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Pamukkale J Sport Sci, 14(3), 234-257, 2023 **Research Article**

A Qualitative Perspective on Anti-Doping: Mixed Methods Research

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ABSTRACT

National and international anti-doping programs are carried out to protect athletes' health, establish an equal and fair competition environment, and defend the basic principles of sports. This study aims to determine the situation regarding the prevention of doping in sports in Türkiye and the recommendations that can be presented to the national sports administration on anti-doping in line with the findings to be obtained. The study was designed with the explanatory sequential design participant selection sub-design, a mixed method research. Three hundred-two people, determined by the purposeful sampling technique, participated in the research. After evaluating the quantitative findings obtained using the questionnaire technique, in-depth interviews were conducted for the qualitative part of the research with 12 people who met the criteria determined among all the participants. Descriptive statistics were used to analyze quantitative data, and theme analysis, descriptive analysis, content analysis, analytical generalization, and discourse analysis were performed in qualitative data analysis. As a result of this research, it is understood that training activities prepared to increase the knowledge and awareness level of sports professionals are considered a more effective method for doping prevention than criminal sanctions. In line with the findings obtained, it is understood that there is a need to establish an independent, multi-faceted anti-doping organization in which all relevant stakeholders are involved and a national action plan in which more importance is attached to guidance and training activities.

INTRODUCTION

The idea of anti-doping first emerged after the death of an athlete at the 1960 Rome Olympic Games. In line with this idea, the International Olympic Committee published a list of substances and methods used to increase sportive performance and applied various penalties to athletes for whom these substances and methods were detected (Ergen, 2011). Furthermore, to emphasize the need for more coordinated global action against doping, which took place during the 1998 Tour de France, the International Olympic Committee (IOC) brought together all parties involved in the fight against doping to organize the World Doping Conference and issued the Lausanne Declaration. According to the declaration, the World Anti-Doping Agency (WADA) was established in Lausanne on 10 November 1999 to promote and coordinate the fight against doping in international sports (WADA, n.d.). In Turkiye, this movement is spearheaded by the Turkish Anti-Doping Commission (TADC).

One of the most extensive pharmacological experiments in history is the administration of drugs to athletes to enhance performance in many different sports. Perhaps the most remarkable aspect of this massive and ongoing global experiment, which has come to be known as doping, is its widely acknowledged covert nature. Doping involves thousands of athletes, doctors, scientists, sports, and government officials (Franke & Berendonk, 1997).

It is necessary to protect athletes' rights regardless of their level (Schneider & Butcher, 2000). Unless doping is prevented, equality and honesty in sports cannot be ensured, and doping, which costs human lives, is a critical moral problem in sports (Şahin, 2018). The anti-doping program and anti-doping code seek to win this fight through education, deterrence, detection, enforcement, and the rule of law (World Anti-Doping Code, 2021). Anti-doping programs aim to protect the 'spirit of sport,' and the fact that doping is against the essence of the spirit of sports is seen as the primary justification for anti-doping in the world as well as in our country (Turkish Anti-Doping Commission, 2019). To create an equal and fair competition environment and protect the health of atheletes, athletes are subjected to in-competition and out-of-competition doping controls by national and international organizations, are continuously monitored with the athlete biological passport and they are obliged to participate in trainings against the harms of doping. At the beginning of each new year, the World Anti-Doping Agency publishes a list of substances and ways that are banned at all times, banned in competition, and banned in some particular sports and informs athletes, coaches, and managers. In order to make the fight against doping more effective, new methods and techniques are constantly being researched. Scientific research also makes contributions to this process.

The fact that technological advances may greatly overshadow the human body's capacitance is of great concern to the various governing agencies in sports. Because of this concern, many organizations seek to protect sports from the invasion of biotechnology (Shafer, 2016). Much time, energy, and money is spent on enforcing doping bans in sports. Nevertheless, there is growing evidence that enforcement of bans is doomed to failure and somehow misses the point (Schneider & Butcher, 2000). According to Schneider and Butcher (2000), the real problem lies in why doping does not fit into sports and the need for educational programs to prevent doping from occurring rather than punishing perpetrators.

Despite the development of anti-doping awareness and anti-doping programs, it is thought that doping is an essential problem for sports worldwide and in our country. Additionally, doping scandals give rise to distrust in sports governance and public unease (Solberg et al. 2010). In this context, it is anticipated that longer-term qualified solutions should be found to increase the success of the fight against doping.

In line with the opinions of professionals in the sports environment, besides amateur and professional sports, in which areas should a long-term and effective struggle be carried out to purge doping from those who participate in sports at the exercise level, to accumulate anti-doping recommendations following Turkish traditions, customs, and cultural perceptions in order to install a clean sports environment? It is of utmost necessity to find an answer to this question. Research emphasizes the importance of cultural adaptation of intervention and preventive measures for a wide range of public health problems, such as health promotion, and drug abuse prevention (Burlew et al., 2013; Steinka-Fry et al., 2017). According to Barkoukis et al. (2022), doping intervention programs should target beliefs concerning legitimacy and social cognitive variables, consider cultural characteristics, and aim at specific beliefs about policy support in different countries.

This research aims to determine the current anti-doping situation in Türkiye based on the views of relevant stakeholders on anti-doping in sports. Moreover, the other purpose of this research is to determine the suggestions that can be presented to the field of Turkish sports management related to anti-doping in line with the findings obtained from the research. Therefore, understanding the opinions of stakeholders in the field, such as academicians, physical education and sports teachers, national team trainers, national team athletes about anti-doping, and several public institution employees constitute the sub-objectives of this research.

Being cognizant of the opinions and suggestions of the stakeholders in the sports field, such as sports scientists, teachers, trainers and athletes, and some public institution officials on the subject of prevention of doping in sports, is considered an important determining factor in the national anti-doping plan. Therefore, as the result of this study, it is envisaged to determine the situation related to the fight against doping in our country and make recommendations on the subject to reach the participants' opinions using mixed research methods.

The Main Problems of the Research

- To present anti-doping suggestions in compliance with Turkish tradition, customs, and cultural perception in line with the stakeholders' opinions in the sports environment.
- In which areas and in what kind of structure can a long-term and effective fight against doping be implemented?

Sub-Problems of the Research (Quantitative Stage)

- Which agencies can be involved in a national anti-doping program?
- According to Sports Stakeholders, what would be the most effective method of deterrence related to anti-doping?

Sub-Problems of the Research (Qualitative Stage) for the Sports Stakeholders;

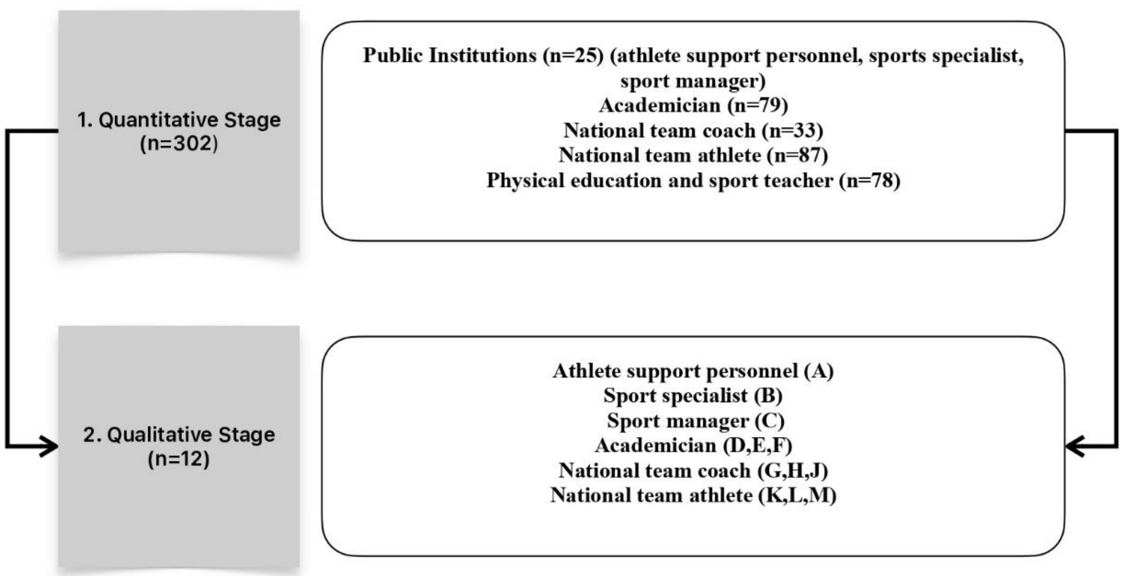
- What are their thoughts on the prohibition or release of doping-containing substances?
- What are their thoughts on the effectiveness of the penalty method in the fight against doping?
- What are their views on anti-doping policies around the world?
- What are their opinions and suggestions about the anti-doping activities carried out in our country?
- What are their recommendations for establishing a national anti-doping plan?
- Which institutions or organizations does it recommend for a national anti-doping program?
- What does anti-doping look like, according to sports stakeholders?

METHODS

Study Group

The study area of this research consists of public institutions, universities, national sports federations, and the Ministry of National Education (MNE) in our country. Three hundred-two people voluntarily participated in the questionnaires prepared for the quantitative research phase. In addition, semi-structured interviews were conducted with 12 participants, who were determined to understand and interpret the findings in depth. The purposive sampling method was used in the first stage to determine the participants, and as a result of the evaluation of the quantitative findings in terms of being suitable for the participant selection research design, the people who would participate in the qualitative dimension were determined with the criterion sampling sub-technique. The scoring system was used in the criterion questions in the quantitative questionnaires. Participants who scored highest from the determined criteria were invited to the qualitative stage. Permission was received from Akdeniz University Social and Human Sciences Scientific Research and Publication Ethics Board (The Project Code: 2021P162/16.04.2021).

Figure 1
Participant selection flowchart



Alphabetical nicknames were given to the participants simultaneously during the interview. In-depth interviews were conducted with 12 people: Athlete support personnel (A), sports specialist (B), sports manager (C), academician (D, E, F), coach (G, H, J), and athlete (K, L, M). The roles of the participants were taken into account since it is thought that the person's role may affect the personal opinion of the answers to the research questions.

Research Design

This research, designed with the mixed method, was constructed with the explanatory sequential design and participant selection sub-design. In order to be suitable for the design of the explanatory sequential model, a priority order approach was used in the data collection and analysis processes. In the first stage, a descriptive survey model (quantitative) was used, whereas in the second stage, descriptive case study-holistic multiple case study sub-pattern and discourse analysis designs (qualitative) were used. The mixing process was carried out in the discussion and conclusion section to connect quantitative and qualitative data. Looking at the whole of the research, following the purpose of the participant selection model, emphasis was placed on the qualitative aspect of the research (second stage). SCID-MMR was used while designing this research (Günbayı, 2020). Explanatory sequential design is a method in which the researcher conducts quantitative research, analyzes the results, and then develops the results to explain in more detail with qualitative research. This method is considered descriptive because quantitative data results are explained in more detail with qualitative data. It is considered sequential because the quantitative phase is followed by the qualitative phase (Creswell, 2014). The participant selection sub-design is used when the researcher focuses on qualitatively examining a phenomenon and needs quantitative results to identify the best participants (Creswell & Plano Clark, 2018). The holistic multiple case study design was used in the qualitative aspect of the study. The research collected data from different sample groups to reveal the views on the fight against doping, which is a holistic issue (Yin, 1984). In the qualitative phase of the study, linguistic analysis (discourse analysis) was included to reach deeper information and answer the qualitative questions to determine the participants' views on the fight against doping. Discourse analysis is a type of qualitative research in which the researcher uses language as an essential analysis method in understanding social events and forms of social relations (Özdemir, 2010).

Data Collection Tools

In this study, the data were obtained by questionnaire, in-depth interview, and metaphors. In the quantitative stage, consisting of open-ended, closed-ended, and multiple-choice questions, including personal information questionnaire forms developed by the researcher based on the opinions of experts, was used as a data collection tool. The level of doping knowledge and opinions on the fight against doping, five different 'Participant Information Questionnaire Forms' were applied to academicians, physical education and sports teachers, and national team trainers, the national team ahletes and some public institution officials. The forms contain different demographic information for each participant group, and there are two common questions about the fight against doping in all forms. These questions are as follows;

> Question 1: If a national anti-doping program was to be established in our country, which institution or institutions should oversee this program? (Please indicate by numbering from 1 to 5 in order of importance; Participant Information Questionnaire Forms)
>
> Question 2: In your opinion, what is the most effective method of deterrence regarding anti-doping in our country? (Options: Punishment, Reward, Education, Release of Prohibited Substances and Other; Participant Information Questionnaire Forms)

In the qualitative stage, a semi-structured interview form consisting of open-ended, indirect, and hypothetical questions and one metaphor question based on discourse analysis, developed by the researcher in consultation with experts, was used. These experts consisted of researchers experienced in mixed research methods and experts in doping. It aims to clarify the answers to the two common questions in the quantitative questionnaires related to the fight against doping, with the questions in the semi-structured interview form and the probe questions developed during the interview. The data were recorded with a voice recorder (Philips, DVT 1000).

Semi-structured Interview Questions;

- Question 1: What do you think about the prohibition or liberalization of doping substances? How? Why?
- Question 2: What do you think about whether the punishment method is effective in the fight against doping? How? Why?
- Question 3: What do you think about the adequacy of anti-doping policies worldwide? Why?
- Question 4: How do you evaluate the anti-doping activities in our country? Why?
- Question 5: If a national anti-doping program were to be established in our country, what kind of an action plan would need to be prepared? How? Why?
- Which institution or institutions do you think this anti-doping program could be under the management of?
- Question 6: If I asked you to compare the fight against doping to something, what would you compare it to? Why?

Data Analysis

Using the questionnaire form, the quantitative data obtained from the descriptive survey method were analyzed using descriptive statistics. Next, themes, descriptive, content, analytical generalization, and discourse analysis methods were used to analyze the qualitative data obtained using the semi-structured interview form. In the theme analysis, sub-themes were determined in line with the opinions received from the participants under the upper themes determined by the researcher within the scope of the problem sentences of the qualitative stage, and these themes were presented with a scoreboard. With the use of the descriptive analysis method, the aim is to understand and present the interview transcripts' major and sub themes related to the research problem with direct quotations. In this direction, the participants' views were associated with the themes presented and described with direct quotations. The content analysis determined the relationship between the participants' demographic characteristics and the themes, and the researcher's comments were included and interpreted. Finally, in the analytical generalization phase, the findings were discussed concerning the existing theory in the literature (Günbayı, 2019).

This study aimed to increase the validity and reliability of the research by using the data diversity method (data collection with survey, interview, and metaphors). Therefore, it was deemed appropriate to use credibility, transferability, consistency, and confirmability criteria to meet the study's eligibility criteria. Credibility is the researcher's clear presentation of how the researcher arrived at the said conclusions and presented the evidence in a way accessible to others. At this stage, the main themes and sub-themes were determined to ensure the study's credibility, and the existing pattern was tried to be given with the interviews. In addition, interview transcripts were shared with the participants, and participant confirmation was provided. Transferability is related to the generalization of the results of the research. Since there is no statistical generalization in qualitative research, analytical generalization has been made to the existing theory in the literature (Yıldırım & Şimşek, 2016). Finally, all the findings are given without comment to increase the research's consistency.

Moreover, the two researchers coded separately on the data obtained during the interviews, and the consistency rate (Kappa Value) was calculated by comparing the coding made with the coding of another person who did not know about the research. As a result, it can be asserted that the 0.86 Kappa Value found is in perfect agreement with the consistency of the research (Landis & Koch, 1977). Thus, the researchers determined that the coding was reliable and that internal reliability was ensured. Furthermore, to increase the research's external reliability (confirmability), all data collection tools, the coding made during the analysis phase, and the inferences that form the basis of the report were consulted with an expert on qualitative research.

RESULTS

In this part of the study, which was designed using the explanatory sequential mixed research method, the quantitative and qualitative findings related to the research problems were included. In the quantitative phase, it is discerned that the initial five responses elicited from participants originate from the Ministry of Youth and Sports, Ministry of Health, Federations, Council of Higher Education (CoHE)-Universities, and the Ministry of National Education, in that particular order. In the quantitative part, the participants emphasized that the most importance should be given to the method of education (n=175, 46.9%) and punishment (n=168, 45%) in the fight against doping. They stated that reward (n = 15, 4%) and other (n = 15, 4%) methods are less effective in anti-doping and deterrence in our country.

At the qualitative stage, the findings were obtained by using two different methods, namely, the data obtained as a result of individual interviews with the participants who were determined with the aim of understanding and interpreting the quantitative findings in-depth, and the data obtained as a result of the metaphor analysis. The participants' opinions on the prohibition or release of doping-containing substances take the first place on the theme of "unethical" (58.3%; Table 1). In this respect, one participant (C1, 1) remarked that: ...the use of doping brings unfair competition in sports, and the prohibition of its use will make this competition more legal.

Table 1
Findings Concerning the Prohibition or Release of Doping Substances

Ban-Release	A	B	C	D	E	F	G	H	J	K	L	M	Frequency (f)	Percentage (%)
Not being ethical	√		√	√				√	√	√	√		7	58.3
Does not differentiate between individuals				√			√				√	√	4	33.3
Protection of health				√		√	√		√				4	33.3
Banning is not the solution					√								1	8.3
Blocking accessibility		√											1	8.3
Raising awareness		√											1	8.3

Regarding the issue of whether the punishment method is effective in the fight against doping, the participants mostly expressed their opinions on the themes of "effective but insufficient" and "lack of prevention power" (Table 2). In this respect, participants remarked that:

> ...the punishment method is of course a deterrent. This is because it has a serious sanction for athletes or those who manage sports. In particular, there are deterrent methods such as bans from international competitions, very long-term bans or withdrawal of awards, but of course, only bans are not enough. Preventive measures should also be taken. (C2, 1)

> ...the penalties are not enough. Not enough in the sense that there should be more punishment, not enough. I don't believe that punishment has the power to prevent. (E2, 2)

Table 2
Findings Regarding the Efficiency of Punishment Method in the Fight Against Doping

Effect of Punishment Method	A	B	C	D	E	F	G	H	J	K	L	M	Frequency (f)	Percentage (%)
Effective but insufficient		√	√	√		√	√		√	√			7	58.3
Lack of prevention power	√				√	√	√						4	33.3
Presence of serious sanctions			√								√		2	16.6
Performance reduction	√										√		2	16.6
Stigmatizing the athlete and the branch								√			√		2	16.6
Enforcement of sanctions							√		√				2	16.6
Not being deterrent												√	1	8.3

Regarding the adequacy of the policies implemented in the world on anti-doping, it is understood that the participants expressed their opinions on the themes, stating that "inadequate because it cannot be prevented" and "the difference between countries" (Table 3). In this respect, participants remarked that: "E3, 1" ...for something to be enough, it has to be finished. You can't say it's enough if it's not finished. "C3, 2" ...some countries follow a method on doping, maybe as a country policy. I mean, recent examples of this were seen in Russia.

Table 3
Findings Regarding the Adequacy of the Policies Implemented in the World on Anti-Doping

Anti-doping in the world	A	B	C	D	E	F	G	H	J	K	L	M	Frequency (f)	Percentage (%)
Inadequate because it cannot be prevented				√	√		√			√			4	33.3
Difference between countries			√				√		√	√			4	33.3
The difficulty of fighting with powerful countries	√	√	√										3	25
Execution of comprehensive activities		√			√			√					3	25
Not being fair and transparent			√							√	√		3	25
The difference between theory and practice				√		√	√						3	25
Inadequacy of development		√			√								2	16.6
Sufficient and insufficient aspects											√	√	2	16.6
Sample collection problems	√												1	8.3
Presence of an institutional structure		√											1	8.3
Ineffective activities						√							1	8.3
Differences between laboratory results			√										1	8.3
Inadequate because it cannot be prevented				√	√		√			√			4	33.3
Difference between countries			√				√		√	√			4	33.3
The difficulty of fighting with powerful countries	√	√	√										3	25

The participants were asked to evaluate the anti-doping activities carried out in our country, and it was observed that they mainly mentioned the themes of "meticulousness in control" and "lack of knowledge and awareness" (Table 4). In this respect, participants remarked that:

> ...I know that there is much discipline in the work, the laboratories, the individuals who take samples related to doping, the organization that makes this organization, ... the work they do is independent of each other and very careful. Well, I know that they work very meticulously and have been doing this for years. ... That is why I think it is above world standards in Turkiye. (F4, 1)

> ...what is doping? What is not, or how does doping work? How it works, etc.... They don't have enough information. There is doping, yes. We can take

a doping test after we leave the competition. I didn't use drugs, etc. I'm not supposed to use drugs or I have to be careful at work. That's all there is to it. I mean, yes, you shouldn't take medication, but which medication should you not take and why? Why don't we know this, for example? If we don't know this, it is actually due to a lack of knowledge in general. There are very good trainings and seminars on anti-doping, but not all athletes this does not reach them. (P4, 2)

Table 4
Findings Regarding the Evaluation of Anti-Doping Studies in Türkiye

Anti-doping in Türkiye	A	B	C	D	E	F	G	H	J	K	L	M	Frequency (f)	Percentage (%)
Meticulousness in controls	√					√	√	√			√	√	6	50
Lack of knowledge and awareness					√	√			√	√			4	33.3
Good, but it can be improved.		√		√									2	16.7
Lack of control in recreational sports						√	√						2	16.7
More effective			√										1	8.3
Therapeutic drugs			√										1	8.3
Awareness raising			√										1	8.3

According to Table 5, the responses of the participants to the questions formulated as "In your opinion, what kind of action plan should be prepared if a national anti-doping program was to be established in our country? How? Why?" are primarily expressed on the themes of "guidance and education," "empathy," "budget" and "moral values." In this respect, participants remarked that:

...with education, they can be told that they have responsibilities both in terms of health and for the country if they are representing the country. But of course, this can be done through family, friends, coaches, athletes... ...from childhood, before they become famous, before they go to international competitions, from the very first moment they start... I think that apart from universities, from primary education, from the youngest ages, from the time they get a license in the federation, they should be trained... Maybe there could be a 4-week course on doping in much more detail. ...I think that especially the coaches of those young age groups, including parents, should receive very serious training. ...Teachers also need to be trained. If they take this child to a competition, they should also be informed about this issue. (D5, 1)

...it's very important to show the consequences of doing. Okay, you did it. You didn't get caught, but what happens after you get caught? There are many examples of this in the world. ... You are not the first to dope. You won't be the first one not to be caught and caught. ... One doped here in I don't know how many years ago, and this is how s/he is now. You have Ben Johnson, who went from being a role model for people in Canada in the courts to being on trial in the courts. He became a sensation in the world because he beat Carl Lewis, but what happened? Nobody is looking at him now. Everybody is judging him for doping. So we are trying to say, 'Overall, this is not going to bring you any profit, know that.' I mean, we show them examples, we show them lived stories. (E5, 2**)**

Table 5
Findings Related to Creating a National Anti-Doping Plan

National Action Plan	A	B	C	D	E	F	G	H	J	K	L	M	Frequency (f)	Percentage (%)
Guidance and education	√	√	√	√	√	√	√		√	√		√	10	83.3
Empathy	√				√		√	√	√	√			6	50
Budget		√	√		√		√		√				5	41.7
Moral values		√			√	√						√	4	33.3
Scientists and research		√	√			√							3	25
Reward and penalty regulation			√						√		√		3	25
Stakeholders			√		√		√						3	25
Psychology				√		√						√	3	25
Control mechanism							√		√			√	3	25
Supervised sales	√		√										2	16.7
Penalties and sanctions				√	√								2	16.7
Doping-free belief in success	√					√							2	16.7
Competitions			√		√								2	16.7
Science and technology		√											1	8.3
Policy and strategy document			√										1	8.3
International joint action			√										1	8.3
Moral punishments						√							1	8.3

According to Table 6, when the participants were asked about the institutions or organizations likely to be involved in the management of a national anti-doping program, it is understood that the participants mostly expressed their opinions on the themes of Ministry of Youth and Sports, "Ministry of Health," "National Sports Federations" and "TADC". In this respect, participants remarked that: "H6, 1", it could be the Ministry of Youth and Sports. It is a process that can move forward with the Presidency. I think it can be done with the Ministry of Youth and Sports. "J6, 2", ...the Ministry of Health, medicine, which examines the direct metabolic properties of our body, down to the smallest vessel. ... Together with doctors, doctors who are experts in this field...

Table 6
Findings Regarding Institutions and Organizations to Be Involved in the Administration of a National Anti-Doping Program

Institutions and organizations	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**Frequency (f)**	**Percentage (%)**
Ministry of Youth and Sports	√	√	√	√	√	√	√	√	√	√		√	11	91.7
Ministry of Health	√	√	√			√	√		√	√	√		8	66.7
National Sports Federations	√				√			√		√	√	√	6	50
Turkish Anti-Doping Commission of		√			√	√				√	√	√	6	50
Council of Higher Education (CoHE)-Universities and Professional Associations	√		√			√	√						4	33.3
Ministry of Education		√		√			√		√				4	33.3
A Multi-Stakeholder, Independent, New Board		√	√	√	√								4	33.3
Ministry of Internal Affairs		√					√						2	16.7
Turkish National Olympic Committee					√	√							2	16.7
Presence of Athletes in Management		√			√								2	16.7
Ministry of Agriculture and Forestry	√												1	8.3
General Directorate of Security							√						1	8.3
Cinema Industry										√			1	8.3

Metaphors

Participants were asked to generate metaphors about "anti-doping," and ten themes were found in line with the answers received. Participants mainly compared the fight against doping to "doctor" (18.2%). In addition, they explained the concept of anti-doping within the context of the metaphors of "cat," "detective," "ship," "war," "to knock one's head against a brick wall," "free diving," "world," "covid-19" and "gazelle." As seen from Table 7, the metaphors generated by the participants regarding the concept of "Anti-doping" were handled under six different categories. These categories are "dilemma," "weakness," "elaboration," "difficulty of the process," "need for time," and "protection of health." Some participants noted that:

Category 1: "Dilemma"

> ...the most recent example I can liken it to Covid. There is a society that believes that Covid exists. There is a society that believes it doesn't exist. ... The fight against doping is also like this. ...So there is a struggle, a struggle in its entirety. But it has its supporters and it also has its non-supporters. And this struggle may actually end with Covid, but the fight against doping will be a struggle that will exist as long as sport exists. (P7, 9)

Category 2: "Powerlessness"

> ...the fight against doping is really a very difficult thing. I mean, it's fought with good intentions, but it's not something that can get one hundred percent results. ... For example, imagine a river with crocodiles. Imagine a gazelle in it. I think that gazelle is the one who fights against doping. Because there are so many factors, the crocodile is around, I think they will prevent it. It will be seen as a visual struggle, but in terms of success, there are hundreds of factors, such as pharmaceutical companies that produce it, etc. I think they will also be crocodiles. ... The gazelle will die. Yes, the gazelle will die. Unfortunately. ... It may not die. It may jump across the road (M7, 10)

Category 3: "Elaboration"

> …...I would liken it to freediving, not scuba diving. In freediving, you hold your breath at the surface and you have to come back to the surface. But the deeper you go, the harder it is to get to the surface, and as the pressure increases, the oxygen in the lungs decreases. To put it diffeently, air decreases along with oxygen. That's why the depths are difficult. ... It is difficult, but it is also essential, that is, if success is to be achieved, it is necessary to go down to those depths and then come to the surface and get fresh air. (F7, 7)

Category 4: "The difficulty of the process"

...imagine you're on a stormy sea, you're struggling with something, there's a destination you want to reach but it's always dragging you backwards, I mean, you're on a boat, maybe you can create a metaphor like that. So there is a struggle, there is a destination you want to reach. But there are waves that constantly throw you off course, so you can look at it like that. ... You have set a goal. Zero tolerance, zero doping, clean sport, but there is also a process that keeps you constantly wobbling, unable to reach the goal, and we will wait for the sea to calm down or we will wait to get rid of the waves stronger and move towards the goal. But those waves sometimes overturn that boat, sometimes you get back on it and move on, but in the end there is a process that forces you to reach your goal... (C7, 4)

Category 5: "The need for time"

Well, one's escaping from prison. By digging a well with a needle, but s/he escapes. How else can we open it? Escaping from the prison in the metaphor is not a positive behavior, but when s/he works with determination, it works there too. (E7, 6)

Category 6: "Health protection"

..for example, a person with cancer. they are told not to smoke. we as parents or doctors tell them not to smoke because it will kill them. They smoke, though. They have such a habit in their head. So I can liken it like that. It is the same with doping. They say, "I'm going to harm my body, I'm going to ruin my body. We say don't do it, don't do it, but I can liken it to that. (J7, 1)

Table 7
Categorical Distribution of Metaphors Generated Regarding the Concept of Anti-Doping

Category	Metaphor code (MC) and metaphors	Number of participants generating metaphors
Dilemma	Covid-19 (MC 09) World (MC 07) War (MC 04)	3
Weakness	Cat (MC 01) Gazelle (MC 10)	2
Elaboration	Free-diving (MC 06) Detective (MC 02)	2
The difficulty of the process	Ship (MC 03)	1
Need for time	To knock one's head against a brick wall (MC 05)	1
Health protection	Doctor (MC 08)	2

DISCUSSION

Prohibition or release

Doping is unjust because it is unfair for a doping athlete to gain or attempt to do so by not paying the full price for what he/she owes for his/her own choice by exploiting others (Angelo et al., 2013). According to the participants, doping should be banned because it does not comply with the concepts of sports ethics, such as equality and fair play; it harms the health of the athlete and the public, and easy accessibility should be prevented. Participants stated that this prohibition should be equal and fair worldwide, not vary according to individuals and countries, and that if the prohibition varies according to people or countries, doping-containing substances can be released worldwide to ensure equality and justice. They also stated that it is essential to raise awareness and that a conscious athlete would not prefer substances containing doping despite being released. Moreover, according to participants, banning doping is not the only solution per se. In line with the content analysis conducted in the research, it is understood that most participants had similar views on the prohibition or release of doping.

The impact of the punishment method

According to the participants, the penalty method is a deterrent in the fight against doping due to its harsh sanctions and negative impact on the athlete and the branch before the public. However, since the method of punishment does not eliminate a behavior, it is not considered sufficient on its own, and it is understood that criminal sanctions are weak in preventing doping. Sports administrators, sports experts, and academics mostly think that deterrence can be increased with primary moral and value education instead of punishment since the punishment method alone does not have the power to prevent it.

Institutions and organizations

Regarding the other problem statement of the quantitative stage, the participants predominantly stated that the Ministry of Youth and Sports, Ministry of Health, National Sports Federations, (CoHE)-Universities, and Ministry of National Education should be the executive of a national anti-doping program in our country. Considering the answers given under the "institutions and organizations" upper theme in the individual interview held at the qualitative stage, researchers had the chance to understand and interpret the participants' views clearly.

According to the participants, a multi-stakeholder, independent, new institution for a national anti-doping program under the directorship of the Ministry of Youth and Sports, where athletes can also take part in decisions, can be established to make the fight more multi-faceted and more effective. As sub-stakeholders of the Ministry of Youth and Sports, the participants proposed the Ministry of Health for the health, laboratory, and equipment section, the Sports Federations and Turkish National Olympic Committee to ensure coordination, the TADC on issues such as doping controls, training of officials, information studies, CoHE-Universities and Professional Associations for education and scientific research, the Ministry of National Education for the training of groundwork athletes and physical education and sports teachers, the Ministry of Internal Affairs, Ministry of Agriculture and Forestry and General Directorate of Security for inspection activities, cinema sector for empathy studies. Following the "Ulusal Gençlik ve Spor Politikası Belgesi," which was approved by the Council of Ministers on 26 November 2012 and entered into force after being published in the Official Gazette on 27 January 2013 and is still in effect, the necessary planning regarding doping and the fight against doping has been specified in our country. Within the scope of the athlete health policy, the national stakeholders regarding the fight against doping are specified as the Ministry of Youth and Sports, the Ministry of Health, the Ministry of National Education, Media Outlets, Sports Federations, and Non-Governmental Organizations (Ulusal Gençlik ve Spor Politikası Belgesi, 2013). Policy Document objectives are mainly described with abstract explanations (Balcı et al., 2018). The necessary arrangements must be made and implemented.

The global anti-doping activities

Evaluating the anti-doping activities in the world and our country separately, the participant's statements, and comprehensive activities align with an organizational structure in the fight against doping globally. Compared to the past, the fact that activities are carried out under the tutelage of an institutional structure is considered a development. However, it has been stated that the struggle is incomplete and inadequate because of the different attitudes between the countries, the difficulty of struggling with solid countries, the problems in sampling, the ineffectiveness of the activities, the problems in taking samples, and doping continues to be an issue as of today.

The anti-doping activities carried out in our country.

According to the participants, our country's doping controls and sampling procedures are carried out with due diligence and attention by TADC. In recent years, with the provision of support personnel for athletes in amateur branches, awareness about doping has begun to be gained in our country. When we look at the past in our country, as in the world, the fight against doping has made headway, but it has aspects that can be improved. In addition, the participants stated that the lack of knowledge and awareness among athletes, trainers, parents, and teachers continues and that there is no control mechanism in recreational sports.

The majority of sports managers have expressed opinions on the sub-themes of "more effective," "therapeutic drugs," and "awareness-raising" regarding the anti-doping activities carried out in our country. It is observed that academicians have opinions on the sub-themes of "good but can be improved," "uncontrolled in recreational sports," and "lack of knowledge and awareness." In contrast, athletes have opinions on the sub-themes of "meticulousness in controls." In terms of the content analysis, it was determined that the opinions of the other participants on this subject were similar.

National Action Plan

It was observed that the participants predominantly focused on guidance and training activities to prevent doping. They expressed their opinion that anti-doping activities should be carried out in schools through the Ministry of National Education so that training can be given to raise awareness of young age groups, families, and teachers starting from the groundwork. According to Faggiano et al. (2008), universal, school-based intervention studies are the most frequently studied prevention approach. Thus, they stated that it is preferred because it offers the most systematic way to reach the highest number of young people every year. Participants stated that athletes should be taught moral values from a young age. For this purpose, guidance and training activities should be planned within the framework of a specific curriculum according to age groups. Backhouse et al. (2012) suggested in their work on anti-doping in sports that the formation of attitudes and values should be targeted at early ages and adapted to suit the developmental stage of the target population. They also stated that the intervention effect could be strengthened by offering activities based on support sessions over several years. Effective anti-doping education can reduce doping cases and, therefore, reduce sanctions (Exner, 2023). In addition, implementing and disseminating effective education programs is an urgent issue that needs to be addressed locally and globally (Backhouse et al., 2012).

Participants stated that creating empathy can be a very effective method for athletes. Psychologists have argued that empathy lies at the bottom of prosocial behavior and that the absence of empathy typically results in aggressive and winning behavior that ignores the rights or suffering of others (Feshbach, 1987; Miller & Eisenberg, 1988; Marshall & Marshall, 2011). Empathy is significant in human life because it stimulates changes in people's behavior. It is observed that people with different levels of empathy display behaviors in various ways (Kaukiainen,1999; Ersoy & Köşger, 2016). Participants will be given examples from the lives of famous athletes who have been punished for doping, making documentaries and movies, encyclopedias, etc. They suggested that resources should be created and these exemplary lives should be shared with young athletes. According to the participants, presenting the lived events effectively affects society and is thought to raise awareness.

The fight against doping is a global problem and, therefore requires interlinked approaches between countries and possibly between relevant organizations (Backhouse et al., 2009). Participants stated that to make the actions they propose in the fight against doping meaningful and applicable, an international understanding of joint action should be adopted, and the fight against doping should progress in a coordinated manner in all countries.

Participants stated that the government should create a budget and resources for training, laboratory, and equipment expenses within the scope of the fight against doping. In their study, Songün et al. (2015) stated, "a new national doping control center should be established, and human and financial resources should be provided by relevant government bodies to carry out routine doping controls of athletes in a healthy way."

Metaphors

It is thought that to obtain opinions about the fight against doping; the participants generated metaphors on the subject, which helped to reveal their thoughts more clearly.

CONCLUSION

In conclusion, it is perceived that doping-containing substances should be banned relatively and equally all over the world, as they are against ethical principles and adversely affect health, and the penalty method is a method that should exist in the fight against doping. However, is perceive revisions can be made to the penal regulation to strengthen the sanctions. In addition, the punishment method alone is understood not sufficient; education and guidance studies for prevention are more important. In the world, comprehensive activities are carried out in an institutional structure in the fight against doping, but there are some problems due to science and technology, especially in powerful countries. In our country, the fight against doping is partially more successful when compared to the world, but some dimensions need to be developed. It is necessary to establish a multi-faceted, independent anti-doping organization that includes all relevant stakeholders. It is necessary to develop and implement a policy and strategy for the fight against doping. It is necessary to implement and disseminate practical guidance and training programs aimed at reinforcing moral values and raising awareness. It is necessary to establish a control mechanism in the fight against doping and to carry out inspections for both athletes and those who exercise and play sports for health.

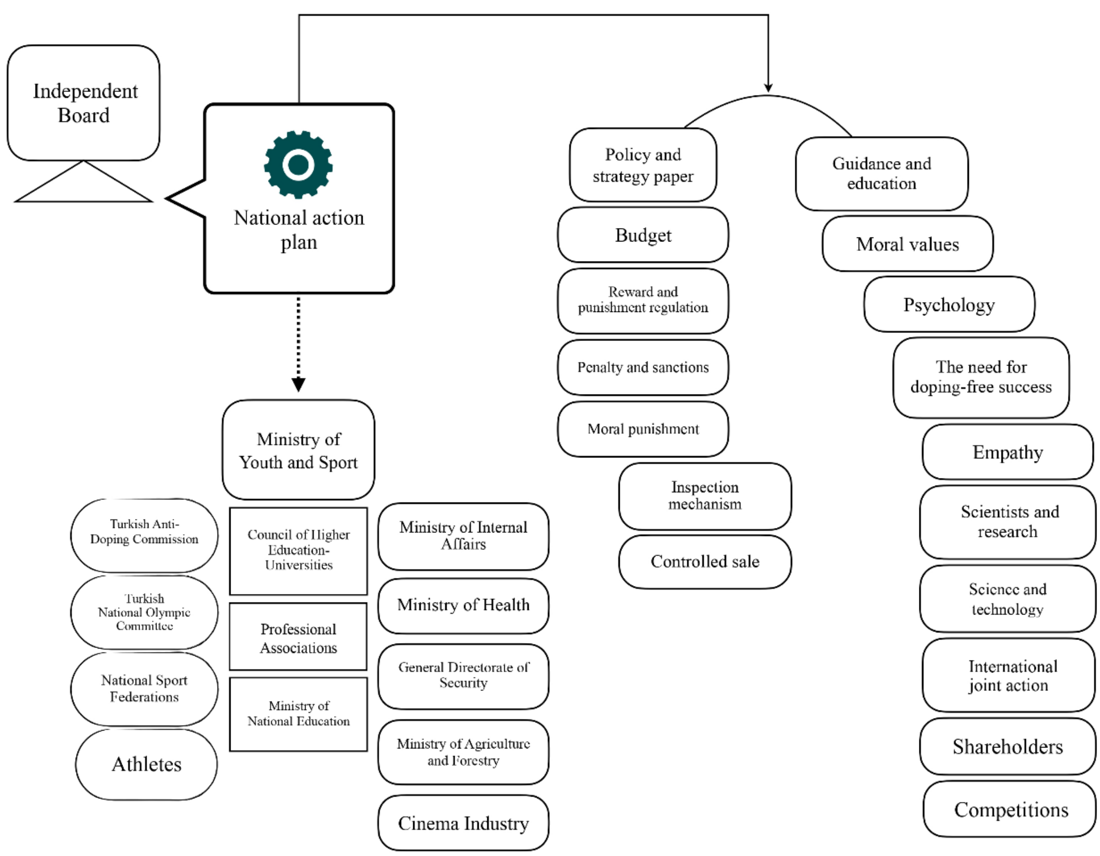
It is necessary to ensure the controlled sale of drugs used for therapeutic purposes containing prohibited substances. It is understood from the participants' opinions that, as a country strong in science and technology, it should have laboratory and testing facilities. As a result of the discourse analysis, it is understood that the fight against doping aims to protect health, but it is a complex and bilateral process. Furthermore, it has been understood that there are weaknesses in the fight against doping and that time and elaboration are needed to achieve success in the fight.

