildren. Topical scientific works found a positive association between better physical

fitness performance and participation in regular PA, including curriculum PE in schoolchildren (Barros et al., 2022; Drenowatz et al., 2021). Wu et al. (2021) reported that motor fitness performance in primary schoolchildren comprises several components of physical fitness, including speed, strength, flexibility, and agility, that is associated with the development of motor skills and enhanced performance in sports activity in schoolchildren aged seven to ten years. Also, it was found that a strong association between motor fitness performance and PA that increases gradually during childhood and adolescence and is mediated by physical fitness, perceived physical exercise ability, and obesity. However, the overall proficiency of motor fitness performance in primary schoolchildren has been found to be insufficient. Hardy et al. (2013) reported that the prevalence of motor fitness mastery among primary schoolchildren was rarely above 50% during 13 years of school-based surveys. Skowroński et al. (2019) reported that standard curriculum PE classes proved to be insufficient for the successful development of gross motor skills of primary schoolchildren, especially for boys. Scientists indicate that a possible motor skill proficiency barrier exists already in seven to ten years old primary schoolchildren. The uninterrupted development of motor fitness and physical fitness performance is crucially important for supporting the promotion of regular PA and successful motor skill development in healthy primary schoolchildren (Wu et al., 2021). Our investigation suggested that HIIT in PE can have strong positive effects on fitness performance (including muscle strength, speed, and cardiorespiratory fitness) and BMI in overweight schoolchildren (seven years old males). In this case, our investigation corresponds to general scientific trends in the successful development of motor skills and motor fitness mastery among primary schoolchildren.

Angawi and Gassy (2021) reported that preventing childhood overweight/obesity interventions to manage weight gain in school settings had various positive and insignificant findings. The majority of interventions that emphasized PA, documented favorable findings. Those PA interventions were associated with a greater percentage of moderate-to-vigorous and vigorous PA daily. The PA interventions encouraged regular PA for > 60 min in a day, were also associated with a significant reduction in BMI, with the greatest effect sizes in overweight/obese children. It can be concluded that vigorous PA is a necessary condition for success in preventing childhood obesity. Cvetković et al. (2018) state that defined types of PA: recreational football and HIIT sessions elicited improvements in muscular and cardiorespiratory fitness performance in schoolchildren, who performed this training in PE. In contrast, schoolchildren, who performed only curriculum PE, increased BMI, body mass, and fat mass. The positive findings of HIIT interventions to correct body mass and improve

the cardiorespiratory capacity of overweight/obese children are presented in scientific literature. Investigators state the significant positive impact of the 28-week HIIT protocol on physical fitness performance and BMI of schoolchildren (Delgado-Floody et al., 2018). Scientists found that a 28-week HIIT intervention improved the anthropometric and cardiovascular parameters of schoolchildren. Also, this HIIT intervention applied in the school PE allowed for reducing the proportion of obese schoolchildren (Espinoza-Silva et al., 2019). However, most positive findings were obtained in nine to eleven years old children and older. Our investigation suggested the strong positive impact of sixteen-week HIIT on fitness performance and correction of BMI in boys (seven years old schoolchildren) with overweight and complemented existing scientific knowledge.

Tsiros et al. (2013) found a significant decrease in motor performance in obese schoolchildren during the 6MWT. Furthermore, other investigators state that overweight schoolchildren had worse speed and power performance in the 10-m and 20-m sprints and SLJ test; than non-overweight schoolchildren (Colella et al., 2009). Castro-Piñero et al. (2010) reported that overweight/obese boys had poorer sprint performance, than their non-overweight counterparts. Our investigation confirms the influence of body weight status on sprint performance in primary schoolchildren with a negative focus on the participants (G-1), who had the largest mean value of BMI in post-investigation. Participants (G-2), who had a lower mean value of BMI, demonstrated a better result in the sprint in the post-investigation test. Özcan Kahraman et al. (2019) presented reference values for 6MWT in healthy preschool and six to twelve years old primary schoolchildren. The mean distances for seven to eight years old children of 488.23-545.07 m. Also, Klepper and Muir (2011) reported that seven to eleven years old schoolchildren, who were overweight or obese, had a mean 6MWT of 518.50 m. Our investigation demonstrated that participants (G-2), who performed HIIT in PE, showed a significant improvement in the performance of 6MWT (from 382.66 m to 507.18 m) and approached the mean performance of 6MWT in healthy children. Our findings have confirmed the hypothesis of this investigation that HIIT would confer greater improvements in fitness performance of overweight schoolchildren (seven years old males).

