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RESEARCH ARTICLE

# The Impact of Training Pencak Silat Using Cooperative Model Type Jigsaw Towards Self-Regulated at Universitas Negeri Jakarta

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**Abstract**
This research aims to determine the impact of training Pencak Silat using Cooperative Model Type Jigsaw towards Self-Regulation at Universitas Negeri Jakarta. This research was conducted at Negeri Jakarta, used an experiment with non-equivalent design. The population of this study is Universitas Negeri Jakarta college students, because there were only two classes with 33 students each, the author used a total sampling technique. Sample is 33 college, consisting of 17 men and 16 women at each class A and B. The instrument used is the self-regulated questionnaire. The result show that experimental class obtained a Statistical value of -14.682, Sig. 0,000. It can be concluded that there is an increase in Self-Regulation at the experimental class. The control class obtained a Statistical value of -0.713, Sig 0.412. It can be concluded that there is no increase in the Self-Regulation at the control class. Meanwhile for the Independent t Test, obtained a Statistical value of 13.039, Sig. 0,000. It can be concluded that students in the experimental class who practiced with the Cooperative Model Type Jigsaw gave better results when compared to students in the control class who practiced with the conventional model. For further research in Pencak Silat material, it is necessary to carry out further experimental research on *Jurus Golok and Jurus Toya* use of other cooperative methods such as STAD and TGT. In order to see their effects and the research should be conducted in a larger sample because the move more complex.

**Keywords**
Pencak Silat, Cooperative Model Type Jigsaw, Self-Regulated

## INTRODUCTION

Pencak Silat is basically a sport that consists of several categories, for the fighting categories it divided into several classes based on the athlete's body weight. While for the art categories consists of *Jurus Tunggal, Ganda, dan Regu* (Lubis et al., 2021). *Jurus Tunggal Tangan Kosong* through 7 main movements with 48 movements, namely 1) Style one consists of seven movements, 2) Style two consists of six movements, 3) Style three consists of five movements, 4) Style four consists of seven movements, 5) Style five consists of six movements, 6) Style six consists of eight movements, and 7) style seven consists of eleven movements (Lanos et al., 2023). In practice, *Jurus Tunggal Tangan kososng* have been implemented in the form of local and extracurricular content as learning materials at primary to secondary school levels (Lubis et al., 2021). Universitas Negeri Jakarta also has a Student Activities Unit which has performed well and used to shape superior student character.

The problem that occurs in this pencak silat lecture is that when the lecturer has to train a large number of students, it is clear that this will not be optimal to meet the students' needs because it is usually taught using a conventional model which is centered on trainers with a command style. It is seen that the conventional model with a command style bored for college student (Lanos et al., 2023) and weaken self-development from cognitive, affective,

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psychomotor and social aspects (Ginanjar & Tarigan, 2018; Lanos et al., 2023). This condition becomes worse when students today have a lot of delinquency and also their inability to study well so they often get bad grades. However, in terms of delivering pencak silat material, it is still often dominated by lectures that focus on the lecturer or presenter alone. Obviously this will make students feel bored. Students always argue that they are not interested in this Pencak Silat courses with the Single Compulsory Step material and tend not to want to try. If this condition occurs, if left unchecked, it will become a weakness and mental decline. So it is necessary to have a lecture breakthrough that is fun and able to attract students' interest (Lubis et al., 2022; Lubis et al., 2021; Lubis, et al., 2021) to be actively involved in it and train Self-regulated students at the same time. Specifically, self-regulation or self-regulation is a person's way of managing, controlling and improving themselves based on the rules, goals or targets that a person wants to achieve (Alvi & Gillies, 2023).

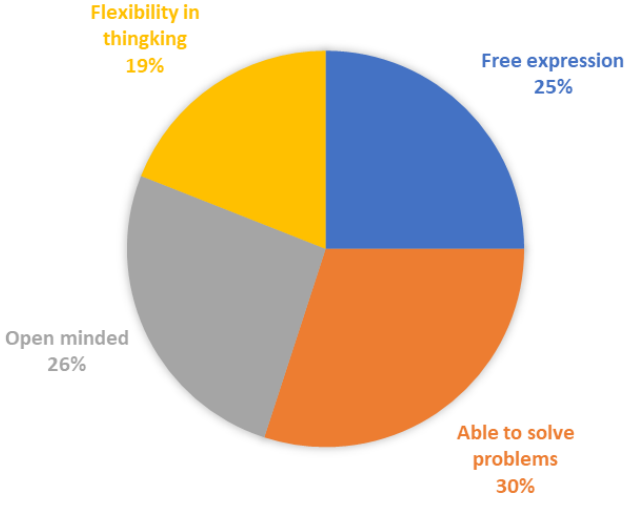


**Figure 1.** The Impact of Learning Creativity Through Social Life Experience (Hardika et al., 2023)

Based on Figure 1, it can be seen how students' enjoyment of learning a skill is seen through their free expression attitude which plays a role of up to 25% on creative learning outcomes. This only happens when students are in a condition capable of practicing. They will not show this free expression attitude when practicing using conventional training patterns with a command style in the conventional training process where students are always under pressure and anxious conditions when practicing pencak silat.

This situation occurs when they are forced to always repeat a series of exercises without understanding the meaning of the explanation given. Usually they will continue to repeat a series of exercises that only the trainer knows their purpose and usefulness. In this concept, usually each move will be repeated until the student is proficient and only continued when they have reached a certain level of desire from the trainer. It is clear that this condition means that students have less opportunity to be active, so it is feared that it will make students stressed and damage their performance (Swann et al., 2017; Toma, 2017). The training process does not work even though input, feedback and clues from the trainer are also determining factors for the success of the training process. So a fun learning model is needed so that students are able to manage their emotions and sports behavior through an interesting training process that can attract students' attention.

The cooperative model is currently being developed and is expected to change and direct students for the better. In this model, students are more active in learning, honing their movement experience as well as social skills (Artanayasa et al., 2023) and increasing their motivation to learn (Setyaningsih, 2023). This cooperative model was first introduced by Slavin (Slavin, 1995) and was proven to be able to improve cognitive, social and affective variables and was appropriate to age maturity levels. In Cooperative Model Type Jigsaw there are five main group work characteristics: 1) Positive dependency, 2) Face-to-face interaction, 3) Individual accountability, 4) Interpersonal and group work skills and 5) group processing (Legrain et al., 2023). The cooperative model is basically a constructivist school that is useful for improving learning outcomes and behavior by working in groups. In this model students learn in groups which is the basis for building an effective learning team (Wibawa, 2023). This is a more specific learning procedure the Cooperative Model Type Jigsaw where through proper planning it is seen as being able to optimize the benefits of the work group (Cochon Drouet et al., 2023; Legrain et al., 2023).

The Cooperative Model Type Jigsaw makes students more skilled, but this needs to be balanced by careful class management and planning so that active time in practicing is effective. In the Cooperative Model Type Jigsaw there is a

uniqueness in that this model relies on a small and diverse group of students, in this diversity they are required to be able to collaborate positively in improving their own and their team's abilities (Jiang et al., 2023). The goal is for students to learn by emphasizing cooperation with peers while collaborating harmoniously to achieve common goals, by encouraging profitable results in an active performance environmentyang aktif (Cereda, 2023).

Literally, self-regulation is a person's way of managing, controlling and improving themselves based on rules, goals or targets that a person wants to achieve (Alvi & Gillies, 2023). In practice, people who have self-regulation will try to think about everything they have done and will do and will continue to try to achieve it through systematic thinking (Alvi & Gillies, 2023) so that it meets their expectations. Apart from that, individuals with high self-regulation will often evaluate themselves (Chu et al., 2023) regarding all the achievements they have made. In simple terms, the self-regulated process according to (Zimmerman, 2000) is described as follows.