Furthermore, the collective perspective among participant groups regarding enhancing the efficacy of anti-doping efforts underscored the imperative of prioritizing educational and guidance initiatives. As a result of this study, it is thought that the current anti-doping situation has been determined. In this context, in light of the information received from the participants, the Anti-Doping National Action Plan Model is given below (Figure 2).

Figure 2

Anti-Doping National Action Plan Model

National Anti-Doping Action Plan Model



PRACTICAL IMPLICATIONS

In line with the results obtained from this study, some suggestions for practitioners and researchers are presented. Within the protocol framework, a new committee of representatives of the concerned sport's stakeholders can be established. Existing anti-doping policies and strategies can be strengthened and implemented. Budget arrangements can be made. Documentaries and motion pictures can be made, and resources can be created on athletes punished for doping. A curriculum can be prepared for guidance and training activities to raise awareness and strengthen moral values. Studies on the planning and executing guidance and training activities can be carried out. This research is limited to academicians, coaches, athletes, sports administrators, sports experts, and athlete support staff. Researchers can expand or diversify the research group in future studies by including different stakeholder groups.

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Authors' contributions

Both authors contributed design of the study, interpretation of the data and reported. The first author collected and analyzed data. The first and second authors are contributed to critical revisions and reviewing the results.

Conflict of interest declaration

No conflict of interest is declared by the authors.

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Pamukkale J Sport Sci, 14(3), 258-278, 2023 Research Article

Health-Related Work Loss: Wellness Profiles of Information Technology Employees

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ABSTRACT

Understanding health-related work loss and creating a comprehensive approach requires the identification of lifestyle behavior patterns. An essential part of this process is the examination of different profiles within the target population to develop effective intervention strategies. This study explored the wellness profiles of information technology (IT) employees regarding lifestyle behaviors and health-related work loss. The cross-sectional study surveyed 405 employees (174 women and 231 men) in six cities in Türkiye to examine lifestyle behaviors (exercise, nutrition, stress management, health responsibility, mental development, and interpersonal relations) and health-related work loss (presenteeism and absenteeism). Data analysis was conducted using independent samples t-test, ANOVA, multiple linear regression, and two-step cluster analysis. Regression findings indicated that physical activity, nutrition, and stress management behaviors statistically predict work performance in IT employees ($p<0.05$). The two-step cluster analysis showed four behavioral motivation clusters, including avoidance (no intention to change), intention (has the intention but no action), participation (has recently started), and maintenance (has become a habit). Certain lifestyle behaviors and clusters appear to be essential factors in health-related work loss among IT employees; thus, organizations that offer workplace wellness programs should prioritize these two issues. Clusters defined in this study could be used to help improve the wellness of IT sector employees.

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INTRODUCTION

As labor market trends in the information technology (IT) sector continue to evolve, there is a global increase in career opportunities for IT employees. This results in recruitment and retention challenges for organizations that employ skilled workers (Blatter et al., 2012). Specific sectors have offered alternatives to the traditional work structure regarding work organization and the nature of work (Mehta, 2022). Similarly, IT labor markets have quickly adapted to the changing skill needs and uncertain job situations. A workforce with digital skills can promptly adapt to novel situations, as the COVID-19 epidemic has demonstrated (Piroșcă et al., 2021). There has been a notable increase in the adoption of remote work among IT employees, with 50% reporting a shift towards flexible work arrangements (Franken et al., 2021).

Driven by the improvements in digital technologies, the evolving landscape of flexible organizational structures reshapes job dynamics. The flexible organizational structure requires low levels of hierarchy and new types of networking (Castells, 2014). In recent years, the rise of digital technologies has given way to innovative employment models such as crowd work and remote work facilitated by information and communication technology. This trend is viewed positively because it offers workers greater flexibility in where and when they work and presents job opportunities for individuals with caregiving responsibilities and disabilities (Rani & Gobel, 2022). In terms of income, IT employees earn higher salaries than other white-collar employees on average, according to the Coolever Life Turkey Report (Coolever, 2021). For these reasons, health-related work loss has more substantial economic impacts on employers.

Lack of engagement in healthy lifestyle behaviors causes a host of health issues, including lack of vitality, neck and shoulder pain, headaches, stomach problems, low back pain, mental issues, and sleeping problems (Ekpanyaskul & Padungtod, 2021). These are the most frequently reported symptoms resulting in work loss (Lee et al., 2021; van Den Heuvel et al., 2010). Health-related work loss refers to an employee's incapacity to execute job tasks due to health problems (Alavinia et al., 2009). It is classified into two main categories: failure of the employee to perform their tasks due to absence (i.e., absenteeism; Johns, 2008) and inability to fulfill their responsibilities fully or partially while at work (i.e., presenteeism; Johns, 2010).

While absenteeism is a well-known and easily quantifiable issue, presenteeism is a hazy and difficult-to-measure phenomenon. Whysall et al. (2018) demonstrated that sickness presenteeism and sickness absenteeism are positively correlated, indicating that employees tend to participate in both rather than replacing one with the other. To measure presenteeism, employers could assess factors such as reduced employee output, failure to maintain regular work standards, and mistakes in work (Ruhle et al., 2020). The cost of presenteeism and absenteeism has been measured in various studies. In a Dutch study of patients with rheumatoid arthritis, it was found that presenteeism accounted for 71% of the total costs (Braakman-Jansen et al., 2012). According to the UK Office for National Statistics, in 2016, 137.3 million working days were missed due to sickness and injury, and the average employee was estimated to be absent for 6.3 days per year (Kinman, 2019). Engaging in poor lifestyle behaviors resulted in chronic diseases, which are associated with higher levels of absenteeism and presenteeism.

The Transtheoretical Model (TTM) of behavior change, which is also known as the stages of change model, was first introduced by Prochaska and DiClemente (1983) and has since been widely used in health behavior research. The TTM proposes that behavior change occurs in a series of stages, including pre-contemplation (no intention to change), contemplation (has the intention but no action), preparation (has recently started), action (has made changes and is actively engaged in the behavior), and maintenance (has become a habit). The present study used the TTM to explain the identified clusters among IT employees. The TTM allows researchers to tailor workplace wellness programs to the specific needs of different groups of employees. Employees in the avoidance cluster may require other interventions than those in the maintenance cluster. These employees may benefit from educational interventions to increase awareness of the benefits of healthy behaviors. The study by Whysall et al. (2006) highlights the importance of targeting interventions based on stages of change. Their findings suggest that stage-matched interventions effectively increase the proportion of workers in the action and maintenance stages and reduce musculoskeletal pain. This finding is relevant to the present study in that it emphasizes the need for personalized interventions considering employees' wellness profiles. Tülin and İmamoğlu (2020) found that differences in nutrition levels are observed based on the stage of exercise behavior, indicating a need for nutrition education and lifestyle interventions to improve eating habits and physical activity levels. By referring to the clusters of employees based on their lifestyle behaviors, organizations and specialists can tailor their interventions to target the specific needs of each cluster. This may lead to more effective interventions and better outcomes in reducing health-related work loss.

Using the TTM to elucidate the identified clusters among IT employees is a strategic choice grounded in its theoretical robustness and applicability to health behavior research. While alternative frameworks exist in the literature, the versatility and comprehensive nature of the TTM make it particularly suitable for the present study, which focuses on IT employees and their lifestyle behaviors. This strategic selection enhances the theoretical foundation of the research, providing a framework that not only explains identified clusters but also offers practical implications for personalized interventions aimed at the IT sector.

Identifying clusters based on people's lifestyle behaviors helps to understand the patterns of behavior associated with health-related work loss. Organizations can design more effective employee wellness programs tailored to population needs by selecting the various clusters of employees with distinct motivation levels in order to change their behavior. Since wellness is a holistic concept, employee wellness programs should address employees' physical, emotional, social, spiritual, financial, and intellectual wellness (Silcox, 2016). Similarly, "wellness profiles" denote distinct clusters of IT employees based on their lifestyle behaviors. These profiles serve as a framework to tailor interventions effectively, recognizing that different groups may require varied approaches to enhance their health and wellness within the workplace. However, focusing on multiple lifestyle behaviors in interventions could result in economic and time loss. Therefore, determining lifestyle behaviors and tailoring are crucial for health-related work loss interventions. In light of this, the first objective of the present study is to examine the relationship between lifestyle behaviors and health-related work loss among IT employees. The second objective involves the identification of the wellness profiles of IT employees working in technoparks. To this end, the following research questions have been determined.

- *Research Question 1*: Is there a relationship between IT employees' lifestyle behaviors and health-related work loss?
- *Research Question 2:* Are there any statistically observed clusters regarding the lifestyle behaviors of IT employees? If yes, do the clusters statistically differ from the groups explored by exercise stages of change?

METHODS

Participants

After the Institutional Human Research Ethics Board approved (08/02/2017, 2107-EGT-014) the study, six Turkish cities (Ankara, İstanbul, Bursa, İzmir, Eskişehir, and Bolu), all home to technoparks that primarily employ IT employees, were identified. The selection of these cities aimed to capture a diverse representation of the IT sector within different regions of Türkiye. Then, the technopark webpages were accessed to collect the contact information of 650 companies and 5220 employees. The primary objective was to identify companies within these technoparks that primarily employed IT professionals. The information sought included the names and contact details of the companies and, by extension, their employees.

The employees were invited to participate in the study via e-mail. In total, 427 full-time IT employees volunteered to participate. Envelopes containing the paper-based surveys and consent forms were sent to employees who declared to participate in the study. They were also sent empty envelopes, and after completing the survey, the participants returned the survey and the form in sealed envelopes. This was done to protect private information.

It is important to note that all personal information collected during the study, including contact details and survey responses, was treated with the utmost confidentiality. Data were securely stored and accessible only to the research team, and any publication or presentation of findings, including personally identifiable information, was avoided.

The criteria for inclusion in the study were being employed full-time at a high-tech company located in a technopark and holding a university degree. Part-time employees were excluded from the study because they had a more flexible working schedule and might have had less workload, which could have led to bias in lifestyle behaviors.

Initial screening of the returned surveys indicated that the surveys of 405 employees (174 women and 231 men) were complete; only these employees were included in the study. The mean age of the women was 31.44±5.83 (min=22, max=48) years, and the men, 32.90±7.41 (min=23, max=52) years. The mean BMI was 22.44±3.39 in women and 25.39±3.05 in men.

Instruments

Healthy Lifestyle Behavior Scale-II (HLBS-II): The Healthy Lifestyle Behavior Scale-II (HLBS-II) measures lifestyle behaviors under six subscales. It is a 52-item questionnaire comprising health responsibility, physical activity, nutritional habits, stress management, mental development, and interpersonal relations (Walker & Hill-Polerecky, 1996). The reliability coefficients of the Turkish version of the HLBS-II are .77 for health responsibility, .79 for physical activity, .68 for nutrition, .79 for mental development, .80 for interpersonal relationships, and .64 for stress management (Bahar et al., 2008). The lowest and highest scores on the scale are 52 and 208, respectively. The stress management component of the scale has moderate internal consistency, as indicated by its Cronbach's alpha coefficient of 0.64. Typically, values of Cronbach's alpha above 0.7 are considered good, indicating strong internal consistency. However, values between 0.6 and 0.7 are still acceptable, suggesting moderate internal consistency (Taber, 2018). On the other hand, the overall scale has a higher Cronbach's alpha coefficient of 0.92, indicating strong internal consistency across all items in the scale. This suggests that the scale is a reliable measure of stress management. Higher total scores on the scale indicate better engagement in healthy lifestyle behaviors.

Exercise Stages of Change Questionnaire: The Exercise Stages of Change questionnaire examines a person's motivation to engage in physical activity (Marcus & Owen, 1992). Four questions are posed to explore the exercise stages of change on a binary scale (yes/no). The participants are categorized into five stages based on their responses: pre-contemplation (does not engage in regular physical activity and has no plans to do so in the future), contemplation (does not engage in regular physical activity but plans to do so in the future), preparation (has just begun to engage in regular physical activity), action (has not engaged in regular physical activity for more than one month but has engaged in it for less than six months), and maintenance (has participated in regular physical activity for longer than six months). The original instrument was validated by Haas and Nigg (2009). The validity and reliability study of the Turkish version was conducted by Cengiz et al. (2009). The analyses were conducted to test the criterion validity of the questionnaire. The test-retest internal consistency of the Turkish version was 0.80.

WHO Health and Work Performance Questionnaire: The World Health Organization Health and Work Performance Questionnaire (HPQW) is a self-administered instrument proposed to estimate the workplace costs of health problems in terms of work loss (presenteeism) and sickness absence (absenteeism). Participants rate their and their colleagues' performance in the presenteeism subscale. The sickness absenteeism subscale asks participants to report missing days that resulted in health problems in the last 30 days (Kessler et al., 2003). Kuru and Balkan (2019) adapted and validated the Turkish version of the questionnaire. The internal consistency of the Turkish version was found to be .82.

Data Analysis

All data were entered into SPSS (IBM SPSS Statistics 24). All participants with z-scores ±3 *SD* above or below the mean for one or more lifestyle behaviors were identified as the outlier group ($n = 4$) and removed. The lifestyle behaviors included in this assessment were health responsibility, physical activity, nutritional habits, stress management, mental development, and interpersonal relations. To address the first research question, multiple linear regression was used to examine the relationship between participants' healthy lifestyle behaviors and health-related work loss.

A two-step cluster analysis was used to address the second research question. Two-step cluster analysis is a statistical procedure to identify distinct sub-groups in the sample, and it involves two stages. In the first step, cases are grouped by constructing a cluster features tree. In the second step, the standard hierarchical clustering algorithm on the clusters is used (Norusis, 2011). Forming clusters hierarchically allows the researcher to explore a range of solutions with different numbers of clusters. This produces a range of solutions, which is then reduced to the best number of clusters based on Schwarz's Bayesian information criterion (BIC). The BIC is considered one of the most valuable and objective selection criteria, as it avoids the arbitrariness of traditional clustering techniques. When determining which variables to remove from the analysis, the one with the lowest BIC is preferred (Norusis, 2011). In the present study, sex (categorical), physical activity (continuous), nutrition (continuous), and stress management (continuous) were used in the first step of the analysis. In the second step, the sex variable with the lowest BIC was removed, and the analysis was conducted again. The results indicated four clusters.

To validate the cluster structure, a one-way ANOVA was conducted to assess the differences among the identified clusters. The one-way ANOVA aligns with the study objectives by providing a statistical test to evaluate whether the identified clusters exhibit distinct patterns in lifestyle behaviors. This approach enhances the robustness of the cluster analysis and contributes to the overall validity and reliability of the findings.

RESULTS

Research Question 1: Health-related work loss was treated as a single variable covering presenteeism and absenteeism as subfactors. The calculation of the work loss variable was done in line with the procedure provided by the instrument developers. Health-related work loss, encompassing both presenteeism and absenteeism as subfactors, was treated as a unified variable. The reason for merging these subfactors into a single variable was to provide a comprehensive measure of the impact of health-related work loss; the procedure was conducted according to the developers' instructions of the original instrument.

The presenteeism scores for women (19.97%±2.51) and men (17.96%±2.25) were not significantly different, $t(380) = -1.52$, $p = 0.13$. The average number of days per year for sickness absenteeism was 10.44 days for women and 7.28 days for men and significantly differed, $t = 1.767$, $p < .001$. Multiple linear regression results indicated that physical activity, nutrition, and stress management statistically predicted health-related work loss, F (6, 335) = 4.019, $p < .005$, $R^2 = .67$. Specifically, IT employees with better physical activity performance (B = ,037, SE = .229, p = .001), nutrition (B = ,039, SE =.146, p = .024), and stress management (B = ,034, SE = .121, p = .048) showed less health-related work loss at work (see Table I).

Table 1
Multiple Linear Regression Model for Predicting Health-Related Work Loss

Variables	*B*	Beta	*SE*	*p*-value	95% confidence interval for *B*	
					Lower Bound	Upper Bound
Constant	7.500			.001*	6.32	8.68
Physical Activity	0.037	0.213	.229	.001*	0.015	0.059
Nutrition	0.039	0.167	.146	.024*	0.005	0.072
Stress Management	0.034	0.121	.048	.028*	0.072	0.004
Mental Development	-0.010	-0.046	-.048	.547	-0.045	0.024
Interpersonal Rel.	0.019	0.068	.170	.300	-0.017	0.055
Health Res.	0.025	0.116	.107	.107	-0.005	0.055
Model significance	F (6, 335) = 4.019, p =0.001, *Adj.* R^2 = .59					

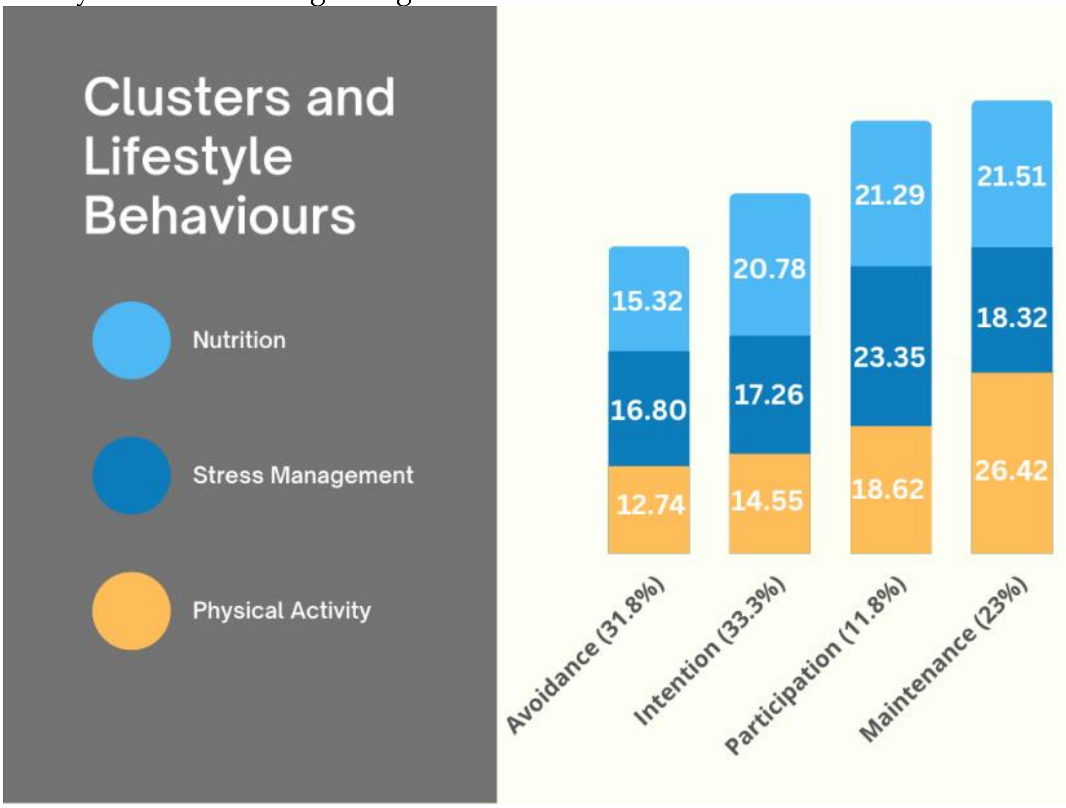
Note. * shows significant association

Research Question 2: The two-step cluster analysis identified four distinct cluster groups with a silhouette coefficient of 0.7. The silhouette coefficient, a widely recognized metric, was crucial in determining the optimal number of clusters. A higher silhouette coefficient indicates that the object is well-matched to its cluster and poorly matched to neighboring clusters. In the present study, the four clusters exhibited a silhouette coefficient of 0.7, indicating a high level of cohesion within each cluster and clear separation between clusters. This approach enhances the reliability and validity of the cluster analysis, ensuring that the identified clusters are distinct and meaningful in the context of IT employees' lifestyle behaviors.

The predictor importance of the variables was 1.0 for physical activity, 0.83 for nutrition, and 0.58 for stress management. Higher predictor importance indicates a more substantial contribution of the variable to the formation of clusters. In the analysis, physical activity had the highest importance (1.0), signifying its predominant role in distinguishing the identified clusters. Nutrition and stress management also held substantial importance (0.83 and 0.58, respectively), highlighting their relevance in differentiating lifestyle behaviors among the participants.

Of the 405 participants, 31.8% (n = 129) were classified as avoidance profile, 33.3% (n = 135) as intention profile, 11.8% (n = 48) as participation profile, and 23% (n = 93) as maintenance profile. A one-way ANOVA was conducted to validate the cluster structure. The one-way ANOVA results showed a statistically significant difference between groups [F (3, 371) = 224.35, p = .000]. A Tukey post hoc test revealed that physical activity behavior in the avoidance profile (12.75 ± 3.31) was significantly lower than that of the intention profile (14.55 ± 3.23, p = 0.003). Physical activity in the intention profile was significantly lower than the participation profile (18.62 ± 4.35, p < 0.001), and the participation profile was significantly lower than the maintenance profile (26.42 ± 3.23, p < 0.001; see Figure 1).

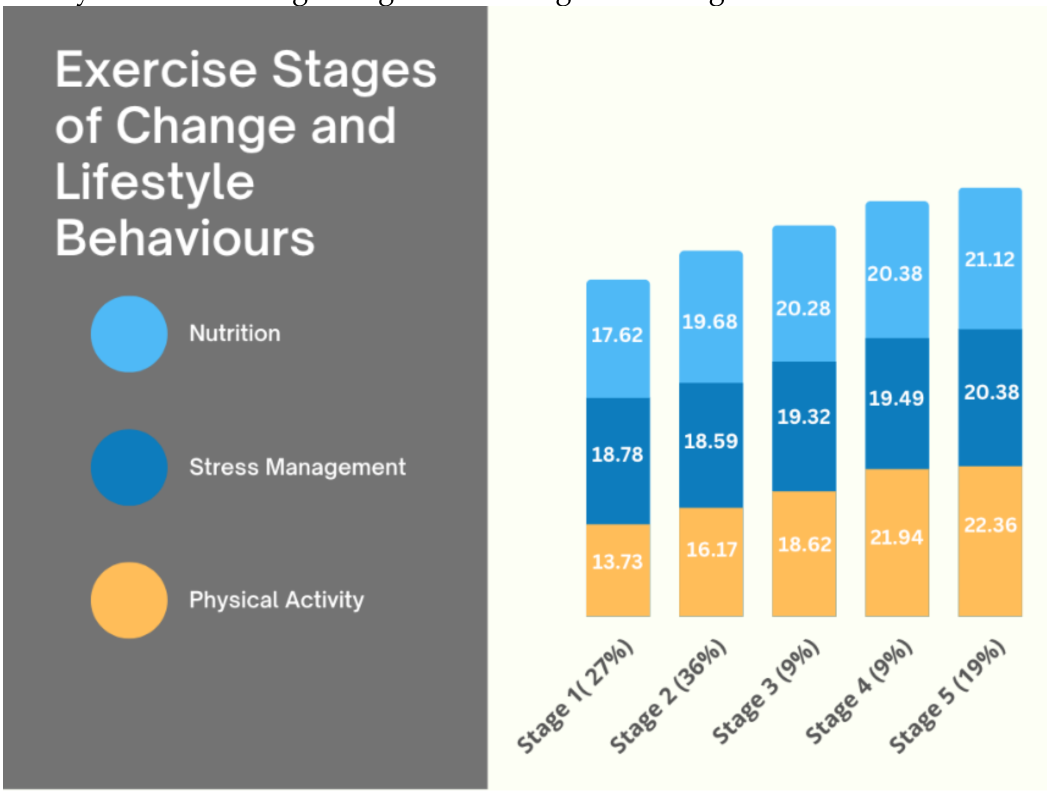
Figure 1
Lifestyle Behaviours Regarding Defined Clusters



The mean scores of the motivational clusters for physical activity, stress management, and nutrition showed an increase from the avoidance profile to the maintenance profile. The descriptive results revealed parallelism between the clusters and the exercise stages of change, with the scores of the variables increasing in both.

To determine whether the identified clusters statistically differed from the exercise stages of change, the latter were analyzed first. A statistically significant difference between the groups was determined by the one-way ANOVA [$F(4,373)$ = 40.64, p < 0.001]. A Tukey post hoc test revealed that Stage 2 (16.18±5.21) and Stage 3 (18.62±4.50) were not significantly different (see Figure 2). The comparisons indicated that Stage 1 (13.73±5.41) and Stage 2 (p = 0.02) were significantly different than Stage 3 (p<0.001), Stage 4 (21.94±2.86, p<0.001), and Stage 5 (22.36±5.20, p<0.001).

Figure 2
Lifestyle Behaviors Regarding Exercise Stages of Change



The results of the ANOVA indicated a non-significant difference between Stage 2 and Stage 3. The analysis revealed four statistically different groups by exercise stages of change—the same number as clusters. To understand whether the clusters and the exercise stages of change groups statistically differed, a dependent samples t-test was conducted with Cluster 1 and Stage 1, Cluster 2 and Stages 2-3, Cluster 3 and Stage 4, and Cluster 4 and Stage 5. The results of the analyses indicated that Cluster 3 and Stage 4; t (34) = -7.36, p = .000 and Cluster 4 and Stage 5; t (76) = 5.11, p = .000 were significantly different from each other. However, Cluster 1 and Stage 1; t (97) = -1.85, p = .067 and Cluster 2 and Stages 2-3; t (101) = -.909, p = .37 were not significantly different from each other. As a result, the following matching clusters and stages emerged: Cluster 1 and Stage 1, Cluster 2 and Stages 2-3 (see Table II).

Table 2
The Means and Standard Deviations of Statistically Matched Clusters and Stages

	Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 4**
Physical Activity	12.74±3.31	14.55±3.23	18.62±4.18*	26.42±3.23*
	Stage1	**Stage 2-3**	**Stage 4**	**Stage 5**
	13.73±5.41	15.00+3.79	21.94±2.86*	22.36±5.20*

*Indicates significant difference (p<0.05)

DISCUSSION

Research Question 1: The results showed that physical activity, nutrition, and stress management statistically predicted health-related work loss in IT employees.

The first predictor of health-related work loss is physical activity. According to studies, physically active people have higher health-related fitness levels and lower health risk profiles (Klemm et al., 2021; Ruiz et al., 2009; Sassen et al., 2010). Furthermore, they have a healthy body composition and a biomarker profile protecting them from cardiovascular disease and type 2 diabetes (Bassuk & Manson, 2005). Evidence shows that such individuals also have better sleep quality and health-related quality of life (Semplonius & Willoughby, 2018). Studies suggest that physical exercise has a beneficial impact on decreasing health-related work loss from the presenteeism perspective (Santos & Miragaia, 2023; Walker et al., 2017). Fitness programs reduce absenteeism and low physical activity levels positively impact sick leave (Proper & van Mechelen, 2008). Furthermore, poor physical activity and cardiorespiratory fitness increase medical care expenditure, a significant cost from the employers' standpoint (Pronk & Kottke, 2009).

The results of the present study reveal that there is a significant relationship between nutrition behavior and health-related work loss. Unhealthy eating habits have been found to cause a considerable economic burden regarding work loss arising from absenteeism and presenteeism (Grimani et al., 2019; Schultz et al., 2009). Previous research on workplace nutrition interventions involving counseling, education, and on-site group activities has shown that the interventions generally result in significant changes in employee nutrition behavior, improve physical and mental health, and lead to a positive return on investment by lowering healthcare costs and absenteeism (Grimani et al., 2019; Van Dongen et al., 2011). These findings are in parallel with the present study findings. Self-perceived health, self-reported absenteeism, work productivity, and job capacity have been mentioned as intervention outcomes in evaluating 21 workplace treatments (Rongen et al., 2013). The recognized advantages of contemporary workplace treatments are greater alertness and cognitive functioning, higher mental performance, and improved well-being (Drewnowski, 2020).

Stress management is the last predictor of health-related work loss identified in the present study. Stress management is vital in preventing health-related work loss because chronic stress can lead to various physical and mental health problems (Shea et al., 2021; Wickrama et al., 2021). When an individual experiences chronic stress, their body responds with a fight-or-flight response, leading to increased heart rate, blood pressure, and cortisol levels (Chu et al., 2021). Over time, these physiological responses can contribute to various health problems, including heart disease, diabetes, and depression (Dar et al., 2019; Moran et al., 2019). Past research has determined a link between stress and performance decline, unhappiness, a lack of motivation and dedication, and increased absenteeism and turnover (Ekienabor, 2016). Effective stress management strategies can help individuals to manage their stress levels and prevent burnout. Some examples of stress management strategies include exercise, mindfulness meditation, deep breathing, and time management techniques (Crivelli et al., 2019; Marais et al., 2020; Toussaint et al., 2021). By proactively managing stress, individuals can improve their physical and mental health, reduce their risk of burnout, and maintain their productivity and engagement in the workplace.

Research Question 2: The results of the two-step cluster analysis indicated four clusters for the sample regarding physical activity, nutrition, and stress management. The four motivational clusters were the avoidance profile, the intention profile, the participation profile, and the maintenance profile. The mean scores of the motivational clusters for physical activity, stress management, and nutrition showed an increase from the avoidance profile to the maintenance profile. The descriptive results revealed parallelism between clusters and exercise stages of change, with the scores of the variables increasing in both. Since the most critical predictor in the cluster analysis was physical activity, further statistical tests were conducted on physical activity behavior. Finally, the following statistically matching clusters and stages emerged: the avoidance profile and Exercise Stage of Change 1 and the intention profile and Exercise Stages of Change 2-3.

Research on effective interventions often involves identifying clusters of lifestyle behaviors. Poortinga (2007) and Schuit et al. (2002) found similar results in their studies on English and Dutch individuals, identifying four lifestyle risk behaviors: alcohol consumption, smoking, physical inactivity, and poor nutrition. Meanwhile, de Vries et al. (2008) discovered three distinct clusters in the Dutch population: healthy, unhealthy, and poor nutrition. More recently, He et al. (2021) conducted a lifestyle behaviors cluster study on adolescents in China, classifying them into low-risk, moderate-risk, and high-risk groups based on their behaviors. These clustering studies provide valuable insights for designing interventions that target specific groups with personalized approaches.

The stages of change model, also known as the transtheoretical model (TTM), provides a helpful framework for understanding behavior change and developing interventions tailored to individuals' needs at different stages of the change process. The significance of the stages of change model in this study is that it provides a theoretical framework for understanding the different levels of behavioral motivation among information technology employees and tailoring interventions to the specific needs of each group. For instance, employees in the avoidance cluster might benefit from treatments that raise awareness of the advantages of changing one's behavior. On the other hand, interventions that assist and motivate the individuals in the participation cluster to maintain their new behaviors may be beneficial. Adoption of lifestyle behaviors is correlated, and the desire to practice one behavior might influence the desire to practice others. According to earlier studies, progress in the exercise stages of change is linked to favorable changes in other health-promoting behaviors like exercise, proper diet, and stress reduction (McKee et al., 2007). The present study showed a motivation shift from physical activity to nutrition and stress management among the four participant clusters.

Thanks to the TTM, workplace wellness initiatives can be more successfully created and adapted to meet the unique requirements of various employee demographics. The TTM offers a valuable framework for comprehending behavior modification and creating interventions. Employers can create more effective workplace wellness programs tailored to the requirements of various employee groups by combining this model with the four behavioral motivation clusters described in the current study. This will improve employee health outcomes and decrease work loss related to illness.

According to the findings, the Exercise Stages of Change Questionnaire can be a helpful tool for defining subgroups of populations when researching physical activity, nutrition, and stress management among IT employees. This approach can be less burdensome than extensive surveys assessing multiple health behaviors, as the questionnaire focuses specifically on exercise behavior and can quickly identify individuals. By using this questionnaire to identify potential participants from the population, researchers can save time and resources that would otherwise be spent on conducting extensive screenings related to physical activity, nutrition, and stress management behaviors. This can be particularly useful when recruiting large samples for studies.

While the Exercise Stages of Change Questionnaire is a practical tool for identifying subgroups based on physical activity, the instrument's limitations and potential biases should also be acknowledged. Although the questionnaire efficiently identifies individuals' exercise behavior, its scope may not fully capture the intricate and multifaceted nature of behaviors related to nutrition and stress management. Addressing the limitations of the instrument ensures a more nuanced understanding of lifestyle behaviors among IT employees, fostering robust research outcomes and the development of tailored interventions.

The present study carries some limitations as well, which should be acknowledged. Firstly, the cross-sectional study limits the ability to establish causality between lifestyle behaviors and health-related work loss. The cross-sectional design highlights the importance of caution in attributing causal relationships between lifestyle behaviors and health-related work loss. The inherent limitations of a cross-sectional approach restrict the ability to establish definite causality. While the findings reveal significant associations, interpreting these as causal should be approached judiciously, considering the inherent constraints of correlation-based evidence.

Secondly, it is unclear whether the sample of employees who responded to the invitation to participate in the study represents all IT employees working in technoparks in the six cities or whether they represent the broader population of IT employees in Türkiye. To enhance the generalizability of the findings, future studies should adopt more robust sampling strategies and delineate the target population.

Additionally, the response rate of 8.2% (427 out of 5220) raises concerns about the potential for non-response bias, where individuals who chose not to participate in the study may differ systematically from those who did participate. Potential factors contributing to disparities between respondents and non-respondents in assessing external validity could include demographic variables, motivational factors, and the mode of data collection. Further investigation may provide insights into the nuanced dynamics affecting participation rates and help refine the research methodology.

In addition, the study relied on self-reported data, which may be subject to social desirability bias and may not reflect the participants' actual behaviors. While self-reported data was used in the present study, it is imperative to delve deeper into the potential impact of social desirability bias on the results. To address this concern, rigorous measures were implemented during data collection to minimize bias. Participants were assured of the confidentiality and anonymity of their responses, fostering an environment conducive to honest reporting. Explicit instructions emphasized the importance of candid and accurate answers, aiming to mitigate the potential influence of social desirability bias on the obtained data.

Finally, the study was conducted in Türkiye, and the results may not be generalizable to other populations or contexts. Acknowledging that cultural and contextual factors may significantly shape health-related behaviors is essential. To address this, future research should explore potential cultural nuances and contextual variations that could impact the applicability of the study's conclusions beyond the Turkish setting. Recognizing the importance of cultural sensitivity in health-related research is paramount, and further investigations in diverse cultural and contextual settings will contribute to a more comprehensive understanding of the relationships explored in this study.

CONCLUSION

The findings of this study have several implications for researchers who intend to design employee wellness programs. Researchers should prioritize physical activity, nutrition, and stress management behaviors in their wellness programs, as these seem to be the most significant predictors of health-related work loss. They should tailor their wellness programs to the specific needs of different behavioral motivation clusters. This personalized approach could increase the engagement and effectiveness of wellness programs. Additionally, researchers should conduct regular evaluations to assess the impact of such programs on health-related work loss and make necessary adjustments. Furthermore, it is crucial to customize these programs according to the distinct needs of various groups of employees.

While emphasizing the potential benefits, it is crucial to acknowledge the challenges associated with conducting longitudinal studies and incorporating objective measurement instruments. Longitudinal studies demand substantial time and resources, and participant attrition can pose a significant challenge. Additionally, using objective measurement instruments such as fitness trackers requires careful consideration of participant adherence, data privacy, and potential biases introduced by the technology. These challenges should be factored into the design and execution of future research efforts. Future research could supplement self-reported data with objective measurement instruments like fitness trackers. Finally, similar studies could be conducted in other populations and contexts to expand our understanding of the impact of workplace wellness programs on health-related work loss.

PRACTICAL IMPLICATIONS

To increase the effectiveness of employee wellness programs and minimize health-related work loss, organizations should prioritize integrating components centered on physical activity, nutrition, and stress management, as these factors heavily influence workplace absenteeism and presenteeism. Secondly, a personalized approach tailored to different motivational clusters is recommended for enhancing engagement and effectiveness of wellness programs. Customizing interventions based on individual needs can provide more targeted and impactful outcomes. Lastly, researchers and practitioners should incorporate periodic evaluations into wellness programs. Continuous assessment allows for dynamic adjustments of interventions and ensures sustained positive impacts on employee health and productivity over time.

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Authors' contributions

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.

Declaration of conflict of interest

The authors declare that there is no conflict of interest.

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Pamukkale J Sport Sci, 14(3), 279-296, 2023 Research Article

Investigation of the Validity and Reliability of Two Smart Bands Selected That Count Steps at Different Walking Speed

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ABSTRACT

Whether activity monitor smart wristbands that have become widespread can accurately estimate the step count while walking is a matter of curiosity. The current study aims to analyze the validity and reliability of step count (SC) estimation at normal walking and fast walking pace under controlled conditions of two selected smart wristbands of the leading wearable device vendors, Xiaomi (Mi4) and Huawei (H4). Twenty healthy adult male and twenty healthy adult female were included in the study and analyzed separately. The mean age of male and female participants was 22.25 and 21.62 years, with BMI values of 24.22 kg/m^2 and 21.42 kg/m^2, respectively. The above-ground walking protocol consisted of four separate five-minute tests: Normal Walking Test, Normal Walking Retest, Fast Walking Test, and Fast Walking Retest. In the study, the analyses were performed by using activity monitor measurements and criterion measurements (the number of steps determined from video recordings), compatibility of test-retest measurement values, error indicators (MPE and MAPE), Intraclass Correlation Coefficients (ICC), and Bland-Altman limits of agreement. According to the current study results, it was revealed that the MAPE values recorded for Mi4 and H4 smart wristbands for both normal and fast walking pace in male and female participants were <5%, which was deemed excellent. According to all analyses, the H4 device was found to be valid and reliable, but according to ICC and Pearson Correlation analyses, the Mi4 device was not found to be valid and reliable at fast walking pace.

INTRODUCTION

The number of wearable devices like smart watches and wristbands has more than doubled worldwide in three years, increasing to 325 million in 2016 and 722 million in 2019. The number of wearable devices, whose commerce market has been growing rapidly, is estimated to have exceeded one billion by 2022 (Statista, 2022). Without the need for expensive laboratory-level equipment, electronic devices that can be worn or carried on the body enable individuals to measure and monitor such physical activity (PA) as step count (SC) and distance, kilocalories, sleep, and other health-related measures quickly, inexpensively, and objectively through powerful microchips using unique algorithms and smart sensors (An et al., 2017; Dobkin & Martinez, 2018; Evenson et al., 2015). Among these outputs, SC and distance measurements while walking are considered the most popular and transformable outputs used today (Bassett et al., 2017; Carlin & Vuillerme, 2021).

Activity tracker smart wristbands are less expensive than a smartwatch due to less expensive hardware and often fewer sensors. Therefore, they usually have better battery life but a limited interface to view monitoring results (Henriksen et al., 2018). The subset of consumer wearable devices used to monitor physical activity and fitness-related measurements are called "activity monitors" or "fitness monitors" (Evenson et al., 2015). Activity monitors can be easily synchronized via a smartphone or computer application and thus can provide continuous PA measurements over weeks, months, or years (Hartung et al., 2020).

Exercise and health researchers also use these popular electronic devices to monitor and facilitate PA behavior changes (Topalidis et al., 2021). Despite the widespread sales and popularity of these wearable fitness monitors over the past decade, which monitor PA and provide feedback at appropriate intervals, the assessments in terms of their use, accuracy, or consistency remain insufficient (Bunn et al., 2018; Dooley et al., 2017).

The most common brands whose validities are most commonly analyzed are Fitbit, Apple, Jawbone, and Garmin, which are quite expensive and beyond the financial means of a significant segment of society. Although the number of published studies on assessing well-known activity monitors has increased (Bunn et al., 2018), only a few studies have addressed low-cost activity monitors (Carlin & Vuillerme, 2021; Xie et al., 2018). These devices are cheaper than $50 (Amazon, 2023). Some recent analyses have revealed that some metrics for activity monitors are accurate enough to measure PA in research settings (Shin et al., 2019; Straiton et al., 2018).

In most studies, there is a lack of consistency among the published validation protocols. This limits valid comparisons among devices. Current articles recommend comprehensive and transparent verification of the devices to ensure that wearable technology can be used safely and to its full potential (Johnston et al., 2020; Silfee et al., 2018). It was found that some of the studies on new, popular, and inexpensively available activity monitors lacked such procedures as gender-separate validity and test-retest reliability, which are commonly recommended in the relevant research protocol guidelines (Johnston et al., 2020).

This study tries to eliminate what the related literature lacks. It aims to analyze the validity and reliability of SC estimation at normal walking and fast walking pace under controlled conditions of two selected smart wristbands of the leading wearable device vendors, Xiaomi (Mi4) and Huawei (H4). This analysis was performed separately with adult male and female data. This research method and its results are necessary to use these devices more safely in scientific research PA monitors. The data obtained in the current study are deemed significant in terms of allowing comparing with similar studies to be conducted. With the current study's data, it is estimated that the use of these technologies in PA research will increase, and the accessibility of PA data of large populations with more accurate methods will be enabled.