Investigators presented accurate knowledge of the values of SRT in healthy primary schoolchildren. Cornbleet and Woolsey (1996) state that a mean SRT value of 24 cm for children five to twelve years old. Milanovic et al. (2019) state that a mean SRT value of 18 cm for overweight boys nine to fourteen years old. Our investigation demonstrated that participants, who have overweight, demonstrated a mean SRT value of 18 cm in the post-intervention period. These findings were equal for all participants, regardless of the PE

program. Sacchetti et al. (2012) investigated that BMI in schoolchildren was negatively correlated with the SLJ test and speed test, while no reliable association was found with tests measuring back flexibility. Oral et al. (2019) also confirmed that there is no reliable association between physical flexibility and obesity indicators in overweight children. Being overweight negatively effects on physical fitness of children but does not cause problems with physical flexibility. We can argue that there were no significant differences in physical flexibility assessments (SRT) between participants in our investigation.

Any inferences presented in this scientific work have some important limitations. These limitations are associated with the overall low number and young chronological age of studied children. In spite of being homogeneous in terms of chronological age (seven years old), all participants were still in the natural process of growth and maturation, and that could have interfered with their perceived intensive physical exertion during PE classes. In addition, there was also no full and accurate information on health-related behaviors, such as daily PA or participation in different sports activity, which unquestionably affected fitness performance and motor competence in participants. Possible overwork or lack of full recovery after the physical exertion of the participants may have a significant impact on the final result of our investigation (in particular, post-investigation fitness test results). Also, we should be acknowledged, as an important methodological limitation of this investigation, the lack of a particular control group (primary schoolchildren seven years old males), who had normal BMI and practiced standard curriculum PE. On the other hand, the utilization of strong and good validation tests that assess various and important components contributing to fitness performance and motor competence of participants, along with a stringent test protocol that was implemented consistently across all test assessments, should be considered a strong part of this investigation.

It should be noted, that limited published scientific knowledge on the improvement of physical fitness performance in overweight primary schoolchildren (seven years old males), emphasizes the need for future investigations can provide viable and accurate knowledge for the implementation of various HIIT experiences that improve motor competence and fitness performance of primary schoolchildren with overweight, particularly during curriculum PE in school.

CONCLUSION

This investigation suggested that a sixteen-week HIIT has a strong favorable effect on to increase of fitness performance and decrease of BMI in overweight primary schoolchildren

(seven years old males). Overweight schoolchildren, who practiced HIIT intervention in PE, demonstrated a higher fitness performance and lower BMI values, than overweight schoolchildren, who had not applied such intervention in PE classes. Although it requires further investigation, the incorporation of different motor and functional training (based on HIIT or other functional training protocols) in PE classes, could be effective part of overweight prevention in primary schoolchildren. Also, future investigations are needed to test the specific interventions addressing different contexts of daily PA of children (e.g., home and school) to help control childhood overweight.

PRACTICAL IMPLICATIONS

The application contribution of this investigation is to develop and test a specific sixteen-week HIIT in PE (based on motor, functional, and speed-power training), which enable to increase in fitness performance and decrease in BMI of overweight primary schoolchildren, more efficiently. This HIIT program can be used by PE teachers and parents to control the physical performance and BMI status of primary schoolchildren, especially seven years old males, who have overweight.

Acknowledgments

We would like to thank the personnel of primary schools, and all parents, whose children participated in this study.

Authors' contributions

The first author contributed to the conceptualization, methodology, design of the study, and supervised the general processes. The second and third authors carried out the data curation and analysis, and validated of the methodology governing this study. The fourth author collected data, and supported the tools selection.

Declaration of conflict interest

There is no conflict of interest to be reported.