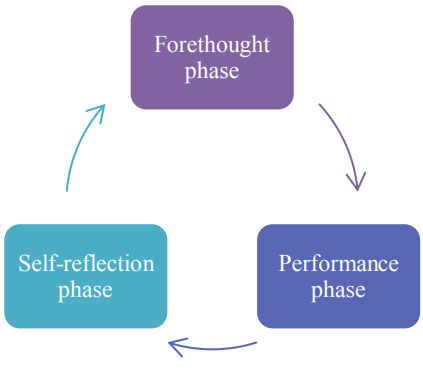


**Figure 2.** The Three Phases Of Self-Regulated Learning (Zimmerman, 2000)

Based on Figure 2, it is explained that in this Forethought phase, every thought and idea is collected and organized to be implemented and tried. The next phase is the performance phase, in this phase every idea and thought begins to be applied and begins to be tried through practice. In this process there will be trial and error, improvements, discussions and concept maturation in order to achieve maximum results. The next phase that occurs is the self-reflection phase, in which there is a process of actualizing understanding and performance that has gone through a series of thoughts and input. It is clear that this self-regulated process does not come by itself, but is a dynamic process between a person's personality influenced by positive cognition, behavior and the environment (Park et al., 2023). So, everything that happens in the surrounding environment will be observed by that person. He will assess the merits and demerits of an event or action that has been or will be carried out, whether by other people or by himself. This will later give rise to independence and the ability to control oneself (Lan et al., 2020) to act according to one's thoughts.

## MATERIALS AND METHODS

*Participant*

This research followed ethical standards and received approval from the Politeknik Kesehatan Kementerian Kesehatan Bandung, Indonesia with reference number (NO.11/KEPK/EC/VI/2024 and date of approval June 6, 2024). Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures. The characteristics of the participants are as follows.

Based on table 1, the characteristics of the students who are the subject of this study divided it into experimental and control group with 33 members each, consisting of 17 men and 16 women. The average age of both was 20 years with standard deviations 1.58. The average height of the experimental group is 1.65 metres with standard deviations 0.08 and the control group is 1.67 meters with standard deviations 0.09. The average weight of the experimental group is 58.88 kg with standard deviations 7.97 and the control group is 60.05 kg with standard deviations 8.55. While for the category of body mass index, experimental group have an average of 21.53 (normal) with standard deviations 2.17 and control group have an average of 21.55 (normal) with standard deviations 2.17.

For age is stated in the questionnaire filled out by the research participants so the author only needs

to include it, but the other components the author measured before the research was conducted. Height was measured using a meter and weight using an electric scale. After that, the author calculated the BMI of the research participants manually, so that the research would be balanced.

**Table 1.** Characteristics of the research subjects

| Group | N | Age | | Height | | Weight | | BMI | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Experimental | 33 | 20 | 1.58 | 1.65 | 0.08 | 58.88 | 7.97 | 21.53 | 2.17 |
| Control | 33 | 20 | 1.58 | 1.67 | 0.09 | 60.05 | 8.55 | 21.55 | 2.13 |

**Design**

An explanation of the experimental design can be seen in table 2.

**Table 2.** Non-equivalent design (Creswell, 2018)

| Class | Pretest | Treatment | Posttest |
|---|---|---|---|
| Eksperiment | O1 | X1 | O3 |
| Control | O2 | X1 | O4 |

Based on table 2, the research method used was experimental, using a non-equivalent design (Creswell, 2018). This condition was implemented because students attended only two classes, so the sample was taken by total sampling (Creswell, 2018). The instrument used is the self-regulated questionnaire from (Brown et al, 1999) which has a reliability value of 0.91, and further information can be seen in the appendix. The assessment for this questionnaire uses a Likert Scale where positive statements are Strongly Disagree = 1, Disagree = 2, Undecided = 3, Agree = 4 and Strongly Agree = 5. Meanwhile for Negative Items, namely Strongly Disagree = 5, Disagree = 4, Undecided = 3, Agree = 2 and Strongly Agree = 1. Items that are to be reverse: 2, 3, 4, 5, 6, 8, 10, 12, 13, 15, 19, 20, 21, 24, 26, 29, 31, 33, 37, 40, 43, 45, 50, 55, 62, and 63. The indicators of the Self-Regulated questionnaire (Brown et al, 1999) are as follows.

**Table 3.** The indicator of self-regulated questionaire

| No | Indicator | Question |
|---|---|---|
| 1 | Receiving | 1, 8, 15, 22, 29, 36, 43, 50, 57 |
| 2 | Evaluating | 2, 9, 16, 23, 30, 37, 44, 51, 58 |
| 3 | Triggering change | 3, 10, 17, 24, 31, 38, 45, 52, 59 |
| 4 | Searching for options | 4, 11, 18, 25, 32, 39, 46, 53, 60 |
| 5 | Formulating a plan | 5, 12, 19, 26, 33, 40, 47, 54, 61 |
| 6 | Implementing the plan | 6, 13, 20, 27, 34, 41, 48, 55, 62 |
| 7 | Assessing the plan's effectiveness | 7, 14, 21, 28, 35, 42, 49, 56, 63 |

Based on table 3, the results of this questionnaire trial prove that the Self-Regulated Questionnaire created by (Brown et al, 1999) The research was conducted on students in Pencak Silat courses with *Jurus Tunggal Tangan Kosong* with 7 main movements and 48 movements which consisting of 63 questions is very usable because it has a reliability of 0.91 and can be used as a research instrument. The test flow can be seen in figure 3. can seen in figure 4 and the table 4 for the lesson plan.