METHODS

The participants were given an oral explanation of the protocol before signing written informed consent to participate in the study, and they were presented with the opportunity to ask questions (Kastelic et al., 2021). While preparing the study method and applying the study protocol, the guidelines of the Consumer Technology Association (CTA) and the best practice protocols for the validation of wearable step counters recommended by Towards Intelligent Health and Well-Being Network of Physical Activity Assessment (INTERLIVE) were taken as a basis (CTA, 2016; Johnston et al., 2020). This study was approved by the decision of Clinical Research Ethics Committee in Uşak University Faculty of Medicine dated 25.05.2022 and numbered 84-84-10, and it was conducted in accordance with Helsinki Declaration.

Study Group

Based on previous studies on the subject, we determined that at least twenty (20) male and twenty (20) female participants were sufficient in order to collect valid data (Carlin & Vuillerme, 2021). All the participants completed the walking tests. Healthy adult male and female students studying at a university in the Western region of Türkiye were invited to participate in the study through direct invitation. All participants were students studying in the Coaching Education Department and Sports Management Department. A few were licensed athletes, but no tests were applied to determine their physical activity levels. Several criteria were determined as the inclusion and exclusion criteria per the recommendations of previous studies. The inclusion criteria were having Body Mass Index (BMI) values less than obesity (<30 kg/m^2), being an adult between the ages of 18-64, and being physically healthy. Obesity, old age, and physical problems were assumed to affect walking movement. These differences should be the subject of research in other studies (Johnston et al., 2020).

The exclusion criteria that negatively affected the participants' walking exercise were pregnancy and having an implanted electromagnetic device (An et al., 2017), neurological diseases and cognitive problems reported by the individual, any musculoskeletal injuries and/or surgeries that may have affected walking, and other problems that may affect the individual's walking ability (Svarre et al., 2020).

The participants that the researchers determined through interviews gave informed written consent before starting the walking tests and completed and signed the standard Physical Activity Readiness Questionnaire (PAR Q). After that, the following demographic and anthropometric data of the participants who were deemed suitable for walking tests were obtained by the researcher through the interview method, and they were written down in the Demographic Information section of the Case Report Form: The number, gender, age, height, body weight, and dominant arm information of the participant (Carlin & Vuillerme, 2021). During the following days, their walking tests were performed on flat ground by making appointments with each of them. The researchers calculated their BMI based on the self-reported heights and body weights of all the participants. The participants participated in the exercises by wearing non-high-heeled shoes and seasonal casual clothes that would not negatively affect their walking patterns. All the participants were physically, cognitively, and spiritually healthy. All but one participant were dominantly right-handed participants. All the participants were Turkish-origin individuals. The data of the study were collected in May 2022. The characteristics of the participants are presented in Table 1.

Data Collection Tools

Activity Monitors: According to the information shared by IDC, the companies that sell the most intelligent wristbands in the Middle East, Türkiye, and Africa are Huawei and Xiaomi (IDC, 2022). For the research, we chose two consumer activity monitor devices that were widely used due to their affordable costs. During the walking tests, an interface was selected on which only the day, time, and step count information would be displayed on the screens of Mi4 and H4, which are the activity monitors.

Mi Band 4 (Mi4; Model: XMSH07HM, Xiaomi Comminations Co., Ltd.) is an activity monitor smart wristband considered a low-cost wearable device. It measures the number of steps through the 3D gyroscope and the 3D accelerometers. The Chinese technology giant Xiaomi announced through its official Twitter account on 09 Jul 2020 that Mi4 had become the world's best-selling smart wristband (Xiaomi, 2022). Mi4 was activated by connecting to the Mi Fit (version: 3.6.0) mobile application installed on an Android phone via Bluetooth.

Huawei Band 4 (H4; Model: ADS-B29, Huawei Technologies Co., Ltd.) is an activity tracker smart wristband considered a low-cost wearable device. It includes a pedometer function that measures the number of steps through the 3D accelerometer. It works with an Android 4.4 and higher operating system or iOS 9.0 and higher (Huawei, 2022). H4 was activated by connecting to the Huawei Health (version: 10.1.1.312) mobile application installed on an Android phone via Bluetooth.

Data Collection Process

Considering the guidelines of the Consumer Technology Association (CTA) and the recommendations of related scientific studies, the exercise duration was determined as five minutes to allow the participants to reach steady-state measurements (CTA, 2016). In order to allow comparison, two different exercise intensities were determined: 'normal walking' and 'fast walking'. Besides, test-retest walking was performed at each walking speed for device consistency specified in related research recommendations (Johnston et al., 2020). Therefore, the on-ground walking protocol included four separate tests. These were the Normal Walking Test, Normal Walking Retest, Fast Walking Test, and Fast Walking Retest.

During each test, the walking was performed on a 32-meter long and 2-meter-wide line with smooth turning points to avoid sharp turns. Turns from right to left did not have a negative effect on the walking pace. During the Normal Walking test and Normal Walking Retest, one of the researchers reminded the participants that they should walk at their standard daily walking pace. During the Fast-Walking Test and Fast-Walking Retest, one of the researchers also reminded the participants that they should walk faster than their average daily walking pace. Another researcher checked the duration of the walking tests with a chronometer (Slx 7061, Selex). The researcher counted aloud the last 10 seconds of the five-minute duration to enable the participant to slow down and stop at the last second.

During all the walking tests, the participants were made to wear the two smart wristbands on their non-dominant wrists simultaneously, just as in similar studies. The two smart wristbands were placed proximal to the radial and ulnar bones and dorsal to the wrist (Carlin & Vuillerme, 2021). While the order of the wristbands was Mi4 and H4 from proximal to distal for half of the male and female participants, the order of the wristbands was H4 and Mi4 from proximal to distal for the other half of the participants.

Before initiating the test applications, all the protocol details were explained to the participants to avoid any interruptions during the protocol, and their questions were responded. To check whether the wristbands were working before testing, the researcher asked the participant to walk towards the starting point. The researcher observed the screen to make sure the activity monitors were active. Before the participants began walking, the number of steps on the Mi4 and H4 smart wristband screens was recorded as the start-up number, and the screens of the activity monitors were photographed at the beginning of the walking line on flat ground. At the end of the five-minute walk, the current step count on the smart wristband screen was recorded as the final number. At the same time, the participants stood in an upright and stable position, and the screens of the activity monitors were photographed. Then, the data saved in the Excel file on the computer were checked by comparing the relevant photos. The difference between the start-up and final numbers obtained in each walking test (the final number minus the start-up number) was calculated as the estimation score of the smart wristband’s walking steps. This procedure was repeated for each participant and the four walking tests separately. At the end of the walking, the total number of laps that each participant walked (one lap is 68 meters) and the distance of the last step in the last lap were calculated, and the total distance was recorded in meters. Later on, the walking speed was calculated as km/hour. After each test, the participants were given a two-minute rest period to complete the procedures.

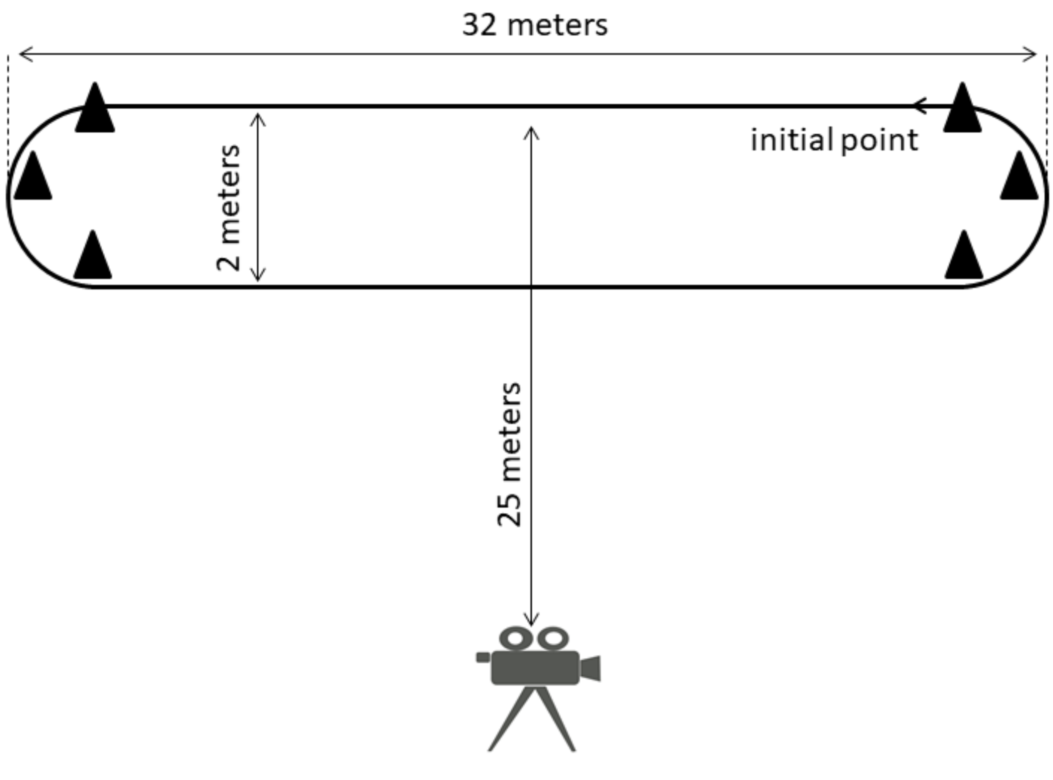
Criterion Measure

As used in previous similar studies, video-based step count was used as the gold standard for actual step count (Johnston et al., 2020; Carlin & Vuillerme, 2021). A video camera (Samsung S7 Edge mobile phone) was determined as a criterion and convergent measurement. Video recordings were made in HD quality with a frame width of 1280, frame height of 720, data speed of 12014 kbps, frame rate of 30 fps, and in mp4 format. The recording device was used by fixing it on a tripod at a distance of 25 meters so that the entire 32-meter walking track would fit on the recording screen (Figure 1).

Video recordings of all the walking tests were numbered separately and transferred to the computer. When the video recordings were opened on the computer monitor (15 inches), it was observed that all the step movements of the participants were clear throughout the entire track. In situations of uncertainty, when it was unclear whether any steps were performed or not, and when it was challenging to follow fast steps, the video was viewed in slow motion. The step definition was accepted as "the act of raising one foot and placing it elsewhere, which results in altering the body mass center" (Johnston et al., 2020). In our study, following this definition, the participant who was ready with both feet parallel to each other before starting to walk, started walking by taking the first step forward with the researcher's "start" instruction. At the end of the time, the participant took the last step forward, transferred his weight, and released the other foot behind. Thus, a repetitive body load transfer was prevented.

Video-based step count was conducted independently by two observers; in case of inconsistency between the step counts obtained by the observers from the video recordings, the two observers repeated the step count, and after reaching a consensus, the actual number of steps (criterion) was recorded in an Excel file on the computer.

Figure 1
Walking Track and Video Recording



Data Analysis

Descriptive statistics were determined, and the step count errors recorded in each activity monitor were calculated as follows:

- Step count error = [(measured steps – actual steps) / actual steps] x 100
- Other definitions are as follows:
- Measured steps are the value of the steps provided by the activity monitor.
- Actual steps are the number of steps counted manually from the video.
- Walk distance is measured using a measuring tape on the walking track (this was only used with duration to determine walking speed).
- Walking time is the time measured by the chronometer and video recording.

Statistical analyses were performed using Microsoft Excel and SPSS 24.0 (SPSS Inc., Chicago, IL, USA). In this study, previously published recommendations were considered to assess the validity of the activity monitors in the male and female participants separately (Johnston et al., 2020; Kastelic et al., 2021). In the study, the measurements of the activity monitors and their criteria measurement fit (step counts determined by the video recordings) were performed by using test and retest measurement values fit, error indicators, Intraclass Correlation Coefficients (ICC), and Bland-Altman agreement analysis limits. Mean Percent Error (MPE) was calculated to investigate group-level agreement, step count estimation, and error direction. Mean Absolute Percent Error (MAPE) was used to investigate the agreement at the individual level. ICC was used to measure the extent of the agreement between the activity monitors and the criteria measure. Since the duration in test and retest measurements is constant, but the speed is relative, albeit slightly, differences in the number of steps may negatively affect the fit, so Pearson Correlation analysis was performed with the error indicator MPE data. For reliability, by taking the Pearson Correlation Coefficient into account, the fit value was accepted as ≥0.75 perfect, 0.60-0.74 good, 0.40-0.59 moderate, and <0.40 poor in fit analyses (Cicchetti, 1994). Parameters for creating Bland-Altman plots were calculated to investigate the systematic and random error. The normal distribution of mean and percent error data was confirmed by the Shapiro-Wilk test. The statistical significance was accepted as $\alpha<0.05$.

RESULTS

All 20 male and 20 female participants in the study completed the procedures. Table 1 describes the characteristics of male and female participants. Previous studies on the subject used the walking speed of 4.8 km/h, assuming that it represented the normal walking speed (Clemes, et al., 2010; Steeves et al., 2011). In our study, the mean normal walking speed was 3.9 ± 0.4 km/h in male participants and 3.6 ± 0.4 km/h in female participants. The mean fast/paced walking speed was 6.6 ± 0.5 km/h in male participants and 6.1 ± 0.4 km/h in female participants. The test results obtained represent these realized speed ranges.

As could be seen in Table 1, the mean age of male participants was 22.25 years (Sd ± 4.56), their mean height was 1.77 meters (Sd ± 0.04), and their mean body weight was 76.42 kg (Sd ± 8.18), with a BMI value of 24.22 kg/m² (Sd ± 2.48). The mean age of female participants was 21.62 years (Sd ± 2.57), their mean height was 1.64 meters (Sd ± 0.57), and mean body weight was 58.00 kg (Sd ± 6.62), with a BMI value of 21.42 kg/m² (Sd ± 2.68).

Table 1
The Characteristics of the Participants

Gender	Characteristics	N	$\bar{X}$	Sd	Min.	Max.
Male	Age (years)	20	22.25	4.56	19	40
	Height (m)	20	1.77	0.04	1.70	1.85
	Weight (kg)	20	76.42	8.18	57.40	89.30
	BMI (kg/m²)	20	24.22	2.48	18.74	28.33
Female	Age (years)	20	21.62	2.57	19	29
	Height (m)	20	1.64	0.57	1.55	1.76
	Weight (kg)	20	58.00	6.62	45.50	71.00
	BMI (kg/m²)	20	21.42	2.68	16.03	27.39

Note. BMI: Bady Mass Index

As could be seen in Table 2, it was found that the compatibility of the Mi4 device according to the criteria step count at normal walking pace was excellent with 83.1% in male participants, and good with 71.6% in female participants. It was also found that the compatibility of the H4 device was good with 70.5% in male participants and good with 70.2% in female participants according to the criteria at normal walking pace. Besides, according to the criteria at fast walking pace, the compatibility of the Mi4 device was found to be poor with 44.2% in male participants and poor with 39.7% in female participants. In contrast, the compatibility of the H4 device was found to be moderate with 59.2% in male participants, and good with 63.1% in female participants according to the criteria at fast walking pace.

Table 2
MAPE Values and Intraclass Correlation Coefficients (ICC) Analysis of the Activity Monitors in Male and Female Participants According to Their Walking Paces

Walking Paces	Devices	Gender	MAPE	Intraclass Correlation Coefficients	ICC Value	ICC P
Normal Walking	Mi4	Male	2.18	.831	5.926	**.000****
		Female	0.11	.716	3.521	**.004****
	H4	Male	1.20	.705	3.386	**.005****
		Female	0.85	.702	3.361	**.006****
Fast Walking	Mi4	Male	0.86	.442	1.791	.107
		Female	2.47	.397	1.659	.139
	H4	Male	3.19	.592	2.450	**.029***
		Female	3.55	.631	2.708	**.018***

Note. MAPE: Mean Absolute Percentage Error
*$p < .05$
**$p < .01$

The MAPE values of the Mi4 device were recorded perfectly, with an error of less than 3%, at both normal walking and fast walking pace in both male and female participants. The MAPE values of the H4 device were also recorded perfectly, with an error of less than 3%, at normal walking pace in male and female participants. The MAPE values of the H4 device were recorded with an error of less than 5% at fast walking pace in both male and female participants.

As could be seen in Table 3, when the test-retest compatibility of the MPE values according to the criterion step count measurement of the Mi4 device was examined, it was found that this fit was high in male participants (r = .921) at normal walking pace. In contrast, it was moderate in female participants (r = .670). When the test-retest compatibility of the H4 device was examined, it was revealed that this fit was moderate in male and female participants (r = .523 and r = .543, respectively) at normal walking pace. It was also revealed that the test-retest compatibility of the Mi4 device was low both in male and female participants (r = .289 and r = .371, respectively) at fast walking pace. Besides, the test-retest compatibility of the H4 device was found to be moderate both in male and female participants (r = .523 and r = .543, respectively) at fast walking pace.

Table 3
Test-Retest Fit (Pearson Correlation) Analysis Regarding the Mean Percent Errors (MPE) of the Devices According to Criteria Measurement at Two Walking Paces

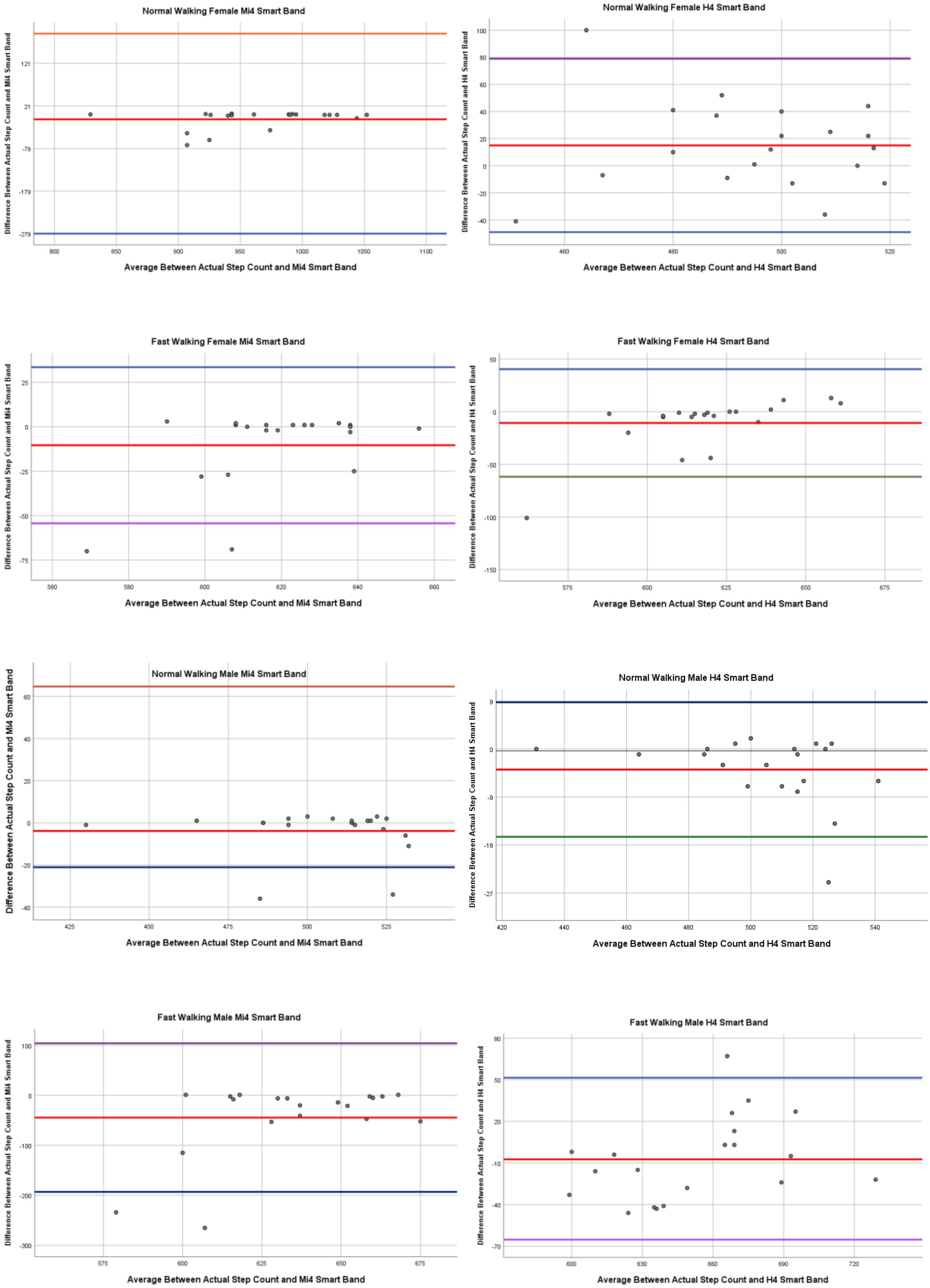
Walking Paces	Devices	Gender	Tests	$\overline{X}$	Sd	r	P
Normal Walking	Mi4	Male	Test	-.731	2.138	.921**	**.000**
			Retest	-1.723	4.526		
		Female	Test	-2.126	4.591	.670**	**.001**
			Retest	-3.203	8.579		
	H4	Male	Test	-.733	1.205	.523**	**.009**
			Retest	-1.138	1.773		
		Female	Test	-1.047	1.729	.543**	**.007**
			Retest	-0.645	1.604		
Fast Walking	Mi4	Male	Test	-6.416	10.588	.289	.108
			Retest	-10.407	12.878		
		Female	Test	-1.712	3.604	.371	.054
			Retest	-6.310	9.419		
	H4	Male	Test	-1.109	4.615	.523**	**.009**
			Retest	2.174	9.177		
		Female	Test	-1.731	4.204	.543**	**.007**
			Retest	-3.043	7.581		

*p < .05
**p < .01

The lower and upper colored lines in the Bland-Altman plot represent the 95% CI limits of the mean difference. The red straight line in the middle represents the equity point. In other words, it is where the difference between the criteria and the device measurement values is equal to 0. When the Bland–Altman plots were examined, it could be said that the compatibility between the criterion number of steps of Mi4 and H4 device was within the acceptable limits in both normal walking and fast walking pace in male and female participants.

Figure 2

Bland-Altman Plots Calculating the Agreement Between Activity Monitors and Actual/Criteria Step Counts in Different Walking Paces



DISCUSSION

It is recommended that future studies should use all of the validity indicators to enable consumers and researchers to make conscious decisions regarding both the validity and reliability of activity monitor devices and to facilitate comparison between devices (Bunn et al., 2018). Previous Xiaomi Smart Band 4 studies evaluated step count validity during the walking/running protocol. However, all these studies had heterogeneous adult groups. Together with the fact that there are studies on the Huawei Talk Band B3 version, no research could be found in the literature on the validity of the step count for the Huawei Smart Band 4 device.

The current study tries to eliminate what the related literature lacks. It aims to analyze the validity and reliability of SC estimation at normal walking and fast walking pace under controlled conditions of two selected smart wristbands of the leading wearable device vendors, Xiaomi (Mi4) and Huawei (H4). Furthermore, it is thought that this study will make significant contributions to the reliability procedures of devices such as gender-based validity and test-retest, which are considered deficiencies in the studies on cheap and accessible activity monitors and which are also recommended in the relevant research protocol guidelines (Silfee et al., 2018; Johnston et al., 2020).

Today, there is no consensus on definite standards for validity, reliability, and sensitivity metrics that will indicate that using a particular calculated metric is adequate for a given situation (Kastelic et al., 2021). Besides, suppose an activity monitor is to be used as an outcome measure in a clinical experiment or as an alternative gold standard measurement tool for step count. In that case, it is recommended that the device display a deficient level of measurement error (MAPE ≤ 5%). However, it is suggested that a higher level of measurement error (MAPE ≤ 10%–15%) may be acceptable if the device is being validated for use by the general population (Johnston et al., 2020). According to this criterion, the MAPE values recorded for Mi4 and H4 smart wristbands for both normal and fast walking pace in male and female participants in the current study were found to be excellent, with a value of <5%.

In a study conducted in laboratory conditions and with an adult population, it was found that there was high accuracy regarding the number of steps recorded with Mi Band 4 and the number of steps recorded with a video recorder in both comfortable (r = 0,665) and fast walking (r = 0,759; de la Casa Pérez et al., 2022). In another study, the validity rate was found to be high for Xiaomi Mi Band 2, with a mean error ratio of <5% (St Fleur et al., 2021). In the current study, the compatibility of the Mi4 device according to the criteria step count at normal walking pace was excellent with 83.1% in male participants and good with 71.6% in female participants. According to the criteria at fast walking pace, the compatibility of the Mi4 device was found to be poor with 44.2% in male participants and poor with 39.7% in female participants. When the steps were not accurately estimated, the Mi4 device tended to underestimate the values. These results differ from the results of the above research. This difference may be due to the walking styles of individuals from different societies included in the study. The reason for this is worth further investigation.

In a study conducted, it was reported that Huawei Talk Band 3 performed very well in terms of the accuracy and stability of SC measurement (Xie et al., 2018). In the current study, the compatibility of the H4 device was good with 70.5% in male participants and good with 70.2% in female participants according to the criteria at normal walking pace. The compatibility of the H4 device was found to be moderate with 59.2% in male participants and good with 63.1% in female participants according to the criteria at fast walking pace. This result is compatible with the results of research conducted on previous Huawei models.

However, in the current study, when the reliability of the devices was calculated, the test-retest compatibility of the Mi4 device was low in both male and female participants ($r = .289$ and $r = .371$) at fast walking pace. According to ICC and Pearson Correlation analysis, it was seen that the Mi4 device was not valid and reliable at fast walking pace. The highest compatibility of the Mi4 device was found in male participants at normal walking pace ($r = .921$). The test-retest compatibility of the H4 device was moderate in male and female participants both at normal walking pace ($r = .523$ and $r = .543$, respectively) and at fast walking pace ($r = .523$ and $r = .543$, respectively). According to all analyses, the H4 device gave both valid and reliable results.

Limitations

Compared with previous studies, this study is thought to have various strengths. First of all, it involves reliability analysis as well as validity analysis. Secondly, the protocol used is accepted in laboratory conditions to analyze the accuracy of smart wearable devices. Thirdly, the study has an adequate sample of male and female participants, and the sample is homogeneous.

However, there are some limitations in our study. First, although we evaluated the SC at different intensities, we did not measure the step count in clinical populations such as individuals with obesity or disability who might have walking differences due to pathology.

Secondly, this study was conducted in a laboratory setting and, therefore, cannot be generalized to leisure activities.

CONCLUSION

According to the current study results, it was revealed that the MAPE values recorded for Mi4 and H4 smart wristbands for both normal and fast walking pace in male and female participants were <5%, which was deemed excellent. The validity and reliability of the H4 device were determined to be at an acceptable level. However, according to ICC and Pearson Correlation analysis, the Mi4 device was not found to be valid and reliable at fast walking pace. In this case, the Mi4 device manufacturers should review their algorithms for SC measurement stability at fast walking pace. Nevertheless, if device evaluations based solely on MAPE values and Bland-Altman plot analyses are considered sufficient, Mi4 and H4 devices can be used in research on the PA levels of populations. Currently, mainstream devices can reliably measure the number of steps used as effective health assessment indicators. Future research should further investigate why there are differences between devices and how activity states affect accuracy; therefore, they should guide and help activity monitor manufacturers improve their algorithms. The interventions targeting physical activity through wearable devices should consider these results when selecting a wearable device as an objective measure of physical activity. The validity of the activity monitors used to measure steps should be analyzed not only for continuous walking in laboratory settings but also for activities focusing on arm movements, intermittent walking, and daily mobility.

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Authors' contributions

The first author took responsibility for the study design, conceptualization, and references. All authors contributed to the study implementation, data collection, data analysis, writing and editing processes.

Declaration of conflict interest

No conflict of interest is declared by the authors.

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Pamukkale J Sport Sci, 14(3), 297-313, 2023 Research Article

Effect of Hydrotherapy on Muscle Activities and Running Kinetics in Adult Males with Pronated Foot: A Randomized Clinical Trial

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ABSTRACT

The potential risk factor for injuries resulting from a pronated foot (PF) has been discussed. The water properties can be used to improve the biomechanics of the lower limb. Therefore, this study aimed to investigate hydrotherapy's effect on muscle activities and running kinetics in adult males with PF. This study was a randomized clinical trial type. Thirty adult males with PF were divided into two equally sized groups. Ground reaction forces (GRFs) were collected by a force plate on the runway. Muscle activities were recorded using a surface electromyography system. Statistical analysis was performed using repeated measures ANOVAs. The significance level was established at p<0.05. Significant main effects of "time" were found for first peak vertical GRF (p=0.032), first peak mediolateral GRF (p=0.007), last peak mediolateral GRF (p=0.041), first peak anterior-posterior GRF (p=0.028) and positive free moment (p=0.003). In the early stance phase of the experimental group, significantly larger tibialis anterior (p=0.026), gastrocnemius medialis (p=0.002), and gluteus medius (p=0.004) muscle activities were found after the test compared to before the test. Hydrotherapy changed the GRFs and muscular activities of the lower extremities in adult men with PF. More research is needed to understand this issue better.

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INTRODUCTION

The pronated foot (PF) has been a topic of discussion for decades, either as a potential risk factor for injuries or as the mechanism behind absorbing impact. The foremost common utilitarian foot abnormality is the PF, with a prevalence rate of 23%. People with PF experience pain and discomfort in the lower limb joints (Zhang & Vanwanseele, 2023). PF deformation can lead to lower limb injury and foot problems. PF defects contribute to tissue injury from lower limb movement. PF can be identified as a risk factor for postural stability (Beelen et al., 2020; Letafatkar et al., 2013). The primary movement of the ankle joint is plantar flexion and dorsiflexion. Conversely, inversion and eversion usually occur in the ankle. The muscles are primarily responsible for the movements of the foot. The foot is a complex system with different functions (Grey et al., 2013). Foot pronation determines the movement of the whole foot. It means that the foot can move in different ways to handle better the forces and movements of the body (Horwood & Chockalingam, 2017). Pronated feet may contribute to running-related injuries, such as shin splints and patellofemoral pain (Wu et al., 2022). When we run, the foot is the only part of our body that touches the ground. So, it helps to absorb and spread the ground reaction forces (GRFs) from stepping on the ground across the foot. There is proof that the way the subtalar joint works is connected to problems in the lower limbs, like having more significant peak medial GRF in the inner part of the foot when walking or running. An atypical medial arch may interfere with shock absorption and mitigation and place more stress on the foot (Jafarnezhadgero et al., 2019; Jafarnezhadgero et al., 2021) because problems in the foot can change kinetic components.

Rehabilitation involves a physical assessment of the subtalar joint. The therapist must comprehend the damaged structures. The fundamental components of rehabilitation are similar, despite therapists' differences in treatment protocols. The primary objective of treatment will be to manage aches and inflation and restore strength, normal function, and range of motion (Kirkby et al., 2020). It was hypothesized that training in the water would be related to an increase in the ankle range of motion and return to natural function (Mooventhan & Nivethitha, 2014). The physical properties of water would permit the therapist to use various exercise options to reestablish normal ankle range of motion. The hydrostatic pressure of the water on the joint and supple tissue would come about lower inflation by offsetting the propensity for the blood to pool in the lower extremities (Javorac, et al., 2020). The patient can do activities that involve weight bearing on their body in the water earlier than on land. This would help them return to normal activities (Ay & Yurtkuran, 2005). Hydrotherapy resistance exercises could be an effective way to improve lower extremity alignment in the form of greater shin mechanical axis angle, lower GRFs, and more significant muscle activities. Additionally, it can make your muscles work better. Resistance exercises can be done in different ways, like using the machines, own body mass, free weights, or hydrotherapy (LeVeau & Rogers 1980; Javorac, et al., 2020; Jafarnezhadgero, et al., 2021). Therefore, the biomechanics of human locomotion could be positively impacted by hydrotherapy.

To the authors' information, there is no randomized clinical trial accessible within the writing that inspected the impacts of hydrotherapy on muscle activities and kinetics during running in adult males with PF. Subsequently, the point of this study was to explore the effect of hydrotherapy on muscle activities and kinetics in adult males with PF. We hypothesized hydrotherapy results in changed muscle activities and running kinetics in adult males with PF.

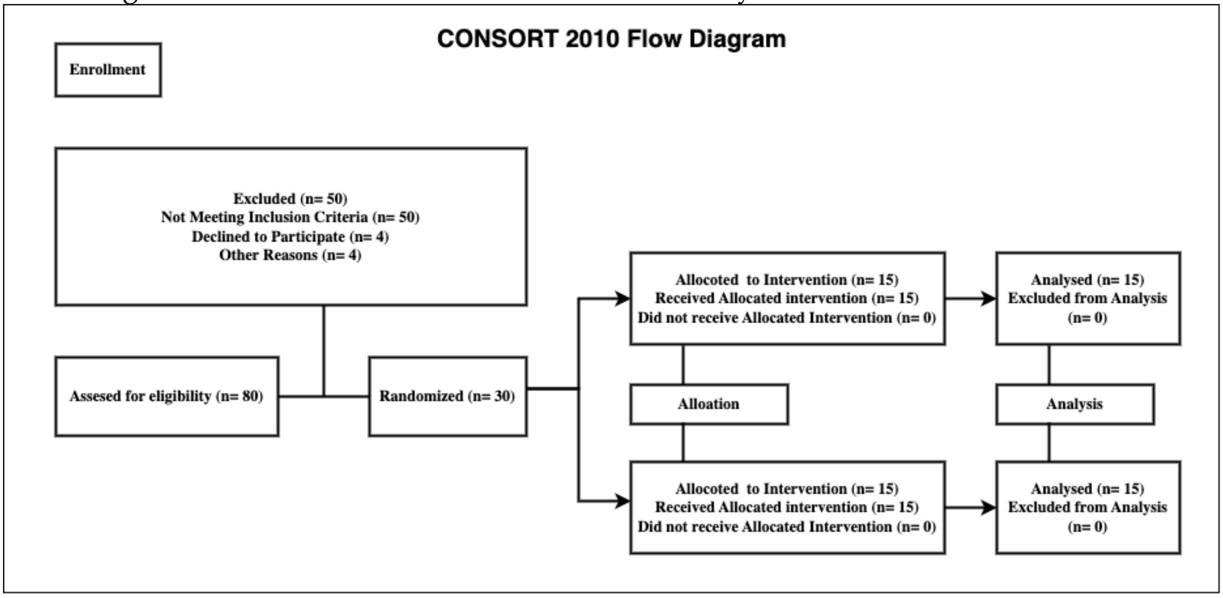
METHODS

Study Group

A randomized controlled design with equal group allocation was used (Figure 1). We used the G*Power software to compute a one-sided a priori power analysis with the F test family. The power analysis was calculated with an accepted Sort I error of 0.05, a Sort II error rate of 0.20, 2 tests, a correlation coefficient of 0.5, and an effect size of 0.80. The examination uncovered that 15 participants would be sufficient. Fifteen adult males with PF were in the control group, and fifteen adult males with PF were in the experimental group. Adult males with PF are eligible to participate in this study. They were utilized to guarantee the concealment of allotment. Each encompass contained a card showing to which group the subject was designated.

One analyst decided whether a participant was qualified for incorporation within the trial, whereas the other carried out gait investigations of the qualified participants. Both analysts and the participants were uninformed of group allotment. The research protocol was approved by the ethics committee of the Medical Sciences University of Mohaghegh Ardabibi Ardabil, Iran (IR.UMA.REC.1401.082), and it was registered with the Iranian Clinical Trial Organization (IRCT20191211045704N2). Before participants signed a paper agreeing to participate, they were given a clear explanation of what they needed to do in the experiment. This research was done following the latest rules of the Declaration of Helsinki. All individuals involved in the study gave their written permission before taking part.

Figure 1
Flow Diagram of Randomized Control Trial in This Study



Data Collection Process

Equity, diversity and inclusion

All assessors and educators were blinded for the group assignment. Inclusion criteria were: 1) young adult (18-30 age); 2) greater than 10 mm navicular drops; 3) a foot posture index of more than 10; 4) endorsement from a medical doctor to take part in this consideration. Within the current study, an altered form of the navicular drop depicted by Brody was utilized to decide the sagittal plane relocation of the navicular between the resting (situated) and stand-on-one-leg positions (Brody 1982). The foot posture index has six items that measure and categorize how feet are positioned. You can find a thorough explanation of the foot posture index somewhere else (Redmond et al., 2006). Individuals were taken out of the study if they had a difference in the length of their limbs that was more than 5mm, or if they said they had muscle spasms, nerve, and muscle disorders, bone and muscle-related illnesses, or had any surgery before on their legs and body. Significant differences in female and male biomechanical characteristics have been found (Bruening et al., 2015). To exclude this potential factor did not affect the study, only men were chosen to take part. Young adults were chosen because resistance training works well at this age, because of the hormones your body produces (Farrell et al., 2011). So, we thought that doing resistance training would make the muscles in the lower legs stronger and maybe even more significant. This could help individuals with PF run better. Everyone who participated in the test of kicking a ball had a right foot (Jafarnezhadgero et al., 2017).

Biomechanics assessment

A force plate was used to measure the GRFs of running. It recorded the data at a rate of 1000 Hz (Figure 2). The forces from the ground were low pass filtered at 20 Hz (4th order Butterworth filter, zero lag). The individual's gait characteristics (heel strike and toe off) were identified using the Bertec force plate. For this purpose, a 10 N threshold was used to detect the stance phase of the gait cycle. When running, certain GRFs are essential in understanding how specific running issues can cause problems. These GRFs include the time-to-peak (TTP) for the force to reach its highest point, how quickly the vertical loading rate, and the free moments (FM) to move within the body. These factors are most important in studying abnormal running patterns (Jafarnezhadgero et al., 2019). These are the variables we got from the GRFs data. The first vertical peak force (Fz_{HC}). The forces (Fy_{HC}) used to slow down (braking) and move forward (propulsion) were measured from the front-back force graph (Fy_{PO}). We found the highest point of the curve that goes from the middle to the side of the foot (Fx_{HC}). It happens right after the heel meets the ground. The GRF amplitudes were adjusted to account for body weight and expressed as a percentage. TTP is when the heel first touches the ground and when the force on the ground reaches its highest point. The loading rate means how fast the force increases between the heel contacting the ground and the point where the force reaches Fz_{HC} on the vertical force curve (Fz_{HC}; Jafarnezhadgero et al., 2018). The measurement of the foot's FM was calculated in the following way: $FM = Mz - (Fy \times COPx) + (Fx \times COPy)$.

Mz is the moment around the vertical axis, x and y are the horizontal components of the center of pressure (COP), and Fx and Fy are the horizontal GRF components. Additionally, FM amplitudes were normalized with regard to BW × height. The measurements for run variables were added together and then divided by three to find an average (Jafarnezhadgero et al., 2018).

A remote EMG with eight pairs of surface electrodes was utilized to record the activity of the vastus lateralis (VL), vastus medialis (VM), rectus femoris (RF), gastrocnemius medialis (Gas-M), tibialis anterior (TA), biceps femoris (BF), semitendinosus (ST), and gluteus medius (GM) muscles of the right leg following the SENIAM recommendation (Hermens et al., 1999). The GRFs and electromyography data were put together using Nexus software. After the running tests, MVIC tests were done on each muscle to normalize the EMG.

Figure 2
The Location of The Force Plate and the Surface Electrodes

Training protocols

The hydrotherapy group performed training in the water over eight weeks with three sessions per week. The intervention program was designed progressively. Every training session started with a ten10-minute warm-up program, including walking and submaximal running exercises and a dynamic stretching program. Finally, every session ended with a five5-minute cool-down. Taken together, the duration of a single training session lasted 90 minutes. All participants were taught the exercises before they started training. Table 1 and Figure. 3 provide more knowledge about the training programme. The control group did not receive any training program during eight weeks. All participants were told not to do any other kind of exercise while the study was happening.