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doi.org/10.54141/psbd.1196801

PAMUKKALE JOURNAL OF SPORT SCIENCES
ISSN: 1309-0356 dergipark.org.tr/en/pub/psbd

Pamukkale J Sport Sci, 14(1), 83-97, 2023 Research Article

Comparison of the Effect of Static and Dynamic Core Exercises on Physical Performance Parameters in Young Boxers

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Keywords
Boxing,
Core,
Exercises,
Sports,
Young

Article History
Received 30 October 2022
Revised 05 February 2023
Accepted 13 March 2023
Available Online 27 April 2023

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ABSTRACT

The purpose of this study was to investigate the effects of six weeks of static and dynamic core exercises on physical performance parameters in young boxers. Twenty well-trained young male boxers aged 14-18 years were voluntarily involved in the study. All participants were grouped randomly into dynamic and static core exercise groups. A six-week core exercise training program was performed on static and dynamic core exercise groups. Before and after six weeks of training, young male boxers performed anthropometric measures and physical performance tests, including the Yo-yo intermittent recovery test, 30m sprint test, hexagon agility test, standing long jump, maximum push-up, 30sec sit-ups, sit and reach flexibility tests. After data collection, analyses were conducted using the paired t-test and ANCOVA test. The results indicated that the core exercise training program significantly improved both groups' agility, long jump, muscular endurance, and 30m sprint performance ($p<0.05$). In addition, a significant difference was found in the maximum push-up test scores of the static core exercise group ($p <0.05$). On the other hand, the dynamic core exercise group's aerobic capacity and flexibility tests showed a statistically significant increase ($p<0.05$). As a result, it was determined that 6-week static core exercises were effective on push-ups, speed, agility, standing long jump, sit-ups, and balance, while dynamic core exercises were effective on VO2max, flexibility, sit-ups, balance, standing long jump, agility, and sprint. These findings show that static and dynamic core exercises have positive effects on performance in young boxers, but these exercises have different effects.

Citation: Gök B. and Özen G. (2023). Comparison of the Effect of Static and Dynamic Core Exercises on Physical Performance Parameters in Young Boxers. *Pamukkale Journal of Sport Sciences*, *14(1)*, 83-97. doi.org/10.54141/psbd.1196801

INTRODUCTION

Regular athletic training and exercise are one of the best ways to improve physical performance and health. In order to be successful at a sport, technical and tactical training and physical exercise that will develop basic motor skills such as strength, endurance, speed, and agility should be added to the primary training program. Since the fundamental training received in childhood and youth period is the main determinant of future athletic success, performing different exercise programs in young athletes is a very important issue for health and athletic performance (Haga, 2008). In this direction, scientific research has been carried out for many years, and new training methods have been developed to improve the basic motoric skills of athletes. In this respect, core exercises, which provide body balance and stabilization in many branches and thus allow technical skills to be exhibited more flawlessly and more efficiently, are a type of exercise that attracts attention in scientific studies and training practices (Luo et al., 2022).

Nowadays, boxing is a popular performance sport in which the interest of young people is increasing with the increasing number of viewers and international investments. For young boxers who continue their work by aiming for championships in the future, as in other team or individual sports, physical performance and physical capacity are very effective in the results of boxing competitions. In order to perform at a high level, the superior performance of today's boxers is seen as a whole of many physiological, biomechanical, and psychological factors (Savaş, 1998). In particular, the muscular strength level of the core region, which includes the abdominal muscles and back and hip muscles, has a great impact on performance (Blower, 2012).

Core exercises increase muscle strength and balance also are often used in training today because they are exercise methods that keep the spine and hips in balance as well as train many trunk muscles. Strengthening the core muscles is a critical factor for development. It is a training method that accelerates the return of the athlete to the field, increases physical performance, and protects from sports injuries and rehabilitation (Boyaci & Biyikli, 2018). In this respect, core exercises are included in training programs of almost all sports branches based on physical performance. In core training, exercises are performed in two different ways, both static and dynamic (Gür & Ersöz, 2017; Luo et al., 2022). Although there are literature studies reporting that static and dynamic core training is beneficial, experimental studies on their effects on boxers are insufficient. There are studies in which the physical performance parameters of young boxers are measured both nationally and internationally in

scientific studies (El Ashker, 2012). Although there are some studies where core exercises are applied to young boxers, there is insufficient information on whether static core exercises or dynamic core exercises are more effective. For this reason, we aimed to present scientific findings to young boxers and their trainers by examining the effects of dynamic and static core exercises on physical performance parameters in young boxers.