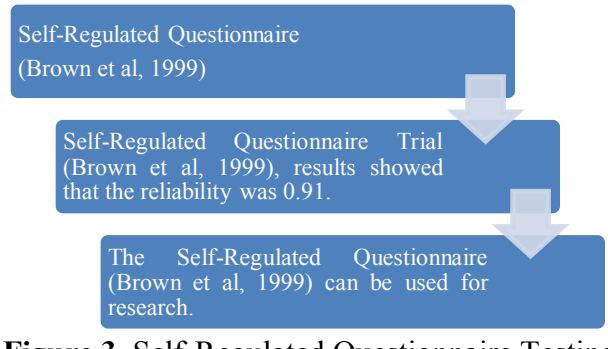


**Figure 3.** Self-Regulated Questionnaire Testing Steps

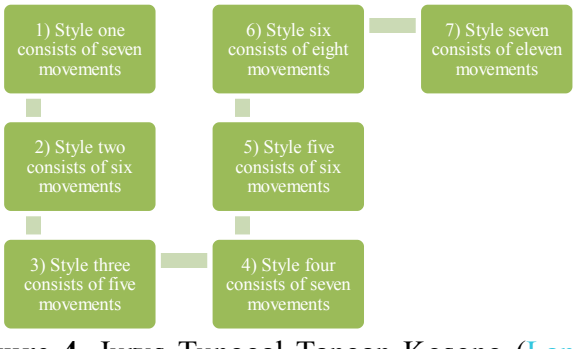


**Figure 4.** Jurus Tunggal Tangan Kosong (Lanos et al., 2023)

**Table 4.** Lesson plan of pencak silat courses with jurus tunggal tangan kosong

| Cooperative Model Type Jigsaw | Lesson |
|---|---|
| • Coaching guidance regarding the implementation of the Cooperative Model Type Jigsaw in pencak silat.<br>• Establishing rules during training where the leader is determined to truly master the material to share his knowledge and understanding with other groups. While the leader is sharing with other groups, his team gains knowledge and understanding from other groups and records all the steps and information provided. Each group must have their own archive to help them practice. After the knowledge and understanding are obtained and the leader returns to the group, the team begins to practice according to their understanding and tries to trace the Jurus Tunggal Tangan Kosong moves that they have learned.<br>• Pretest Self-Regulated | **1** |
| • Students warm up.<br>• Students are divided into 7 groups according to the number of Jurus Tunggal Tangan Kosong moves, namely 1) Style one consists of seven movements, 2) Style two consists of six movements, 3) Style three consists of five movements, 4) Style four consists of seven movements, 5) Style five consists of six movements, 6) Style six consists of eight movements, and 7) style seven consists of eleven movements.<br>• Students in their groups practice the Jurus Tunggal Tangan Kosong move and at the end of the third meeting determine a leader who will share knowledge and understanding of the Jurus Tunggal Tangan Kosong move that he has learned.<br>• Students cooling down in groups. | **2-3** |
| • Students warm up in groups.<br>• The leader of each group cross-references the material with other groups and shares knowledge and understanding.<br>• Group 1 is trained by leader B, leader A trains group 7. Group 2 is trained by leader C, leader G trains group 6. Group 3 is trained by leader D, leader F trains group 5, and group 4 is trained by leader E.<br>• Meanwhile, the team from his group receives knowledge and knowledge from other groups and records it.<br>• After the sharing process is complete, the leader returns to the group and practices according to the material obtained from other groups.<br>• Students cooling down in groups. | **4-5** |
| • Students warm up in groups.<br>• The leader of each group cross-references the material with other groups and shares knowledge and understanding.<br>• Group 1 is trained by leader C, leader A trains group 6. Group 2 is trained by leader D, leader G trains group 5. Group 3 is trained by leader E, leader F trains group 4, and group 7 is trained by leader B.<br>• Meanwhile, the team from his group receives knowledge and knowledge from other groups and records it.<br>• After the sharing process is complete, the leader returns to the group and practices according to the material obtained from other groups.<br>• Students cooling down in groups. | **6-7** |
| • Students warm up in groups.<br>• The leader of each group cross-references the material with other groups and shares knowledge and understanding.<br>• Group 1 is trained by leader D, leader A trains group 5. Group 2 is trained by leader E, leader G trains group 4. Group 3 is trained by leader F, leader B trains group 6, and group 7 is trained by leader C.<br>• Meanwhile, the team from his group receives knowledge and knowledge from other groups and records it.<br>• After the sharing process is complete, the leader returns to the group and practices according to the material obtained from other groups.<br>• Students cooling down in groups. | **8-9** |
| • Students warm up in groups.<br>• The leader of each group cross-references the material with other groups and shares knowledge and understanding. | **10-11** |

| | |
|---|---|
| • Group 1 was trained by leader E, leader A trained group 4. Group 2 was trained by leader F, leader G trained group 3. Group 5 was trained by leader B, leader C trained group 6, and group 7 was trained by leader D.<br>• Meanwhile, the team from his group receives knowledge and knowledge from other groups and records it.<br>• After the sharing process is complete, the leader returns to the group and practices according to the material obtained from other groups.<br>• Students cooling down in groups. | |
| • Students warm up in groups.<br>• The leader of each group cross-references the material with other groups and shares knowledge and understanding.<br>• Group 1 is trained by leader F, leader A trains group 3. Group 2 is trained by leader G, leader B trains group 4. Group 5 is trained by leader C, leader D trains group 6, and group 7 is trained by leader E.<br>• Meanwhile, the team from his group receives knowledge and knowledge from other groups and records it.<br>• After the sharing process is complete, the leader returns to the group and practices according to the material obtained from other groups.<br>• Students cooling down in groups. | **12-13** |
| • Students warm up in groups.<br>• The leader of each group cross-references the material with other groups and shares knowledge and understanding.<br>• Group 1 is trained by leader G, leader A trains group 2. Group 3 is trained by leader B, leader C trains group 4. Group 5 is trained by leader D, leader E trains group 6, and group 7 is trained by leader F.<br>• Meanwhile, the team from his group receives knowledge and knowledge from other groups and records it.<br>• After the sharing process is complete, the leader returns to the group and practices according to the material obtained from other groups.<br>• Students cooling down in groups. | **14-15** |
| • Students warm up in groups.<br>• Performance from each group towards the Jurus Tunggal Tangan Kosong.<br>• Strengthening the trainer's understanding regarding the implementation of the Cooperative Model Type Jigsaw in pencak silat.<br>• Students cooling down in groups.<br>• Posttest Self-Regulated | **16** |

***** Notes : A = Leader Team 1, B = Leader Team 2, C = Leader Team 3, D = Leader team 4, E = Leader Team 5, F = Leader Team 6, G = Leader Team 7

| **Conventional Model** | **Lesson** |
|---|---|
| • Coach's guidance regarding the implementation of the Conventional Model in pencak silat.<br>• Self-Regulated Pretest. | **1** |
| • Students warm up.<br>• Students learn Pencak Silat courses with Jurus Tunggal Tangan Kosong Style one consists of seven movements.<br>• Students cooling down. | **2-3** |
| • Students warm up.<br>• Students learn Pencak Silat courses with Jurus Tunggal Tangan Kosong Style two consists of six movements.<br>• Students cooling down. | **4-5** |
| • Students warm up.<br>• Students learn Pencak Silat courses with Jurus Tunggal Tangan Kosong Style three consists of five movements.<br>• Students cooling down. | **6-7** |
| • Students warm up.<br>• Students learn Pencak Silat courses with Jurus Tunggal Tangan Kosong Style four consists of seven movements.<br>• Students cooling down. | **8-9** |
| • Students warm up. | **10-11** |

| | |
|---|---|
| • Students learn Pencak Silat courses with Jurus Tunggal Tangan Kosong Style five consists of six movements.<br>• Students cooling down. | |
| • Students warm up.<br>• Students learn Pencak Silat courses with Jurus Tunggal Tangan Kosong Style six consists of eight movements.<br>• Students cooling down. | **12-13** |
| • Students warm up.<br>• Students learn Pencak Silat courses with Jurus Tunggal Tangan Kosong Style seven consists of eleven movements.<br>• Students cooling down. | **14-15** |
| • Students warm up in groups.<br>• Performance of the Jurus Tunggal Tangan Kosong.<br>• Strengthening the trainer's understanding regarding the implementation of the Convenstional model in pencak silat.<br>• Students cooling down in groups.<br>• Posttest Self-Regulated | **16** |

**Procedure**

As a first step, the author conducted a preliminary survey at Universitas Negeri Jakarta to see the actual problems that occurred. After that, communicate with the pencak silat course lecturer team and determine the main problem. After that, the author asked Dean of Universitas Negeri Jakarta for permission to conduct research and distribute ethical approval sheets to students.

This consent must also be acknowledged by the parents, which includes a notification to the students' parents that within the period from June to July 2024 they will be included in the research. Students involved have fully obtained approval and all procedures are approved by **Politeknik Kesehatan Kementerian Kesehatan Bandung, Indonesia.** After that, the author determined the population and sample of Universitas Negeri Jakarta college students who were interested in martial arts with a focus on Pencak Silat courses with *Jurus Tunggal Tangan Kosong* material, because there were only two classes with 33 students each, the author used a total sampling technique.

The next step is to prepare a self-regulated questionnaire from (Brown et al., 1999), then carry out a pre-test which aims to measure self-regulated students before being given treatment. The next step is implemented the treatment by practicing Pencak Silat courses with *Jurus Tunggal Tangan Kosong* using the Cooperative Model Type Jigsaw for the experimental group every monday and the conventional model for the control group every wednesday. The treatment process was given once a week, the number of meetings was 16 meetings with a duration of 90 minutes each meeting, and the treatment was given by the author and one assistant who was competent in the single empty hand technique. The treatment for the experimental class was carried out in hall A every Monday, while the control class was carried out in hall B every Wednesday. This condition was carried out by the author so that participants remained focused on the treatment given and factors that interfered with the test results could be minimized because there was no contact or communication from fellow treatment participants in each class. After the posttest was completed and after that the author processed and analyzed the data.