Table 1
Exercise Protocol of the Intervention Group

Protocols	Range of motion (20 minutes)	Strength (35 minutes)	Proprioception (20 minutes)
Hydrotherapy	1. Active exercises involve moving your foot underwater using a small flotation device called a water wing. You should move your foot by pointing it downwards and upwards and turning it inwards and outwards. As you get better, you can use more significant flotation devices. 2. Easy exercises for your calf muscles: stretch by standing with your leg straight and then with your leg bent.	1. Walk from one end of the pool to the other (try to go faster each time to make it more complicated). 2. Move forward to jogging or running in deep water. 3. Heel raises involve lifting your heels off the ground using both legs first and then one leg at a time. 4. Flutter kicking means moving your legs up and down while you are in the pool's deep end. You hold onto the side of the pool while doing this. As you get better, you can do it for a longer time. 5. One or both feet jump on a flat surface and move forward to reach the stars.	1. Doing balance exercises in the water involves standing on one leg and practicing balancing. Participants do these exercises with their eyes open or closed. 2. Move forward to unstable positions with your eyes open and then with your eyes closed.

Figure 3
Exemplified Exercises of the Intervention in the Water

Note: 1: Going up and down the stairs; 2: squatting in the water; 3: step on the spot.

Data Analysis

After deciding on the ordinary dissemination of information utilizing the Shapiro-Wilk test, we carried out the statistical analysis using separate 2 (groups: control and hydrotherapy) x 2 (time: pre-test vs. post-test) repeated measures ANOVAs. Post hoc investigations were calculated utilizing Bonferroni-adjusted paired sample t-tests. Additionally, effect sizes were determined by converting partial eta-squared (η^2_p) to Cohen's d. According to Cohen, $d < 0.50$ demonstrate minor effects, $0.50 \leq d < 0.80$ demonstrate medium effects and $d \geq 0.80$ demonstrate significant effects. The significance level was set at $p < 0.05$. All examinations were performed utilizing the SPSS version 20.0.

RESULTS

Participant characteristics and all outcome variables at baseline are illustrated in Table 2. There were no significant differences between the groups at the beginning for all examined variables.

Table 2
Group-specific Baseline Values of All Reported Muscular Activity and Kinetic Result Factors

Variables		Control group	Experimental group	p-value
Participant characteristics	Age (years)	22.35±2.33	22.85±2.11	0.390
	Haigh (cm)	177.07±0.07	177.40±0.07	0.900
	Weight (kg)	80.53±9.83	79.73±8.86	0.817
	BMI (kg/m2)	25.81±3.79	25.45±3.50	0.791
Kinetics	Fz_{HC}	180.90±18.28	174.57±31.45	0.506
	Fx_{HC}	3.01±4.56	2.89±1.46	0.838
	Fx_{PO}	-13.93±3.37	-13.91±4.23	0.990
	Fy_{HC}	-2.84±0.97	-2.84±1.20	0.752
	Fy_{PO}	3.15±1.15	3.37±1.66	0.675
	$TTPFz_{HC}$	117.57±31.45	119.47±21.47	0.800
	FM (negative)	-019±0.11	-0.17±0.08	0.904
	FM (positive)	2.03±0.52	2.06±0.43	0.740
	LR	1.63±0.54	1.57±0.36	0.730
EMG (early stance phase)	TA	62.53±20.60	65.76±16.74	0.641
	Gas-M	25.95±7.73	28.28±14.89	0.594
	VL	66.53±15.77	61.19±29.61	0.543
	VM	62.35±22.79	58.47±19.32	0.619
	RF	49.69±19.01	45.91±23.13	0.628
	ST	33.47±9.70	34.34±12.08	0.831
	BF	46.04±10.98	43.03±16.41	0.560
	Glut-M	35.03±12.43	38.04±17.48	0.591
EMG (late stance phase)	TA	55.47±27.94	64.76±21.53	0.317
	Gas-M	157.61±36.92	163.12±50.03	0.734
	VL	123.62±24.41	118.90±38.54	0.733
	VM	119.29±24.41	122.01±38.28	0.818
	RF	38.18±23.20	41.64±23.68	0.689
	ST	50.60±23.60	48.65±20.04	0.809
	BF	41.29±20.29	38.10±17.93	0.652
	Glut-M	92.34±29.83	96.74±33.01	0.705

Note. Fx_{HC}: top lateral GRF during initial contact, Fx_{PO}: top medial GRF during propulsion, $Fz_{HC:}$ top vertical GRF during initial contact, Fy_{HC}: braking force, Fy_{PO}: propulsion force, TTP: time to peak, y: anterior-posterior course, z: vertical course, x: mediolateral course, LR: Loading rate, VL: vastus lateralis, VM: vastus medialis, RF: rectus femoris, TA: tibialis anterior, Gas-M: gastrocnemius medialis, BF: biceps femoris, ST: semitendinosus, GM: gluteus medius

Significant major effects of "time" were observed for FzHC, FxHC, FxPO, FyHC, and positive FM ($p<0.041$; Table 3). Pair-wise comparisons revealed significantly lower FzHC ($p=0.032$), FxHC ($p = 0.007$), FxPO ($p = 0.041$), FyHC ($p = 0.028$), and positive FM ($p = 0.003$) in the post-test compared with the pre-test (Table 3). In addition, we observed significant major effects of "group" for TTP FzHC and LR ($p < 0.029$; Table 3). Pair-wise comparisons revealed significantly longer TTP FzHC ($p = 0.002$) and lower loading rate ($p=0.029$) in the experimental group compared with the control group (Table 3). Finally, the statistical analysis showed significant group-by-time interactions for FxHC, FyPO, TTP FzHC, and LR ($p < 0.021$; Table 3). In the experimental group, significantly lower FxHC ($p = 0.000$), FyPO ($p = 0.021$), LR ($p = 0.009$), and longer TTP FzHC ($p = 0.008$) were observed during the hydrotherapy Protocol (Table 3).

The statistically significant major effects of "time" were observed for TA and Gas-M muscle activities during the early stance ($p < 0.032$; Table 4). Pair-wise comparisons revealed significantly larger TA ($p = 0.032$) and Gas-M ($p = 0.005$) muscle activities in the post-test compared with the pre-test (Table 4). The statistical analyses illustrate significant major effects of "group" for TA, Gas-M, and BF muscle activities during the early stance ($p < 0.032$; Table 4). Pair-wise comparisons revealed significantly larger TA ($p = 0.023$), Gas-M ($p = 0.006$), and BF ($p = 0.032$) muscle activities in the experimental group compared with the control group (Table 4). Finally, we observed significant group-by-time interactions for TA, Gas-M, and GM muscle activities during the early stance ($p < 0.026$; Table 4). In the experimental group but not the control group, significantly larger TA ($p = 0.026$), Gas-M ($p = 0.002$), and GM ($p = 0.004$) muscle activities were observed during hydrotherapy Protocol (Table 4).

No statistically significant major effects of "time" were observed for muscle activities during the late stance ($p>0.05$; Table 5). The statistical analyses illustrate the significant main effects of "group" for TA muscle activity during the late stance ($p<0.030$; Table 5). The pair-wise comparison revealed significantly larger TA ($p = 0.030$) muscle activity in the experimental group compared with the control group (Table 5).

Finally, we observed significant group-by-time interactions for TA muscle activity during the late stance ($p < 0.035$). In the experimental group but not the control group, significantly larger TA ($p = 0.035$) muscle activity was observed during the hydrotherapy Protocol (Table 5).

Table 3

Data are Means and Standard Deviations for GRFs During Hydrotherapy in Adult Males with PF

GRF	Control				Experimental				Sig. (Effect size)		
	Pre	Post	CI 95%	%Δ	Pre	Post	CI 95%	%Δ	Time	Group	Group x Time
Fz_{HC}	180.90±18.28	168.65±30.10	171.61,6.43	-6.77	174.57±31.45	167.64±28.19	174.27,6.43	-3.96	**0.032(0.154)**	0.772(0.003)	0.396(0.026)
Fx_{HC}	3.01±4.56	3.30±1.57	2.44,3.87	9.63	2.89±1.46	1.79±0.85	1.63,3.05	-38.06	**0.007(0.230)**	0.110(0.089)	**0.000(0.473)**
Fx_{PO}	-13.93±3.37	-12.40±4.31	-14.95,-11.12	-10.98	-13.91±4.23	-12.65±5.46	-15.96,-11.37	-9.05	**0.041(0.140)**	0.854(0.001)	0.714(0.005)
Fy_{HC}	-2.84±0.97	-2.29±0.82	-2.93,-2.07	-19.36	-2.84±1.20	-2.23±1.02	-2.96,-2.10	-21.47	**0.028(0.161)**	0.915(0.000)	0.670(0.007)
Fy_{PO}	3.15±1.15	3.26±1.05	2.67,3.73	3.49	3.37±1.66	2.23±0.83	2.27,3.32	-33.82	0.054(0.126)	0.277(0.042)	**0.021(0.175)**
TTP Fz_{HC}	117.57±31.45	93.14±21.27	98.11,112.45	-20.77	119.47±21.47	125.05±12.25	115.09,129.43	4.67	0.084(0.103)	**0.002(0.296)**	**0.008(0.226)**
FM (negative)	-0.19±0.11	-0.16±0.11	-0.21,-0.13	-15.78	-0.17±0.08	-0.15±0.05	-0.20,-0.12	-11.76	0.253(0.238)	0.656(0.007)	0.966(0.000)
FM (positive)	2.03±0.52	1.91±0.51	1.76,2.18	-5.91	2.06±0.43	1.56±0.40	1.60,2.02	-24.27	**0.003(0.282)**	0.265(0.044)	0.055(0.125)
LR	1.63±0.54	1.91±0.60	1.55,1.99	17.17	1.57±0.36	1.28±0.43	1.21,1.64	-18.47	0.986(0.000)	**0.029(0.159)**	**0.009(0.222)**

Note. Fy_{HC}: braking force; Fy_{PO}: propulsion force; Fz_{HC}: peak vertical GRF during initial contact; Fx_{HC}: peak lateral GRF during initial contact; Fx_{PO}: top medial GRF during propulsion; FM: free moment; TTP: time to peak; LR: Loading rate; CI: confidence interval

Table 4

Data are Means and Standard Deviations for Muscle Activity in the First Stance Phase (%MVIC) During Hydrotherapy in Adult Males with PF

Muscles	Control				Experimental				Sig. (Effect size)		
	Pre	Post	CI 95%	%Δ	Pre	Post	CI 95%	%Δ	Time	Group	Group x Time
TA	62.53±20.60	62.15±21.07	54.47,70.22	-0.60	65.76±16.74	85.10±16.29	67.56,83.31	29.40	**0.032(0.154)**	**0.023(0.171)**	**0.026(0.165)**
Gas-M	25.95±7.73	24.60±15.81	18.39,32.16	-5.20	28.28±14.89	50.22±22.28	32.37,46.14	77.58	**0.005(0.244)**	**0.006(0.236)**	**0.002(0.293)**
VL	66.53±15.77	63.61±22.20	54.74,75.41	-4.38	61.19±29.61	66.12±21.01	53.32,73.99	8.05	0.814(0.002)	0.844(0.001)	0.360(0.030)
VM	62.35±22.79	59.77±18.14	53.22,68.90	-4.13	58.47±19.32	45.22±21.10	44.01,59.69	-22.66	0.134(0.078)	0.100(0.094)	0.307(0.037)
RF	49.69±19.01	46.03±18.95	39.99,55.74	-7.36	45.91±23.13	45.23±15.44	37.69,53.45	-1.48	0.634(0.008)	0.676(0.006)	0.743(0.004)
BF	33.47±9.70	33.05±12.50	35.95,45.61	-1.25	34.34±12.08	47.22±16.38	28.44,38.09	37.50	0.072(0.111)	**0.032(0.154)**	0.055(0.125)
ST	46.04±10.98	40.67±13.25	36.51,50.19	-11.66	43.03±16.41	42.28±17.28	35.81,49.49	-1.74	0.241(0.049)	0.883(0.001)	0.373(0.028)
Glut-M	35.03±12.43	31.10±11.15	26.38,39.76	-11.21	38.04±17.48	50.57±16.20	37.61,51.00	32.93	0.111(0.088)	0.724(0.090)	**0.004(0.262)**

Note. TA: tibialis anterior; Gas-M: gastrocnemius medialis; VL: vastus lateralis; VM: vastus medialis; RF: rectus femoris; BF: biceps femoris; ST: semitendinosus; GM: gluteus medius

Table 5
Data are Means and Standard Deviations for Muscle Activity in the Late Stance Phase (%MVIC) During Hydrotherapy in Adult Males with PF

Muscles	Control				Experimental				Sig. (Effect size)		
	Pre	Post	CI 95%	%Δ	Pre	Post	CI 95%	%Δ	Time	Group	Group x Time
TA	55.47±27.94	50.23±28.81	41.03,64.66	-9.44	64.76±21.53	78.33±21.53	59.73,83.36	20.95	0.336(0.033)	**0.030(0.158)**	**0.035(0.149)**
Gas-M	157.61±36.92	153.51±82.13	132.10,179.02	-2.60	163.12±50.03	179.41±50.03	147.80,194.72	9.98	0.648(0.008)	0.341(0.032)	0.447(0.021)
VL	123.62±24.41	117.41±55.52	101.52,143.03	-5.02	118.90±38.54	125.65±38.54	99.76,141.27	5.67	0.967(0.000)	0.903(0.001)	0.320(0.035)
VM	119.29±24.41	116.95±39.25	101.49,134.75	-1.96	122.01±38.28	130.87±38.28	109.82,143.07	7.26	0.597(0.010)	0.474(0.018)	0.367(0.029)
RF	38.18±23.20	36.76±20.97	27.72,47.22	-3.71	41.64±23.68	44.11±23.68	33.13,52.63	5.93	0.917(0.000)	0.429(0.023)	0.698(0.005)
BF	50.60±23.60	52.62±20.66	40.21,59.05	3.99	48.65±20.04	50.60±20.04	42.19,61.03	4.01	0.637(0.008)	0.763(0.003)	0.993(0.000)
ST	41.29±20.29	45.53±23.82	34.27,52.55	10.26	38.10±17.93	42.54±17.93	31.18,49.47	11.65	0.261(0.045)	0.629(0.008)	0.978(0.000)
Glut-M	92.34±29.83	87.38±41.04	74.91,104.80	-5.37	96.74±33.01	98.29±33.54	82.57,112.46	1.60	0.817(0.002)	0.464(0.019)	0.658(0.007)

Note. TA: tibialis anterior; Gas-M: gastrocnemius medialis; VL: vastus lateralis; VM: vastus medialis; RF: rectus femoris; BF: biceps femoris; ST: semitendinosus; GM: gluteus medius

DISCUSSION

This research aimed to appraise the effect of hydrotherapy on muscle activities and running kinetics in adult males with PF. In this study, hydrotherapy persuaded significant reductions in the first top of lateral and straight GRFs during initial contact, along with reduced LR. Nevertheless, lower limb injuries can be predicted by more fabulous LR and top straight strike GRFs (Adams et al., 2018). For example, greater strike force and LR values can be linked to orthopedic injuries like stress fractures (Crowell et al., 2010). Our findings showed that hydrotherapy has the potential to lower top strike straight GRFs and LR during running in adult males with PF. In this manner, the applied training program may have an injury-preventive outcome. Future research should auscultate whether standard hydrotherapy indeed diminishes the injury event. Injuries to the knee and hip joints can be caused by both top mediolateral and straight GRFs (McLean et al., 2003). Our results illustrated that hydrotherapy reduced top mediolateral GRFs.

It is essential to consider the emphasis of the FM as an indicator of the rotational torque practical to the lower limb from a clinical perspective. The hazard components for PF-dependent injuries, especially for runners, are believed to be too much twisting force on the lower limb. A force plate can be used in a clinical setup to quicklyassess this torque easily and in this study peak positive free moment decreased during hydrotherapy in adult males with PF. Inducing ankle joint pronation in natural individuals should be considered because it focuses on the immediate impact on the natural position of the foot, not necessarily the long-term factors. In other research that was executed on runners, the researchers established significantly higher free-time parameters in individuals with a history of leg fractures. In conclusion, these studies were done while running, and according to previous research, water plays a big role in how our body moves and torque is transferred to the lower extremity (Milner et al. 2006; Yazdani et al.,2020).

To compensate for the PF pose, greater GRFs are expected to be created by lower limb muscles that back the medial longitudinal arch in adult males with PF. Hence, we adjudged that the TA muscle activity, which chips into backing the medial longitudinal arch, would be greater in individuals with PF (Zhang et al., 2017). This adjudge is corroborated by our results, which show a greater TA muscle activity in the experimental group than in the control group. However, a previous study by Angin et al. reported lower foot muscle activities in PF compared to normal foot (Angin et al., 2014). Although they too, examined asymptomatic individual with PF, a conceivable clarification for the nonattendance of indications in their populace could be due to inadequate introduction to loading. Therefore, the creators guess that physical dynamics within the adult males with PF might have adjusted to control foot pronation by expanding the TA muscle activity and hence anticipate themselves from creating overuse injuries. Assist investigation is required to affirm this. It has been archived that PF is related to an increment in muscle actuation of outward invertor muscles and a diminish in muscle actuation of outward evertor muscles (Zhang et al., 2017). One clarification for this is that the invertor muscles are constrained to greater levels of enactment to keep the already everted foot from everting assist. This is often the case, we would anticipate to see seeing an increment within the constrain producing capacities, and thus morphology, in those muscles. We found a difference in TA muscle activity between the experimental group and the control group.

After hydrotherapy, our results showed that there was larger GM muscle activity during the first stance phase. In adult males with PF, the knock knee is associated with hip adduction during the first stance phase, as illustrated by previous studies. The hip abductor muscle activities are increased in this condition, mainly because of the increased activity of the GM muscle (Park et al., 2010). In expansion, the GM muscles' infirmity may increase the chance of supporting injuries ascribed to intemperate lower leg joint pronation (Ukoha et al., 2012). While running, the GM muscle shrinks to preserve lower appendage from the pelvis to the foot (Farahpour et al., 2018). Be that as it may, the foot muscle activities essentialare additionally basic within the mid-stance for maintaining a strategic distance from over-pronation. A lessening in pronation might result in expanded GM muscle action, leading to modern lower extremity alignment and GM muscle activation. Following our research and past research, we hold forth that hydrotherapy may be a viable rehabilitative that implies lower extremity injuries due to creating greater muscle activities (Barrett et al., 1998).

Hydrotherapy also demonstrated significantly higher Gas-M muscle activity in the post-test compared to the pre-test. According to the research, no study has examined the effects of hydrotherapy on the muscular activities of PF individuals. Moore, (2016) discovered a significantly higher peak activation of the gastrocnemius muscle during the late stance phase, which involves plantar flexion of the ankle joint. Another study found that if the foot rolls too much eversion during gait, it can also cause the tibia to rotate too much inward. This can make hip rotate inward more than usual, which also increases how much hip moves towards the center of your body, and may affect the angle of your knee (Clark & Lucett, 2010). Subsequently, expanding the activity of GM muscle alongside Gas may be expanded the hip abduction and diminish the ankle eversion individually.

Limitations

With respect to the ponder confinements, we tried youthful men, as it were. Subsequently, our discoveries are particular to this cohort and cannot fundamentally be applied to females, distinctive ages, or quiet bunches. More inquiry is required in this zone with distinctive age or understanding bunches. In this consideration, we did not record kinematic information. This ought to be discovered to investigate merging kinematic, dynamic, and EMG information in the future. Confiscating extra muscles such as the peroneus longus would be beneficial.

CONCLUSION

The sequels can be credited to the truth that adult males with PF need more diverse muscles for hydrotherapy. In this manner, we can approve the potential of water as an unused preparing fabric when endeavoring to upgrade running capacities, especially the running mechanics in adult males with PF. The expanded hip and knee extension of movement amid running in adult males with PF can be incompletely ascribed to the expanded electromyography actuation of the Gas-M and GM muscles. Even though a total assessment and consideration are essential, ours can give analysts and clinicians experience to anticipate or treat wounds in adult males with PF, particularly when managing running-related injuries in these subjects.

PRACTICAL IMPLICATIONS

Training in the water resulted in lower GRFs and higher muscle activities during the first stance phase. This might mean changes in the way the muscles and nerves in the lower legs work when adult males with PF run. In PF adult males, having stronger lower limb muscles and more stability in the upper leg might help make up for less stability in the lower limb. Adult males with PF could return to normal function sooner if they could perform hydrotherapy. Hydrotherapy can help improve your running by using different muscles and reducing the forces when your feet hit the ground. It can also help with how quickly the body absorbs the impact and how much run it twists when running. More research is needed to understand better to understand this better to understand this matter better.

Authors' contributions

The first author contributed to the visualization, validation, methodology, investigation, formal analysis, data curation, writing – original draft, writing – review & editing. The second author contributed to the validation, methodology, investigation. The third author contributed to the visualization, validation, supervision, resources, project administration, methodology, investigation, formal analysis, conceptualization, funding acquisition, writing – original draft, writing – review & editing.

Declaration of conflict interest

No conflict of interest is declared by the authors.

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Research Article

Healthy Nutrition Attitude, Sleep Quality and Musculoskeletal Disorders in University Students During Covid-19 Pandemic

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ABSTRACT

This study aims to college students' healthy nutrition attitude, sleep status, and musculoskeletal disorders during the COVID-19 pandemic. In total, 165 university students participated in this research. The students filled out the Attitude Scale for Healthy Nutrition, Pittsburgh Sleep Quality Index (PSQI), and Cornell Musculoskeletal Discomfort Questionnaire. The attitude toward healthy eating of 34 (20.6%) students was found to be moderate, 100 (60.6%) high, and 31 (18.8%) very high. There was no meaningful difference between groups according to having COVID-19 disease (p>0.05). Among the participants, 43 (26.06%) students were found to be good and 122 (73.94%) to be poor in terms of sleep quality. The global PSQI and sleep duration subgroup scores of those who had COVID-19 were statistically higher (p=0.010 and 0.043, respectively). The five regions with the most musculoskeletal symptoms were the upper back (78.18%), lower back (70.91%), neck (69.09%), right shoulder (55.76%) and left shoulder (49.09%). Significant differences were observed in the scores of the right wrist (p=0.009), left wrist (p=0.007), right lower leg (p=0.024), left lower leg (p=0.026), right foot (p=0.001), and left foot (p=0.009). The COVID-19 pandemic partially affected university students in terms of healthy eating attitudes and, to a greater extent, in terms of sleep and musculoskeletal disorders.

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INTRODUCTION

COVID-19 is a China-based pandemic announced by the World Health Organization on January 30, concerning the world in a short time (WHO, 2020). With the COVID-19 pandemic, states worldwide have gone to other procedures, and the length of stay of most individuals at home has increased with various restrictions. This situation has changed the habits of individuals who go out of their regular routine. These habits mainly were about hygiene and nutrition. It has created radical changes in the attitudes of individuals to foods and their shopping habits. In particular, people have changed their shopping methods to minimize the danger due to the fear of contamination, and an increase in online shopping has been observed (di Renzo et al., 2020). While the preference for perishable foods such as fruits and vegetables has decreased in shopping, the tendency to foods for perishable foods such as fruits and vegetables has decreased in shopping, and the tendency to foods called ready-to-eat foods has increased (Zhao et al., 2020). University students have to cope with the problems brought by university life while trying to fulfill their developmental tasks specific to the period they are in (Altın, 2015). Students generally tend to have inadequate and unbalanced nutrition. The fact that food choices are mainly in the direction of high-carbohydrate foods affects the academic success and general health of this group (Güllü & Küçükkömürler, 2020). It is predicted that the eating habits of young people may deteriorate with the pandemic. Studies have shown that more than half of the students' appetite levels, snack consumption, night eating tendencies, and tendency to packaged foods have increased (Dilmen Bayar et al., 2021; Doyan et al., 2021).

Sleep is a multidimensional factor that affects every aspect of our lives and enables us to maintain our daily routines (Lange et al., 2010). Sleep quality is waking up fresh in the morning, feeling fit and fit, without experiencing any sleep disruptions during the night. Sleep directly affects an individual's quality of life. As a result of poor sleep quality, psychological conditions such as fatigue, memory disorders, deterioration in the immune system, exhaustion, tension, and unhappiness occur that negatively affect daily activities (Birben & Karadeniz, 2010). Depression, anxiety, and stress levels have increased in individuals as a result of changes in sleeping hours, increased use of social media before sleep, and spending more time in bed (Cellini et al., 2020).

COVID-19 disease also adversely affects the musculoskeletal system (Disser et al., 2020; Hasan et al., 2021; O. Öztürk & Özer Kaya, 2020). Students can stay in static and bad postures long due to long hours at home and distance education. This situation may pave the way for various musculoskeletal disorders. It has been reported that decreased physical activity levels and increased musculoskeletal pain during the COVID-19 pandemic (Kutlutürk & Yıkılmaz, 2021). This study was planned to investigate healthy nutrition attitude, sleep duration, quality and status, and musculoskeletal pain and discomfort, which are thought to be in university students during the COVID-19 pandemic. Another objective of the study is to compare healthy eating behavior, sleep status, and musculoskeletal disorders in individuals who had and had not COVID-19.

METHODS

Study Group

In total, 165 university students participated in this study. The mean age was 21.33±2.20, the mean height was 165.47±7.28 cm, the body weight was 60.09±13.15 kg, and the Body Mass Index (BMI) was 21.81±3.71 kg/m^2. Among the participants, 149 (90.30%) of the students were female and 16 (9.70%) were male. Of the students, 75 (45.45%) had Covid-19 disease and 90 (54.55%) had not. The number of students who had no COVID-19 vaccine was 9 (5.45%), one vaccine was 5 (3.03%), two vaccines were 89 (53.94%), and three vaccines were 62 (37.58%). When the BMI values were examined, it was determined that 20 (12.12%) of 165 students were below 18, 118 (71.51%) were between 18-25, 19 (11.52%) were between 25-30, and 8 (4.85%) were over 30. The mean total score of the Attitude Scale for Healthy Nutrition (ASHN) was 74.21±11.70 and classified as having a high attitude towards healthy eating. The mean score of the Knowledge of Nutrition (KN) subgroup was 20.96±4.59, the Emotion for Nutrition (EN) subgroup was 17.36±5.32, the, Positive Nutrition (PN) subgroup was 17.48±4.91, and the and Malnutrition (MN) subgroup was 18.22±4.96. The attitude toward healthy eating of 34 (20.6%) students was found to be moderate, 100 (60.6%) high, and 31 (18.8%) very high.

The research was conducted with students at the Faculty of Health Sciences of Demiroğlu Bilim University and the questionnaires were sent via Google Forms. The students filled the Attitude Scale for Healthy Nutrition (ASHN), Pittsburgh Sleep Quality Index (PSQI), and Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). All information provided within the scope of the research is kept confidential, and participation in the study was voluntary. The Informed Consent Form has been added to the survey digitally, and consent will be given by clicking the relevant section of the participant. Demographic information of the students such as age and gender, were evaluated with the questionnaire we have created.

Permission was obtained from Demiroğlu Bilim University Clinical Research Ethics Committee will conduct the study (Decision no: 10.05.2022/2022-09-02).

Data Collection

Data collection tools were Attitude Scale for Healthy Nutrition, Pittsburgh Sleep Quality Index, and Cornell Musculoskeletal Discomfort Questionnaire.

Attitude Scale for Healthy Nutrition: The nutritional status of the students was evaluated using the ASHN developed by Tekkurşun Demir et al. at 2019, and the scale is valid and reliable. It consists of four subgroups and two items. These subgroups were determined as Knowledge of Nutrition (KN), Emotion for Nutrition (EN), Positive Nutrition (PN), and Malnutrition (MN). The lowest score that can be obtained from ASHN is 21, and the highest score is 105. (Tekkurşun Demir & Cicioğlu, 2019).

Pittsburgh Sleep Quality Index: Students' sleep quality was evaluated by the PSQI. PSQI is a scale for sleep quality and disorder that evaluates the last month (Buysse et al., 1989). Ağargün et al. determined at 1996 that the index is suitable for Turkish society. PSQI contains 18 items and seven components. The total score is evaluated between 0-21a high score between 5-21 is associated with poor sleep quality, and a score of 0-4 means good sleep quality (Buysse et al., 1989, 2008).

Cornell Musculoskeletal Discomfort Questionnaire: Musculoskeletal disorders of the students were evaluated with the CMDQ. Cornell University researchers developed the scale to evaluate the musculoskeletal system of workers (Hedge et al., 1999). Erdinç et al. determined at 2011 that the scale was suitable for Turkish society. The scale evaluates the pain status in 20 different body sections in the last week and its impact on work. Frequency of pain, ache, or discomfort was rated from 1 to 5. The pain intensity and its effect on work performance is scored from 1 to 3. The parts with the highest percentage score relative to the total score of all body parts evaluated are used to identify the body parts with the most severe problems (Erdinc et al., 2011).

Data Analysis

The analyzes were carried out with the IBM SPSS Statistics 21.0 program. Numerical variables were given as mean±standard deviation, and comparisons between groups were calculated by independent sampled t-test. The significance level was determined as $p<0.05$.

RESULTS

The comparison of ASHN scores according to the status of having COVID-19 disease is given in Table 1.

Table 1
The Comparison of ASHN Scores According to the Status of Having Covid-19 Disease

ASHN Scores	Covid-19		p
	Yes (n=75) Mean±SD	No (n=90) Mean±SD	
Total Score	74.75±12.36	73.41±11.17	0.371
KN	20.08±4.52	21.09±4.66	0.582
EN	18.05±5.01	16.78±5.53	0.269
PN	17.21±4.83	17.70±4.98	0.966
MN	18.68±4.84	17.84±5.06	0.924

Note: SD: standard deviation; KN: Knowledge of Nutrition; EN: Emotion for Nutrition; PN: Positive Nutrition; MN: Malnutrition

The global PSQI score was found as 6.49±2.82, sleep quality 1.32±0.58, sleep onset latency 1.38±0.93, sleep disturbance 1.36±0.58, hypnotic drugs 0.09±0.45, daytime dysfunction 1.45±0.89, sleep efficiency 0.26±0.64, and sleep duration 0.64±0.88. When sleep quality was examined, 43 (26.06%) people were found to be good and 122 (73.94%) to be poor. The comparison of global and PSQI subgroup scores according to the status of having COVID-19 disease is given in Table 2.

Table 2
The Comparison of PSQI Scores According to the Status of Having Covid-19 Disease

PSQI Scores	Covid-19		p
	Yes (n=75) Mean±SD	No (n=90) Mean±SD	
Global score	6.72±3.14	6.30±2.53	**0.010***
Sleep quality	1.37±0.56	1.28±0.60	0.819
Sleep onset latency	1.41±0.96	1.34±0.91	0.565
Sleep disturbance	1.36±0.58	1.36±0.59	0.936
Hypnotic drugs	0.07±0.38	0.11±0.51	0.211
Daytime dysfunction	1.52±0.91	1.39±0.87	0.603
Sleep efficiency	0.24±0.61	0.28±0.67	0.475
Sleep duration	0.75±0.99	0.54±0.78	**0.043***

Note: SD: standard deviation; PSQI: Pittsburgh Sleep Quality Index

The number of students with musculoskeletal symptoms and their weighted CMDQ scores is given in Table 3.

Table 3
The Number of Students with Musculoskeletal Symptoms and Their Weighted CMDQ Scores

Body Parts	Musculoskeletal symptoms n (%)	Weighted CMDQ scores (0-90) Mean±SD
Neck	114 (69.09)	10.20±18.83
Right shoulder	92 (55.76)	5.93±13.11
Left shoulder	81 (49.09)	5.88±13.76
Upper Back	129 (78.18)	11.47±18.18
Right upper arm	48 (29.09)	1.67±5.37
Left upper arm	46 (27.88)	1.30±3.91
Lower back	117 (70.91)	11.69±20.10
Right forearm	30 (18.18)	1.17±4.23
Left forearm	31 (18.79)	1.25±4.36
Right wrist	51 (30.31)	2.87±9.20
Left wrist	40 (24.24)	2.11±6.03
Hip	55 (33.33)	2.10±5.37
Right thigh	41 (24.85)	1.65±7.48
Left thigh	37 (22.42)	1.55±7.45
Right knee	43 (26.06)	3.35±11.39
Left knee	43 (26.06)	2.46±8.41
Right lower leg	41 (24.85)	2.02±8.09
Left lower leg	42 (25.45)	2.11±8.20
Right foot	49 (29.70)	3.30±12.66
Left foot	48 (29.09)	2.72±10.63

Note: SD: standard deviation; *CMDQ:* Cornell Musculoskeletal Discomfort Questionnaire

The five regions with the most musculoskeletal symptoms were the upper back (78.18%), lower back (70.91%), neck (69.09%), right shoulder (55.76%) and left shoulder (49.09%). The five regions with the highest weighted CMDQ scores were the lower back, upper back, neck, right shoulder, and left shoulder, respectively. The comparison of the weighted CMDQ scores according to having COVID-19 disease is given in Table 4.

Table 4
The Comparison of the Weighted CMDQ Scores According to Having Covid-19 Disease

Body Parts	Covid-19		p
	Yes (n=75) Mean±SD	No (n=90) Mean±SD	
Neck	9.10±17.36	11.11±20.03	0.406
Right shoulder	5.53±12.49	6.26±13.66	0.560
Left shoulder	5.19±12.69	6.44±14.64	0.295
Upper back	11.66±18.20	11.31±18.26	0.713
Right upper arm	1.88±7.05	1.50±3.42	0.382
Left upper arm	1.43±4.86	1.19±2.90	0.790
Lower back	13.55±22.47	10.14±17.87	0.092
Right forearm	1.27±5.25	1.09±3.15	0.648
Left forearm	1.53±5.46	1.01±3.09	0.228
Right wrist	4.00±12.58	1.92±4.72	**0.009***

Table 4 (Continues)

Body Parts	Covid-19		p
	Yes (n=75) Mean±SD	No (n=90) Mean±SD	
Left wrist	2.91±7.72	1.44±4.05	**0.007***
Hip	2.01±4.76	2.17±5.86	0.637
Right thigh	2.19±10.54	1.20±3.18	0.191
Left thigh	2.14±10.53	1.05±3.08	0.139
Right knee	3.81±14.77	2.97±7.57	0.326
Left knee	2.86±10.88	2.13±5.63	0.309
Right lower leg	2.92±11.35	1.27±3.49	**0.024***
Left lower leg	3.01±11.40	1.37±3.83	**0.026***
Right foot	5.25±18.11	1.68±4.12	**0.001***
Left foot	3.96±15.07	1.68±4.12	**0.009***

Note: SD: standard deviation; *CMDQ:* Cornell Musculoskeletal Discomfort Questionnaire

DISCUSSION

The mean total score of the ASHN was 74.21±11.70 and classified as having a high attitude towards healthy eating. Out of 165 students, 34 (20.6%) attitudes towards healthy eating were found to be moderate, 100 (60.6%) high, and 31 (18.8%) very high. Studies report different results as well as consistent with our findings. In the study conducted by Gürsoy & Atmaca (2021) on 355 university students, the mean ASHN total score was determined as 77.7±11.0. Sümen et al. (2022), in their study of 907 adolescent students, found the mean total ASHN score was 61.75±14.94 and classified as moderate. The mean total scores of women were found to be higher. The stress, distress and emotional changes caused by the pandemic have also caused significant changes in individuals' eating habits. Studies show that eating habits are deteriorating (Başaran & Pekmezci Purut, 2021; Cena et al., 2021; Huber et al., 2021). Although studies have investigated the influence of the COVID-19 pandemic on nutrition, few studies compare individuals who have had the disease with those who have not. Although ASHN total score, EN and MN subgroup scores were higher and CN and PN subgroup scores lower in students who had COVID-19 disease, no statistically significant difference was found in the total score and sub-parameters in the group who had COVID-19 disease and the group who have not.

By examining sleep quality, 43 (26.06%) people were found to be good, and 122 (73.94%) to be poor. The global PSQI score was found as 6.49±2.82, sleep quality 1.32±0.58, sleep onset latency 1.38±0.93, sleep disturbance 1.36±0.58, hypnotic drugs 0.09±0.45, daytime dysfunction 1.45±0.89, sleep efficiency 0.26±0.64, and sleep duration 0.64±0.88. Timurtaş et al. (2022) examined physical activity, depression, stress, sleep, and quality of life of university students during the COVID-19 pandemic and determined the average PSQI scores of the participants as 4.2±2.0. They found poor sleep quality in 25.3% of the participants and good sleep quality in 74.7%. In their study, Alaca et al. (2022) evaluated students' physical activity level, sleep status and time management capacity during the COVID-19 pandemic. Sleep quality was found to be poor in 72.48% of the students. Mean global PSQI score was determined as 5.59± 2.57, subjective sleep quality 1.23± 0.59, sleep latency 1.21± 0.84, sleep duration 0.59± 0.79, habitual sleep efficiency 0.23± 0.60, sleep disorder 1.22± 0.52, sleep drug use 0.05± 0.28, daytime dysfunction as 1.06±0.85. Öztürk et al. (2022) examined the relationship between university students' anxiety levels, sleep quality, and musculoskeletal pain during the COVID-19 pandemic, and 79.9% of the students were found to have poor sleep quality. Mean global PSQI scores were determined as 7.9±2.8, sleep quality 1.24±0.78, sleep onset latency 2.94±0.28, sleep duration 0.47±0.65, sleep efficiency 0.76±0.93, sleep disturbance 1.42±0.65, hypnotic drugs 0.12±0.5, daytime dysfunction 0.96±0.95. When the global and PSQI subgroup scores according to the status of having Covid-19 disease are reviewed, our results suggest that the global PSQI and sleep duration subgroup scores of those with COVID-19 were statistically significantly higher ($p = 0.010$ and 0.043 respectively). No statistically significant difference was found in other subgroups ($p>0.05$). According to the study of İde and Gündüz (2021), 75.3% of the students had disturbed sleep patterns during the pandemic period. Systematic reviews also show that the COVID-19 pandemic is associated with poor sleep quality (Souza et al., 2021).

It is a controversial issue whether musculoskeletal complaints increase with COVID-19 disease. Our study suggests that the five regions with the most musculoskeletal symptoms were the upper back (78.18%), lower back (70.91%), neck (69.09%), right shoulder (55.76%) and left shoulder (49.09%). The five regions with the highest weighted CMDQ scores were the lower back, upper back, neck, right shoulder, and left shoulder, respectively. Şengül et al. (2020) found that the mean total CMDQ scores and pain levels were statistically significantly different before and during COVID-19 in their study of 1138 people ($p<0.001$, respectively). They determined the body regions with the most musculoskeletal disorders during the COVID-19 disease period as neck (76.9%), back (70.6%), and waist (66.2%). In a study investigating the effects of home arrangements on the musculoskeletal system in people working at home during the pandemic, Yener et al. (2022) reached 424 people, and 376 (88.7%) people reported pain in one of their body parts. The body parts with the most complaints were the neck (79.48%), shoulder (81.6%), upper back (79.71%), lower back (91.74%), and knee (91.03%). İde and Gündüz (2021) examined 154 university students, and when the CMDQ results were evaluated, the discomfort scores of the body parts: waist (18.26%), back (17.02%), neck (16.81%) and shoulder (11.54%). In another study (Toprak Celenay et al., 2020) carried out during the pandemic, low back pain was higher in the group working at home compared to the group that went to the workplace physically. Compared to pre-lockdown, neck, upper back, shoulder, and hip thigh pain decreased, and lower back pain increased. In the study of Şengül et al. (2020), pain and musculoskeletal discomfort findings were found to be lower in the COVID-19 period compared to the pre-COVID-19 period. Our findings on comparing the weighted CMDQ scores according to having Covid-19 disease suggest that significant differences were observed in the scores of the wrists, lower legs, and feet. Consistent with our findings, Murat et al. (2021) examined 210 Covid-19 patients at the hospital and found signs of fatigue, pain, fever, and cough. Of the 133 patients with pain symptoms, 92 (69.2%) had muscle and joint pain, 58 (43.6) had back pain, 33 (25.0%) had low back pain, and it was found to be more common than in the pre-COVID-19 period. 139 undergraduate students participated in the study of Şahan and Güler (2022), and the most painful body regions were the neck, back, and waists. Roggioe et al. (2021) interviewed 1654 students at the end of 1 year following Covid-19 and reported that 43.5% of the participants reported neck pain and 33.5% reported low back pain. Most of the students had high healthy eating. There was no statistically significant difference in the tendency to eat healthy food among students with Covid-19. We can conclude that everyone who has or has not had the disease with the COVID-19 pandemic has developed healthy eating behaviors. The majority of students have poor sleep quality. The global score and sleep duration were statistically lower in those who had COVID-19. We can conclude that the COVID-19 lockdown period and disease negatively affect sleep quality. The musculoskeletal system's upper back, lower back, neck, and shoulders were the most affected areas. The most affected areas in the musculoskeletal system are the upper back, lower back, and neck may be the weakening of the paraspinal muscles due to being immobile for a long time or the load due to staying in a fixed position at home. Pain may also develop in the shoulder area due to weakening or spasms of the rotator cuff and upper trapezius muscles.