METHODS

Research Model

In the study, the pre-test-post-test design from experimental research methods was used. All participants were randomly divided into dynamic (DCEG) and static core exercise groups (SCEG) by unbiased assignment. Both groups were subjected to measurements under equal conditions before and after the experiment. Before the research was conducted, the aims, test protocols, and core exercise program of this research were explained to all boxers and their parents. This study was approved in advance by Çanakkale Onsekiz Mart University Scientific Research Ethics Committee (2100049931 - 2021).

Study Group

A total of twenty well-trained young male boxing players aged 14-18 years with body height 178.7±6.88 cm in SCEG and 177.5±8.59 cm in DCEG, body weight 69.40±7.50 kg in the SCEG and 66.80±14.06 kg in the DCEG voluntarily participated in the study. Participants were both healthy and regularly trained for at least three years, two times a week for about two hours in every training session.

Data Collection Tools

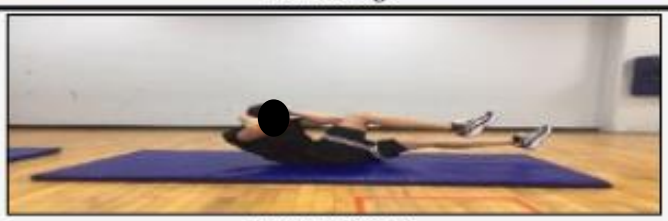
Training Protocol

The SCEG and DCEG consisted of 10 athletes and performed seven core exercises with increased difficulty levels for six weeks after the usual boxing training three days a week. The techniques and important points of the exercises in the training program were taught to all athletes before the training began. The training program and core exercises were determined according to current reference studies. The number of repetitions and times were determined by considering the literature examples (Das, 2017; Gür & Ersöz, 2017; Gür, 2020). Time limits were introduced for static core exercises and repetition/number limits for dynamic core exercises. All movements were performed in three sets. The activities were tried to be done with the right technique, controlled, and slow speed. The resting time between movements is determined as 30 sec, and the resting time between sets is defined as one min. The training programs of the SCEG and DCEG are demonstrated in Figure 1.

Figure 1
Static and Dynamic Core Exercise Training Programmes

Static Core Exercises	Time*Rep		
	1-2 Week	3-4 Week	5-6 Week
 Static Side Plank	30s*3	45s*3	60s*3
 Front Plank	30s*3	45s*3	60s*3
 Lower Up Plank	20s*3	25s*3	30s*3
 Posterior Plank	20s*3	25s*3	30s*3
 Static Squat	20sn*3	30s*3	45s*3
 Superman Arch Body	5s*6x3	10s*6x3	15s*6x3
 Alternate Heel Touch	12*2x3	15*2x3	20*2x3

Figure 1 (Continued)

Dynamic Core Exercises	Time*Rep		
	1-2 Week	3-4 Week	5-6 Week
 Dynamic Side Plunk	15*2x3	20*2x3	25*2x3
 Spiderman Plank	10*2x3	15*2x3	20*2x3
 Crunch With Pushing Hands	10*2x3	15*2x3	20*2x3
 Forward Lunge	8*2x3	10*2x3	12*2x3
 Pulse Lunge	10*2x3	12*2x3	15*2x3
 Bicycle Crunch	10*2x3	12*2x3	15*2x3
 Push Up	12x3	15x3	20x3

Data Collection

Anthropometric measurements; body mass index (BMI), body height, weight, and physical performance tests; Yo-yo intermittent recovery test, standing long jump, hexagon agility, maximum push-up, 30-sec sit-up, flamingo balance, sit and reach flexibility and 30m sprint tests were performed to determine the effect of six-week core training. Pre-and post-anthropometric measurements and physical performance tests were carried out in an indoor sports hall (American College of Sports Medicine, 2013; Ashok, 2008). First, baseline measurements and tests of participants were performed. Following the first measurements, their post-measurements and tests were performed after the six-week static and dynamic core training period. Physical performance tests were performed in the morning and afternoon on the same day. After a standard 10-minute warm-up in the morning session, 30m sprint, flamingo balance, 30-sec sit-up, sit and reach flexibility, and maximum push-up tests were performed two times, respectively. The participants' best test scores were accepted. The yo-yo intermittent recovery test was conducted in the afternoon session. Participants were given five min rest periods between performance tests. According to yo-yo intermittent recovery test results, Bangsbo's formula was used to calculate the estimated VO_{2max} values.