**Data Collection**

Data were collected from participants using a Self-Regulated questionnaire prepared by the author. This Self-Regulated questionnaire was distributed to participants at the first meeting after briefing from the trainer in the experimental and control classes and at the sixteenth meeting after reinforcement of understanding from the trainer. The duration of time given to each participant to fill out this questionnaire was 60 minutes. After the participants finished filling out the Self-Regulated questionnaire, the author collected it for processing.

**Statistical Analysis**

Data was processed using Microsoft Office-Excel and IBM SPSS Statistics v.26 software. Author provides scores, totals, averages, standard deviations and makes graphic diagrams. after that, analyze the data which includes normality and homogeneity test. In the end the author carried out an analysis to answer the hypothesis using the paired and Independet t Test because the results of the improvement of each group can be seen clearly and it will be proven which training model is better.

**Table 5.** The Result of Normality and Homogeneity

| Group | Normality | Sig. |
|---|---|---|
| Experimental Pretest | 0.112 | 0.200 |
| Experimental Posttest | 0.068 | 0.200 |
| Control Pretest | 0.112 | 0.200 |
| Control Posttest | 0.109 | 0.200 |
| **Group** | **Homogeneity** | **Sig.** |
| Experiment >< Control | 5.228 | 0.026 |

Based on table 5, it can be seen from the results of the Lavene test that the scores of the pleasure of student learning in the experimental & control classes obtained a statistical value of 5.228, Sig. 0.026. It can be concluded that the scores of the pleasure of student learning in the experimental class and the control class are homogeneous. Based on these results, the data can be processed to the next stage.

## RESULTS

The findings of this study will be explained in the following section.

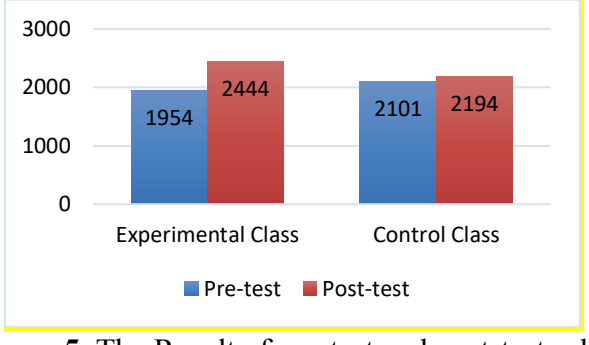


**Figure 5.** The Result of pre-test and post-test self-regulated at universitas negeri Jakarta

Based on Figure 5, it can be seen that the experimental class obtained a pretest score of 1954 and a posttest of 2444, while in the control class a pretest score of 2101 and a posttest of 2194 was obtained. Based on table 1, the score of the enjoyment of learning for students who study with Cooperative Model Type Jigsaw model has a greater value than students who learn with conventional models.

**Table 6.** Paired and independent t test

| Paired Test | t | Sig. |
|---|---|---|
| Experimental | -14.682 | 0.000 |
| Control | -0.713 | 0.412 |
| **Independent t Test** | **t** | **Sig.** |
| Experimental >< Control | 13.039 | 0.000 |

Based on table 6, it can be seen the paired test, the experimental class obtained a Statistical value of -14.682, Sig. 0,000. It can be concluded that there is an increase in Self-Regulation at the experimental class. The control class obtained a Statistical value of -0.713, Sig 0.412. It can be concluded that there is no increase in the Self-Regulation at the control class. Meanwhile for the Independent t Test, obtained a Statistical value of 13.039, Sig. 0,000. It can be concluded that students in the experimental class who practiced with the Jigsaw type of Cooperative Learning gave better results when compared to students in the control class who practiced with the conventional model.

Training Pencak Silat courses with *Jurus Tunggal Tangan Kosong* using Cooperative Model Type Jigsaw creates a fun atmosphere but remains serious and active. Clearly this can foster a positive attitude and encourage students' active participation in practicing. This situation will not occur if learning is fun, because the process of forming cooperation as shown in Figure 6 will not be formed optimally.

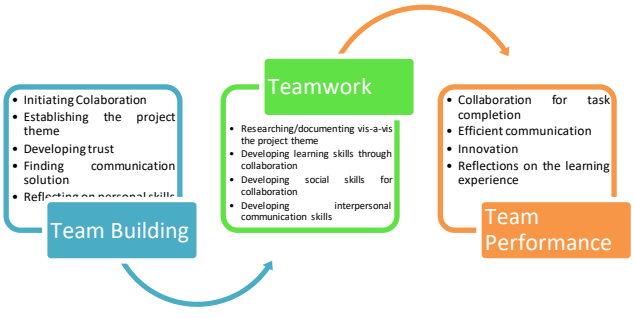


**Figure 6.** TTT framework (Dincă et al., 2023)

The training Pencak Silat courses with *Jurus Tunggal Tangan Kosong* using Cooperative Model Type Jigsaw makes students motivated to be active and able to collaborate well. In the context of learning pencak silat, every student is able to be actively involved in practicing.

## DISCUSSION

Based on the results, the following findings are presented including:

***There is an Influence of the Cooperative Model Type Jigsaw toward Self-Regulated College Student***

The training Pencak Silat courses with *Jurus Tunggal Tangan Kosong* using Cooperative Model Type Jigsaw makes students motivated to be active and able to collaborate well. In the context of learning pencak silat, every student is able to be actively involved in practicing. This will enable students to benefit from motor development that is appropriate to their level of needs (Pavlović, 2018; Pavlović et al., 2022). It needs to be realized that in this, college student activity arises because of mutual trust and good communication between student and student or student and their trainer. This will enable students to benefit from motor development that is appropriate to their level of needs (Pavlović, 2018; Pavlović et al., 2022). It needs to be realized that in this, college student activity arises because of mutual trust and good communication between student and student or student and their trainer. Training Pencak Silat courses with *Jurus Tunggal Tangan Kosong* using Cooperative Model Type Jigsaw creates a fun atmosphere but remains

For example, Tessa, when practicing Pencak Silat courses with the *Jurus Tunggal Tangan Kosong*, because she already understands it, sometimes appears to be able to explain to other students the mastery of a single style that she is learning. Even though the trainer observes, when the context is positive the trainer also provides opportunities for students to interact well. This is deemed necessary because it will hone the social aspects that are the advantage of this Cooperative Model Type Jigsaw (Jiang et al., 2023). Apart from that, good planning is also needed so that learning can run optimally. The use of this makes students' abilities more honed, where students are able to practice and show a high level of confidence in the material provided by the trainer. This seen increase in cognitive abilities clearly requires fluency in thinking, flexibility in seeing opportunities, high imaginative abilities and accuracy in decision making in the field (Cochon Drouet et al., 2023; Setyaningsih, 2023). This condition also makes it clear that the main emphasis in practicing single moves is how students are able to be actively involved in each set of specified training processes.

Every student needs to apply self-regulation for themselves, they need to do this because every human being is different, has different characteristics because it has a different learning style and goals. Every student must of course follow the rules and goals that the school wants to achieve. However, in relation to their survival in the future they need to apply self-regulation to themselves (Wei et al., 2023; Wu et al., 2023) First of all, they need to know what they are studying for. If students already know this then it will be the foundation for them to learn. Students who apply self-regulation in learning will continue to try to motivate themselves to learn better. They will create discipline based on their own awareness. Students who already have self-regulation will still try to focus when participating in learning activities. They will try to record important information given by the teacher without having to wait to be given instructions (Heikkinen et al., 2023; Poitras et al., 2023). Apart from that, these students will also try to do the practice questions seriously because they are aware that all their behavior will be assessed by the teacher and of course this assessment will greatly influence their grades on the report card. They try to avoid random assignments and also try to submit them on time as a form of accountability towards teachers, parents and themselves (Boshoff-Knoetze et al., 2023; Yang et al., 2023) and also always search for and dig up all the information they need regarding school subject matter outside of school hours. They will do this through several sources such as books, internet, newspapers, magazines, etc.