CONCLUSION

The COVID-19 pandemic partially affected university students in terms of healthy eating attitudes and, to a greater extent, in terms of sleep and musculoskeletal disorders. The attitude toward healthy eating of most students was found to be high. There was no meaningful difference between groups according to having COVID-19 disease. Most students were found to be poor in terms of sleep quality. The global PSQI and sleep duration subgroup scores of those who had COVID-19 were statistically higher. The five regions with the most musculoskeletal symptoms were the upper and lower back, neck, and shoulders. Significant differences were observed in the wrists, lower legs and foot scores between those with COVID-19 were statistically higher. More research is needed to evaluate the long-term effects of COVID-19 on nutrition, sleep, and the musculoskeletal system.

PRACTICAL IMPLICATIONS

The COVID-19 pandemic has not had much negative impact on the healthy eating attitude of university students, and students generally have healthy eating habits. Efforts should be made to maintain and develop this. Sleep quality and the musculoskeletal system have been negatively affected by the COVID-19 pandemic, and these parameters can be improved with exercise programs that include endurance, strengthening, and relaxation components. In addition, a specialist dietitian can advise on improving a healthy diet.

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Authors' contributions

The first and second author collected data and contributed to the study design. The first author analyzed the data and all authors revised the manuscript and contributed to the interpretation of the results. All authors contributed to the supervision and critical reviewing of the original draft. All authors have read and approved the final version of the manuscript.

Declaration of conflict interest

The authors have no conflicts of interest to report.

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Research Article

Adaptation of Sports Involvement Scale to Turkish Culture: A Validity and Reliability Study in Football Spectators

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ABSTRACT

The Psychological Continuum Model (PCM) represents a gradual change of attitude formation. The continuum in the model is divided into four stages (Awareness, Attraction, Attachment, and Allegiance), which represent the formation of attitudes and involvement levels in increasingly stronger degrees towards the sport object (Funk & James, 2001). The first aim of the research is to adapt the Sports Involvement staging tool/scale developed for sports spectators by Doyle et al. (2013) within the scope of PCM for Turkish culture. The second aim of the research is to examine the differences in resistance to change levels of sports spectators regarding their involvement profiles. A total of 239 ($\bar{x}_{age}$ = 37.00±14.46) football spectators aged between 18-70 participated in the study [56 female ($\bar{x}_{age}$ = 31.79±13.29) and 183 male ($\bar{x}_{age}$ = 38.59±14.47)]. CFA was performed for adapting the scale. The findings of the Confirmatory Factor Analysis revealed that the Sports Involvement Scale represented its structural validity and psychometric properties as in the original scale (Chi-square/sd = 2.43, p<0.01, RMSEA = 0.078, NNFI = 0.98, SRMR = 0.038, GFI = 0.95). The Cronbach alpha value was checked for the internal consistency of the Emotional Resistance to Change sub-dimension of the Resistance to Change Scale, which was developed by Oreg (2006) and adapted to Turkish culture by Çalışkan (2019), and the value was found to be 0.80. The findings show that the Sports Involvement Scale is a valid and reliable measurement tool for Turkish culture. A statistically significant difference was found in the Resistance to Change values of the participants, depending on their level of sports involvement.

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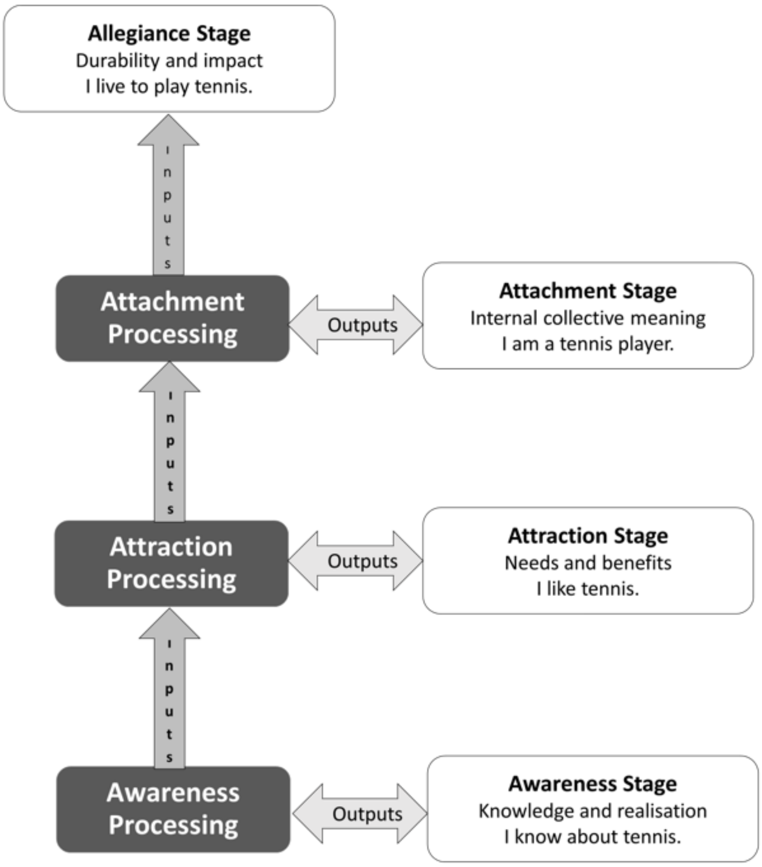
INTRODUCTION

The level of interest in sports teams and following activities for sports teams varies from person to person. This varying level of interest shown towards a sport and sports product is expressed as involvement. Involvement was evaluated by Iwasaki and Havitz (1998) as "the state of motivation, arousal or interest towards a recreational activity or product for users" (p. 260). While the interest of some people in sports competitions is to follow them as long as they come across them on television, for some, it is to watch every match and even to plan their life according to the dates and times of the competition. These different approaches of people to sports competitions are defined by Pooley (1978) as a continuum where there are spectators at one extreme and fans at the other, depending on their level of interest in sports. While this continuity defines sports spectators as individuals who observe a match and forget quickly, it defines supporters as individuals who have high emotional intensity towards the team and maintain their interest during the day or at intervals to increase this emotional intensity. According to this statement, individuals feel a sense of personal achievement when the team wins and a sense of personal loss when the team loses due to their strong bond with the sports team. The level of this feeling is affected by the individual's psychological involvement in that sport or activity.

The first studies conducted in sports evaluated the extent to which a person's attitude towards a sports object is generally positive or negative and the effect of this attitude on emotions and behaviors (Mahony & Howard, 1998; Mahony & Moorman, 1999). On the other hand, the first research on loyalty in consumer behavior is based on competition participation numbers to measure the behavioral component of loyalty (Hansen & Gauthier, 1989). The attitudinal component of fan loyalty has been largely overlooked, as it is relatively easy to consider engagement numbers when measuring behavior. However, by emphasizing the psychological aspect of involvement in sports, researchers have discovered that the phenomenon of loyalty is more complex than is possible, as well as the need for cognitive, emotional, and behavioral factors to explain brand loyalty for consumer products (Gladden & Funk, 2001; Hill & Green, 2000). In their study with professional baseball fans, Funk and Pastore (2000) observed that commitment was highly correlated with behavior and behavioral intention. Similarly, Hill and Green (2000) observed that team commitment and psychological involvement explain future participation intentions for rugby fans. This situation has revealed the importance of attitudinal research to understand how the attitudes and ascribed importance towards the sport object by the individual affect the cognitive process and behavior. In line with all these studies, Funk and James (2001) developed the Psychological Continuum Model (PCM) by reviewing relevant studies in the literature and taking into account the situation that creates a temporal difference in the attitude of an individual toward his/her relationship with a sport or team.

Figure 1
Psychological Continuum Model Stages



Note. From Funk (2008). Consumer behavior in sport and events: Marketing action. Oxford: Elsevier

PCM is a stage-based attitude determination tool that determines the individual's psychological connection with an object, subject, or activity and explains social psychological processes. Continuum in the model refers to an individual's increasingly stronger degree of attitude formation and involvement towards an object, subject, or activity. The current continuum is divided into four stages (Awareness, Attraction, Attachment, and Allegiance) in the model (Beaton et al., 2011; Funk & James, 2001). The first stage, “Awareness,” refers to awareness of an object, subject, or activity. Merely knowing or recognizing a sport indicates that the individual is in the awareness stage. For example, if the individual says, “I know about tennis,” or is conscious of it, it is an indication that he is in the “Awareness” stage. The second stage is the “Attraction” stage. The attraction stage represents the beginning of positive emotional interest (like love, etc.) towards a sport. If the individual says "I love tennis" or is aware of their positive emotional interest, it indicates that they are in the "Attraction" stage. "Attachment," which is another stage, refers to the internal integration of the individual with the sports branch/object or activity. Defining himself as a "tennis player" shows he is integrated with that sport. The last stage, “Allegiance,” refers to maintaining dedication and commitment to the sporting object or activity. Individuals in the Allegiance stage act according to the sports object or activity while organizing their daily lives. For example, an individual's statement, "I live for tennis," or organizing his life according to tennis indicates that he is in the Allegiance stage. The continuum framework in the model encompasses both internal factors, such as consumers' psychological needs, and external factors, such as socializing factors, to explain consumers' cognitions, preferences, and behaviors. The factors that determine consumer behavior in sports and events emerge by evaluating the internal (i.e. personal and psychological) and external (i.e., environmental) inputs as a whole. This is achieved through three types of assessment: cognitive, emotional, and behavioral. For example, knowledge about a sport or activity object stimulates cognitive evaluation, affecting cognition. This cognitive effect also initiates emotional and behavioral evaluations. In other words, the formation of an attitude towards a sporting object or activity occurs through the evaluation of environmental, psychological, and personal inputs. This evaluation reveals the psychological and behavioral consequences of the sports object or activity in consumer behavior. Psychological consequences indicate the formation of an attitude toward the object or experience of sports. As cognitive thoughts affect emotions, these emotions influence behavioral intention and actual behavior. Behavioral outcomes indicate an individual's observable response to a particular sporting object. These responses include purchasing behavior, post-purchase activities, and post-experience behavior. In summary, as shown in Figure 1, there is horizontal and vertical mobility in PCM, depending on the effect and size of internal and external inputs. While the psychological and behavioral outcomes differ in each stage, at the same time, as involvement increases, internal and cognitive development increases. In addition, as attitudes develop and fluctuate over time, a movement occurs along the continuum (Funk & James, 2006). Although this mobility differs according to the individual is stage, it can be downward (from the Allegiance stage to the Awareness stage) or upward (from the Awareness stage to the Allegiance stage). The Psychological Continuum Model also reveals these transitions between the stages and the commitment in each stage in line with the level of interest in sports. Because sports are unpredictable, dynamic, and variable in nature, such as the unpredictability of the outcome in sports competitions, and that the course of the competition can change instantaneously or that unexpected developments can occur during the competition, determining the level of involvement of the sports spectators is extra important in terms of understanding and directing the level of involvement in the process. Evaluating the involvement in sports objects using more than one dimension is important in terms of determining the internal and external factors that affect the level of involvement, as well as understanding the behavioral and cognitive outcomes of the effects of these elements in the sports audience (Havitz & Dimanche, 1997; Kapferer & Laurent, 1993). To explain this with an example, although two people from the Sports Involvement Scale had the same overall score, their level of involvement towards the team may have been affected by different dimensions. The first person who values hedonistic benefits more gets a higher score on the Pleasure sub-dimension. In contrast, the second person with a high score on the Centrality and Sign sub-dimensions may score lower on the pleasure sub-dimension because the team's performance is low (For example, the team is about to be relegated to a lower league). Therefore, using a profile-based system rather than a one-dimensional approach provides the opportunity to explain the theoretical meaning inherent in each dimension. Considering the efforts of the clubs not to lose their supporters, especially in the field of sports marketing, and the strategies they have developed on how to act about the fans in the future; It is also important to determine the level of involvement and profiling of fans towards their teams. PCM is of great importance in that it provides an opportunity for the supporters, i.e., the market, to be segmented and to develop marketing plans suitable for these market segments (using marketing mix components by the appropriate segments). For this reason, understanding the Psychological Continuum Model and determining what stage the individual is in, in terms of the level of involvement in line with the model, will help create a prediction, especially for profit-oriented sports organizations.

In previous studies on the Sports Involvement Scale, only the English version of the scale was expressed as a limitation, and the importance of conducting intercultural tests with different sample groups was mentioned (Beaton et al., 2011; Doyle et al., 2013). Tests with different cultures and racial groups are valuable in demonstrating the scale's global validity and comparing it with adaptations to be made in different cultures. Also, Beaton et al. (2011) stated that translating the scale into different languages would benefit its use as an alternative in international studies and multicultural (racial) countries. The current study expands the scale by testing it with different racial and cultural structures and testing it with different sample groups. Although several scales were developed in the Turkish language or adapted into Turkish to measure the fans' love for their team and their hatred for their arch-rival (Özsoy & Karlı, 2022), the psychological attachment of the fans to their team (Bozgeyikli et al., 2018), the level of identification of the fans with their team (Günay & Tiryaki, 2003) and the level of fanaticism of football spectators (Taşmektepligil et al., 2015), there is no measurement tool that can be used to evaluate the involvement levels of sports spectators towards the sports teams they support. Such a deficiency in the studies and the fact that this deficiency has limited the relevant studies has increased the importance of adapting the Sports Involvement Scale developed by Doyle et al. (2013) into Turkish and bringing it into the literature. From this point of view, the first aim of this research is to adapt the Sports Involvement Scale, an interest-based classification model, for Turkish culture. The second aim of the research is to examine the differences resistance to change sports spectators' levels regarding their involvement profiles.

METHODS

Study Group

Football is one of our country's most common and watched sports. While determining the population of this research, the population was limited to football fans, considering the interest and viewing level of football compared to other sports branches in our country. Within the scope of the research, literature was examined to determine the sample size to represent the main population in question. Tabachnick and Fidell (2007) stated that the sample size can be calculated by adding 50 to eight times the total number of expressions, while the International Test Commission (2018) stated that the sample size that can adequately reveal the psychometric structure of a scale is at least 200. In adaptation studies, many characteristics such as age range, education level, and gender of the sample group are expected to be the same as the target group of the original scale (Çapık et al., 2018; Erkuş, 2007). For this reason, the original study was taken to determine the relevant sample group for the current study. The population of the current research consists of fans of a football team over the age of 18, who have a minimum undergraduate degree in education, and who are fans of a football team above.

In this direction, 280 football spectators were reached as a sample from the population using the criterion sampling method, which is one of the purposive sampling types, but, because of not meeting the particpation criteria and inconsistent responses, 41 of the participants were excluded from the analysis. The data obtained from the remaining 239 participants were analyzed. In this context, a total of 239 ($\bar{x}_{age}$ = 37.00±14.46) football spectators, 56 females ($\bar{x}_{age}$ = 31.79±13.29) and 183 males ($\bar{x}_{age}$ = 38.59±14.47) between the ages of 18-70, who have minimum an undergraduate degree were included in the research.

Data Collection

In order to test the validity and reliability of the Sports Involvement Scale in Turkish culture and to determine the level of interest of football spectators to sports teams, permission was obtained from the scale owners via e-mail. Within the scope of the research, the application process has been started to translate the original English form of the Sports Involvement Scale into Turkish. The most crucial stage of adaptation studies is translation from source to the target language. For this reason, the standard procedure Brislin (1986) recommended for the translation-back translation method was followed. The translation of the scale from English to Turkish was carried out by three faculty members with field knowledge and English language proficiency. Then, these three translated texts, together with the original text of the scale, were given to two experts in the field of psychological counseling and sports sciences, and they were asked to choose the most appropriate expressions from the expressions in the translations. After this process, the Sports Involvement Scale was translated into Turkish and took its final form. This Turkish scale was given to two referees who are experts in the field of English, and it was translated into English again. and it was decided by making comparisons that there is a semantic integrity between the original text of the scale and the translated text from Turkish. After the translation processes, a pilot study was conducted to determine the scale's language intelligibility; for this purpose, it was applied to 50 football spectators. In line with the feedback received, no criticism/suggestion emerged, language intelligibility was found to be good, and the Turkish version of the scale took its final form.

Data Collection Tools

Ethics committee approval was obtained for this study from Marmara University Institute of Health Sciences with the number 05 on 17.01.2022 within the scope of doctoral thesis. In order to collect the data in the research, the participants were given the Personal Information Form, the Sports Involvement Scale, and the Resistance to Change Scale-Emotional Resistance subscale and an information note was added regarding the content and purpose of the research. Within the scope of the research, the *Personal Information Form* was used to gather the personal information of the participants (age, gender, education level, whether they support a specific football team).

The Sports Involvement Scale developed by Doyle et al. (2013), based on the research of Beaton et al. (2009), was used to determine the level of involvement of the participants in the sports teams they support. This scale was developed to measure the level of interest of sports spectators towards the teams they support. The scale has three sub-dimensions "Pleasure," "Sign" and "Centrality," and each sub-dimension consists of three items, a total of nine items. All items are positive items. Pleasure sub-dimension measures sports spectators' enjoyment and satisfaction from the course of the competition. The Sign sub-dimension measures the ability of the sports spectators to express themselves while watching the match of the team they support or the symbolic value that the team's course expresses to them. The sub-dimension of Centrality represents the place of the sports fans in the life of the competitions of the team they support and their centrality in their lives, and it measures the extent to which sports fans organize their lives to watch the team competitions they support. The average scores obtained from each sub-dimension of the scale are again classified separately for each sub-dimension [Low (< 4.5), Medium (4.5–5.65), and High (> 5.65)], creating an individual involvement profile for each respondent. According to the combination of scores (Low, medium, and high) from each sub-dimension, 27 possible involvement profiles emerge (Doyle et al., 2013). In line with the emerging profiles, it can be determined at which stage the individual is in PCM (Awareness, Attraction, Attachment, and Allegiance). Cronbach's alpha values of sub-dimensions ranged from .82 to .86. The scale is a 7-point Likert scale (1 = Strongly Disagree, 7 = Strongly Agree).

Finally, the Resistance to Change Scale developed by Oreg (2006) and adapted to Turkish culture by Çalışkan (2019) was given to the participants to measure their attitudes toward change and to test the criterion validity of the Sports Involvement Scale. The scale consists of three sub-dimensions: "Cognitive Resistance," "Behavioral Resistance," and "Emotional Resistance." Each sub-dimension consists of five items, four items of the "Emotional Resistance" sub-dimension we used within the scope of the research are positive and 1 item is negative. Emotional Resilience sub-dimension is concerned with how individuals feel and think about change. For this reason, only the "Emotional Resistance" sub-dimension was used to test the criterion validity within the scope of the research. The scale is five point Likert type (1 = Strongly Disagree, 5 = Strongly Agree).

Data Analysis

During the data analysis process, 41 data belonging to the participants who did not have the condition of being a supporter but filled out the questionnaire and who were determined as extreme value as a result of the extreme value analysis were excluded from the analysis, and statistical analyzes were applied on the remaining 239 participants out of 280 people.

In addition to descriptive statistics (frequency, percentage, mean, and standard deviation), confirmatory factor analysis was performed to test whether the scale preserves its psychometric structure with three factors. Cronbach's internal consistency calculation was conducted to determine the internal consistency coefficients of the items belonging to the dimensions, and AVE and CR values were calculated to evaluate the convergent validity of the scale. Furthermore, a non-parametric analysis of variance (Kruskal Wallis Test) was performed to determine the differences in the resistance to change levels of the spectators according to their sports involvement profiles. Lisrel 8.80 and SPSS 21 programs were used for the analysis.

RESULTS

The findings obtained from the analyses made in adapting the Sports Involvement Scale to Turkish culture are presented below, respectively.

Descriptive Statistics

Descriptive statistical findings obtained from the study participants are presented in Table 1. According to Table 1, the sample consists of 239 ($\bar{x}_{age}$ = 37.00±14.46) football fans, 56 of whom are female ($\bar{x}_{age}$ = 31.79±13.29) and 183 are male ($\bar{x}_{age}$ = 38.59±14.47). While the ages of the female participants range between 18 to 56, and the ages of the male participants range between 18 and 70. The mean age of the participants is 37.00±14.46. Undergraduate students represent 36.8% of the current sample, while participants with an undergraduate degree represent 42.3%. Participants with a master's degree represent 15.1% of the sample, and finally, participants with a PhD degree represent 5.9%.

Table 1

Findings of Descriptive Statistics

GENDER	N	Age_{mean}	sd	Age_{min}	Age_{max}
Female	56	31.79	13.29	18	58
Male	183	38.59	14.47	18	70
Total	239	37.00	14.46	18	70

EDUCATIONAL LEVEL	N	%	Cumulative Percentage
Undergraduate student	88	36.8	36.8
Undergraduate Degree	101	42.3	79.1
Master's Degree	36	15.1	94.1
PhD	14	5.9	100
Total	239	100	100

Findings of the Factor Analysis

Findings of the model fit and construct validity analyses regarding the scale's validity are presented. Figure 2 shows the results of the Confirmatory Factor Analysis (CFA) conducted on the data obtained from 239 participants using the adapted version of the Sports Involvement Scale. As shown in Table 2, findings indicate that the values regarding model fit indices fall within acceptable fit ranges (chi-square/df = 2.43, p<0.01, RMSEA = 0.078, NNFI = 0.98, SRMR = 0.038, GFI = 0.95).

Figure 2
Sub-Dimensions of the Sports Involvement Scale Path Chart

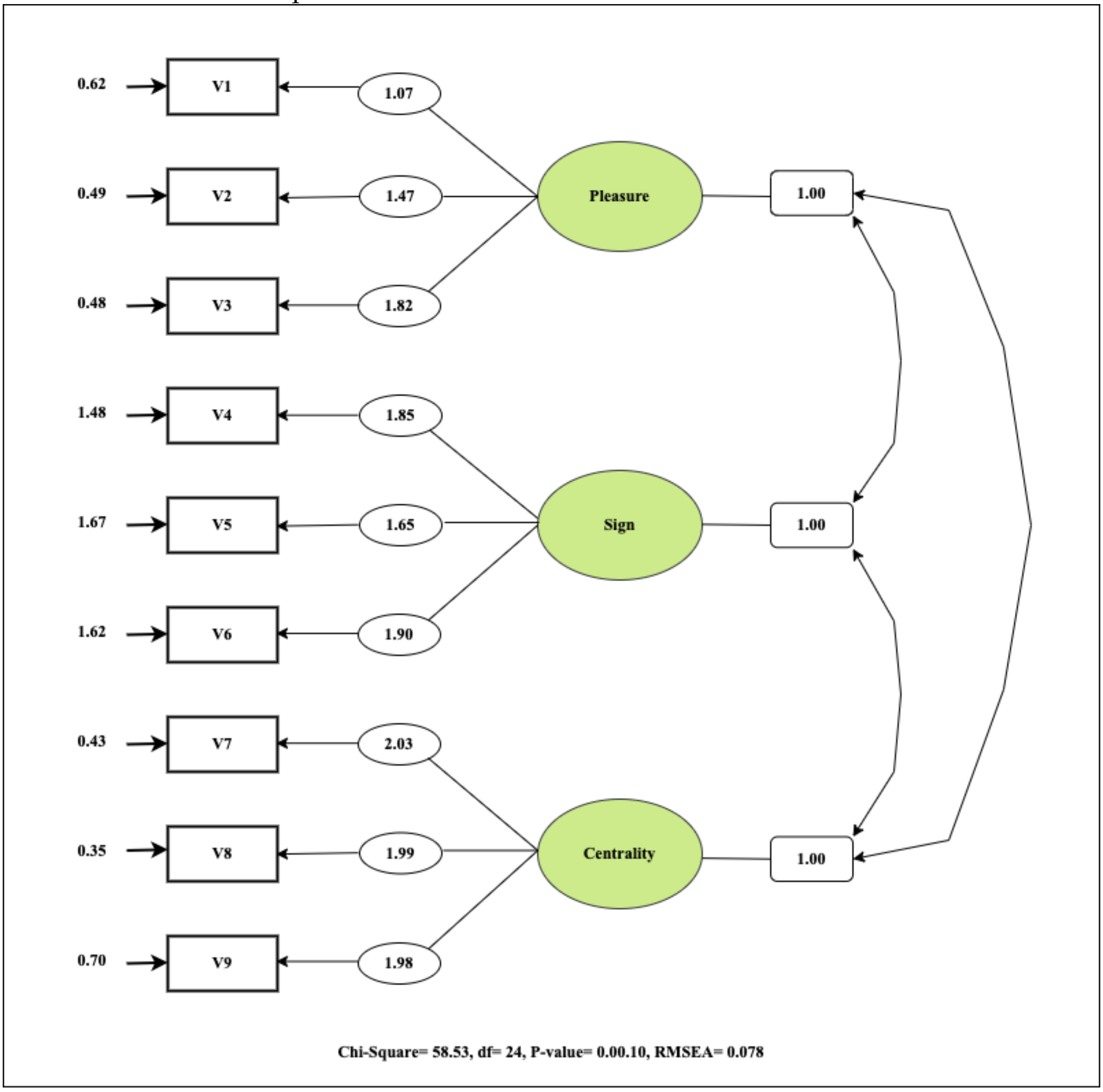


Table 2
Model Fit Criteria Used as a Reference for the Model in the Study

Fit Indices	Excellent Fit Threshold	Acceptable Fit Threshold
[1]χ^2/sd	$0 \leq \chi^2/sd \leq 2$	$2 \leq \chi^2/sd \leq 4$
[2]RMSEA	0 ≤ RMSEA ≤ 0.05	0.05 ≤ RMSEA ≤ 0.08
[2]NNFI	0.95 ≤ NNFI ≤ 1	0.90 ≤ NNFI ≤ 0.95
[3]SRMR	0 ≤ SRMR ≤ 0.05	0.05 ≤ SRMR ≤ 0.10
[2]GFI	0.95 ≤ GFI ≤ 1	0.90 ≤ GFI ≤ 0.95

Note: [1]Schermelleh Engel et al. (2003); [2]Hu & Bentler (1999); [3]Browne & Cudeck (1992).

Reliability Findings

In order to determine the reliability of the scale, internal consistency coefficient, factor loadings, and AVE values are presented, as well as the results of the Kruskal-Wallis test, which was performed to determine the statistical significance of the difference between groups. According to the findings shown in Table 3, the factor loadings of the Sports Involvement Scale vary between 0.79 and 0.96. Based on the findings of the reliability analysis, the internal consistency coefficients of the sub-dimensions were determined as 0.91, 0.84, and 0.94 for the Pleasure, Sign, and Centrality sub-dimensions, respectively. The AVE values for all sub-dimensions were determined to have been above 0.50 for convergent validity. Regarding construct reliability, the CR values for the respective sub-dimensions were all determined as above 0.80 (Yaşlıoğlu, 2017).

Table 3
Sports Involvement Scale Sub-dimensions, Dimension Items, t Values, Error Variances, Factor Loadings, Cronbach's Internal Consistency Coefficient, and CR-AVE Values

Scale Sub-dimensions	Item	t values	Error Variances	Factor Loadings	Cronbach's Alpha	CR	AVE
Pleasure	1	18.45	0.15	0.92			
	2	17.86	0.18	0.90	0.91	0.94	0.85
	3	18.93	0.13	0.94			
Sign	4	14.43	0.35	0.81			
	5	13.97	0.38	0.79	0.84	0.85	0.66
	6	15.09	0.31	0.83			
Centrality	7	19.69	0.09	0.95			
	8	19.98	0.08	0.96	0.94	0.96	0.89
	9	18.59	0.15	0.92			

Table 4 shows the profiles of the participants in line with the Sports Involvement Scale and their average scores for both scales. The average scores obtained from each sub-dimension of the Sports Involvement Scale increased in each stage as participants transitioned from the Awareness stage to the Allegiance stage. Similarly, average scores obtained from the Resistance to Change subscale increased in each stage as participants transitioned from the Awareness stage to the Allegiance stage.

Table 4
Mean Values of the Sports Involvement Scale Sub-dimensions and Resistance to Change Subscale According to the Involvement Levels of the Participants

Sub-dimensions	Involvement Level	N	Mean	Median	sd
Pleasure	Awareness	69	3.08	3.33	1.15
	Attraction	78	5.69	5.67	0.80
	Attachment	59	5.96	6.33	1.43
	Allegiance	33	6.83	7.00	0.40
Sign	Awareness	69	2.03	1.67	1.07
	Attraction	78	2.68	3.00	1.13
	Attachment	59	5.16	5.33	1.11
	Allegiance	33	6.38	6.33	0.64
Centrality	Awareness	69	1.31	1.00	0.59
	Attraction	78	1.98	2.00	1.03
	Attachment	59	4.02	4.00	1.50
	Allegiance	33	6.36	6.33	0.68
Resistance to Change	Awareness	69	2.77	2.60	0.88
	Attraction	78	3.41	3.30	1.05
	Attachment	59	4.11	4.20	0.85
	Allegiance	33	4.44	4.20	0.53

Since the data were not distributed normally, non-parametric tests were conducted to examine whether there were any differences between groups. According to the findings of the Kruskal-Wallis test, which was performed to determine whether there were differences in the participants' scores on the sub-dimensions of the Sports Involvement Scale and the Emotional Resistance to Change subscale depending on their involvement levels, statistically significant differences were found in participants' Resistance to Change levels and participants' scores on the Pleasure, Sign and Centrality sub-dimensions depending on their sports involvement levels ($p<0.01$, Table 5).

Table 5
Comparison of Participants' Pleasure, Sign, Centrality, and Resistance to Change Scores in Terms of Involvement Levels

Sub-dimensions	Involvement Level	N	Mean Rank	Chi-square	df	p	Groups with Difference
Pleasure	Awareness	69	38.96	156.897	3	**0.000***	1-2, 1-3, 1-4, 2-4, 3-4
	Attraction	78	132.58				
	Attachment	59	155.03				
	Allegiance	33	197.08				
	Total	239					
Sign	Awareness	69	63.09	162.906	3	**0.000***	1-3, 1-4, 2-3, 2-4
	Attraction	78	88.35				
	Attachment	59	176.41				
	Allegiance	33	212.95				
	Total	239					
Centrality	Awareness	69	60.69	159.557	3	**0.000***	1-2, 1-3, 1-4, 2-3, 2-4, 3-4
	Attraction	78	95.43				
	Attachment	59	166.89				
	Allegiance	33	217.70				
	Total	239					
Resistance to Change	Awareness	69	71.02	76.847	3	**0.000***	1-2, 1-3, 1-4, 2-3, 2-4
	Attraction	78	110.90				
	Attachment	59	156.33				
	Allegiance	33	178.95				
	Total	239					

*$p<0.01$

Mann Whitney U tests with Bonferroni correction were conducted to make pairwise comparisons and to determine the differences in the Resistance to Change scores between involvement level groups in detail. Statistically significant differences were found between all groups except between Attachment and Allegiance involvement level groups. Differences between those other profile groups showed that the resistance to change levels favor groups with higher sports involvement profiles (Table 6).

Table 6
Pairwise Comparisons of Participants' Resistance to Change Levels According to Their Involvement Levels

Group Pairs	Mean Rank Difference	Std. Error	Adj. Sig. (p)
Awareness-Attachment	-85.309	12.213	**0.000***
Awareness-Allegiance	-107.933	14.577	**0.000***
Attraction-Allegiance	-68.051	14.303	**0.000***
Attraction-Attachment	-45.427	11.884	**0.001***
Awareness-Attraction	-39.882	11.383	**0.003***
Attachment-Allegiance	-22.624	14.972	0.785

*$p<0.01$

DISCUSSION

The aim of this study was to adapt the Sports Involvement Scale, which was developed by Doyle et al. (2013) for sports spectators based on the study of Beaton et al. (2009) within the scope of PCM and to develop a measurement tool that will determine the interest levels of football spectators towards sports teams. CFA was performed to evaluate the structure and psychometric properties of the scale in its adapted language. When evaluating model fit, a Chi-square/sd value less than four and RMSEA value less than 0.08 indicate acceptable fit, an NNFI value greater than 0.95, an SRMR value less than 0.05, and an GFI value greater than 0.95 indicate excellent fit (Browne & Cudeck, 1992; Hu & Bentler, 1999; Schermelleh Engel et al., 2003). Evaluating the findings related to the model fit obtained by factor analysis (chi-square/sd = 2.43, $p<0.01$, RMSEA = 0.078, NNFI = 0.98, SRMR = 0.038, GFI = 0.95), it is possible to say that the model fit values are at the level of excellent and good fit when compared to the values accepted as criteria (Browne & Cudeck, 1992; Hu & Bentler, 1999; Schermelleh Engel et al., 2003). In addition, findings indicate that every item under each sub-dimension of the scale has very high factor loadings (0.79-0.96). As the factor loading of an item increases, the item's explanation rate of the related sub-dimension increases. A value over 0.60 indicates that the related item has a high factor loading (Büyüköztürk, 2002). As for the convergent validity, Average variance extracted (AVE) is seen as an essential criterion in determining the convergent validity of the scale in scale adaptation studies. The construct reliability of the scale was evaluated with CR and its internal consistency with Cronbach's alpha coefficient. (Hair et al., 2011). The AVE value is expected to be above 0.50, and the CR values to be higher than 0.70. As seen in Table 3, AVE values are above 0.66, and CR values are above 0.85. This indicates that the scale meets the expected criteria for convergent validity.

The findings regarding the construct validity obtained from the study are in line with other studies conducted with different sample groups [sports participants (Beaton, 2009, 2011), exercise participants (Beaton et al., 2009; Funk et al., 2011) and sports fans (Doyle et al., 2013)], showing that the original three-factor structure of the model is preserved.

A Cronbach Alpha coefficient between 0.80 and 1 indicates that the scale has high reliability (Alpar, 2000; Büyüköztürk, 2014; Tavşancıl, 2014). In other words, each item in the scale explains the structure for the relevant sub-dimension or concept to a high degree of reliability (Alpar, 2000; Büyüköztürk, 2002, 2014; Tavşancıl, 2014). According to the findings of this study, Cronbach's Alpha values for the sub-dimensions of the Sports Involvement Scale were calculated as 0.84, 0.91, and 0.94 for Sign, Pleasure, and Centrality, respectively. These values show that the Sports Involvement Scale is a reliable measurement tool for Turkish culture (Alpar, 2000; Browne & Cudeck, 1992; Hu & Bentler, 1999). Similarly, in the study of Doyle et al. (2013), two different sample groups were used, and the Cronbach's Alpha values obtained from the first group were determined as 0.76, 0.84, and 0.92 for Sign, Pleasure, and Centrality, respectively. In the second sample group of their study, alpha coefficients for Sign, Pleasure, and Centrality were determined as 0.81, 0.86, and 0.89, respectively. Compared to existing studies, it is seen that the Sports Involvement Scale adapted to Turkish culture has very high-reliability findings for each sub-dimension.

The Emotional Resistance to Change scale was utilized to test the criterion validity of the findings obtained within the research scope. The predicted result was that the Emotional Resistance to Change scores would increase as the PCM stages moved from the Awareness stage to the Allegiance stage. The findings, which supported our prediction, showed statistically significant differences in the emotional resistance to change levels at each stage of PCM ($p<0.05$). It supported the assumption that the groups that emerged within the PCM framework would have increasingly positive attitudes toward the team they support as they progressed from the Awareness stage to the Allegiance stage under the system in the PCM. Statistical findings obtained from sport spectators' emotional resistance to change and the PCM stage show that the resistance attitude gets stronger with the transition from the Awareness stage to the Attraction stage, from the Attraction stage to the Attachment stage, and from the Attachment stage to the Allegiance stage. While the current findings are in line with the original study (Doyle et al., 2013), they also support other studies on the relationship between PCM and resistance to change (Beaton et al., 2009, 2011; Funk et al., 2011).

In previous studies concerning the PCM framework, researchers suggested that new studies be expanded with different samples (Funk et al., 2011; Stewart et al., 2003), but most of the studies focused on sports participants or exercise participants (Beaton et al., 2009; Funk et al., 2011; Iwasaki & Havitz, 2004). This research both brought a new scale/staging tool to the national literature and supported the international literature within the scope of sports spectators. On the other hand, as stated by Stewart et al. (2003), sports organizations can use staging tools to determine their marketing strategies, build loyal spectator bases, and increase revenue. Marketing strategies targeted for individuals in each stage can be designed based on meeting the needs and wishes of these individuals. These strategies determined through PCM can be applied to move the spectator to the next stage in PCM (Beaton et al., 2011). In this context, the research contributes to the marketing literature. For example, for football spectators who are in the "Awareness" stage, football matches can be combined with the element of entertainment. Using the event with the right marketing strategy and considering other factors affecting participation can enable individuals to pass from the Awareness stage to the Attraction stage. Similarly, digital TV series and sports broadcast platforms can combine their marketing strategies. A one-month free sports package membership can be given to consumers who purchase a subscription from the TV series platform. In this way, if a sports spectator at the "Awareness" stage evaluates this package, watches and enjoys the competitions, both sports consumption level and interest towards the team will increase. Similarly, for a fan in the "Allegiance" stage to maintain his/her loyalty, free tickets can be given to the competitions in different sports branches of the same team's club when purchasing combined tickets or licensed sports products. In this way, "Awareness" is created for a different sport with fewer spectators, and loyalty to the sports team makes it sustainable. Studies show that high-cost products such as licensed products or combined tickets increase resistance to switching to another team and are an, influential factor in determining brand loyalty (Dick & Basu, 1994; Göksel et al., 2020).

CONCLUSION

The findings show that the Sports Involvement Scale (staging tool) is highly valid and reliable in determining and profiling the involvement levels for sports teams for football spectators, but further research on the subject is essential to support the current findings. In addition to the fact that football is the most widely produced and consumed sport in our country, the fact that only football, that is, a single sport, is included in the research can be considered a limitation. The study sample was limited to football spectators, considering the media interest in football and the rate of viewing in our country. In this context, it can be expanded with different sports branches while also increasing the sample size in future studies. In addition to the variable of emotional resistance to change, which is discussed in the research, the research can be diversified by considering different behavioral and attitudinal variables (Commitment to sports, motivation, etc.) in future studies.

In conclusion, this study showed that the Sports Involvement Scale is a valid and reliable measurement tool for Turkish culture and that staging (Awareness, Attraction, Attachment, and Allegiance stages) can be performed for football spectators in line with PCM, thus, making it possible for sports clubs to stage their fans in terms of sports involvement and to create marketing plans by putting forward appropriate marketing strategies based on the product, that is, the sports team, they have.

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Authors' contributions

First and second author contributed to conceptualization of the research, literature review, data collection, research outline, determining the research method, collecting the data, evaluating the analysis of the data, and critically interpreting the final draft. Third author contributed to performing data analysis and interpreting findings, critical interpretation of final draft.

Conflict of interest declaration

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

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Pamukkale J Sport Sci, 14(3), 346-367, 2023 Research Article

The Relationship Between Physical Activity and Life Satisfaction: The Mediating Role of Social-Physique Anxiety and Self-Esteem

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ABSTRACT

The primary aim of the study was to investigate the relationship between physical activity, life satisfaction, and the mediating effects of social-physique anxiety and self-esteem. Furthermore, this study assessed the measurement invariance of research models according to gender and age. A total of 334 participants (29.43 ± 8.17 years) completed the measures. Path analysis was utilized to appraise the research models. The research models exhibited excellent fit based on the data fit index values. The findings of the study showed a positive relationship between physical activity and both self-esteem and life satisfaction. In contrast, a negative relationship was observed between social-physique anxiety and physical activity. Social-physique anxiety was negatively related to self-esteem and life satisfaction. Furthermore, social-physique anxiety played a mediating role in the correlation between physical activity and life satisfaction. Additionally, self-esteem was a mediator in the relationship between social-physique anxiety and life satisfaction. Physical activity directly and indirectly positively impacted life satisfaction, mediated by social-physique anxiety and self-esteem. Eventually, the finding highlights physical activity's significance in mitigating social-physique anxiety and promoting self-esteem and life satisfaction. Hence, promoting physical activity can yield positive outcomes for both physical and psychological well-being, contributing to an overall improvement in quality of life. Encouraging regular physical activity can be incorporated into public health campaigns and wellness programs, as well as in individualized health plans.