Formula: VO_{2max} (ml.kg–1.min–1) = 36.4 + (0.0084*Running distance) (Bangsbo et al., 2008).

Data Analysis

Statistical analyses were performed using the SPSS statistic software package (version 15.0). Categorical variables were calculated as frequency (n) and percentage (%), while continuous variables were calculated as arithmetic mean (X) and standard deviation (sd). The Shapiro-Wilk W test was used to determine that data was acceptable with regard to homogeneity. As variances showed a normal distribution, Paired t-tests were used for within-group comparisons. An analysis of covariance (ANCOVA) with the pre-test value as the covariate was performed to compare the effects of static and dynamic core training of core training between SCEG and DCEG groups for post-test values. The level of statistical significance was set at $p<0.05$.

RESULTS

The intra-group comparison results of the anthropometric pre- and post-test means of the static and dynamic core exercise groups are presented in Table 1. There were statistically significant differences between the pre-and post-test mean scores. It was found a significant increase in SCEG's body height in the post-test ($t(9) = -3.354$, $p = 0.008$), and significant

decreases in the post-test BMI (t(9) = 2.593, p = 0.029) and waist circumference mean scores (t(9) = 2.866, p = 0.019). On the other hand, there was no significant difference between the pre-and post-test mean scores of SCEG's body weight, hip circumference, and waist-hip ratio (p> 0.05). When the pre-and post-test mean scores of DCEG's anthropometrics were compared, it was found that there was no significant difference between their pre-and post-test mean scores in anthropometric measurements (p> 0.05).

Table 1
Comparison of Anthropometric Measurement Parameters of Training Groups

Variables	Group	Test Time		t	p
		Pre-Test	Post Test		
Body Weight (kg)	Static	70.30±8.24	69.40±7.50	1.711	0.121
	Dynamic	67.50±16.58	66.80±14.06	0.843	0.421
Height (cm)	Static	177.7±7.16	178.7±6.88	-3.354	**0.008***
	Dynamic	177.1±8.87	177.5±8.59	-1.809	0.104
BMI (kg/m²)	Static	21.10±2.30	20.77±2.32	2.593	**0.029***
	Dynamic	21.36±3.70	21.18±3.12	0.925	0.379
Waist Circumference (cm)	Static	79.20±2.44	76.70±3.02	2.866	**0.019***
	Dynamic	79.40±10.93	78.4±7.53	0.826	0.430
Hip Circumference (cm)	Static	95.20±3.67	94.30±3.74	1.588	0.147
	Dynamic	96.3±8.87	95.6±8.23	0.677	0.515
Waist-Hip Ratio	Static	0.83±0.03	0.81±0.02	1.856	0.096
	Dynamic	0.82±0.41	0.82±0.31	0.217	0.833

**: p< 0.05*

The intra-group comparison results of the VO_{2max}, 30m sprint, and agility pre- and post-test means of the static and dynamic core exercise groups were presented in Table 2. It was found that there were statistically significant differences between the pre-test and post-test mean scores, including an increase in the maximum oxygen capacity (VO_{2max}) of the DCEG in the last test (t(9) = -2.674, p = 0.025), a decrease in the mean sprint score in the post-test (t(9) = -3.608, p = 0.006), and a decrease in the agility average in the post-test (t(9) = 3.37, p = 0.008). It was determined that there was a significant difference between the pre-and post-test mean scores, including a decrease in the 30m sprint performance (t(9) = -3.118, p = 0.012) and agility (t(9)=5.49, p = 0.00) test averages of SCEG in the post-tests (p> 0.05). When the pre-test and post-test VO_{2max} mean scores of SCEG were compared, it was found that there was no significant difference between the mean scores of the pre-test and post-test (p> 0.05).