***There is no Influence of Conventional Models toward Self-Regulated College Student.***

The conventional model in Pencak Silat courses with the *Jurus Tunggal Tangan Kosong* uses a command style in which repetition occurs. For example, before students are given the material, they practice basic move with repetition. This condition usually occurs in the conventional training process and has been passed down from old generation. This condition will actually create a condition of excessive anxiety which can reduce creativity (Ginanjar & Tarigan, 2018). The increased anxiety occurs because students become afraid of being criticized or ridiculed by their friends, especially if they take the wrong action. These attitudes and conditions will not enable students to develop a collaborative process (see

figure 3), because they only make the training process centered on what the teacher exemplifies. Obviously this is not the desired creative process because students just wait their turn and wait for understanding from the trainer's evaluation to correct their mistakes. This makes Team Building, Teamwork and Team Performance of students who practice single moves unable to form well, because of their passive attitude (Aelterman et al., 2019; Cohen et al., 2022). High dependence on the role of trainer makes students limited in making decisions and creates a lack of courage to try.

Another view has also been expressed that repetition is not necessarily the most effective way to improve technical skills, because of the passivity generated in children either by repeating a series of exercises without understanding their true meaning by the explanations and demonstrations (Giménez et al., 2010; Puente-Maxera et al., 2021). It needs to be understood that the training process a balance must be achieved between skills and the challenges felt by students. It is not uncommon in practice for students to often make mistakes, for example when Rapli performs a sweeping kick technique his legs do not match the trajectory and target, this happens because Rapli does not understand it. Apart from that, Rapli also believes that "learning in this way makes me stressed and afraid of making mistakes." This needs to get more attention because if left unchecked it will make students lazy in learning *Jurus Tunggal Tangan Kosong*.

This is different from students who do not apply self-regulation in Pencak Silat courses with the *Jurus Tunggal Tangan Kosong* (Rueda et al., 2023; Xu et al., 2023). They tend to be take part in learning activities, do exercises and do their assignments. This is happened because they do not have demands on themselves and do not have targets they want to achieve (Boroughani et al., 2023). That is what will later cause their low motivation to learn. Apart from that, students who have not implemented self-regulation tend not to be disciplined and have no responsibility, so their motivation to learn is very lacking.

***Cooperative Model Type Jigsaw Gives Better Influence towards Self-Regulated College Student than Conventional Model***

A Good and planned training process can provide high benefits for students in learning Pencak Silat courses with the *Jurus Tunggal Tangan Kosong*. In line with Figure 3, this happens because Team Building, Teamwork and Team Performance are formed in the training process using Jigsaw Model. This will challenge students in a meaningful practice process and is seen as providing better results (Lavoie et al., 2021; Leppänen et al., 2021; Reyes et al., 2023; Rossi et al., 2021) compared to using conventional models. It is not uncommon for students to experience a problem, but when using this Jigsaw Model, it will give them the strength to be able to solve it. This condition is very important as a provision for students to continue studying Pencak Silat courses with the *Jurus Tunggal Tangan Kosong* and other physical activities in the future (Cupeiro et al., 2020).

By using conventional models, whether we realize it or not, it can influence feelings and thought processes. This happens because students' negative emotional conditions will produce less than optimal results (Lavoie et al., 2021). This situation is reflected in Ridho who has not been able to perform the *Jurus Tunggal Tangan Kosong* in under 2 minutes. Ridho seemed hesitant in making his movements. This condition is clearly different from Ragil's, when the time is still more than 2 minutes, Ragil is seen always discussing with his teammates and if deemed necessary, Ragil also doesn't hesitate to ask the coach. This condition is a picture that arises when using a different model and it is clear that college sudents who train with the conventional model will not be as flexible and fluent than college sudents who train using this jigsaw type cooperative model (Segundo-Marcos et al., 2023).

Through this Jigsaw Model, the process becomes more meaningful. Its use clearly needs to be supported by good classroom management (Dorofieieva et al., 2019). Enjoyable learning conditions will make it easier to achieve the goals set by the trainer (Ginanjar et al., 2023; Ginanjar & Tarigan, 2018; Whittle et al., 2018) which makes students more mature in thinking. Every student can practice more effectively through the connection between students' thinking abilities and physical skills (Boshoff-Knoetze et al., 2023; Yang et al., 2023). Good management of positive emotions in learning will make it easier for students to concentrate on learning Pencak Silat course process with the *Jurus Tunggal Tangan Kosong* can be achieved well.

## Conclusion

The Pencak Silat course process with the *Jurus Tunggal Tangan Kosong* which uses Cooperative Model Type Jigsaw provides better results when compared to the conventional model. Pencak Silat course process with the *Jurus Tunggal Tangan Kosong* that uses Cooperative Model Type Jigsaw is considered to be the right and planned way so that students can get the benefits. The conventional model with a command style is considered not the right way for college students. In the process, this command style can influence college students' feelings and thought processes, such as anxiety, boredom and boredom. The uses Cooperative Model Type Jigsaw packaged in an interesting way and also challenges students to actively think critically. In this context, college students can learn happily but are always actively involved in challenging learning in order to obtain better results. This is clearly needed in the learning process at university, in practice students are also able to concentrate well.

For further research in Pencak Silat material, it is necessary to carry out further experimental research on *Jurus Golok and Jurus Toya*. The research in Pencak Silat *Ganda and Regu* in arts category is also needed because the approach is different. In addition, the use of other cooperative methods such as STAD and TGT is also needed in the *Ganda and Regu* categories, in order to see their effects and the research should be conducted in a larger sample because the move more complex.

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## Ethics Statement

This research followed ethical standards and received approval from the Politeknik Kesehatan Kementerian Kesehatan Bandung, Indonesia with reference number (NO.11/KEPK/EC/VI/2024 and date of approval June 6, 2024).

## Conflict Of Interest

The author declares that there is no conflict whatsoever related to the research, writing and publication of this article.

## Author Contribution

Study Design, SN, TR; Data Collection, SN, TR; Statistical Analysis, SN, TR, SG; Data Interpretation, SN, TR, SG; Manuscript Preparation, SN, SG; Literature Search, SN, TR, SG. All authors have read and agreed to the published version of the manuscript.

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RESEARCH ARTICLE

# Attenuating Plasma Cytokines Response After High-Intensity Exercise Through Selenium Supplementation

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**Abstract**
High-intensity exercise are associated with muscle injury and an acute inflammatory response characterized by an increase in cytokines. Interleukin 6 (IL-6) is one of the proinflammatory cytokines that is most highly elevated by high-intensity exercise, which in turn reduces muscle strength, limits range of motion, and causes general discomfort, affecting performance and training programs. The purpose of this study was to investigate the effect of Selenium supplementation on IL-6 and CRP post high-intensity exercise. This research used an experimental pre-post control group design with 36 male students from the sports science department of Universitas Negeri Surabaya. Participants were randomly assigned to either a selenium supplementation group (n=18) or a placebo group (n=18) and instructed to consume one capsule daily for 21 days in a double-blind manner. Following a 21-day supplementation period, on the 22nd day, participants performed a 100 Drop Jump (DJ) exercise protocol to induce cytokines response. IL-6 and CRP plasma concentration were assessed immediately after, 24 hr and 48 hr after exercise. This study's results demonstrated that during the 24 to 48-hour period following high-intensity exercise, both groups experienced a reduction IL-6 and CRP plasma concentration compared to immediately after. The study's findings indicated that the group supplemented with selenium exhibited a significantly more pronounced decrease in IL-6 with P=0.000 (<0.05) and CRP plasma concentration with P=0.006 (<0.05) compared to the placebo group. In conclusions, Selenium supplementation may lower inflammatory response following high-intensity exercise, as it effectively decreases IL-6 and CRP plasma concentration the bloodstream.