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INTRODUCTION

Physical activity has gained significant attention as a crucial contributor to psychological and physiological health, supported by burgeoning research (Maher et al., 2015; O'Brien et al., 2020). Extensive evidence demonstrates the effectiveness of physical activity in preventing and treating several diseases, including stress, depression, and obesity-related disorders, leading to widespread recommendations by healthcare professionals (WHO, 1997). Moreover, attendance in physical activity is linked to improved general well-being (Brown, 1992). Considering the significant influence of physical activity on health, further research is warranted to delve into the multifaceted aspects of this intricate matter.

Within this context, the primary goal of this study is to reveal the relationship between physical activity and life satisfaction. Physical activity any kind of activity that causes an individual to expend energy in the musculoskeletal system, such as walking, working in the garden, or exercising (Caspersen et al., 1985). Life satisfaction evaluates an individual's general happiness, satisfaction, and subjective well-being (Diener et al., 1985; 1999). Past studies have proven a positive correlation between physical activity and life satisfaction (Elavsky & McAuley, 2005; Maher et al., 2015; Zayed et al., 2018). The mechanisms that connect physical activity and life satisfaction are thought to involve the release of hormones such as endorphins, which play a crucial role in overall bodily health (Dishman & O'Connor, 2009), reduction in depression symptoms (Craft & Perna, 2004; Schuch et al., 2018), promotion of cognitive development (Hillman et al., 2008), positive emotions (Reed & Buck, 2009), and overall well-being (Steptoe & Butler, 1996). However, the precise mechanisms underlying this relationship require further investigation. Therefore, researchers are exploring various potential mediators, such as loneliness (Santino et al., 2022), self-control (Zhou et al., 2023), well-being (Randall et al., 2021), and weight perception (Meyer et al., 2021), to explore the relation between physical activity and life satisfaction. In the context of these explanations, it is essential to recognize that the relationship between physical activity and life satisfaction is complex and can be influenced by many different variables. In this study, it was thought that social-physique anxiety and self-esteem may also be important mediators in this relationship.

Social-physique anxiety can be defined as the unease or apprehension individuals feel concerning how their bodies appear in social settings. This often results in body comparisons and a fear of being negatively judged by others (Hart et al., 1989). Notably, evidence suggests a significant relationship between social-physique anxiety and physical activity (Brunet & Sabiston, 2009). This relationship may arise from the inherent evaluation of body shape in environments where physical activities are undertaken (Sabiston et al., 2014). However, it is essential to note that the existing literature presents conflicting findings regarding the relationship between physical activity and social-physique anxiety. Some studies report a negative relationship (Brunet & Sabiston, 2009; Herring et al., 2021; Kowalski et al., 2001), while others indicate a positive relationship (Aşçı et al., 2006; Bowden et al., 2005), and some studies find no significant relationship (Niven et al., 2009; Portman et al., 2018). These divergent findings underscore the need for further research to understand the relationship between physical activity and social-physique anxiety. Furthermore, it is also explained that life satisfaction, which is defined by concepts such as happiness and well-being (Diener et al., 1985; 1999), has a negative relationship with social-physique anxiety (Erçevik, 2021; Ürün & Öztürk, 2020). The literature has also reported that social-physique anxiety negatively affects variables such as well-being (Berger et al., 2021; Brown, 1992). All these findings suggest that the level of physical activity can be influenced by social-physique anxiety, which can affect life satisfaction. In other words, social-physique anxiety could mediate between physical activity and life satisfaction.

Another crucial mediating variable examined within this study is self-esteem. Self-esteem is essential in human existence, as it represents an individual's optimistic or pessimistic evaluation of themselves (Rosenberg et al., 1995). Social-physique anxiety might be related to self-esteem, including self-assessments (Hart et al., 1989). Some studies indicate that individuals with low self-esteem might experience more anxiety about being negatively evaluated by others (Brunet et al., 2010; Hagger & Stevenson, 2010). Additionally, it is reported that individuals who experience anxiety about their appearance might experience a decrease in self-esteem and an increase in negative emotions (Brunet et al., 2010; Davison & McCabe, 2006). Low self-esteem can lead to decreased life satisfaction due to increased negative emotions (Diener & Diener, 1995; McPhie & Rawana, 2012; Ürün & Öztürk, 2020) because self-esteem is an important predictor of life satisfaction (Maher et al., 2015). All these findings together suggest that self-esteem might be a mediating variable in the relationship between social-physique anxiety and life satisfaction.

To summarize, recent research findings have provided compelling evidence that engaging in physical activity yields positive outcomes in terms of life satisfaction (Elavsky & McAuley, 2005; Maher et al., 2015; Zayed et al., 2018), social-physique anxiety (Brunet & Sabiston, 2009; Herring et al., 2021; Kowalski et al., 2001), and self-esteem (Legrand et al., 2020). Furthermore, existing literature has documented a negative relationship between social-physique anxiety and self-esteem (Brunet et al., 2010; Hagger & Stevenson, 2010), as well as between social-physique anxiety and life satisfaction (Erçevik, 2021; Ürün & Öztürk, 2020), while conversely revealing positive links between self-esteem and life satisfaction (Bozoğlan et al., 2013; Chen et al., 2006; Diener & Diener, 2009). However, it is worth noting that comprehensive research examining the correlation between physical activity and life satisfaction, with due consideration to social-physique anxiety and self-esteem as potential mediating variables, remains limited. Exploring the intricate relationships among these concepts within a unified framework can contribute significantly to the existing body of literature. Additionally, it is crucial to emphasize that much of the prevailing research on social-physique anxiety and self-esteem primarily focuses on adolescents and women (Sabiston et al., 2014). Therefore, investigating these correlations among adults can yield further advancements in the field. In light of these considerations, the principal aim of this study was to investigate the relationship between physical activity and life satisfaction. At the same time, delve into the potential mediating influences of social-physique anxiety and self-esteem.

The findings of this study will significantly contribute to the current body of literature by offering a comprehensive insight into the interconnections among variables of the research. Identifying mediating variables would provide valuable information about the mechanisms behind the efficacy of physical activity on life satisfaction. Thus, with a deeper understanding of the factors affecting life satisfaction, it becomes possible to make positive changes that can increase the general life satisfaction of individuals. Additionally, examining measurement invariance would enhance the applicability of the findings, offering valuable insights for future research and interventions aimed at various subgroups.

Measurement Invariance

It is crucial to consider subgroups, such as gender and age, in modeling studies and examine their consistency (Vandenberg & Lance, 2000). aIt is important to assess measurement invariance to determine whether the model retains the similar structure among subgroups (Cheung & Rensvold, 2002). About physical activity, life satisfaction, social-physique anxiety, and self-esteem, it is essential to examine literature findings related to gender and age variables within the model of this research.

> Some studies have reported that physical activity levels differ by age and gender (Azevedo et al., 2007; Bauman et al., 2009; Troiano et al., 2008). In these studies, it was reported that the physical activity levels of men were higher than women, and the physical activity levels of the individuals decreased as they aged.

Regarding life satisfaction, there are conflicting findings about gender differences. Some studies claim that men have higher life satisfaction (Pinquart & Sörensen, 2001), while others indicate no gender difference (Diener et al., 1999; Stone et al., 2010). Age and life satisfaction often exhibit a U-shaped trend, characterized by lower levels in middle adulthood followed by an upturn in later adulthood (Blanchflower & Oswald, 2008).

Social-physique anxiety varies according to gender and age, with higher levels of social-physique anxiety in women as age increases (Hagger & Stevenson, 2010; Zartaloudi et al., 2023). However, measurement invariance of social-physique anxiety has yielded conflicting results, with some studies indicating no distinction according to age and gender (Abdollahi et al., 2023; Pacewicz et al., 2023; Tiggemann, 2004).

The findings concerning gender discrepancy in self-esteem are inconsistent. Certain studies propose that men exhibit superior self-esteem than women (Bleidorn et al., 2016; Kling et al., 1999), while others indicate no significant difference (Trzesniewski et al., 2003). Moreover, the relationship between age and self-esteem can differ across various stages of adulthood. Higher self-esteem is commonly reported in early adulthood, followed by a decline during middle adulthood and a subsequent increase in older adulthood (Orth et al., 2012; Robins et al., 2002).

It is crucial to recognize that these findings may not hold for every individual and can be impacted by various variables, including financial, health status, and personal circumstances (Diener et al., 1999; Orth et al., 2012). Given the contradictory findings reported in previous studies and individual variations, it is imperative to analyze the measurement invariance of variables, including gender and age, in the current study. An analysis of the measurement invariance of variables such as physical activity, life satisfaction, social-physique anxiety, and self-esteem across various subgroups can be attained more thoroughly comprehend the relationship between these factors. Therefore, a secondary aim of this study was to assess whether the research models exhibit measurement invariance across various gender and age groups.

METHODS

Research design

The study utilized a correlational research approach to investigate the relationships between variables. The convenience sampling method was employed in the study. Structural equation modeling was utilized to assess the validity of the model constructed for exploring these relationships.

Study Group

Determining the appropriate size of a research group can be challenging, and different methods have been proposed for this purpose. Comrey and Lee (1992) introduced a classification for sample size, indicating that a group of 300 is considered good. The research group comprised 174 women and 160 men, with 334 participants. Participants were among the ages of 18-45 (mean 29.43, years ± 8.17). Participants, 58.1% (194 people) fell within the 18-29 age range, while 41.9% (140 people) were in the 30-45 age range.

Data Collection Tools

Personal characteristics, an information form with three open-ended questions and the Sports Awareness Scale (SAS) developed by Uyar and Sunay (2020) were used to collect research data. In the personal information form in the first part of the data collection tool, there are eleven personal information items and three open-ended questions to determine the gender, age, marital status, educational status, professional experience, job title, unit of employment, monthly income, province of residence, relationship with sports, and reason for choosing the profession.

Data Collection Process

Physical Activity Scale-2 (PAS-2) assessed physical activity and sedentary behavior in adults. PAS-2 was initially developed by Pedersen et al. (2018) and later adapted by Gür (2021). PAS-2 includes nine items that assess sedentary behavior during work, transportation, and leisure time, as well as physical activity levels of different intensities. Calculating the metabolic equivalent (MET) equivalents of each item on the scale makes it possible to estimate an individual's daily and weekly physical activity levels. In addition, the test-retest reliability coefficient in Gür's (2021) scale version was 0.81.

The Social-Physique Anxiety Scale (SPAS) was originally developed by Hart et al. (1989) as an evaluation of individuals' levels of social-physique anxiety. SPAS was later adapted to the Turkish context by Mülazımoğlu-Ballı and Aşçı (2006), and its cross-cultural validity was further investigated by Hagger et al. (2007). Based on their findings, Hagger et al. (2007) recommended using seven items from the scale and confirmed its one-dimensional structure in Turkish culture. The SPAS is a five-point Likert-type. SPAS was evaluated with a total score, the lowest possible score was seven and the highest was 35. It shows that as the score obtained from the SPAS increases, the level of anxiety about the person's appearance also increases. In this study, the Cronbach alpha reliability coefficient of the scale was 0.86.

The Global Self-Esteem Scale, originally developed by Rosenberg (1965), is widely used to assess self-esteem. The questionnaire was adapted to the Turkish context by Çuhadaroğlu (1986) to ensure its relevance and applicability to the target population. The scale comprises ten items that designed to measure a single construct. Participants respond on a four-point Likert type. A score between 0 and 6 can be obtained from the scale. In the Turkish adaptation, scores between 0 and 1 indicate low self-esteem, scores between 2 and 4 indicate medium self-esteem, and between 5 and 6 indicate high self-esteem. An increase in the score obtained from the scale suggests an increase in self-esteem. The Cronbach's alpha coefficient of the scale was found to be 0.75 in this study.

The Satisfaction with Life Scale, developed by Diener et al. (1985), was adapted to Turkish by Dağlı and Baysal (2016) to assess individuals' satisfaction with their lives. The scale comprises five items, each rated on a 5-point Likert type. It was a unidimensional scale, scored from 1 to 5, and the total score was obtained by calculating the average of the responses. An increase in the Satisfaction with Life Scale score indicated an increase in life satisfaction. The Cronbach's alpha coefficient of the scale was 0.89 for this study.

Procedure

The study received ethical approval from the Ethics Committee of Pamukkale University (30/03/2021-07) and adhered to the principles outlined in the Declaration of Helsinki. Participation in the study was voluntary, and participants received written and oral explanations regarding their participation and the importance of providing accurate information. Research data were collected face-to-face and online. Face-to-face forms (197 people) were filled out by the participants in places such as cafes, workplaces, and sports fields near the researchers. Online forms were applied to the participants (137 people) through the social media accounts of the researcher and their relatives. No specific list of names was created for the participants, and data collection tools were randomly sent and collected from their social media accounts. Necessary explanations were written on the data collection tools for the target participants. No identifying information, such as their names, was requested, ensuring that their identities remained confidential. To increase the return, the data was shared twice. There was no time limit for filling out the forms. Participants were also assured that their privacy and confidentiality would be maintained throughout the study.

Data Analysis

Descriptive statistics and structural equation model (SEM) analyses were implemented to investigate the relationships between research variants. The data analyses were performed using SPSS version 21.0 (IBM Corp., Armonk, NY) and AMOS version 23.0 (IBM Corp., Wexford, PA) software. The first stage of data analysis involved conducting descriptive statistics, assessing the data's normality, evaluating measures' reliability, and handling missing values. For the normality analysis, the ±2 interval suggested by George and Mallery (2012) was used for skewness and kurtosis values. The reliability evaluation was based on the value of 0.70 recommended by Nunnally and Bernstein (1978). In the second step, the correlation coefficients between the variables were calculated. In the third stage, path analysis, a component of the structural equation model, was employed to evaluate the adequacy of the research model. While evaluating the path analysis, acceptable limits were set according to Marsh et al., (2004), including the ratio of chi-square to degrees of freedom (x^2/df) was smaller than three, comparative fit index (CFI), Tucker–Lewis index (TLI) more significant than 0.90, and standardized root mean square residual (SRMR), root-mean-square error of approximation (RMSEA) < .08/.10. Perfect fit limits were also considered, including x2/df < 2.00, CFI, TLI > 0.95, and SRMR, RMSEA < 0.05. In the fourth stage, to ensure measurement invariance was conducted by including gender and age variables and evaluating configural, metric, scalar, and strict invariances. The criteria suggested by Chen (2007) and Cheung and Rensvold (2002) were used to assess the degree of invariance, with ΔCFI (change in CFI) and ΔRMSEA (change in RMSEA) values compared between the nested models. The significance of the chi-square difference (Δχ2) for measurement invariance should also be reported.

RESULTS

Upon examining the mean values, it was thought that the scores for social-physique anxiety fell within the moderate range, while the scores for self-esteem and life satisfaction were slightly above average. The normality assumption was confirmed as the skewness and kurtosis values for the variables fell within the recommended range of ±2, indicating that the data followed a normal distribution. The Cronbach's alpha coefficients of the scales ranged from 0.75 to 0.89. Additionally, composite reliability values ranged from 0.86 to 0.90, further confirming the reliability of the scales. These values indicated acceptable internal consistency coefficients. Table 1 reports the descriptive statistics.

Table 1
Descriptive, Reliability and Correlation of the Research Variables

Variables	*M* ±*SD*	Skewness	Kurtosis	α	*CR*	1	2	3	4
1. Physical activity	2364.571 ±352.269	.776	1.772	-	-	-			
2. Social-physique anxiety	18.03 ±6.75	.541	-.556	.86	.86	-.226**	-		
3. Self-esteem	5.22 ±4.02	1.057	.170	.75	.90	.082	-.296**	-	
4. Life satisfaction	3.24 ±.96	-.287	.565	.89	.90	.226**	-.392**	.233**	-

**$p < .01$, * $p < .05$
Note. α = cronbach alpha, CR = composite reliability

According to the correlation coefficients reported in Table 1, positive relationships were observed between physical activity and both life satisfaction and self-esteem. Conversely, social-physique anxiety negatively affected physical activity, self-esteem, and life satisfaction. Apart from physical activity and self-esteem, all the correlation coefficients reached statistical significance at the $p < .01$ level.

Research models

The research model (Figure 1) was developed to depict the relationships among physical activity, social-physique anxiety, self-esteem, and life satisfaction. According to the model, the level of physical activity influences life satisfaction by impacting both social-physique anxiety and self-esteem. Additionally, social-physique anxiety directly influences life satisfaction through its effect on self-esteem.

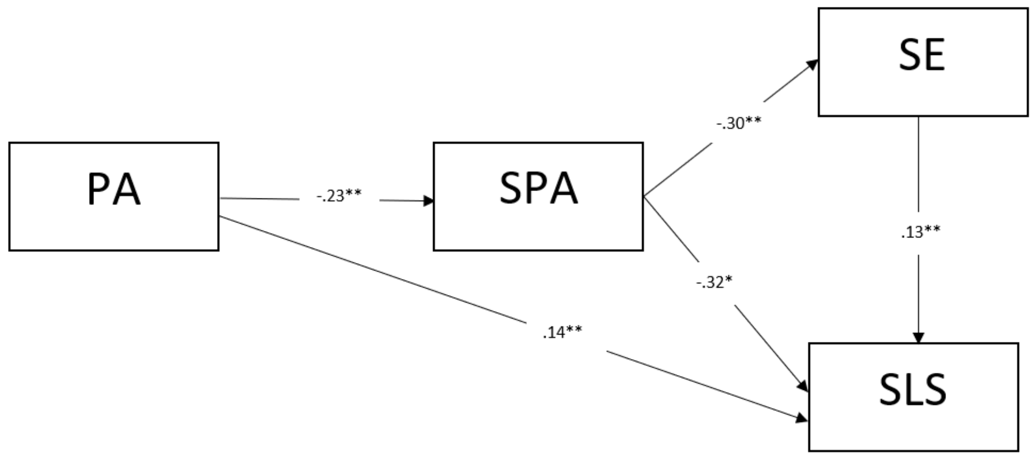
The results of the path analysis indicated that the research model provided a perfect fit for the datum (Table 2). The x2/df < 3, the RMSEA and SRMR values were less than 0.05. Additionally, the values of CFI, TLI, and IFI exceeded 0.95, as indicated in Table 3. The standardized coefficients indicated that physical activity positively influenced life satisfaction (β = .14, $p < .01$), and self-esteem positively influenced life satisfaction (β = .13, $p < .01$). Conversely, the relationships between physical activity and social-physique anxiety (β = -.23, $p < .001$), social-physique anxiety and self-esteem (β = -.30, $p < .001$), and social-physique anxiety and life satisfaction (β = -.32, $p < .001$) were negative. The path coefficients were shown in Figure 1. In addition, the research model was repeated for men and women, 18-29 years old and 30-45 years old. Similar results were obtained with the research model in the models made according to gender and age (Table 2).

Table 2
Model-Test Findings of Study Variables

Variables	χ^2	*df*	χ^2/df	*p*	*RMSEA*	*SRMR*	*CFI*	*TLI*	*IFI*
Research model	.090	1	.090	.764	.000	.005	1.000	1.000	1.000
Female	003	1	.003	.953	.000	.001	1.000	1.091	1.014
Male	1.448	1	1.448	.229	.053	.029	.991	.945	.992
18-29 years	.197	1	.197	.657	.000	.009	1.000	1.071	1.011
30-45 years	1.155	1	1.155	.212	.063	.031	.987	.923	.988
Perfect fit thresholds			<3	>.05	<.05	<.05	>.95	>.95	>.95

Based on the findings derived from the path analysis of the research model (as illustrated in Figure 1), there exist significant relationships between various factors: physical activity and social-physique anxiety, social-physique anxiety and self-esteem, and self-esteem and life satisfaction. Indirect relationships were also found between physical activity and life satisfaction, mediated by social-physique anxiety, and between social-physique anxiety and life satisfaction, mediated by self-esteem. Findings suggest that an increase in physical activity was related to a decrease in social-physique anxiety, leading to an increase in life satisfaction. Conversely, higher social-physique anxiety was related to lower self-esteem, resulting in decreased life satisfaction.

Figure 1
The Research Model of the Study Variables



Chi-Square = .090, df = 1, P-value = .764, RMSEA = 0.000
standardized coefficient, p < .01*, p < .001**
Note. PA = physical activity, SPA = social-physique anxiety, SE = self-esteem, SLS = satisfaction with life.

The model analysis results, as presented in Table 3, revealed that the strongest effect in the model was observed for the relation between social-physique anxiety and life satisfaction. The effects of social-physique anxiety on self-esteem, physical activity on social-physique anxiety, self-esteem on life satisfaction, and physical activity on self-esteem were observed. These findings suggest that social-physique anxiety significantly influences overall life satisfaction. Additionally, social-physique anxiety impacts self-esteem, physical activity influences social-physique anxiety, self-esteem contributes to life satisfaction, and physical activity affects self-esteem.

Physical activity standardized indirectly affected life satisfaction through social-physique anxiety ($\beta 2$ = .081). Social-physique anxiety indirectly affected life satisfaction through self-esteem ($\beta 2$ = -.037). Physical activity indirectly affected self-esteem through social-physique anxiety ($\beta 2$ = .067). All direct (Table 3) and indirect path coefficients established in the research models were determined to be meaningful.

Table 3
Direct Paths Analysis of Study Variables with Bootstrap Analysis from the Research Model

Variables			B^1	β^2	*SE*	*CR*	*p*
SPA	<--	PA	-.004	-.226	.001	-4.233	p<.001
SE	<--	SPA	-.059	-.296	.010	-5.654	p<.001
SLS	<--	SE	.091	.126	.037	2.439	p<.01
SLS	<--	SPA	-.046	-.322	.008	-6.083	p<.001
SLS	<--	PA	.000	.142	.000	2.808	p<.01

Note. β^1 = non-standard coefficients, β^2 = standard coefficients, PA = physical activity, SPA = social-physique anxiety, SE = self-esteem, SLS = satisfaction with life

Measurement invariance

Measurement invariance findings from the research model indicated that the data fit indices for gender and age levels met the recommended thresholds for $\chi 2/df$, RMSEA, and SRMR scores, as presented in Table 2. However, upon analyzing the research model, it was found that the gender variable did not demonstrate metric, scalar, and strict invariance (see Table 4). On the other hand, the age variable exhibited structural, metric, scalar, and strict invariance in the research model (see Table 4).

Table 4
The Research Models Short Form Measurement Invariance Results by Gender, Age Level

	Invariance Test	χ2 (df)	Δ χ2 (Δ df)	CFI	Δ CFI	RMSEA	Δ RMSEA	Invariant?
Gender for Short Form	Configural invariance	1.452 (2)	-	1.000	-	.000	-	Yes
	Metric invariance	8.992 (7)	7.540 (5)**	.983	.017	.029	.029	No
	Scalar invariance	14.762 (8)	5.770 (1)	.941	.042	.050	.021	No
	Strict invariance	22.664 (11)	7.902 (3)	.898	.043	.057	.007	No
Age level for Short Form	Configural invariance	1.754 (2)	-	1.000	-	.000	-	Yes
	Metric invariance	5.995 (7)	4.241 (5)**	1.000	.000	.000	.000	Yes
	Scalar invariance	8.105 (8)	2.111 (1)**	.999	.001	.006	.006	Yes
	Strict invariance	9.036 (11)	.931 (3)**	1.000	.001	.000	.006	Yes

DISCUSSION

The findings of this research, which investigated the relationships among physical activity, social-physique anxiety, self-esteem, and life satisfaction, indicate that an increase in physical activity levels results in an enhanced sense of life satisfaction. This relationship is observed through both direct and indirect avenues. Notably, social-physique anxiety and self-esteem act as mediating factors in the indirect relationship. Furthermore, self-esteem serves as a mediator between social-physique anxiety and life satisfaction.

This study offers evidence in support of a positive correlation between physical activity and higher life satisfaction. This finding is consistent with previous research conducted (Elavsky & McAuley, 2005; Maher et al., 2015; Zayed et al., 2018) and further strengthens the validity of the relationship between physical activity and life satisfaction. When reviewing the existing literature, it can be observed that an increase in the level of physical activity supports positive emotions (Ludwig & Rauch, 2018), enhances well-being (Steptoe & Butler, 1996), reduces fatigue, and raises energy levels (Puetz et al., 2006), thus influencing variables that impact life satisfaction. Furthermore, it is observed that physical activity's physiological contributions (Dishman & O'Connor, 2009) and psychological benefits (Craft & Perna, 2004; Reed & Buck, 2009; Steptoe & Butler, 1996) lead to increased life satisfaction. Possibly, the positive psychological and physiological contributions of the increase in the level of physical activity individuals cause individuals to have a more positive outlook on life (O'Brien et al., 2020; Maher et al., 2015). This also affects life satisfaction. However, research also indicates that life satisfaction can be approached as a broad term and can be influenced positively or negatively by various variables (Elavsky & McAuley, 2005; Maher et al., 2015; Zayed et al., 2018). Both the existing literature and the findings of this study show that mediating variables significantly affect the relationship between physical activity level and life satisfaction.

Based on the findings of this study, it can be said that social-physique anxiety functions as a mediator between physical activity and life satisfaction. The study observed that a high physical activity level is linked to a low level of social physique anxiety, positively influencing life satisfaction. This observation aligns with previous research that supports the relationship between physical activity and social-physique anxiety (Brunet & Sabiston, 2009; Herring et al., 2021; Kowalski et al., 2001), as well as the connection between social-physique anxiety and life satisfaction (Erçevik, 2021; Ürün & Öztürk, 2020). Individuals with high levels of social-physique anxiety might avoid participating in physical activities in public settings due to concerns about their bodies and the fear of judgment (Brunet & Sabiston, 2009; Eng et al., 2001) and may even have more difficulty enjoying various aspects of life (Eng et al., 2005). This anxiety could lead to a decrease in life satisfaction. On the other hand, adopting a different perspective by increasing physical activity level can have a protective effect. Engaging in activities such as exercise can enhance body confidence and a positive body image (Campbell & Hausenblas, 2009; Cruz-Ferreira et al., 2011; Legrand et al., 2020). This, in turn, may lead to a reduction in social physique anxiety. Consequently, as individuals' body concerns decrease, an improvement in life satisfaction can be observed (Ürün & Öztürk, 2020). Indeed, existing literature supports the relationship between social-physique anxiety and negative body image (Zartaloudi et al., 2023), increased anxiety disorders (Herring et al., 2021), and decreased overall well-being (Berger et al., 2021), all of which can negatively impact life satisfaction. Therefore, promoting activities such as exercise, which can help alleviate social-physique anxiety or enhance physical activity levels, has gained further significance.

This study has revealed a significant negative correlation between social-physique anxiety and life satisfaction, with self-esteem as a mediating factor in this relationship. Similar research has supported the connections between social-physique anxiety and self-esteem (Brunet et al., 2010; Hagger & Stevenson, 2010), social-physique anxiety and life satisfaction (Erçevik, 2021; Ürün & Öztürk, 2020), as well as self-esteem and life satisfaction (Bozoğlan et al., 2013; Chen et al., 2006). Self-esteem, as defined, pertains to an individual's positive or negative self-evaluations (Rosenberg et al., 1995). Social physique concerns can lead to negative self-evaluations, self-criticism, and pessimistic thoughts (Hart et al., 1989), potentially leading to a decline in self-esteem. An individual characterized by high social-physique anxiety and low self-esteem may consequently experience a detrimental impact on their life satisfaction due to these negative self-evaluations (Hagger & Stevenson, 2010). Supporting this finding, low self-esteem has been found in the literature to be related to many variables that can negatively affect life satisfaction, such as depression (Orth & Robins, 2013) and emotional and behavioral problems (Leary et al., 1995). In summary, these findings underline that social-physique anxiety is directly related to life satisfaction, operating through the mediating influence of self-esteem.

As an additional discussion, in this study, the initial hypothesis was that self-esteem would mediate between physical activity and life satisfaction. However, the results indicated no significant correlation between physical activity and self-esteem in the constructed model. For this reason, physical activity and life satisfaction links were not included in the model. Notably, existing literature generally supports a positive relationship between physical activity and self-esteem (Altıntaş et al., 2014; McAuley et al., 2005; Tremblay et al., 2000; Zamani Sani et al., 2016). Nevertheless, sporadic studies in the literature present conflicting outcomes in this regard (Liu et al., 2015). We propose that further investigation should be conducted to discern whether this particular outcome is unique to the dataset of this study or if it might be attributed to cultural differences. These intricate findings imply the possibility of other underlying factors that might predominantly mediate the relationship between physical activity and self-esteem. Current research suggests that social-physique anxiety could potentially play a pivotal role as a mediating element in the connection between these variables.

Measurement invariance

Another objective of this research is to evaluate the measurement invariance of this research model across various genders and ages. These findings revealed that the research model achieved measurement invariance based on age variables, while measurement invariance based on gender was not attained. It is worth noting that previous research suggests potential differences in variables such as social-physique anxiety and physical activity between genders (Azevedo et al., 2007; Hagger & Stevenson, 2010; Zartaloudi et al., 2023). Gender differences might have influenced the absence of measurement invariance in the research model. However, it is significant to note that the research model demonstrated satisfactory data fit for both men and women, suggesting that the model is valid and applicable to both genders. Therefore, despite the lack of measurement invariance, the research model can be considered applicable and relevant for both genders.

Limitations

By limiting the age range to 18-45 years, the generalizability of the findings to other age groups may be limited. Moreover, despite the study's efforts to maintain gender parity, it is essential to acknowledge that gender-related disparities may exist in the correlation between physical activity and the variables investigated in this research. Subsequent studies could examine these discrepancies by concentrating on single-gender cohorts or comparing outcomes across various age groups.

An additional constraint of this research is its cross-sectional design, which precludes causality determination. Future research with longitudinal or experimental designs could provide more insights into the relationships between physical activity, social-physique anxiety, self-esteem, and life satisfaction over time.

Moreover, the study solely investigated self-esteem as a mediating variable and did not establish a significant relationship with the level of physical activity. Future studies could explore additional potential mediator variables, such as mood measures, to enhance the comprehension of the relationship between physical activity, social-physique anxiety, self-esteem, and life satisfaction.

CONCLUSION

Overall, this study underlines the significance of physical activity in enhancing life satisfaction. The results indicate that increased physical activity is related to favorable outcomes, including elevated self-esteem and life satisfaction, while reducing social-physique anxiety. Therefore, it is recommended for individuals of various age groups to do regular physical activity to develop their overall welfare and well-being. Future research endeavors could extend these findings by examining the long-term outcomes of physical activity on health using longitudinal or experimental study designs.

PRACTICAL IMPLICATIONS

It is worth noting that engaging in physical activity has reduced social-physique anxiety and enhanced self-esteem, resulting in higher life satisfaction. Hence, promoting physical activity can yield positive outcomes for both physical and psychological well-being, contributing to an overall improvement in quality of life. Encouraging regular physical activity can be incorporated into public health campaigns and wellness programs, as well as in individualized health plans. Furthermore, healthcare professionals can actively engage in conversations with their patients about the advantages of physical activity and offer guidance on integrating exercise into their daily routines, providing them with valuable resources and support in the process.

Physical activity is recommended to prevent and treat many physical and psychological diseases (WHO, 1997; Liu et al., 2015). Due to its lack of side effects, physical activity is readily accessible and cost-effective, making it an efficient and affordable approach to improving overall well-being. Therefore, we highly recommend that individuals of all ages increase their physical activity level and engage in exercise activities, such as using the stairs, walking instead of driving short distances, going to the gym, and walking. These recommendations can have positive results for individuals' physical and psychological well-being.

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Authors' contributions

Both authors contributed conception and design of the study; both authors have collected data; the first author analyzed, and interpretation of the data; the first author contributed to drafting the article, its critical revisions, and reviewing the results, then both of them approved the final version of the manuscript.

Conflict of interest declaration

The authors declare that they have no conflict of interest.

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Basic Psychological Needs in Exercise Among Adult Exercisers

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ABSTRACT

This study aimed to examine the basic psychological needs in exercise among adult exercisers regarding gender, type of exercise, age groups, and years of exercise. The Basic Psychological Needs in Exercise Scale was administered to 234 adult exercisers (M_{age}=25.11, SD = 8.89 years). The participants were classified into two age groups (18-29 and 30-45 years) and three groups based on years participating in exercise programs (6 months to less than one year, 1-3 years, and more than three years) and three types of exercise groups (individual, group, and both). We found statistically significant gender and age group differences on the relatedness subscale ($p<0.01$). Female and in 30-45 age group exercisers had higher relatedness scores than those in the 18-29 age group and male exercisers. We also found statistically significant differences between groups of exercise types in all subscales ($p<0.01$). PostHoc comparisons revealed that exercisers participating in individual plus group exercises had significantly higher scores in all subscales than those participating only in individual or group exercises. Furthermore, significant differences regarding the years of participating were found in all subscales ($p<0.01$). Post hoc group (6 months to less than one year, 1-3 years, and more than three years) comparisons showed that participants exercising for six months to less than one year had lower scores. It was concluded that female and younger exercisers satisfied more relatedness needs in exercise. In addition, it has been noted that the type of exercise and longer-term participation are significant factors in meeting psychological needs during exercise.

INTRODUCTION

The physical and psychological benefits of regular exercising have been studied extensively (Akyol et al., 2008; Paluska & Schwenk, 2000; Penedo & Dahn, 2005). Because society in general has become inactive and sedentary with the effect of technological developments (Proper et al., 2011; Corder et al., 2019), the results of studies on the benefits of physical activity are now more important (Gür & Küçükoğlu, 1992; Reis et al., 2000). Due to the physical, psychological, and social positive effects of regular exercise, increasing physical activity in the general public has been among the primary goals of public health in many developed countries (Caspersen et al., 2000). The state of being physically inactive in adolescence (Ekblom et al., 2018) may also manifest itself in adulthood (Kumar et al., 2015). The physical and psychological benefits provided by exercise are associated with individuals' well-being and social needs. (Wilson et al., 2006). From this vantage point, the value of the "need" issue, which has been on the agenda of researchers for a long time, has been better understood. In physically inactive individuals, it is thought that psychological problems will be added to the physiological problems that may occur due to physical inactivity, with the effect of social factors, including motivating behaviors (or lack thereof). In this case, the psychological needs that affect the individuals' behaviors also gain importance in exercise behaviors (Vallerand, 2001).

Self-Determination Theory (SDT) examines the goals and desires of individuals in two main categories: intrinsic and extrinsic motivation. While making these definitions, Self-Determination Theory (SDT) is considered a meta-theory, also draws upon and relates to micro theories such as Cognitive Evaluation Theory, Organismic Integration Theory, Causality Orientation Theory, Goal Contents Theory, and Basic Psychological Needs Theory, emphasizing their interconnectedness (Ryan & Deci, 2000). In this study, the assessment of the needs of regular exercisers is attempted to be explained within the framework of SDT, focusing on the theory of Basic Psychological Needs in Exercise. The basic psychological needs that regulate the interaction of individuals with each other in daily life become essential in terms of determining, implementing, and achieving results (Deci & Ryan, 2000). SDT emphasizes that individuals must meet their basic psychological needs for healthy development. According to the theory, three needs in particular are fundamental: autonomy, competence, and relatedness (Ryan & Deci, 2020). The need for autonomy is defined as the individuals' feeling of independence in determining their goals and the feeling of freedom in their behaviors. It expresses the desire to act in activities of one's choosing and to be the source of one's behavior (Ryan & Deci, 2020). The need for competence expresses the belief that an individual will achieve their purpose and confidence in their capacity to exist in society. It is also defined as the desire of individuals to interact efficiently with the environment, to experience a sense of competence in producing desired results, and to prevent undesirable events (Edmunds et al., 2006). The third need, relatedness, is the feeling of being connected to the people with whom individuals interact in their social lives and belonging to the environment in which this interaction takes place (Vlachopoulos & Michailidou, 2006). In other words, it includes a sense of connectedness or belonging to a particular social circle (Edmunds et al., 2006). The inhibition of these three needs is seen as detrimental to motivation and wellness (Ryan & Deci, 2020). Self-determination theory proposes that when needs are met, the most self-determined forms of regulations will lead to behavior. In contrast, low self-determination results from blocking these three basic needs (Edmunds et al., 2006).

Using SDT as a guide, the importance of "interpersonal support resources" that can play an essential role in basic psychological need fulfillment has been emphasized. They are autonomy support, structure, and involvement. Autonomy support embodies teaching methods (for example, being empathetic and encouraging) designed to identify and enhance psychological needs by prioritizing the person's values and interests. The amount and clarity of information that the others supply to support the desired goals are referred to as their structure. Involvement is an interpersonal support that can be achieved through warmth, participation, unconditional interest, and the ability to empathize with and respond effectively to the unpleasant feelings of others (Mack et al., 2017). In other words, it can also be explained as the ability to accept the difficulties encountered in situations such as performing sports and to show genuine interest in an individual's well-being (Wilson et al., 2009). The proposition that these interpersonal supports are related to meeting basic psychological needs has been supported by studies conducted in the context of exercise (Mack et al., 2017). From this perspective, it is thought that the interpersonal support of the participants in the group and individual exercise programs may differ in the exercise environment. Therefore, there may be differences in fulfillment of their basic psychological needs. In addition, relatedness, one of the basic psychological needs, is the sense of establishing a meaningful bond with other people in the individual's social environment (Wilson et al., 2007). In other words, people need to experience the feeling of bonding with others and belonging (Mehra et al., 2016). In this context, it is thought that the concept of meeting this need may differ between those participating in group exercise programs and those participating in individual exercise programs. For example, exercising with peers can motivate them to continue the exercise program (Mehra et al., 2016). The varying results in exercise experience in the conducted studies have emphasized the necessity of contributing results to the literature regarding the needs and duration of exercise participation. In Güler's (2020) study, no significant difference was found in exercise experience, while Kaşka (2022) concluded that different exercise experiences have different needs. In addition, research exercises research in the literature has shown that basic psychological needs are not adequately addressed in terms of variables such as the type of individual or group activities of exercise programs and the period of exercise participation. For these reasons, main objective of this study was to examine the basic psychological needs of the participants who exercise regularly in relation to the type and period of exercise participation.

Many studies have examined fulfillment of the basic psychological needs in exercise via different variables. Reis et al. (2000) reported that the needs for autonomy, competence, and relatedness were significantly related to well-being and that satisfying these needs positively affected people's well-being. Kirkland et al. (2011) examined the connection between motivation, meeting basic psychological needs, and exercise in older adults and found that individuals who exercised had higher scores in meeting their needs for relatedness, competence, and autonomy than those who did not (Kirkland et al., 2011). Vlachopoulos et al. further supported this theory with cross-cultural studies (Vlachopoulos et al., 2011; 2013). Edmunds et al. (2006) examined the relationship between basic psychological needs in exercise and exercise behavior and reported significant statistical results supporting SDT. Goulimaris et al. (2014) investigated the connection between psychological well-being and basic psychological needs in exercise in adults who participated in recreational activities. They concluded that well-being in individuals who exercised was positively concerning the fulfillment of three basic psychological needs. Edmunds et al. (2007) conducted a study on overweight/obese individuals who took part in a 3-month exercise program and concluded that an improvement in the satisfaction of competence and relatedness needs increased commitment to the program more over time. Increases in general need satisfaction experienced during the program positively predicted self-determination motives in participation in physical exercise. In a study conducted by Martinez et al. (2013) on individuals participating in exercise programs at sports centers, it was found that the psychological need for competence was effective in females' exercise participation, while it did not affect men's exercise participation.

It has been reported that there are gender differences in the satisfaction of basic psychological needs in different age groups. For example, Molix and Nichols (2013) studied individuals aged 20-81 years and found that females' levels of competence and relatedness satisfaction were higher than their male counterparts. Navarro-Patón et al. (2018) examined the satisfaction of basic psychological needs in physical education classes in students aged 10-17 years and found that male students' satisfaction levels in three basic needs were higher than those of female students. In Güler's (2020) study, it was found that male participants had higher need scores, whereas Ekiz and Sezgin (2021) concluded that female participants had higher scores. In terms of results, Kaşka's (2022) and Güler's (2020) studies also differ. Kaşka (2022) did not find significant differences among age groups, while Güler (2020) concluded that there were different needs in different age groups. As can be seen, different results were obtained in different age groups. In addition, there are few studies on whether there is a change in the satisfaction of basic psychological needs in the exercise environment according to gender and age. A recent study stated that examining basic psychological needs in relation to age, gender, and a different kind of exercise would help them understand the topic better (Kazak, 2018). For these reasons, this study's secondary aim was to examine the basic psychological needs of the participants who exercise regularly in relation to gender and age groups.