Table 2
Comparison of VO_{2max}, 30m Sprint, Agility Measurement Parameters of Training Groups

Variables	Group	Test Time		t	p
		Pre-Test	Post Test		
VO_{2max} (ml. kg–1.min–1)[a]	Static	41.63±2.02	41.72±1.52	-0.193	0.852
	Dynamic	42.27±1.91	43.51±2.63	-2.674	**0.025***
30m Sprint (sec)	Static	4.76±0.25	4.94±0.32	-3.118	**0.012***
	Dynamic	4.65±0.25	4.91±0.25	-3.608	**0.006***
Agility (sec)	Static	14.99±2.51	12.92±1.93	5.493	**0.000***
	Dynamic	14.36±1.10	12.49±147	3.377	**0.008***

*: *p< 0.05*
[a]*Calculation Formula of VO_{2max} for the groups.*

The intra-group comparison results of the long jump, push-up, and sit-ups pre-test and post-test means of the static and dynamic core exercise groups presented are in Table 3. There were significant differences between SCEG's pre-and post-test mean scores in the maximum push-up (t(9) = -2.864, p = 0.019), long jump (t(9) = -2.408, p = 0.039) and 30sec sit-ups (t(9) = -3.539, p = 0.006) test while there were significant differences between DCEG's pre-test and post-test mean scores in the long jump (t(9) = -3.681, p = 0.005) and 30 s sit-ups test (t(9) = -6.107, p = 0.000). However, it was found that there was no statistically significant difference between DCEG's pre-test and post-test mean scores in the maximum push-up test (p> 0.05).

Table 3
Comparison of Long Jump, Push-Ups, and Sit-Up Measurement Parameters of Training Groups

Variables	Group	Test Time		t	p
		Pre-Test	Post Test		
Long Jump (cm)	Static	171.80±18.90	176.80±21.66	-2.408	**0.039***
	Dynamic	166.50±17.29	191.00±28.55	-3.681	**0.005***
Push-up (Reps) [a]	Static	24.20±15.12	28.60±13.35	-2.864	**0.019***
	Dynamic	30.60±8.99	33.50±9.28	-2.169	0.058
Sit-ups (Reps) [a]	Static	23.10±5.21	28.20±6.01	-3.539	**0.006***
	Dynamic	25.80±4.58	30.60±5.37	-6.107	**0.000***

*: *p< 0.05*
[a]: *The number of repetitions*

The intra-group comparison results of the balance and flexibility pre-test and post-test means of the static and dynamic core exercise groups were presented in Table 4. There were statistically significant differences between the pre-test and post-test scores. It was found a

decrease in the number of balance errors of the DCEG in the post-test (t(9) = 4.611, p = 0.001) and an increase in the mean of flexibility performance of the DCEG in the post-test (t(9)=-2.377 p = 0.041). On the other hand, only a significant decrease in the number of balance errors was determined between the pre-test and post-test mean score in SCEG's flamingo balance test (t(9) = 4.272, p = 0.002). However, it was found that there was no statistically significant difference between the pre-test and post-test mean scores in SCEG's flexibility performance (p> 0.05).

Table 4
Comparison of Balance and Flexibility Measurement Parameters of Training Groups

Variables	Group	Test Time		t	p
		Pre-Test	Post Test		
Balance (number of errors)	Static	7.50±1.90	5.10±1.72	4.272	**0.002***
	Dynamic	8.30±3.33	5.00±2.21	4.611	**0.001***
Flexibility (cm)	Static	29.60±7.26	33.50±9.09	-1.896	0.091
	Dynamic	31.60±9.97	34.30±6.92	-2.377	**0.041***

*: *p< 0.05*

In the study, ANCOVA comparisons of post-test mean scores of SCEG and DCEG made by covariation the groups' pre-test mean scores are presented in tables 5, 6, 7, and 8. Pre-test mean scores of groups were covariates in ANCOVA analyses.

Table 5
Comparison of Anthropometric Measurement Post-Test Averages of Training Groups

Variable	Group		f	p
	Static	Dynamic		
Body Weight (kg)	69.40±7.50	66.80±14.06	0.145	0.708
Height (cm)	178.7±6.88	177.5±8.59	3.127	0.095
BMI (kg/m²)	20.77±2.32	21.18±3.12	0.985	0.335
Waist Circumference (cm)	76.70±3.02	78.40±7.53	2.588	0.126
Hip Circumference (cm)	94.30±3.74	95.60±8.23	0.091	0.767
Waist-Hip Circumference	0.81±0.02	0.82±0.31	0.819	0.378

In the study, the results of the comparison of the post-test mean scores of SCEG's and DCEG's anthropometric measurements were presented in Table 5. According to the results of the ANCOVA analysis, it was determined that there was no significant difference between the post-test mean scores of groups in the body weight, height, BMI, waist circumference, hip circumference, and waist-hip ratio (p> 0.05).