**Keywords**
Exercise, Muscle Damage, Inflammation, Sports Injured, Supplement

## INTRODUCTION

Regular physical activity of light to moderate intensity has been consistently linked to a wide range of health benefits, including a reduced risk of chronic conditions such as cardiovascular disease, type 2 diabetes, certain cancers, as well as neurodegenerative disorders like dementia and Alzheimer's disease (Fuller et al., 2020). However, high-intensity exercise triggers a substantial release of pro-inflammatory cytokines and free radicals from activated leukocytes, which play a role in muscle damage and tissue injury (Suzuki et al., 2020).

It has been stated in many studies that all forms of high-intensity exercise are associated with muscle injury and an acute inflammatory response (Middelbeek et al., 2021). Increased levels of a number of pro- and anti-inflammatory cytokines, naturally occurring cytokine inhibitors, and chemokines are observed. These studies explain that the presence of muscle injury and inflammatory response is reflected by the elevated activity of both

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inflammatory and anti-inflammatory cytokines in the bloodstream (Fleckenstein et al., 2021; Taherkhani et al., 2020) such as tumor necrosisfactor (TNF)-alpha, interleukin (IL)-1 beta, IL-1 receptor antagonist (IL-1ra), TNF-receptors (TNF-R), IL-10, IL-8, Interleukin 6 (IL-6) (Lin et al., 2021), and C-Reactive Protein (CRP) (Boukhris et al., 2020), which are typically released from damaged muscle cells.

Larger amounts of IL-6 are produced in response to exercise than any other cytokine, IL-6 is produced locally in the skeletal muscle in response to exercise. IL-6 production peaks shortly after the training session ends due to reduced muscle glycogen availability, followed by a rapid decline to baseline concentrations. However, if the exercise is accompanied by muscle damage, IL-6 will increase again to signal the acute-phase response and tissue repair during the recovery period (Nash et al., 2023) and experienced a peak increase 24 hours after completing the exercise session (Hennigar et al., 2017).

The level of inflammatory response from high-intensity exercise can vary based on factors such as the type, intensity, and duration of the exercise, as well as the individual's sex and age (Daniela et al., 2022). This process is the body's natural response to muscle damage and inflammation, as the body tries to repair and adapt to new levels of exertion (Suzuki, 2021). While the inflammatory response is a common part of the healing process, uncontrolled inflammation can prolong skeletal muscle recovery after intense exercise or exercise-related injury, muscle soreness, temporary decrease in muscle force, edema, which can influence the magnitude of performance decrement and the time course recovery following high-intensity exercise (Ringuet et al., 2021; Tidball & Villalta, 2010).

This shows that exercise, particularly high-intensity training, is known to induce inflammation through the release of pro-inflammatory cytokines and free radicals, which can contribute to muscle damage and delayed recovery as mention above. While various nutritional supplements are commonly used by athletes and fitness enthusiasts to enhance performance and recovery, their effectiveness in modulating exercise-induced inflammation remains unclear. Some supplements may reduce inflammation and oxidative stress, promoting quicker recovery, while others might exacerbate the inflammatory response or have minimal impact.

Selenium is a vital trace element that is crucial for human health. It acts as a potent antioxidant and has been shown to possess anti-inflammatory properties. Selenoproteins, in which selenium is a key component, are essential for various functions including redox catalytic activity, structural support, and transport processes (Zheng et al., 2022).

Selenium (Se) is associated with antioxidant defense, support for thyroid hormone production, regulation of testosterone metabolism, preservation of DNA structure, modulation of vitamin E (alpha-tocopherol), promotion of anti-cancer mechanisms, and improvement of muscle performance (Kuršvietienė et al., 2020).

Previous research has indicated that elevated levels of selenium and selenoenzymes (such as GPx and Se protein) in the bloodstream have been observed during the initial stages of severe illnesses marked by inflammation and oxidative stress (Hariharan & Dharmaraj, 2020). Consequently, additional studies are required to validate the potential advantages of selenium, particularly in mitigating the likelihood of exercise-induced inflammatory response.

The original value of this study lies in its exploration of selenium supplementation as a potential strategy to modulate exercise-induced inflammation resulting from high-intensity exercise. Selenium, a key antioxidant, may play a role in reducing oxidative stress and the release of pro-inflammatory cytokines following exercise.

The study seeks to offer fresh perspectives on the efficacy of selenium in lessening muscle damage, facilitating recovery, and improving exercise performance. By delving into selenium's impact on inflammation and recovery, the study fills a gap in existing literature and provides evidence-based recommendations for athletes and individuals seeking to enhance recovery and mitigate inflammation-related performance effects. Understanding the impact of supplementation on post-exercise inflammation is vital for enhancing recovery and performance in athletes.

The study aimed to explore the physiological effects of 21 days of selenium supplementation on IL-6 and CRP as indicators of inflammation triggered by high-intensity exercise. Through investigating various supplementation approaches, the study sought to shed light on the potential of

selenium supplementation in reducing muscle damage, expediting recovery, and optimizing performance. Ultimately, this research contributes to a deeper understanding of how supplementation can be utilized to manage inflammation in athletes and active individuals.

## MATERIALS AND METHODS

### *Subjects*

This study was a randomized, double-blind, placebo-controlled experiment. Thirty-six healthy, non-smoking recreational male students from the Sports Science Department at Universitas Negeri Surabaya were randomly and double-blindly assigned to either a selenium supplementation

group (n=18) or a placebo group (n=18). Participants were selected based on specific criteria, excluding those currently undergoing drug treatment, using chemical drugs, or taking any supplements. Both group was low risk of bias.

All participants were required to have had no intense exercise in the past month and no prior pain or discomfort. They were also instructed to refrain from taking any medication or undergoing any therapy during the study period. Furthermore, participants were directed to avoid any strenuous physical activities not only during the 4-week study period, but also for 48 hours after the experiment, to ensure a consistent and controlled environment.

Before the study began, the research team ensured that all participants had identical physical measurements across the groups. The team then explained the study's goals and procedures to the participants, who provided their informed consent. Prior to joining the study, participants were asked to confirm they had no pain or injuries by completing the Physical Activity Readiness Questionnaire (PAR-Q). To complete the questionnaire, participants were accompanied by a fitness expert from the Faculty of Sports and Health Sciences while completing the questionnaire, which consists of seven questions that cover medical history, symptoms, and physical limitations.

This study adhered to ethical guidelines and was granted permission by the Health Research Ethics Committee of the Faculty of Public Health at Airlangga University, and was deemed acceptable with a specific identification number: 104/EA/KEPK/2023.

### *Experimental Procedures*

The study lasted for a month and began with an initial visit to gather baseline information. Participants in both the Selenium group and the Placebo group recorded their initial data, including body weight, height, fat percentage, physical activity level, and VO2Max, to ensure that the groups were similar at the start. To measure VO2Max, we used the Multistage Fitness Test (MFT). Before starting the study, all participants provided informed consent after being fully informed about the study's objectives and procedures.

Within this study, the Selenium group (n=18) was administered capsules, each containing 200µg of selenium capsules (commercially available products), and the Placebo group (n=18) received placebo capsules containing 100mg of corn starch. Both groups consumed one capsule per day after breakfast for a 21-day period.