METHODS

Research design

In this study, a quantitative research design, specifically a descriptive research model, has been utilized. These studies aim to collect and analyze data to determine the specific characteristics of a group and reach a conclusion (Büyüköztürk et al., 2012).

Study Group

A total of 234 individuals, 111 females (mean age 27.5 years; SD = 9.42 years) and 123 males (mean age 22.94 years; SD = 7.82 years), who engaged in regular exercise programs in sports centers in Kırıkkale participated in this study. The study's sample size was calculated with power analysis as 207 adult exercisers, considering that the parameters for α and β were 0.05 and 0.90, respectively. In light of this, participants were recruited using the convenience sampling technique. Participants who complied with the requirements to participate in an exercise program 1-3 times a week for at least six months were eligible to participate in this study. The exercise type categorizations (group and individual exercise programs) were presented to the participants as options in the personal information form. Additionally, they were instructed to write down the specific groups or individual activities they participated in.

The exercise programs were grouped as they were conducted in the sports centers where the study was carried out. Demographic information of the participants is presented in Table 1.

Table 1
Demographic Characteristics of the Sample

Demographic variables		f	%
Gender	Female	111	47.4
	Male	123	52.6
Age Groups	18-29	157	67.1
	30-45	43	18.4
Participation period in exercise	Six months - < 1 year	91	38.9
	1-3 years	58	24.8
	> 3 years	85	36.3
Type of exercise	Group	51	21.8
	Individual	142	60.7
	Group + Individual	41	17.5

Data Collection Tools

Demographic Information Form: This form was used to obtain information such as the demographic characteristics of the participants, the type of exercise they attended, and the participation period.

The Basic Psychological Needs in Exercise Scale (BPNES): The BPNES was developed by Vlachopoulos and Michailidio (2006) and consists of 12 items in three subscales: Competence (items 1, 4, 7, and 10), Autonomy (items 3, 6, 9, and 12), and Relatedness (items 2, 5, 8 and 11). Each item was evaluated on a 5-point Likert scale ranging from 1 (Strongly disagree) to 5 (Strongly agree). The validity and reliability of the Turkish version of BPNES were undertaken by Vlachopoulos et al. (2013). The goodness of fit index values of the Turkish version of the BPNES were found to be acceptable levels (Satorra-Bentler X^2 (42) = 199.71; CFI = 0.912; RMSEA = 0.074). The composite reliability coefficients ranged from 0.73 (Competence) to 0.80 (Relatedness), and Cronbach alpha coefficients also ranged from 0.72 (Competence) to 0.81 (Relatedness) (Vlachopoulos et al., 2013). The alpha coefficients for the present sample range 0.79 (Autonomy) to 0.83 (Competence).

Data Collection

Before the data collection process, participants were informed verbally and within the information sheet that involvement in the study was voluntary and results would be strictly confidential. The participants who signed written consent forms participated in the study. The BPNES, demographic information form, and informed consent form were administered to the participants. Self-report questionnaire responses were anonymous and took 10 to 15 minutes to complete. The research met ethical requirements for research with human participants in Türkiye and was conducted in accordance with the Principles of the Declaration of Helsinki.

Data Analysis

The participants were classified according to the variables of age group, the type of exercise they participated in, and the period of participation in exercise programs. The classifications made are given in Table 1, and these classifications were used in statistical analysis. The normality of the data was assessed using the Kolmogorov-Smirnov test, and it was determined that the data did not follow a normal distribution ($p < 0.01$). Non-parametric tests were conducted to examine BPNES score differences because of non-normally distributed data. The Mann-Whitney U test was performed to examine differences in BPNES scores in gender (female/male) and age groups (18-29/30-45 years). In addition, Kruskal Wallis analysis of variance was conducted to determine group differences (groups of types of exercise and exercise participation period) in BPNES scores.

RESULTS

The descriptive statistics of basic psychological needs in exercise for all participants are presented in Table 2.

Table 2
Descriptive Statistics of Basic Psychological Needs in Exercise for All Participants (N = 234)

Subscales	Scale range	M	SD	*Cronbach Alpha* (α)
Autonomy	1-5	4.05	0.74	0.79
Competence	1-5	3.03	0.61	0.83
Relatedness	1-5	3.91	0.77	0.80

It was observed that the subscale with the highest mean value in meeting the basic psychological needs of the participants was autonomy, followed by relatedness and competence, in this order. Table 3 indicates the results of the Mann-Whitney U test and descriptive statistics by gender.

Table 3
Mann-Whitney U Test Results of Basic Psychological Needs in Exercise by Gender

Subscales	Gender				Z	p	*r* *
	Female (n = 111)		Male (n = 123)				
	M	SD	M	SD			
Autonomy	4.11	0.63	3.99	0.82	-.441	.659	-
Competence	3.09	0.54	2.98	0.66	-.886	.376	-
Relatedness	4.08	0.66	3.76	0.83	-2.785	.005	0.18

* *r*: Effect size (Field, 2009)

As seen in Table 3, the only significant difference was found between female and male exercisers in the relatedness subscale of the basic psychological needs in exercise ($p<0.01$, $r=.18$). An inspection of the means showed that female exercisers had a significantly higher score in the relatedness subscale than male exercisers. Regarding age group differences, we found significant differences only in the relatedness subscale ($p<0.05$, $r = .16$). The participants in the 30-45 years age group had significantly higher scores in the relatedness subscale than those of the 18-29 age group (Table 4).

Table 4

Mann-Whitney U Test Results of Basic Psychological Needs in Exercise by Age Groups

Subscales	Age Groups: 18-29 years (n =157)		30-45 years (n = 43)		Z	p	*r*
	M	SD	M	SD			
Autonomy	4.03	0.72	4.15	0.69	-1.025	.305	-
Competence	3.02	0.59	3.13	0.56	-1.272	.203	-
Relatedness	3.86	0.76	4.14	0.72	-2.289	.022	0.16

The results of The Kruskal Wallis analysis of variance indicated that significant differences were found in all subscales by type of exercise groups ($p<0.01$, $.23 < r < .33$). PostHoc comparisons using the Mann-Whitney U test revealed that the mean scores in all three subscales of the exercisers participating in both group and individual exercise programs (group + individual) were significantly higher than the scores of those participating in individual exercises (Table 5).

Table 5

BPNES Scores Regarding Exercise Type and Results of Kruskal Wallis Analysis of Variance

Subscales	Exercise Type: Group (n = 51)		Individual (n = 142)		Group+Individual (n = 41)		X^2	p	*r*
	M	SD	M	SD	M	SD			
Autonomy	4.15	0.53	3.93	0.81	4.33	0.61	10.108	.006	0.23
Competence	3.10	0.48	2.92	0.66	3.34	0.39	16.764	.001	0.31
Relatedness	4.13	0.61	3.73	0.82	4.28	0.55	21.076	.001	0.33

The results of Kruskal Wallis analysis of variance showed that statistically significant participation period group differences were found regarding all BPNES scores ($p<0.01$, Table 6). Post hoc comparisons using the Mann-Whitney U test revealed that the difference was because the individuals who performed exercise for six months to less than one year had lower scores than those who exercised longer ($p<0.01$).

Table 6
BPNES Scores in Terms of Participation Period and Results of Kruskal Wallis Analysis of Variance

Subscales	Participation Period						X^2	p	*r*
	6 mth-1 yr. (n = 91)		1-3 yr. (n = 58)		>3 yr. (n = 85)				
	M	SD	M	SD	M	SD			
Autonomy	3.76	0.78	4.27	0.65	4.21	0.66	24.286	.001	0.31
Competence	2.81	0.67	3.18	0.49	3.17	0.52	19.508	.001	0.30
Relatedness	3.72	0.81	4.05	0.78	4.02	0.69	11.578	.003	0.22

DISCUSSION

This study investigated the basic psychological needs in exercise of regular exercisers regarding gender, age, exercise type, and period of exercise participation. According to the research findings, a statistically significant difference was found in the relatedness subscale of the basic psychological needs in exercise concerning gender. Female exercisers had higher scores in the subscale of relatedness than male exercisers indicates that females are more committed to their relationships in exercise environments than males (Vlachopoulos & Michailidou, 2006). In this respect, it is possible to say that females have a higher sense of belonging to the exercise environments they interact with and are therefore more satisfied. The low scores of the male exercisers in the relatedness subscale can be explained by the fact that they feel the need for relationships less. This finding was in line with the findings of Kirkland et al. (2011) study with older adults, which reported that female exercisers had significantly higher scores than males in the psychological need of relatedness. Similarly, Çankaya (2009) and Goulimaris et al. (2014) stated that while there was no significant difference between genders in the subscales of autonomy and competence, females had higher scores in the subscale of relatedness. These studies noted that females' wellness increased, and their psychological well-being improved by meeting their basic psychological needs through exercise programs. In this respect, it can be said that females benefit more psychologically (reduction in anxiety, depression, stress, etc.) by participating in exercise programs than men. In the literature, it is seen that females fulfilled their relatedness needs more than males in terms of establishing bonds and making sense of relationships in daily life (Çankaya, 2009; Sarı et al., 2011). When the success of women in controlling their social behaviors and emotions stemming from their gender roles (Ertürk et al., 2016) is combined with the positive feelings (wellness and psychological well-being) to be obtained by participating in exercises, it is thought that the need for bonding related to the interaction with the environment is fulfilled more. However, some studies also did not find gender differences in basic psychological needs among regular exercisers (Öner, 2019; Standage et al., 2005; Vlachopoulos & Karavani, 2009). Both male and female individuals participating in exercise programs may need to be offered similar satisfying interactions.

The results of this study showed that younger individuals had lower scores in the relatedness subscale compared to older participants. Young adult exercisers may not care about the sense of belonging and interaction in their exercise environment compared to older exercisers. Öner (2019) conducted a study on individuals who participated in regular exercise for an average of 4.49 years and concluded that 20-29 years old individuals scored significantly lower in all subscales, including the subscale of relatedness, compared to individuals aged 30-39 years and over 40 years. Goulimaris et al. (2014) reported that, in parallel with the present results, as the age of the participants increased, they had significantly higher scores in the relatedness subscale. Kirkland et al. (2011) examined the relationship between motivation, exercise, and basic psychological needs; they concluded that autonomy, competence, and relatedness needs were positively related to the motivation to participate in exercise in adults aged 55 and older. Based on this result, it is recommended that exercise practitioners working with younger individuals create the content of the exercise program in a structure that would meet the participants' autonomy, competence, and relatedness needs. Thus, exercise programs in which this age group participates would contribute to meeting these needs.

The current study indicated that the exercisers who participated in both individual and group exercise programs had significantly higher scores in all subscales of BPNES than exercisers who participated in only individual or group activities. It can be said that exercisers participating in both programs have a higher level of freedom (autonomy). It is possible to say that individuals who choose different alternatives in exercise programs would feel both autonomous and competent for different programs. Lovell et al. (2016) reported that the competence and relatedness needs of the females who participated in group exercise programs were fulfilled more. Group exercises were more associated with relatedness due to the need for socialization. However, with the feedback of the exercise practitioners in group exercises, it was also stated that females considered themselves more competent in reaching their goals through exercise programs. The current study's finding that the autonomy, competence, and relatedness needs of exercisers participating in mixed (group+individual) exercise programs are met more supports SDT's tenets. In other words, since mixed (group+individual) exercise programs would provide more socialization, it is expected that the feeling of commitment to the exercise environment and the need to establish relationships are high (Vlachopoulos & Michailidou, 2006). The high level of interaction in group activities would enable the participants to observe themselves more clearly and, in this way, to feel more competent in social production (Edmunds et al., 2006).

In this study, we found that exercisers who participated in an exercise program between six months and a year fulfilled their basic psychological needs less than those who exercised longer. The needs in which people's feelings of achievement, determination, and struggle emerge in daily life are motivational needs. As individuals satisfy these needs, they adjust their program preferences accordingly to increase these feelings even more (Arık, 1996). In this context, it may be possible to say that at the beginning of the exercise programs, the individual may not feel competent according to the content of the exercise and may not act autonomously in determining the content. Vlachopoulos et al. (2011) stated that participation in exercise contributes to the formation of exercise identity in the individual over time. They reported that basic psychological needs may be necessary in this process and that the period of participation in exercise programs is effective in meeting the psychological needs of individuals, such as expressing themselves and defining the outside world. They also stated that meeting the needs may be related to the participants' being novice or experienced. Öner (2019) reported that the increase in exercise participation and the weekly training amount of individuals participating in exercises increased the fulfillment of the overall basic psychological needs. The fact that the basic psychological needs of the exercisers who participated in the exercise program between six months and a year in this study were met less can be explained by the possibility that these participants did not yet feel competent in performing these exercises because they had exercised less than the others. Similarly, since they spent less time, compared to others, in the wellness and sports centers where they participated in activities, sufficient time may not have been created for interacting with individuals and meeting their commitment needs.

The research has some limitations that need to be addressed. First, the findings may be relevant only for male and female exercisers in a few recreational sports centers, limiting the the results' generalizability, having not considered exercisers participating in exercise programs in different sports centers. Future studies might examine basic psychological needs in exercise among exercisers participating in exercise programs in different sports centers. The second limitation of this study is that the participants were grouped according to the exercises offered in the sports center where the programs were organized. Therefore, outdoor exercise programs could not be included in this study. Because individuals go to recreational sports centers not only to be healthy, but also for different purposes such as socialization and gaining a place in society, in future studies, examining the basic psychological needs of the participants from the areas where different recreational exercise programs are organized may help with the creation and design of the programs. Finally, only the exercisers aged 18-45 years participated in this study. In future studies, the participation of an extensive age range of exercisers may reveal the differences in meeting the basic psychological needs of young, adult, and elderly individuals in the exercise environment.

When basic psychological needs are satisfied, the individual will be determined to attend the exercise program (Kirkland et al., 2011). Based on this study's findings, we recommend that exercise practitioners develop exercise programs that will meet the need for the relatedness of young male participants and thus ensure their adherence to the exercise program. Group programs with enriched exercise type and content, the implementation of the "exercise buddy" practice with participants with similar goals and ability in individual programs, and the exercise leader's being empathetic in communication with the exercise participants, avoiding being judgmental or accusatory, and having an approach that respects the participant's feelings, perspective, and values are examples of practices geared towards the need for relatedness (Standage & Ryan, 2012). In addition, exercise leaders can use some techniques to address the need for competence, autonomy, and relatedness to increase beginners' persistence in the exercise program. For example, diversifying exercise programs to enable participants to decide for themselves which type of exercise (e.g., different and new skills), where (e.g., indoors or outdoors), and when (e.g., how many days a week and what time of the day) they will participate in a practice to satisfy the need for autonomy. As for the competence need, the activities and tasks should be well-defined and appropriate to the competence of the participants. The exercise leader should help the participant set realistic, challenging, but attainable goals, monitor their progress, and provide regular feedback (Standage & Ryan, 2012).

CONCLUSION

This study indicates that female exercisers fulfilled the need for relatedness and belonging more in exercise environments than male exercisers. Results indicated that younger exercisers fulfilled relatedness needs less in the exercise environment than older exercisers. Unfulfilling the need for relatedness might lead to feelings of exclusion and loneliness. For this reason, it is essential to determine the priority needs of young adults to participate in exercise environments. The participants who chose both group and individual exercise programs satisfied their basic psychological needs more, which revealed how much the variety of recreational physical activities supported the goal of meeting the needs of the participants. Finally, exercisers participating in an exercise program for six months to less than one year satisfied their basic psychological needs less than those who exercised longer. Based on this, it can be said that regular and long-term participation may play an important role in need satisfaction.

Authors' contributions

The first author's contributions are conceptualization, methodology, investigation, data analysis, writing - original draft, writing - review & editing. The second author's contributions are conceptualization, methodology, data analysis, writing - review & editing.

Declaration of conflict interest

The author(s) declared no potential conflicts of interest.

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The Acute Effects of Velocity Loss During Half Squat Exercise on Jump Performance

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ABSTRACT

The velocity loss (VL) approach during squat exercise may increase the post-activation potentiation enhancement effect on squat jump performance. If this method succeeds, then different conditions of VL should be researched before its implementation to the field. This study hypothesized that squat jump performance would be increased after different volumed VL conditions during half-squat exercise. Eighteen resistance-trained men (mean [M] ± standard deviation [SD]; age: 24.00±3.53 years; body mass: 78.37±5.53 kg; height: 179.35±7.04 cm; one-repetition maximum (1RM) half squat: 110.85±11.92 kg) voluntarily performed squat jump under unloaded and four different VL conditions (R_6: six repetitions, R_{uf}: repetitions until failure, VL_{10}: velocity loss thresholds 10%, VL_{20}: velocity loss thresholds 20%) after a set of half-squat exercises at 80% of one-repetition maximum separated by at least 72 hours. The results revealed that subjects demonstrated significantly better squat jump performance in VL_{10}, $VL_{20,}$ and R_6 conditions than the unloaded and R_{uf} conditions ($p<0.05$). According to these findings, if coaches and sports scientists desire to increase the post-activation potentiation enhancement effect, following heavy resistance training with a VL approach, VL_{10} and VL_{20} conditions instead of the traditional repetition method for squat jump performances are recommended.

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INTRODUCTION

Explosive power is a key and the most distinctive component of performance in many sports activities (Dobbs et al., 2019; Sinovas et al., 2015; Yilmaz et al., 2021), such as sprinting and vertical jumping. While vertical jump (VJ) is a crucial component of sports performance, it is also the most valid and reliable field test for the determination of explosive power of the lower limbs (Dobbs et al., 2019; Markovic et al., 2004). The high correlation of VJ with other sports components, such as weightlifting performance and sprinting speed, makes it widely used by both trainers and researchers (Boullosa et al., 2013; Dobbs et al., 2019). Even minor improvements in the explosive performances of players can cause significant differences, especially at high levels. Therefore, coaches and sports scientists examine those components' chronic and acute effects to develop effective training programs (Blazevich & Babault, 2019; Prieske et al., 2020). For example, using post-activation potentiation enhancement (PAPE) in the warm-up is one of the most preferred tools in sports science. PAPE refers to the acute positive effects of a pre-load stimulus on muscular performance, such as maximal strength, power, and speed (Atalag et al., 2021; Blazevich & Babault, 2019; Prieske et al., 2020; Zimmermann et al., 2020).

Two main factors that acutely affect sports performance are fatigue and potentiation. In contrast to potentiation, which enhances performance, fatigue has the most obvious negative effect on it (Dobbs et al., 2019; Nibali et al., 2015; Rassier & MacIntosh, 2000; Sale, 2002; Zimmermann et al., 2020). The balance between potentiation and fatigue determines muscle performance. If fatigue exists more, muscle performance may decrease (Rassier & MacIntosh, 2000; Seitz & Haff, 2016). Previous potentiation studies reported inconsistent results (Dobbs et al., 2019). One possible reason for that could be the volume strategies of those studies. There are two main approaches for adjusting the volume of pre-load. The first is the fixed number of repetitions per set with a given percentage of one-repetition maximum (% of 1RM), a daily changeable value. Coaches cannot be sure if the athletes are training with the appropriate loads in each session (Pareja-Blanco et al., 2017b). The other approach is the number of repetitions until failure (Galiano et al., 2020; González-Badillo et al., 2011; Pareja-Blanco et al., 2017b) however, it is thought that this method could not be optimal for some athletes (Davies et al., 2016; Pareja-Blanco et al., 2017b). Therefore, coaches should use new strategies that guarantee low-level fatigue and high-level potentiation to PAPE (Boullosa et al., 2013).

Studies have shown that velocity-based training (VBT) has been a good alternative to traditional repetition training in the last decades (Galiano et al., 2020; Pareja-Blanco et al., 2017a; Pareja-Blanco et al., 2017b; Sánchez-Medina & González-Badillo, 2011; Weakley et al., 2020). The repetition with velocity loss can be an objective tool to monitor the degree of fatigue (Pareja-Blanco et al., 2017a; Pareja-Blanco et al., 2017b; Weakley et al., 2020). So, it can be used to keep the balance between fatigue and potentiation. Velocity loss (VL) training ensures more remarkable power development due to reduced neuromuscular fatigue and preferential hypertrophy of type II fibers (Galiano et al., 2020; Pareja-Blanco et al., 2017a; Pareja-Blanco et al., 2017b; Sánchez-Medina & González-Badillo, 2011; Weakley et al., 2020). Thus, this method seems to be a useful and practical approach for PAPE. Not many studies examined the acute effects of VL on PAPE (Tsoukos et al., 2019, 2021). In these studies, only upper body exercises were used. Additionally, in these studies, only two different VL methods were compared. At the same time, there is no comparison of VL with traditional load strategies or any information regarding the effects of lower limb exercise. Therefore, this study aimed to evaluate the acute effect of different velocity loss (VL) thresholds as 10% (VL_{10}) and 20% (VL_{20}) with six repetitions (R_6) and repetitions until failure (R_{uf}) of half-squat (HSQ) exercises. HSQ is one of the most used exercises for PAPE on squat jump performance. It is also sport-specific because it consists of closed kinetic chain activities (Boullosa et al., 2013). The hypothesis of this current study was squat jump performance of subjects would be more significant after the VL conditions through the less volume due to lower development of fatigue than traditional repetition methods (Galiano et al., 2020; Pareja-Blanco et al., 2017a; Pareja-Blanco et al., 2017b; Weakley et al., 2020).

METHODS

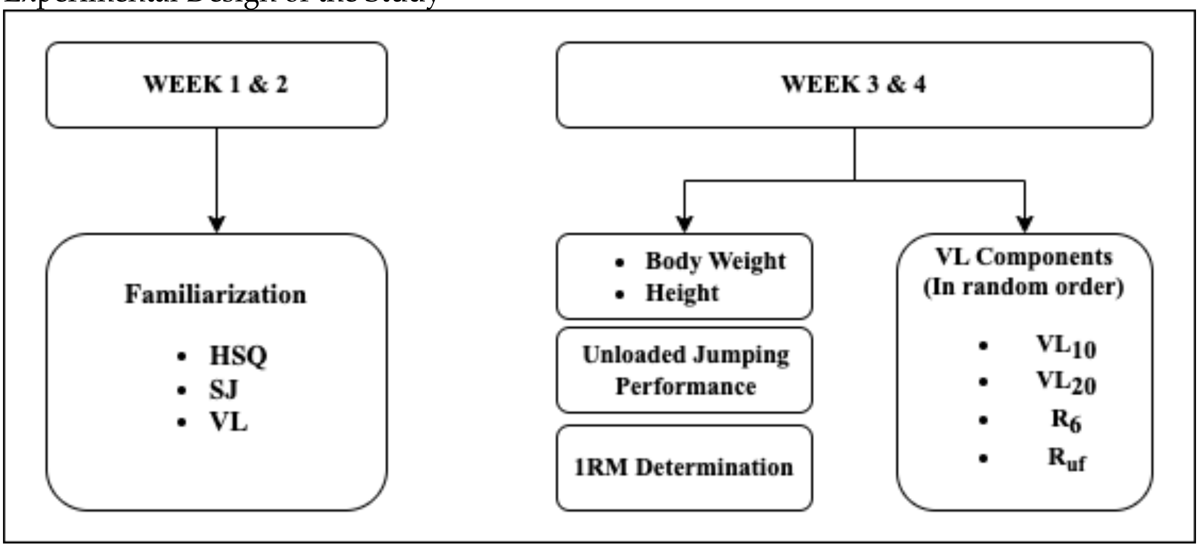
Study Group

G-Power analysis was conducted to determine the sample size for this study. According to the results of this analysis, eighteen resistance-trained men (mean ± standard deviation [SD]; age: 24.00±3.53 years; body mass: 78.37±5.53 kg; height: 179.35±7.04cm; 1RM half squat: 110.85±11.92 kg) voluntarily participated in this study. Seventeen subjects completed the entire experimental protocol, with one subject withdrawing due to performing less repetition than six in the R_{uf} condition. Subjects were required to have experience in resistance training for more than two years and were familiar with the technique involved with HSQ. They have no health problems or other injuries that would limit their participation in the study. All participants were informed about the procedures, rules, advantages, and risks of the research before providing their informed consent. The study was approved by the local University Ethics Committee of Non-Invasive Clinical Research (E.23467 - 2020) and conducted by institutional ethical requirements on human experiments consistent with the Declaration of Helsinki.

Data Collection

This study used a randomized, crossover research design to compare the acute effects of unloaded and four different velocity loss conditions (R_6: six repetitions, R_{uf}: until failure, VL_{10}: velocity loss thresholds 10%, VL_{20}: velocity loss thresholds 20%) of half-squat (HSQ) exercises at 80% of 1RM on squat jump (SJ) performance. Figure 1 shows the experimental design of this study. The subjects were asked to maintain their daily habits and avoid non-routine physical activities, alcohol, and caffeine before the all-testing sessions. Subjects participated in 4 sessions of familiarization with the HSQ and SJ for two weeks. In the first session, followed by the familiarization week, height, body mass, and one repetition maximum (1RM) HSQ were determined for each subject. During the third and fourth weeks, subjects were asked to perform SJ tests 4 minutes after the unloaded and VL_{10}, VL_{20}, R_6, and R_{uf} of HSQ. The subjects performed all the conditions randomly after a standardized warm-up, which comprised unloaded cycling for five minutes at a slow pace, five minutes series of dynamic stretches, and ten unloaded half squats. The tests of the conditions were separated by at least 72 hours. During the VL_{10}, VL_{20} conditions, and 1RM test, the bar was fitted with a Push™ accelerometer (PUSH Inc., Toronto, Canada) device.

Figure 1
Experimental Design of the Study



Note. HSQ = Half Squat; SJ = Squat jump; VL_{10} = velocity loss 10 %; VL_{20} = velocity loss 20 %; R_{uf} = repetitions until failure; R_6 = six repetitions

Data Collection Tools

One Repetition Maximum Protocol

After the standardized warm-up, the 1RM of subjects practiced in the familiarization period of this study were defined to the PUSH application (Version 7.18.0) via mobile phone. Subjects were asked to perform the movement's concentric phase with the maximum achievable speed (Balsalobre-Fernández et al., 2016). All lifts were recorded with 200 Hz (Balsalobre-Fernández et al., 2016) and automatically detected by the software (Hughes et al., 2019). Subjects performed HSQ on smith-machine equipment (Esjim, Eskişehir, Turkey - the barbell only moves along the vertical axis) with five sets of 3 repetitions at 40%, 50%, 60%, 70%, and finally 80% of the 1RM, which were defined to the software before. The rest periods between trials were 3 minutes. After determining the 1RM, subjects were asked to perform velocity-based 1RM for adapting them to the test conditions. According to their performance responses within three attempts with five minutes rest periods between trials (Bogdanis et al., 2011), the resistances were set for each subject, if needed. The push device was placed parallel to the ground, inside the barbell's left collar, on the bar's upper side (Balsalobre-Fernández et al., 2016).

Half Squat Exercise (HSQ)

At the beginning position of HSQ, subjects stand on their feet fully extended. They kept their feet roughly shoulder-width apart while holding the barbell across the top of the shoulders and upper back. Each subject was instructed to perform a countermovement to 90º of knee flexion and then return to an upright position while keeping their toes grounded (Pérez-Castilla et al., 2020). They were required to perform each repetition of the half squat exercise as fast as possible, from the first repetition until reaching muscle failure (R_{uf}), six repetitions (R_6) or 10% (VL_{10}) and 20% (VL_{20}) velocity loss. During VL_{10} and VL_{20}, the most important value was the target mean concentric velocity (MCV), which was usually the fastest and achieved on the first repetition in each session (Pareja-Blanco et al., 2017a). The set was terminated when the velocity loss limit (10% or 20% of MCV) was exceeded. Trained spotters gave subjects visual and verbal real-time velocity performance feedback and encouraged them to provide maximal effort for each repetition (Pérez-Castilla et al., 2020; Weakley et al., 2019).

Vertical Jump Test

Squat jump (SJ) is one of the most valid and reliable field tests for the determination of explosive power of the lower limbs (Tsoukos et al., 2019). Each subject executed two maximal SJs on a compact pressure-sensitive mat (Smart Speed; Fusion Sport, Brisbane, Australia) followed by a 30-second rest period. The subjects were instructed to perform maximum effort on jumping, and the highest value was recorded in centimeters. The subject was asked to keep the hands on hips throughout the test.

Velocity Measurement

The PUSH™ band is one of the devices designed to measure the velocity of body or bar movement in body weight and resistance exercise using a smartphone. PUSH provides sampling with 200 Hz via a 3-axis accelerometer and a gyroscope, which provides six degrees of freedom (6DOF; van den Tillaar & Ball, 2019). The PUSH™ calculates vertical mean concentric velocity by integrating vertical acceleration values regarding time. To calculate the mean velocity of the movement, the software takes the average of all instantaneous velocities registered (González-García et al., 2019). Balsalobre-Fernández et al. (2016) reported that PUSH™ showed a very high association (mean velocity, $r = 0.85$, SEE = 0.08 $m \cdot s^{-1}$) and agreement (mean velocity ICC = 0.907) with linear position transducer. PUSH™ was found to be a highly reliable device (ICC = 0.981); (CV = 5.0%) also showed high individual load-velocity correlation ($R^2 = 0.94$; Balsalobre-Fernández et al., 2016).

Data Analysis

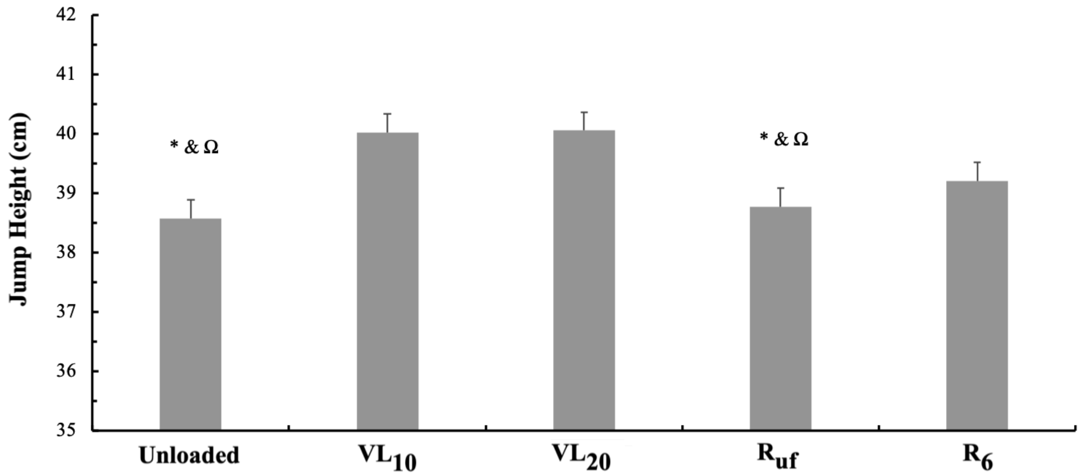
The data were reported as means and standard deviations. Before using parametric tests, skewness and kurtosis were calculated to determine the normality of the values (between -2 and +2). The differences between the five conditions (unloaded, VL_{10}, VL_{20}, R_6, R_{uf}) on SJ height were determined using a one-way analysis of variance for repeated measurements. Effect sizes (η^2) for the practical differences between conditions were calculated with descriptors of "small" for 0.01, "medium" for 0.06, and "large" for 0.14 and above (Cohen, 1988). A pairwise comparison between the five conditions was determined using the paired-t-test. Cohen's d (d) values were also calculated by dividing the mean differences by the standard deviation of the differences. The results were considered small = 0.20-0.49, medium = 0.50-0.79, and large = 0.8 and above (Cohen, 1988). Additionally, the reliability of measurements was determined using intraclass correlation coefficients (ICC). The dispersion of sample means was measured using the standard error of mean (SEM). The statistical significance level was set at $p < 0.05$.

RESULTS

VL_{10} and VL_{20} conditions were found to be the most effective conditions on SJ performance, whereas the lowest SJ heights were found in the unloaded and R_{uf} conditions

(Figure 2). One-way repeated analysis of variance findings indicated statistically significant differences among the five conditions regarding SJ performance (F = 9.125, p = 0.000, η^2 = 0.363, large effect; ICC = 0.995). According to paired-t comparisons, there were significant differences between SJ performance of subjects following unloaded conditions and VL_{10} (t = -5.120; p = 0.000; 95%CI = -2.045, -0.847; SEM = 1.438; *d* = 1.242, large effect), VL_{20} (t = -4.284; p = 0.001; 95%CI = -2.206, -0.745; SEM = 1.593; *d* = 1.038, large effect) and R_6 (t = -3.093; p = 0.007; 95%CI = -1.902, -0.355; SEM = 1.533; *d* = 0.750, medium effect) in exception of R_{uf} (t = -0.575; p = 0.573; 95%CI = -0.935, 0.536; SEM = 1.514; *d* = 0,139). Additionally, subjects performed significantly lower jump height in R_{uf} condition than VL_{10} (t = 4.094; p = 0.001; 95%CI = 0.601, 1.892; SEM = 1.438; *d* = 0.993, large effect); VL_{20} (t = 4.286; p = 0.001; 95%CI = 0.645, 1.907; SEM = 1.593; *d* = 1.039, large effect) and R_6 (t = -3.446; p = 0.003; 9%5CI = -1.497, -0.361; SEM = 1.533; *d* = 0.841, large effect).

Figure 2
Squat Jump Performance Following Different Pre-Load Protocols



Note. VL_{10} = velocity loss 10 %; VL_{20} = velocity loss 20 %; R_{uf} = repetitions until failure; R_6 = six repetitions; *Significantly different from VL_{10}; &Significantly different from VL_{20}; Ω Significantly different from R_6

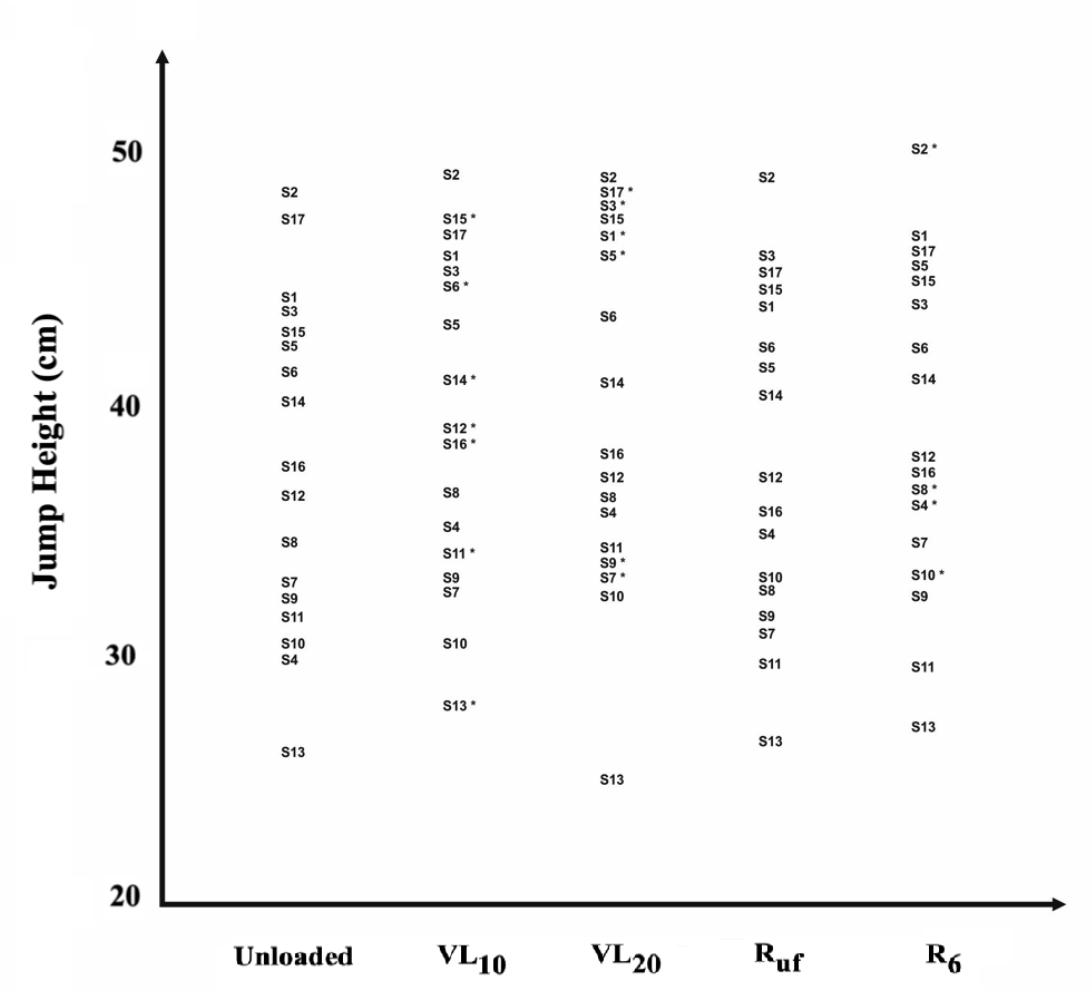
Table 1
Average Squat Jump Height and Repetition Number of Half Squat Exercise Following Different Pre-Load Protocols

Variables	Unloaded		VL_{10}		VL_{20}		R_{uf}		R_6		ES	
	M±SD	CV (%)	M±SD	CV (%)	M±SD	CV (%)	M±SD	CV (%)	M±SD	CV (%)		
SJ (cm)	38.58±5.98	15	40.03±5.9	14	40.06±6.57	16	38.78±6.24	16	39.71±6.32	15	0.363	large
Repetition (number)			4.11±0.78	18	5.05±0.74	14	6.8±0.95	13			0.899	large

Note. SJ = Squat jump; VL_{10} = velocity loss 10 %; VL_{20} = velocity loss 20 %; R_{uf} = repetitions until failure; R_6 = six repetitions; CV = coefficient of variance; ES: Effect size

The statistically significant change in the number of repetitions across the three conditions (VL_{10}, VL_{20}, R_{uf}) is shown in Table 1 (F = 143.038, p = 0.000, η^2 = 0.899, large effect; ICC = 0.862). Obviously, subjects performed more repetitions during the R_{uf} (SEM = 0.230) condition which statistically different from both VL_{10} (t = -13.143; p = 0.000; 95%CI = -3.142, -2.269; SEM = 0.189) and VL_{20} (t = -9.670; p = 0.000; 95%CI = -2.151, -1.377; SEM = 0.181). There were also significant differences between VL_{10} and VL_{20} (t = -16.000; p = 0.000; 95%CI = -1.065, -0.816). Figure 3 displays the best SJ performance of each subject; while four subjects reached their best performances following R_6 conditions, the rest of the subjects performed the highest jump performance after the velocity loss approach (V_{10} = 7 subjects; V_{20} = 6 subjects, R_6 = 4 subjects).

Figure 3
Squat Jump Performance of Each Player in All Conditions



Note. S: Subject; VL_{10} = velocity loss 10 %; VL_{20} = velocity loss 20 %; R_{uf} = repetitions until failure; R_6 = six repetitions. *Best performance

DISCUSSION

The aim of the current study was to investigate the acute effect of velocity loss during half-squat (HSQ) exercise on squat jump performance (SJ). The main result was that the VL approach seems more appropriate than traditional repetition methods despite less volume. In addition, the fixed number repetition method is also an appropriate method to create the PAPE effect without the need for any technological devices. Finally, repetition until failure could affect the performance very little or negatively because of increased fatigue.

Squats are one of the most commonly and widely used exercises to improve performance in sports and to examine the acute effects of pre-load on jump performance in research (Crewther et al., 2011). However, previous potentiation studies examining the acute effects of squat exercise reported inconsistent results. One possible explanation is that different intensities (Fukutani et al., 2014; Lowery et al., 2012) and rest intervals (Crewther et al., 2011; Koklu et al., 2022; Lowery et al., 2012) have been used in the previous studies. On the other hand, the vertical jump could be increased if appropriate intensity (≥80% 1RM; Dobbs et al., 2019; Esformes & Bampouras, 2013; Evetovich et al., 2015; Fukutani et al., 2014; Koklu et al., 2022) and rest periods (3-7 min) are used (Bauer et al., 2019; Dobbs et al., 2019; Esformes & Bampouras, 2013; Evetovich et al., 2015; Koklu et al., 2022; Lowery et al., 2012) in pre-load squat exercise, just as the current study design. The reason for PAPE could be neuromuscular, mechanical, and biochemical factors (Beato et al., 2021). A greater rate of cross-bridge attachment due to phosphorylation of the myosin regulatory light chains occurring in type II muscle fibers during a muscle contraction, a Ca^{2+}-dependent process, could be underlying physiological mechanisms (Beato et al., 2021; Blazevich & Babault, 2019; Evetovich et al., 2015; Prieske et al., 2020; Rassier & MacIntosh, 2000; Seitz & Haff, 2016) and greater motor unit recruitment could be another reason (Beato et al., 2021; Evetovich et al., 2015; Prieske et al., 2020; Seitz & Haff, 2016). Additionally, changes in muscle temperature, muscle/cellular water content, and muscle activation could be a factor that creates PAPE (Blazevich & Babault, 2019).