Table 6
Comparison of VO_{2max}, Sprint, Agility Post-Test Averages of Training Groups

Variable	Group		f	p
	Static	Dynamic		
VO_{2max} (mL/kg/min)	41.72±1.52	43.51±2.63	3.794	0.680
30m Sprint (sec)	4.94±0.32	4.91±0.25	0.408	0.532
Agility (sec)	12.92±1.93	12.49±147	0.007	0.934

In the study, the comparison results of the VO_{2max}, speed, and agility post-test score mean of SCEG and DCEG were presented in Table 6. According to the results of the ANCOVA analysis, there was no significant difference between the VO_{2max}, sprint, and agility post-test mean scores of the groups ($p > 0.05$).

Table 7
Comparison of Long Jump, Push-Up, and Sit-Ups Post-Test Averages of Training Groups

Variable	Group		f	p
	Static	Dynamic		
Long Jump (cm)	176.8±21.66	191.0±28.55	7.772	**0.013***
Push-ups (Rep)	28.60±13.35	33.50±9.28	0.092	0.766
Sit-Ups (Rep)	28.20±6.01	30.60±5.37	0.000	0.992

*: *$p < 0.05$*

In the study, the comparison results of the long jump, push-up, and sit-up post-test mean scores of SCEG and DCEG were presented in Table 7. According to the results of the ANCOVA analysis, it was determined that there was a significantly higher increase in the long jump performance of DCEG ($f = 7.772$, $p = 0.013$). However, no significant difference was found between the push-ups and sit-ups post-test mean scores of the groups ($p > 0.05$).

Table 8
Comparison of Balance and Flexibility Post-Test Averages of Training Groups

Variable	Group		f	p
	Static	Dynamic		
Balance (number of errors)	5.10±1.72	5.00±2.21	0.502	0.488
Flexibility (cm)	33.50±9.09	34.30±6.92	0.099	0.757

In the study, the results of the comparison of the balance and flexibility post-test mean scores of SCEG and DCEG were presented in Table 8. According to the results of the ANCOVA analysis, there was no significant difference between the balance and flexibility post-test mean scores of the groups ($p > 0.05$).

DISCUSSION

In the study, the findings on the effects of two different core training protocols applied on the anthropometric and physical performance parameters of young boxers were synthesised with literature studies and discussed. It is seen that most of the similar studies in the literature are performed regardless of core exercise practices as dynamic or static. However, it is also known that static and dynamic core exercises have different physiological effects due to mechanical differences. For this reason, the effects of static and dynamic core exercises were examined separately in this study.

In the study, young boxers' body weight, height, body mass index, waist circumference, hip circumference, and waist-hip ratio were examined. In the statistical comparison within the group in the pre-and post-test, it was seen that there was an increase in the mean height of the SCEG and a decrease in the means of BMI and waist circumference. When the literature studies are examined, it is known that static core exercises contribute to muscle development and fat burning, especially in the abdominal region. In the study conducted by Sever (2016), which investigated the effect of dynamic and static core exercise training for 30 min / three days a week in eight weeks on young football players, have been reported that a decrease occurred in the BMI score of players. In this respect, the positive effects of static core exercises around BMI and waist were also seen in this study. However, there was no literature finding that could base the increase in height completely on static core exercises as a result of 6 weeks of exercise. In order to state definitively that this change in height is due to static activities, it is necessary to confirm it with different studies. It may also be coincidental due to the fact that the participants are at a growing age. In addition, in the post-test ANCOVA comparison made by neutralising the pre-tests, it was determined that this difference was not significant compared to the DCEG's mean height values. On the other hand, significant differences in the variables of height, body mass index, and waist measurements are thought to be not only related to core exercises but also play a role in factors such as environmental and genetic factors. When the literature on training practices is examined, it is necessary to consider the growth process when measuring physical performance in children and adolescent athletes (Sağlam et al., 2002). It is thought that there was a significant difference in the body mass index and waist circumference measurements of the static core training group, and this difference was due to the effect of the increase in height. For this reason, it is reported that the height increase of the athletes is 7-12 cm per year in these groups of athletes

due to the secretion of growth hormone more in this age, and the increase in the height of the athletes participating in the research is, therefore, an expected normal result (Brown et al, 2017).