Following a 21-day supplementation period, on the 22nd day, Participants performed a Drop Jump (DJ) exercise protocol that has been proven to induce muscle damage. Before the protocol, participants were instructed on the proper technique to ensure correct form and maximum effort. The exercise protocol consisted of five sets of 20 maximal drop jumps from a height of 60 cm with a 10-second interval between jumps and a 2-minute rest between sets. This protocol has been shown to cause significant muscle damage in previous studies (Kirby et al., 2012).The timeline of this present study showed in figure 1.

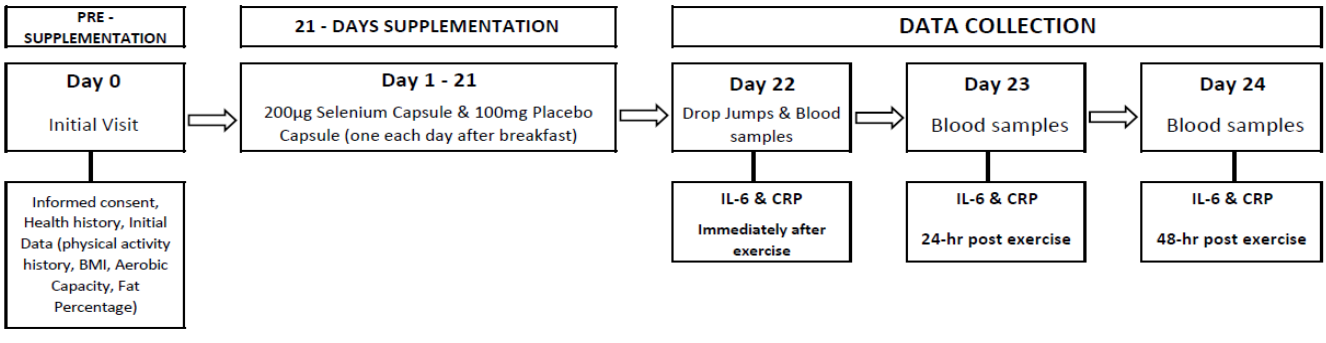

***Figure 1.*** Timeline of the study

***Data Collection Tools***

***Assessment of IL-6***

IL-6 in the blood was obtained through the cubital vein, collecting up to 10 cc and placing it into an SST (Serum Separator Tube). Subsequently, the tube containing frozen blood was centrifuged for 15 minutes to separate the plasma from the blood. The plasma formed in the tube was then transferred into several polypropylene tubes, which were closed and labeled. Plasma IL-6 levels were measured using the ELISA method (Ruhee et al., 2020).

ELISA stands for Enzyme-Linked Immunosorbent Assay, a common technique used to detect and quantify specific proteins, antibodies, or other substances in a sample. In this case, the ELISA IL-6 method was likely used to measure the plasma levels of IL-6 in the blood. A commercially available ELISA kit (brand Finetest EH0205) was used for this purpose.

***Assessment of C-Reactive Protein (C-RP)***

Plasma Level of C-RP was measured using High-Sensitivity C-Reactive Protein (Hs-CRP) method (Boukhris et al., 2020). High-sensitivity CRP (Hs-CRP) is a specific type of CRP that is sensitive enough to detect even small increases in CRP levels. A commercially available Hs-CRP Assay (brand Abbexa) was used for this purpose. .

***Statistical Analysis***

Data collected was processed both manually and digitally to convert it into information. A one-way repeated measures (immediately, 24, and 48 hours after exercise) ANOVA was used to analyze the data statistically focusing on subject characteristics. The normality test utilized was the Kolmogorov–Smirnov test. The Mann–Whitney U-test was applied for non-normally distributed data, while the independent t-test was used for normally distributed data. The significance level can be written as $p < 0.005$.

## RESULTS

***Subjects***

A total of 36 recreational male students of the Sports Science Department, Universitas Negeri Surabaya students, with an average age of 19.56 years (±0.89) and a mean BMI of 20.93 (±1.14), participated in this study. All participants willingly agreed to become respondents, providing informed consent. The participants were then randomly divided into two groups, Selenium group and Placebo group.

The study examined the characteristics of the participants in the Selenium group (n=18) and the participants in the Placebo group (n=18). The average age of the Selenium group was 19.69 years, while the average age of the Placebo group was 19.44 years. This study also analyzed other characteristics, such as height, weight, BMI, body fat percentage, physical activity level, and aerobic capacity, to ensure that the two groups were normally distributed and homogeneous. The results indicated that the differences between the groups have p-values greater than 0.05 ($p > 0.05$), which means that the data is normally distributed. The Subject characteristics of both groups (Selenium group and Placebo group) are shown in Table 1.

**Table 1.** Subject characteristic

| | Subject Characteristic | | |
|---|---|---|---|
| | Selenium (M ± SD) | Placebo (M ± SD) | *P-values* |
| Age (years) | 19.11 ± 0.68 | 19.21 ± 0.76 | 0.673 |
| Height (cm) | 166.72 ± 4.10 | 166.42 ± 3.22 | 0.273 |
| Weight (kg) | 62.44 ± 3.54 | 62.67 ± 3.75 | 0.404 |
| BMI (kg/m3) | 22.45 ± 0.70 | 21.18 ± 1.14 | 0.586 |
| Body Fat (%) | 12.44 ± 1.22 | 12.26 ± 0.88 | 0.185 |
| Physical Activity Level (MET) | 1332.26 ± 242.18 | 1292.48 ± 228.42 | 0.654 |
| Maximum Oxygen Intake (mL/( kg·min)) | 36.75 ± 4.54 | 33.82 ± 5.52 | 0.112 |

***Interleukin 6 (IL-6)***

High-intensity exercise increased plasma IL-6 concentrations. Repeated-measures tests showed that plasma IL-6 concentrations increased significantly ($P < 0.05$) at baseline (immediately after exercise) in both groups. The increase in plasma IL-6 concentrations immediately after exercise was followed by a significant decrease at 24 and 48 hours ($P < 0.05$) in both groups as the recovery period progressed. However, although all post-exercise assessments showed decreased plasma IL-6 concentrations in both Selenium ($P < 0.024$) and PLA ($P < 0.001$) compared to baseline, it was observed that Selenium decreased plasma IL-6 concentrations more than PLA at 24 and 48 hours post-exercise ($P < 0.020$). Changes in plasma IL-6 concentrations at baseline, 24 hours, and 48 hours can be seen in Figure 2.

***C-Reactive Protein (CRP)***

High-intensity exercise causes a significant increase in plasma CRP concentration immediately after exercise, followed by a decrease in plasma CRP concentration over the next 24 and 48 hours during the recovery periods. In both groups, the initial increase in CRP was statistically significant ($P < 0.05$). However, the rate of decline in plasma CRP concentration was faster in the Selenium group compared to the Placebo group. In fact, the difference between the two groups was statistically significant at 24 and 48 hours post-exercise ($P < 0.05$). This is shown in Figure 3, which plots the changes in plasma CRP concentration levels over time.