While potentiation enhances performance, fatigue causes diminished performance owing to decreasing peak Ca^{2+} concentration in the myoplasm (Rassier & MacIntosh, 2000). Thus, the balance between potentiation and fatigue must be considered for PAPE (Dobbs et al., 2019). Coaches should select appropriate pre-load exercises, which may induce less fatigue and more potentiation. It is essential to monitor fatigue via velocity loss in order to quantify neuromuscular fatigue during resistance training objectively (Galiano et al., 2020; Pareja-Blanco et al., 2017a; Pareja-Blanco et al., 2017b; Sánchez-Medina & González-Badillo, 2011; Weakley et al., 2020). In a study where the acute effects of the bench press, with low and moderate loads on bench throw exercise, were examined, it is reported that V_{10} is a more effective method than V_{30} for PAPE (Tsoukos et al., 2019). Another study also reported that after heavy bench press V_{10} exercise, the bench throw performance of players improved

(Tsoukos et al., 2021). Our study results show similarities with previous studies. It could be stated that using the small velocity loss approach could be more effective than the failure rep approach due to the high lactate response and rising ammonia levels that could indicate an accelerated purine nucleotide degradation (Sánchez-Medina & González-Badillo, 2011). Moreover, there were moderate CVs in both SJ performance and number of repetitions ranging between 14 -16 and 13-18 % respectively in the current study. Figure 3 shows that appropriate approaches could be changeable for each individual. Therefore, sports scientists and coaches should consider individual differences, while configuring volume (Tsoukos et al., 2019, 2021), rest duration (Koklu et al., 2022; Lowery et al., 2012), intensity (Fukutani et al., 2014), and several sets configuration (Boullosa et al., 2013).

CONCLUSION

As this study is one of the early studies to provide knowledge of velocity-based training and the implementation of velocity loss thresholds, it has its limitations. The physiological aspects, which would explain the mechanism underlying fatigue and could have supported our results, were not measured in the current study. On the other hand, if the biomechanical analysis had also examined, the fatigue-related technical corruptions during half squat movement could have been evaluated. Additionally, the daily differentiation of 1RM was not considered, while the daily velocity loss threshold was used for the velocity loss approach.

PRACTICAL IMPLICATIONS

This study assessed how the velocity loss approach positively affects SJ performance in resistance-trained men. On the other hand, the requirements of technological devices or applications for the VL method should be taken into consideration while applying these methods. Additionally, coaches should account each player's daily first repetition’s velocity and optimum percent velocity loss. The fixed number repetition method could be a practical alternative to the VL method. Sports scientists and coaches should be careful while using the R_{uf} method; a longer rest period could be one solution to increase the effects of this method on PAPE and decrease fatigue.

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Authors' contributions

The first and second authors contributed to the study design, data collection and data analysis. The second, third and fourth authors contributed to data interpretation, drafting the manuscript and its critical revision. All authors have read and approved the final version of the manuscript.

Conflict of interest declaration

The authors declare that there is no conflict of interests.

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Pamukkale J Sport Sci, 14(3), 398-407, 2023 Research Article

Muscle Activation During Squat on Different Surfaces

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ABSTRACT

This study aimed to compare the vastus medialis and vastus lateralis muscle activations during squat exercises performed on different surfaces. Recreationally active 14 males (age: 20.43±1.28 years; height: 176.94±6.58 cm; body weight: 72.78±10.72 kg) participated in this study. A ground surface is used as a stable surface, a gymnastics mat and a Bosu ball are used as an unstable surface. Participants performed two sets of squats on three surfaces and ten repetitions of each set. Participants performed squat exercises with their body weight. Muscle activation measurements were made from the vastus medialis and vastus lateralis muscles during the squat movement on each surface. A one-way repeated-measures analysis of variances was used to statistically compare muscle activations between surfaces. As a result of statistical analysis, no significant differences were found in the vastus medialis and vastus lateralis muscle activations between surfaces ($p>0.05$). In conclusion, it was determined that the vastus medialis and vastus lateralis muscle activation in the squat movement was not affected by the stability of the surfaces. Therefore, it can be suggested that the surfaces used in this study can be used interchangeably for vastus medialis (VM) and vastus lateralis (VL) muscle activation in the squat exercise.

INTRODUCTION

Innovative approaches in strength training today increase the quality of resistance training by supporting the use of functional exercises to increase the effectiveness of the muscles comprehensively involved in sports skills. These exercises include gross, fine motor, and balancing movements by involving large and small muscle groups (Cook et al., 2006). Squat exercise is widely used in resistance training to increase lower extremity strength. Squat exercises are commonly performed using body weight, barbell, or machine (Escamilla, 2001). There are many studies examining neuromuscular function in resistance training (Aguilera-Castells et al., 2019; Andersen et al., 2014; Boudreau et al., 2009; Bruhn et al., 2006; Ebben et al., 2009; Ekstrom et al., 2007; Farrokhi et al., 2008; Häkkinen & Komi, 1983; Mausehund et al., 2019; Seger & Thorstensson, 2005). Resistance training on unstable surfaces has been applied by physical therapists and coaches to regain the functions lost after injury in individuals and to improve the athletic performance of athletes (Behm & Anderson, 2006; Behm et al., 2002; McBride et al., 2006; Wahl & Behm, 2008). Unstable conditions could be provided by changing the surface stability using equipment such as a Bosu ball, TRX band, balance discs, and foam pads.

Those who emphasized the importance of an unstable surface in resistance training concluded that greater instability increased neuromuscular stress (Anderson & Behm, 2005a; Anderson & Behm, 2005b; Behm & Anderson, 2006; Norwood et al., 2007). Besides, studies comparing the effects of surface stability in terms of the muscles responsible for exercise in the lower extremities reported different electromyographic activity (Hyong & Kang, 2013; Maior et al., 2009; McBride et al., 2006; McBride et al., 2010; Saeterbakken & Fimland, 2013). McBride et al. (2006) examined vastus medialis (VM) and vastus lateralis (VL) muscle activations in isometric squat movement performed on stable and unstable surfaces. They found that VM and VL muscle activations were higher on the stable surface. McBride et al. (2010) compared squat exercises with stable and unstable conditions, and they concluded that stable conditions showed the same or significantly higher value for VL muscle activity. Saeterbakken and Fimland (2013) stated that there was no significant difference between surfaces in VM and VL muscle activations during squats on stable and unstable surfaces. Although the above-mentioned studies showed no difference between surfaces in VM and VL muscle activation or that muscle activation was higher on a stable surface, Hyong and Kang (2013) stated that VM muscle activation was higher on an unstable surface. Maior et al. (2009) reported that greater

VM, VL, and rectus femoris (RF) muscle activity was observed in the unstable condition compared to the stable condition.

Considering the previously mentioned studies, various outcomes were observed regarding the impact of surface stability on muscle activation. Therefore, more studies are needed on the effects of surface stability on muscle activation using different surfaces. The aim of this study was to compare the muscle activity of the VM and VL muscles in the squat exercises performed on stable and unstable surfaces in recreationally active male individuals.

METHODS

Study Group

Fourteen recreationally active males (age: 20.43±1.28 years; height: 176.94±6.58 cm; body weight: 72.78±10.72 kg) voluntarily participated in this study. Before starting the study, the participants were informed about the study. Ethics committee approval of the study was given by the Hitit University Non-Interventional Ethics Committee (Decision No: 2022-28).

Data Collection

The study was conducted using the crossover experimental design model. Before starting the study, squat exercises were tried on three different surfaces. In this study, stable ground (S), gymnastics mat (GM), and Bosu ball (BB) were used as the surface. GM and BB were used as unstable surfaces. Throughout the study, measurements were taken for each individual on two different days. Participants' height and body weight measurements were taken in the morning on the first day. Then, the participants were randomly divided into groups, starting on three different surfaces. On the second day, participants' muscle activation measurements were taken on different surfaces during the squat exercise. Each participant exercised on all three surfaces. Measurements were made at the same time of the day and with the whole body rested. Before the measurements, participants were warned not to consume caffeine or other stimulants.

Data Collection Tools

Participants' height was measured by using a Seca 213 stadiometer (Seca, Hamburg, Germany). Body weight was determined using Tanita BC-418 (Tanita Corporation, Tokyo, Japan). All measurements were taken while the participants wore shorts and a t-shirt and were barefoot. Muscle activation measurements were performed using the Delsys Trigno 4-channel surface electromyography device (Delsys Inc., Boston, MA, USA). A 40 cm thick and 24-density gymnastics mat was used.

Squat Exercises: Participants performed squat exercises with their thighs descending until they were parallel to the ground with their feet shoulder-width apart (parallel squat) on three different surfaces: S, GM, and BB. They performed two sets of squat exercises on each surface with their body weight, each set consisting of 10 repetitions, and a 3-minute rest was given between sets and surface changes.

Muscle Activation Measurements: Measurements were made using the Delsys Trigno 4-channel EMG device. Before the electrodes were attached to the relevant muscles, the surfaces of the muscles were shaved and cleaned with alcohol. The electrodes were placed as described by Şimşek et al. (2016) for VM and VL muscles. Muscle activation measurements were performed from the VM and VL muscles in the dominant leg. The EMG signals were sampled at 1926 Hz and bandpass filtered at 20-450 Hz. Maximum isometric voluntary contraction (MVIC) measurements were performed for each muscle before the measurements. Subjects performed MVIC measurements in a seated position with 90° knee flexion against the resistance, which was provided by using a belt around the shank (Slater & Hart, 2017). MVIC measurements were performed twice, and each trial lasted for five seconds. The first and last one-second parts of the two MVIC data were subtracted, and the average of three seconds was used in the normalization calculation (Slater & Hart, 2017).

Analysis of EMG Data: The amplitude analysis was performed using the root mean square (RMS) calculation to analyze the raw data. In the squat exercise, eight repetitions were used in the analysis by discarding the highest and lowest values from 10 repetitions in each set. The average of eight repetitions in two sets was calculated for each exercise. These mean values were normalized to the MVIC data. A 500-millisecond window length was used for RMS calculations (Earp et al., 2016; Evans et al., 2019). All EMG data analyses were performed with Delsys EMGworks Analysis software (Delsys, Boston, MA, USA).

Data Analysis

The mean and standard deviation ($\bar{X}$±SD) values of all data were used in the study. The normal distribution characteristics of the data were examined using the Shapiro-Wilk normality test. A one-way repeated-measures analysis of variances was used in the statistical analysis of the data. The significance level of $p<0.05$ was accepted for all statistical analyses. All analyses were performed using the SPSS 25 program.

RESULTS

Normalized muscle activation data obtained during squat exercises performed on different surfaces are shown in Table 1.

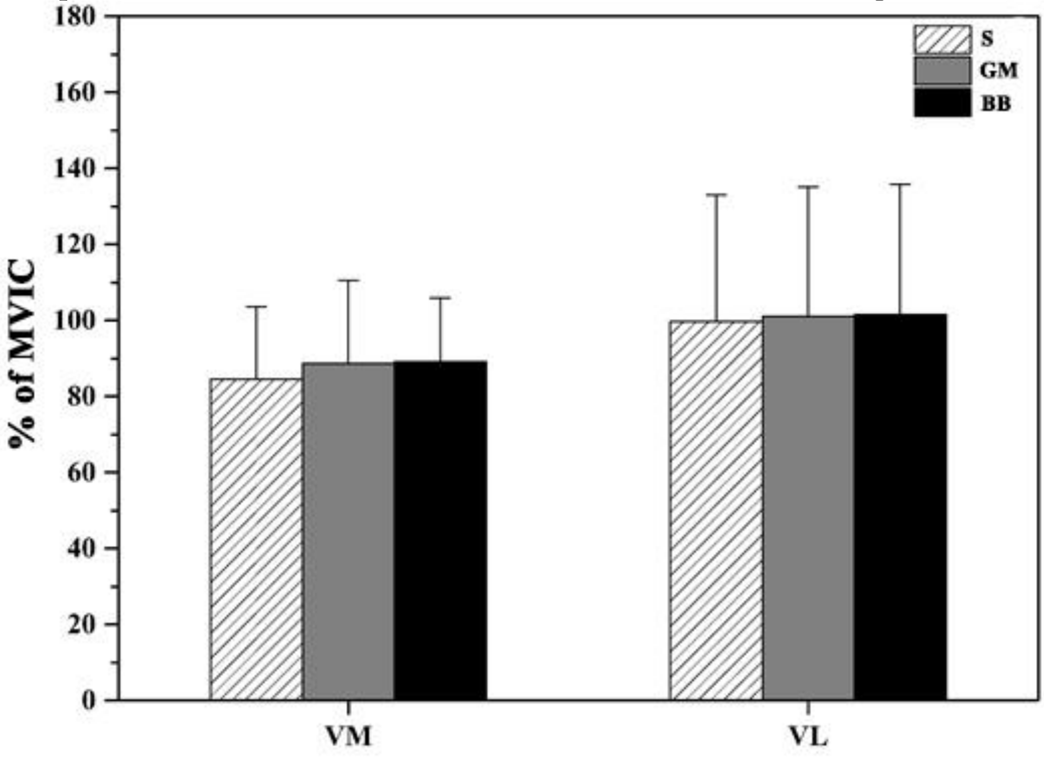
Table 1
Normalized (%MVIC) Muscle Activation Obtained During Squat Exercises Performed on Different Surfaces

Muscles	S	GM	BB	F	p
VM	84.57 ± 19.04	88.70 ± 21.92	89.16 ± 16.74	1.158	0.330
VL	99.72 ± 33.23	101.03 ± 34.01	101.52 ± 34.33	0.124	0.884

Note: S: Stable surface, GM: Gymnastics mat, BB: Bosu ball, VM: Vastus medialis, VL: Vastus lateralis

According to the result of the statistical analysis, there was no significant difference in the VM and VL muscle activations between the surfaces (p>0.05). Comparison of normalized VM and VL muscle activations according to surfaces are shown in Figure 1.

Figure 1
Comparison of normalized VM and VL muscle activations according to surfaces



VM muscle activation was 4.88% higher in GM than S and 5.43% higher in BB than S. VL muscle activation was 1.31% higher in GM than S and 1.81% higher in BB than S. However, none of these differences were statistically significant for VM and VL (p>0.05).

DISCUSSION

This study was carried out to compare the effects of stable and unstable surfaces on VM and VL muscle activations in squat exercise. As a result of this study, no significant difference was found between surfaces in VM and VL muscle activations. Performing the squat on an unstable surface did not have an additional effect on VM and VL muscle activation.

Aguilera-Castells et al. (2019) examined muscle activations using stable and unstable surfaces in the Bulgarian squat movement. They reported that there is no difference in the VM and VL muscle activations between the exercises with the stable surface, the exercise in which the back foot is on the suspension device, and the exercise in which the foot in the back is on the suspension device and the foot in the front is on the Bosu ball. Saeterbakken and Fimland (2013) investigated the electromyographic activities and force outputs of the lower extremity and some trunk muscles on surfaces with different levels of instability and on stable surfaces. In this study, a stable surface and three unstable surfaces were used, and no significant differences were found between the surfaces in VM and VL muscle activations. Andersen et al. (2014) stated there was no significant difference when comparing the VM and VL muscle activations obtained during squat exercises performed on stable and unstable surfaces. Monajati et al. (2019) found that VM and VL muscle activations were similar in exercises performed on a stable surface and Bosu ball. Li et al. (2013) did not detect a significant difference between the surfaces at different loads in the VM and VL muscle activations on a stable ground and an unstable ground using the Reebok core board. On the other hand, Anderson and Behm (2005b) stated that muscle activity of erector spinae and abdominal stabilizers was greater in squat performed on the unstable surface than the stable surfaces. Besides, they found that muscle activity of the soleus was greater in squat, which were performed on the unstable surface than the stable surfaces. According to the results of this study, it appears that the trunk and soleus muscles may prioritize maintaining balance. Saeterbakken and Fimland (2013) stated that although there was no significant difference between BOSU and stable surface, a tendency for more EMG activity was observed in BOSU for soleus. Besides, it has been stated that trunk muscles may be the primary muscles in maintaining balance instead of lower limb muscles (Monajati et al., 2019). Therefore, it is thought that there is no difference between the surfaces in the VM and VL muscle activations in our study.

Anderson and Behm (2005b) examined trunk and lower extremity muscle activations during squats on the Smith machine, free squats on stable ground, and free squats on balance discs. They stated that the VL muscle activation was highest in the squat with the Smith machine on stable ground. VL muscle activation in the Smith machine was 4.8% higher than on the unstable surface and 14.3% higher than on the free squat. Maior et al. (2009) stated that RF, VM, and VL muscle activations obtained during squat exercises performed on unstable ground were greater than muscle activations obtained on stable ground. McBride et al. (2010) stated that in squat exercises performed at different loads on both stable and unstable surfaces, VL muscle activation was greater in both eccentric and concentric phases on stable ground at all loads. Hyong and Kang (2013) compared the VM and VL muscle activations obtained during squat exercises performed on a hard plate, foam, and rubber air disc. They stated that the highest VM muscle activation occurred on the rubber air disc. However, no significant differences were found between the surfaces in VL muscle activation. Marín and Hazell (2014) stated that VM muscle activation was lower on unstable ground than on stable ground, and there was no difference in VL muscle activation between surfaces.

The present study had some limitations. Only recreationally active males took part in this study. The muscle activities of VM and VL were investigated in the parallel squat exercises performed by body weight, not by any external load. The gymnastics mat and Bosu ball were used as unstable surfaces.

CONCLUSION

This study compared the effects of surface stability on muscle activities of VM and VL during squat exercise. It was concluded that similar VM and VL muscle activation were obtained in squat exercises performed on stable ground and unstable surfaces. According to these results, it can be suggested that the surfaces used in this study can be used interchangeably for VM and VL muscle activation in the squat exercise.

PRACTICAL IMPLICATIONS

Squat exercise is widely used, especially for improving quadriceps muscle group strength. This exercise can be performed on different surfaces. The use of stable and unstable surfaces in squats has increased. This study has shown that using a stable ground, gymnastics mat, and Bosu ball in squat exercises performed with body weight produces similar effects on muscle activity of VM and VL muscles. Therefore, these three surfaces can be used for VM and VL muscle activation in squats with body weight. Coaches and athletes may use these three surfaces interchangeably to improve VM and VL muscle strength.

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Authors' contributions

All authors contributed to the design of the study and collection of data. The second author contributed to the interpretation of the results by analyzing the data. All authors contributed to the drafting of the article and its critical revision. All authors approved the final version of the manuscript.

Conflict of interest declaration

No conflict of interest is declared by the authors.

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Pamukkale J Sport Sci, 14(3), 408-418 2023 **Research Article**

Comparison of Various Devices Used in the Evaluation of Vertical Jump Height

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ABSTRACT

This study aimed to compare force plate, motion analysis, and mobile application methods for calculating vertical jump height. Twenty-nine male college students (age: 22.4 ± 1.0 years; height: 178.1 ± 6.2cm; body weight: 71.2 ± 8.0 kg) voluntarily participated in the study. Two countermovement jumps (CMJ) with 1-minute intervals on a force platform (BERTEC 4060-10) were performed. The countermovement jump performances were captured using an iPhone 11 (Apple Inc., USA). The experimental setup involved using three high-speed cameras, specifically the My Jump 2 and SIMI Motion 7.5. Obtained results from hip displacement (HD) data with motion analysis system showed that participants had significantly lower vertical jump height calculated from motion capture (p = 0.01; -8.3 ± 3.86, 95%CI; MyJump2-SIMI_HD = 1.24/3.30). It was also found that calculations from left and right foot displacement were higher than My Jump 2 results (95%CI; MyJump2-SIMI_RF = 0.66/2.93) and 95%CI (MyJump2-SIMI_LF) = (-0.63/2.65). In contrast, force plate calculations, known as the gold standard in the literature, were very similar to My Jump (95%CI; MyJumpII-FP) = (2.38/4.01). The findings indicate that the My Jump 2, used for assessing vertical jump height, may be a reliable alternative for determining vertical jump height instead of setting up gold standard methods. Individuals' athletic performance abilities and birth, gender, and sports preferences should be considered. Finally, when coaches or sports scientists intend to measure CMJ, My Jump 2 application can be recommended as a laboratory application as well as a practical and valid measurement method, especially for field applications.

INTRODUCTION

Vertical jump performance is frequently applied in studies for evaluating power and strength. Thus it is important to make sure that how vertical jump height is measured is accurate and consistent (Cronin et al., 2004). A counter-movement jump (CMJ) is a type of vertical jump that is often used to measure the explosive power and jumping ability of a person's lower body. CMJ has significant importance in all areas of sports science, fitness assessments, and biomechanics research. Vertical jump height can be measured using a variety of methods and equipment. Motion capture systems, force plates, inertial measurement units (IMUs), and jump mats are used in sports to measure or predict the height of a jump (Dias et al., 2011; Magnúsdóttir et al., 2014). The main difference amongst measurement types lies in methods and variables used to estimate or measure vertical jump height. Apart from directly measurement the height reached by the athlete during the jump, calculations may be based on the time the athlete spends in the air, ground reaction forces while take-off and landing, or the analysis of kinematical data obtained from the displacement of joints from motion analysis systems. In motion analysis, hip, knee, foot, or centre of mass (COM) displacement can be used to calculate vertical jump height. In vertical jump height calculations hip joint or COM are commonly used. However, it is important to realize that the movement of the knee and ankle joints also contributes to the significant vertical displacement during a jump. During the upward phase of a jump, the knee joint exhibits rapid extension, which is important in optimizing vertical jump height. Ankle plantar flexion plays a vital role in generating ground reaction forces (Chiu & Dæhlin, 2020; Giustino et al., 2022; Yamashita et al., 2020). The selection of the joint to prioritize depends on the specific study or training goals, as well as the capabilities of the motion analysis system used.

The initial conditions of the free fall equation, such as take-off height and velocity, can be determined by assessing the instantaneous vertical acceleration of the centre of mass. Therefore, the preferred method for evaluating vertical jump performance is the application of 3D motion analysis instruments together with a force platform, which is a gold standard (McLaughlin, 2013). A previous study investigated the correlations and differences between 3D video analysis and force platform analysis in terms of predicting vertical centre of mass (COM) displacement during take-off compared to maximum COM. The use of maximum centre of mass (COM) velocity in the computation of vertical COM displacement has been determined with comparable reliability to the assessment conducted using three-dimensional (3D) video analysis (Nordin, 2013). Yet, due to the requirement of an efficient laboratory, extensive testing procedures, and an important purchase cost, its applicability in environments such as athletic facilities or other unstructured conditions is limited (Castagna et al., 2013).

The vertical jump height may be determined using many different methods to calculate vertical ground reaction force based on take-off velocity with a force platform. On the other hand, using an equation of constant acceleration, measuring flight time (FT) is a typical way of estimating vertical vertical jump height (Linthorne, 2001). While the current approach for calculating vertical jump height takes consideration of the placement of the centre of mass at both take-off and landing, it is worth noting that this accordance is not often achieved. However, FT measurement has several advantages, including the fact that it only requires an application and a simple and accessible method for physical trainers and sports scientists (Garci´a et al., 2013). With the improvement of smartphone technology, applications (apps) allowing measuring vertical jump height from video footage have recently been developed. High-speed cameras have been integrated into mobile phones. With the increase in smartphone usage and improved accessibility, the application of mobile applications in sports science research and practice is experiencing an increase in popularity. The cost-effective mobile software known as My Jump has demonstrated successful application in both sports science research and training. Furthermore, its suitability for use on iOS devices has consistently been verified in terms of its validity and reliability. My Jump II uses phone cameras in capturing slow-motion images that perform different jump tasks. Users can determine the take-off and landing frames to obtain vertical jump height information. Several groups have previously reported on its accuracy and reliability (Balsalobre-Fernández et al., 2015; Cruvinel-Cabral et al., 2018; Haynes et al., 2019). Other Android apps include Jumpo, whose reliability and accuracy were evaluated using squat jumps (SJ), single- and double-leg countermovement (CMJ), and other exercises. Due to a significant relationship between its flight time measurements and those obtained from a force platform, the Jumpo App provided a reliable indicator of jump performance. The Jumpo's flight time was slightly underestimated. This shows that using the calibration equation when comparing Jumpo and force platform data is beneficial. Previous studies have found statistically significant but insignificant errors when comparing CMJ data from a force platform to data from another mobile app, My Jump for iOS (Balsalobre-Fernández et al., 2015). Unlike previous research, the current investigation compared the vertical jump heights obtained from the My Jump 2 application based on the time in the air on the force platform and the displacement of different joints via a motion analysis system, meaning that kinetic and kinematic data were used. Considering these studies, this study aimed to determine the difference amongst vertical jump measurements from the force plate using the time-in-air method, the motion analysis system using tracking markers from three different joints, and the My Jump 2 application using the time-in-air method.

METHODS

Study Group

The study sample consisted of 29 recreationally active male students in the sports sciences faculty who volunteered for participation (age: 22.4 ±1.0 years; height: 178.1 ± 6.2 cm; body weight: 71.2 ±8.0 kg). The study protocol complied with the Declaration of Helsinki for Human Experimentation. Participants were informed regarding the procedure and written informed consent was obtained.

Data Collection Process

Each participant was given one day to familiarise themselves with the jump procedure and equipment before beginning the measurements. On measurement day, participants had a 10-minute warm-up that comprised running, lower-body stretching, and vertical jumps before the countermovement jump (CMJ) test and were familiarised with the jumping procedures. Subsequently, each participant performed two countermovement jumps (CMJ) on a force plate (BERTEC 4060-10) while performances being captured using an iPhone 11 (Apple Inc., USA) using the My Jump II application and SIMI Motion 7.5 (SIMI Reality Motion Systems GmbH) with two high-speed cameras (Basler A 602f). A 1-minute passive rest duration separates each jump. The participants were told to perform vertical jumps with maximal effort during the data collection process (Häkkinen et al., 1985).

During a singular testing session, individuals performed the countermovement jump (CMJ) while assuming a static standing posture with their hands placed on their hips and their legs fully extended during the flight phase of the jump. The landing manoeuvre was performed with simultaneous contact of both feet while ensuring the maintenance of ankle dorsiflexion throughout the entire process. Two high-speed cameras recording at 100 frames per second were used to record the participants' attempts (Basler A 602f high-speed camera). Captured 3-dimensional jump views digitized in SIMI Motion 7.5 (SIMI Reality Motion Systems GmbH-Germany) by tracking seven anthropometrical markers which were attached on both the side of the body, the lateral condyle of the femur (knee), the lateral malleolus (ankle), and the fifth metatarsal (toe) and trochanter major before jump performances. The cameras were positioned on the right and left sides of the force plate in such a way as to create a 90-degree angle between them. The highest jump was selected for subsequent analysis. The SIMI and iPhone devices were successfully synchronized with a flashlight. The same researcher conducted my Jump II record for all participants as previously described (Balsalobre-Fernández et al., 2015). Likewise, the same researcher made the digitization of the markers.

Calculation

The participants' vertical jump height was calculated using the following equipment and methods: 1a) Motion analysis system (SIMI Motion 7.5, GER) according to the vertical displacement of the right toe (SIMI_RF), 1b) left toe from instant take-off to land on (SIMI_LF) and 1c) according to hip displacement from instant take-off to land on (SIMI_HD) by Motion analysis system (SIMI Motion 7.5, GER); 2) My Jump 2 app with time in air method concerning toe displacement from instant take-off to land on; 3) Force Plate (Force Plate [FP];BERTEC 4060-10, USA) according to flight time (FT) from instant take-off to land on.

To calculate vertical jump height (JH) with the motion analysis system, recorded images from the motion analysis system were tracked and digitized frame by frame in SIMI and processed by following markers during the task—instant take-off and landing on predetermined moments were defined, and the displacement data collected was utilized to calculate vertical jump height.

The vertical jump height (JH) for the data acquired from the force plate (FP) was calculated using equation ($JH=g*AT^2/8$) where JH was vertical jump height, AT was the spent in air time, and g was the acceleration due to gravity g= -9.81 (m/s^2) published in the literature (Bosco et al., 1983). A low-pass, fourth-order Butterworth filter with a 4Hz cut-off frequency was used to filter obtained kinetic and kinematic data. The My Jump II data were collected using the same phone and by the same researcher. The recordings were obtained at an equal height of approximately one meter and approximately one and a half meters from the participants, ensuring an accurate analysis of their lower extremities. In contrast to the point of view provided by the frontal plane, the sagittal plane allows for easier observation of the different phases of take-off and landing (Stanton et al., 2017).

Data Analysis

All data are presented as the mean value (M) and the standard deviation (SD). 95 % limits of agreement were used to measure the accuracy and reliability of My Jump 2, and the other calculation methods 95 % LOA (Bland & Altman, 1999) and the coefficient of variation

(Atkinson & Nevill, 1998). were calculated, respectively. The Bland-Altman method was used to estimate the bias and the 95% limits of agreement (bias ± 1.96 x Sd). The 95% limits include 95% of the difference between the two measurement methods used (Myles & Cui, 2007). The coefficient of variation (CV) value (<10%) was calculated by Atkinson and Nevill (1998). Before using parametric tests, the assumption of normality was verified using the Shapiro-Wilk test ($p > 0.05$). A one-way analysis of variance for repeated measures was used to determine differences between My Jump 2 and other measurement methods. To make pairwise comparisons between My Jump 2 and the various measurement methods, the Bonferroni Post Hoc test was used. The level of statistical significance was set at $p < 0.05$. Effect sizes (η2) were also calculated to determine the practical difference between My Jump II and other measurement methods. Small, medium, and large differences were defined as ES values of 0.01, 0.06, and 0.14 and above, respectively (Cohen, 1988). The 95%CI was also calculated for the difference between the means for each estimated variable.

RESULTS

The means of the jump data (±SD), the CV (%), and the 95% LOA values for vertical jump height in cm across three different measurement devices are presented in Table 1 and Table 2. There is no significant difference in vertical jump height based on using the My Jump 2 force platform and RFD and LFD of the motion analysis system through SIMI (Table 1). The only statistically significant difference was in HD data versus the data obtained from all other measurements ($F = 139.658$, $p = 0.01$, $\eta^2 = 0.83$, η^2 represents a significant change)

Table 1
Comparison of Vertical Jump Heights (cm) Amongst My Jump 2, Force Plate, and SIMI

Variable	SIMI RF	SIMI LF	My Jump 2	SIMI HD	FP	ES	M_oC
Vertical jump height(cm)	28.46 ± 6.24	28.59 ± 5.60	29.60 ± 4.94	27.32 ± 5.15*	29.32± 4.48	0.833	Large

* Significantly different to Flight Time Force Plate ($p < 0.05$)
Note. FT = Flight Time; SIMI_HD = SIMI Hip Displacement; SIMI_RF = SIMI_Right Toe Displacement; SIMI_LF = SIMI Left Toe Displacement; FP = Force Plate; ES = Effect Size; M_oC = Magnitude of Change

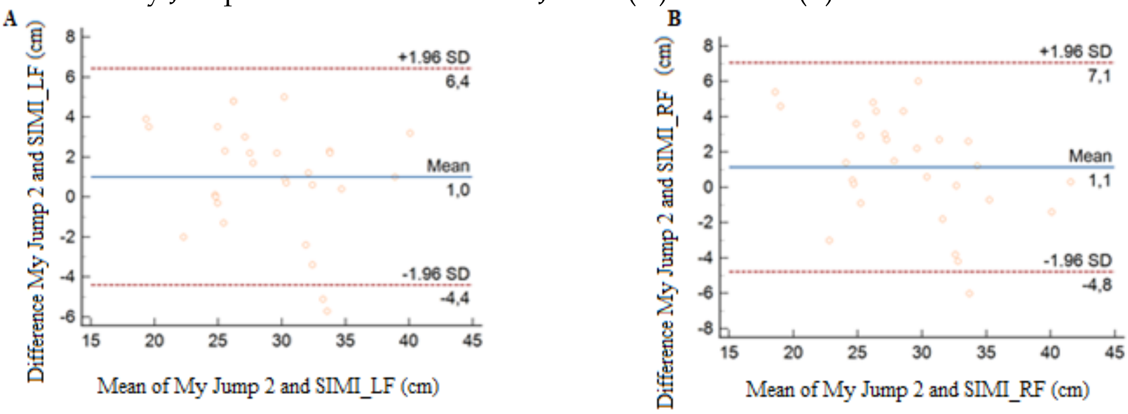
Table 2
Bland-Altman Bias (SD) and 95% Limits of Agreement Amongst Measurement Methods

Variable	My Jump 2-SIMI-RF		My Jump2-SIMI LF		My Jump2-FP		My Jump2-SIMI HD	
	CV (%)	**95% LOA (Bias±1,96xSd)**	**CV (%)**	**95% LOA (Bias±1,96xSd)**	**CV (%)**	**95% LOA (Bias±1,96xSd)**	**CV (%)**	**95% LOA (Bias±1,96xSd)**
Vertical Jump Height(cm)	7.74	1.14 ±5.91	7.05	1.01 ± 5.42	2.45	0.60 ± 1.60	17.79	-8.3± 3.86

Note. SIMI_HD = SIMI Hip Displacement; SIMI_RF = SIMI_Right Toe Displacement; SIMI_LF = SIMI Left Toe Displacement; FP = Force Plate; CV = Coefficient of Variation, 95%IOA = 95% Limits of Agreement

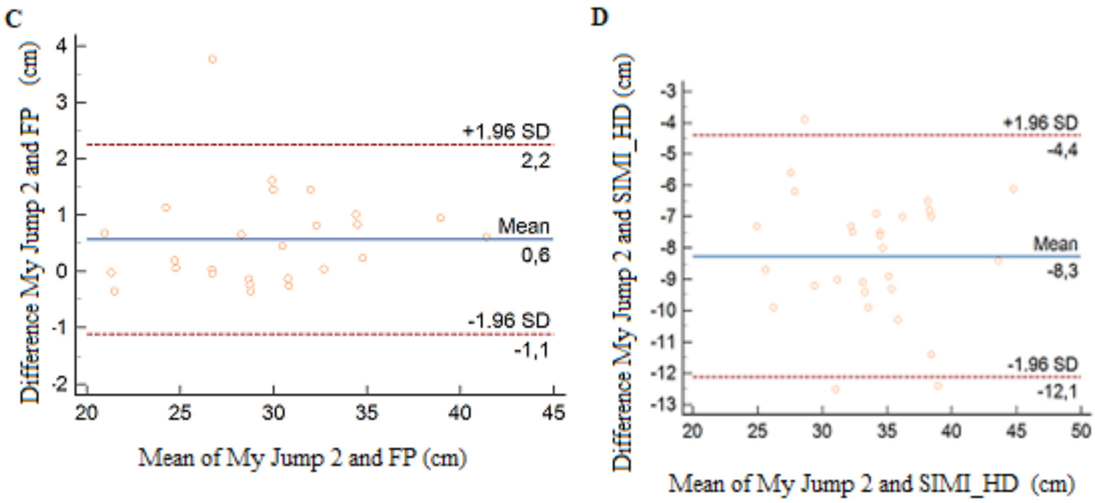
Bland-Altman plots were created for all conditions. The largest mean difference (-8.3 cm) was found in vertical jump height data calculated from HD. The 95% LOA values suggest an underestimation of HD values compared to My Jump 2 data (-8.3 ± 3.86, 95%CI; MyJump2-HD) = 1.24/3.30), while RFD and LFD values were similar to My Jump 2 data (1.14 ± 5.91, 95%CI; MyJump2- -0.66/2.93 RFD); (1.01 ± 5.42, 95%CI; MyJump2-LFD = -0.63/2.65). A positive mean difference for RFD, LFD, and My Jump II conditions indicated that the calculated height from the My Jump 2 data was like the vertical jump height measured by SIMI. In addition, vertical jump height values of My Jump II were very similar to those calculated from force platform data, known as the gold standard in literature (0.6 ± 1.60, 95%CI; MyJump2-FP= 2.38/4.01)

Figure 1
Bland-Altman with 95% Limits of Agreement (Dashed Lines) and Mean Difference (Solid Line) between My Jump 2 and the SIMI for CMJ from (A) LFD and (B) RFD



Note. SIMI RF = SIMI Right Toe Displacement; SIMI LF = SIMI Left Toe Displacement; SD = Standard Deviation

Figure 2
Bland-Altman with 95% Limits of Agreement (Dashed Lines) and Mean Difference (Solid Line) Between My Jump 2 and the FT of (C) FP and (D) HD for CMJ



Note. SIMI HD = SIMI Hip Displacement; FP = Force Plate; SD = Standard Deviation

DISCUSSION

The aim of this study was to determine the difference amongst vertical jump measurements from the force plate using the time-in-air method, the motion analysis system using tracking markers from three different joints, and the My Jump 2 application using the time-in-air method. The findings indicate that My Jump 2 demonstrated a greater level of concurrence with SIMI RF and LFD in the assessment of vertical jump height during a CMJ. Furthermore, the Bland Altman plots (Figures 1 A and B) illustrate that a great deal of countermovement jump (CMJ) values is closely correlated with the mean of the differences observed between My Jump 2 and SIMI. Furthermore, Bland–Altman plots (Figures 1 A and B) show that many of the results are close to the mean difference between My Jump II and SIMI based on toe displacement, indicating a good level of agreement (Bland & Altman, 1999). The presented figure illustrates a consistent bias (Figure 1 A and B), where the values obtained from the SIMI indicate a slight increase compared to those obtained from the My Jump II application for all countermovement jumps (CMJ), which generates positive differences in scores. In regard to the CMJ analysis, the mean bias observed between the My Jump 2 and SIMI systems was found to be lower than 1.1 cm (1.14 ± 5.91cm RFD; 1.01 ± 5.42cm LFD). The similarities between SIMI and My Jump II are not significant, even though the importance of manually performing the take-off and landing frame selection, has the potential of creating measurement errors. Similarly, both measurement methods measure the vertical jump height by taking the toe as a reference. Therefore, these slight differences between the right and left toes can be explained by the contrast of the participants' dominant legs.

However, the results of My Jump II appear to be underestimated compared to the vertical jump height calculated from SIMI according to HD (-8.3 ± 3.86cm Figure 2 D). This difference could be the reference point in the calculation of My Jump II, which was the toe. Simultaneously, the analysis conducted by SIMI relied on the differences in hip position during the time when the feet are in the air and when they contact the ground again. The main difference between this study and previous ones relates to the methodology used to calculate vertical jump height. Specifically, the vertical jump height in this study is determined by the displacement of three different joints using the SIMI motion analysis program. With one of these points being the foot. The vertical jump height data in the My Jump application is collected through the computation of the duration between the foot's take-off and initial contact. According to the obtained results, FP and My Jump II CMJ heights were very similar. The data demonstrate a consistent bias (shown in Figure 2 D) where, regardless of the vertical jump height, the values obtained from the My Jump 2 application displayed a slight increase compared to those obtained from the force platform, resulting in positive difference scores. The mean differences in CMJ height between My Jump 2 and the force platform were determined to be less than 0.6 cm.

Moreover, the observed minimal bias in our study is consistent with prior research that has compared My Jump to force platforms, where the average bias ranged from 0.2 to 1.1 centimeters (Driller et al., 2017; Gallardo-Fuentes et al., 2016).

As known to the authors, there are limited studies comparing vertical jump height calculations amongst the displacement of different body joints in a motion analysis system, force plate, and My Jump 2 application.

CONCLUSION

The results of the study suggest that the My Jump II application demonstrates validity and reliability as an alternative to force plates and motion analysis systems. The My Jump 2 application can be utilized by coaches to assess vertical jump height during athletic events, providing an applicable and practical solution.

Authors' contributions

All authors carried out the research design together. All authors were involved in the data collection, took responsibility for data analysis and interpretation of the data. The second author supervised and reviwed the original draft. First author took responsibility all writing process beginning from the manuscript's preparation to approval of the final draft.

Conflict of interest declaration

The author(s) declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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