In the comparison of findings before and after the core exercises between the groups, it was seen that there were no significant differences in body weight, height, BMI, waist circumference, hip circumference, and waist-hip ratio characteristics of both exercise groups. In the study conducted by Boyacı and Bıyıklı (2018), in which 40 football players aged 11-13 years old, the physical characteristics of 10-week core exercises were examined. Their findings show that there was no statistically significant difference in anthropometric characteristics such as height and body weight before and after training. In general, these findings and our findings are similar. Since the athletes train regularly in groups, their general physical characteristics are in ideal dimensions; therefore, it is thought that there is no significant change in anthropometric measurements as a result of core exercises.

When the intra-group changes of SCEG and DCEG included in our study were examined, physical performance variables VO_{2max}, sprint, agility, long jump, push-ups, sit-ups, balance, and flexibility were analyzed. It is seen that there were positive changes in the sprint and agility performance test durations of the static and dynamic core exercise groups. In addition, it was determined that there was a significant increase in the VO_{2max} performance of DCEG, but no significant change was found in the VO_{2max} performance of SCEG. This difference between the groups is an expected result, as dynamic core exercises positively affect cardiac parameters and aerobic endurance performance, such as interval training applications. Scientific studies have reported that core exercises have a positive effect on agility and sprint performance (Bayrakdar et al., 2020). In the literature, it is stated that the strength of the core muscles contributes to the change-of-direction maneuverability, especially the balance, and the increase in sprint performance (Brull-Muria & Beltran-Garrido, 2021; Başkaya, et al., 2023). In this context, our research revealed that both static and dynamic core exercises cause improvement in both agility and sprint performance. The effect of trunk stability exercises on sportive performance was investigated in the study in which 30 female volleyball and basketball athletes for ten weeks participated. As a result of the study, a significant change occurred in the agility tests in the experimental group (Mills et al., 2005). Another study stated that static core stabilisation exercises in 17 children aged 9-12 years increased their long jump performance (Allen et al., 2014). Considering our study and the literature, it is recommended that static and dynamic core exercises have positive effects on athlete performance in terms of explosive strength and endurance properties. Since strength and endurance are important

parameters in performance sports; it is recommended that static and dynamic core exercises be added to the routine training programs of the athletes.

When the intra-group changes of SCEG and DCEG before and after the study were examined, balance performance showed a significant positive change in both groups. On the other hand, positive change in flexibility performance was seen only in the DCEG. When we examined the literature, Samson (2005) investigated the relationship between core exercises and dynamic balance for tennis players with an average age of 20. In the study, 13 athletes were the experimental group, and 15 athletes were in the control group. The effects of 5-week core training have been examined with the Star Excursion Balance Test. As a result of the test, there was a significant change in the dynamic balance characteristic of the experimental group. In another study (Ardali & Gönerer, 2019), the effects of core exercises applied to swimmers between the ages of 10-12, 3 days a week for eight weeks, on the motoric performance of the athletes after the training were examined. When the pre-test and post-test values of the experimental group were compared, they found that there was a significant increase in balance, flexibility, and long jump test measurements. Similarly, Gür and Ersöz (2017) reported that core training had a positive effect on the core strength and balance of tennis athletes aged 8-14 years old. When our study and related literature are examined, static and dynamic core exercises should be added to training programs in order to improve balance and flexibility, which are important parameters for athlete performance.

CONCLUSION

As a result, it was determined that 6-week static core exercises were effective on push-ups, speed, agility, standing long jump, sit-ups, and balance, while dynamic core exercises were effective on VO_{2max}, flexibility, sit-ups, balance, standing long jump, agility, and sprint. This shows that static and dynamic core exercises in young boxers have positive effects on performance in general but these exercises have different positive effects. Accordingly, it is an effective opinion for both static and dynamic core exercises in training practices, and if possible, to have combined core exercises.

Acknowledgments

The data used in this article has been obtained from the master thesis study of Bilal GÖK that has been conducted at Çanakkale Onsekiz Mart University. We gratefully acknowledge the help of all the participants who took part in the study.

Authors' contributions

All authors carried out the research design together. The first author was involved in the data collection and writing process. The second author took responsibility for data analysis and interpretation of the data, the supervision and critical reviewing of the original draft, as well as the approval of the final draft. All authors contributed to the discussion of the results and the manuscript's preparation.

Conflict of interest declaration

The authors declare that they have no conflict of interest.

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