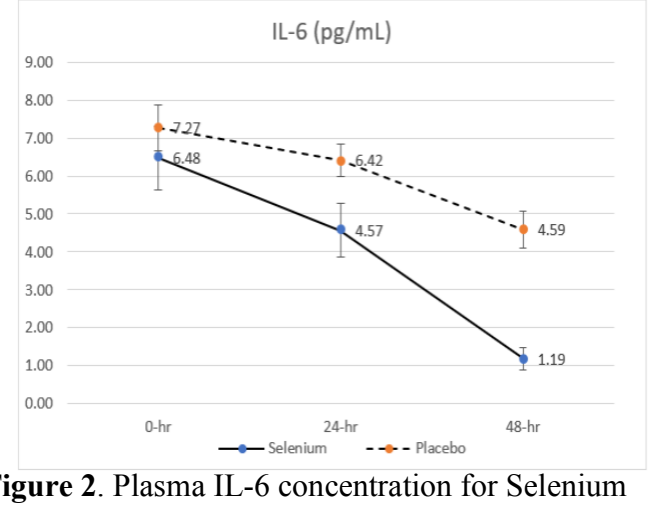


**Figure 2**. Plasma IL-6 concentration for Selenium group and Placebo group subjects across time

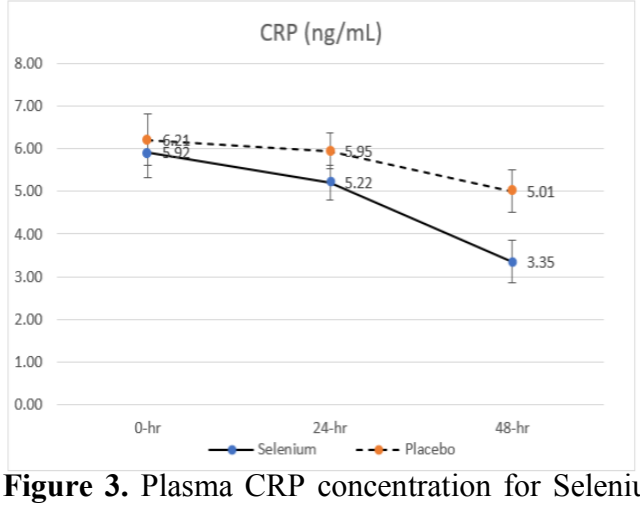


**Figure 3.** Plasma CRP concentration for Selenium group and Placebo group subjects across time

**Table 2.** Time after exercise, in hours

| | Groups | 0-hr (M ± SD) | 24-hr (M ± SD) | 48-hr (M ± SD) | P Value |
|---|---|---|---|---|---|
| Interleukin 6 (IL-6) | Selenium | 6.48 ± 0.84 | 4.57 ± 0.70 | 1.19 ± 0.29 | 0.000 |
| | Placebo | 7.27 ± 0.60 | 6.42 ± 0.42 | 4.59 ± 0.49 | |
| C-Reactive Protein (CRP) | Selenium | 5.92 ± 0.61 | 5.22 ± 0.59 | 3.35 ± 0.49 | 0.006 |
| | Placebo | 6.21 ± 0.30 | 5.95 ± 0.40 | 5.01 ± 0.49 | |

## DISCUSSION

During high-intensity exercise, Interleukin 6 (IL-6) is produced and released from contracting muscles into the circulation (Villar-Fincheira et al., 2021), reaching peak circulating concentrations immediately after completion of high-intensity exercise, then rapidly decreasing with recovery to baseline concentration (Islam et al., 2024). However, if the exercise is accompanied by muscle damage, immune cells infiltrate the muscle and

release IL-6 to signal the acute-phase response and tissue repair (Philippou et al., 2021).

High-intensity exercise with inadequate recovery may result in an increase in cytokines, especially IL-6 and CRP, as an inflammatory response in circulation, leading to detrimental physiological effects such as increased muscle damage and decreased nutrient absorption (Takami et al., 2024). It may also interfere with the body's normal ability to adapt to exercise, making it more difficult to recover and train effectively (Peake, 2019). The primary objective of this study was to investigate the physiological effects of 3 weeks of selenium supplementation on the inflammatory response, specifically Interleukin 6 (IL-6) and C-Reactive Protein (CRP) as markers of inflammation after high-intensity exercise.

IL-6 is an important inflammatory marker that plays a critical role in the body's response to exercise-induced muscle damage and inflammation. The mechanical damage to a muscle fiber appears to trigger an inflammatory response, which is not limited to the damaged muscle but also extends to the entire body (Stožer et al., 2020).

The results of this study indicated that there were increased levels of IL-6 and CRP in both groups (Selenium group and Placebo group) immediately after exercise as a baseline, followed by decreases at 24 hours and 48 hours after exercise as part of the recovery process (figure 2 and figure 3). The main finding of this study was that the selenium-supplemented group had a significantly greater reduction in plasma IL-6 and CRP compared to the Placebo group ($p<0.05$). This means that daily supplementation of selenium for 3 weeks (21-days) can reduce the risk of inflammatory response following high-intensity exercise.

High-intensity exercise may trigger an increase in IL-6 levels, possibly due to the generation of free radicals during exercise (Pal et al., 2014). These free radicals, also known as reactive oxygen species (ROS), play a role in cell signaling and affect various cellular processes. Excessive ROS levels due to high-intensity exercise can stimulate increased plasma IL-6 levels, resulting in damage to biomolecules such as lipids, proteins, and nucleic acids. This can potentially cause cell damage through increased skeletal muscle IL-6 expression (Jakubczyk et al., 2020). The body's antioxidant system helps counteract the oxidative stress caused by the overproduction of ROS during intense exercise (Di Meo et al., 2019).

Increased oxidative stress, which triggers the production of Reactive Oxygen Species (ROS) during exercise. ROS are general mediators of signal transduction pathways and have the ability to induce cytokine production from various cell types (Aguiar et al., 2020; Dos Reis et al., 2023). In this case, researchers have focused their research on administering antioxidant supplements before high-intensity exercise in an effort to enhance antioxidant and anti-inflammatory properties, reducing factors that contribute to the exercise-induced inflammatory response. Among the supplements studied are vitamin C (Righi et al., 2020), vitamin E (Martínez-Ferrán et al., 2022), BCAA (Greer et al., 2007), curcumin (Rahmat et al., 2021), and Vitamin D (Żebrowska et al., 2020).

Therefore, they identified the release of reactive oxygen species (ROS) due to oxidative stress as a significant stimulus for exercise-induced cytokine production. Their study aimed to determine whether implementing specific measures could reduce the severity of muscle injury and inflammation that occurs as a result of the exercise-induced inflammatory response.

Selenium (Se) is an essential trace element that plays key roles in antioxidant and immune systems (Mal'tseva et al., 2022). It is a crucial component of selenoproteins, involved in redox catalysis, structure, and transportation. Selenium functions include antioxidant defense, thyroid hormone synthesis, testosterone metabolism, DNA integrity maintenance, vitamin E modulation, cancer prevention, and muscle performance enhancement (Bryan et al., 2023).

Multiple studies have shown that Selenium supplementation boosts the activity of plasma Glutathione Peroxidase (GPx), a potent antioxidant enzyme that relies on Selenium. This suggests that the relationship between GPx and Selenium is crucial for antioxidant defense against Reactive Oxygen Species (ROS) (Bjørklund et al., 2022). The interplay between ROS generation during exercise and Selenium's antioxidant protection may play a significant role in enhancing exercise performance.

Furthermore, the present study showed that 3 weeks selenium supplementation reduced the increase in IL-6 and CRP plasma concentrations in the blood. This suggests that selenium supplementation can help alleviate muscle damage caused by high-intensity exercise. The decrease in IL-6 and CRP plasma concentrations was attributed

to selenium's ability to restrain the NF-kappa B pathway (Wang et al., 2022). NF-kappa B is a protein that regulates inflammation, and when it's active, it increases the production of inflammatory markers like IL-6 and CRP (Maehira et al., 2003).

Selenium supplementation re duced the activity of NF-kappa B, which in turn decreased the production of these inflammatory markers. Selenium also reduced nitric oxide (NO) production by regulating the expression of nitric oxide synthase (NOS) and inducible NOS (iNOS) genes (Jomova et al., 2023). NO is a molecule that can contribute to oxidative stress and inflammation, so reducing its production may have contributed to the anti-inflammatory effects of selenium supplementation.

**Conclussion**

In conclusion, Selenium supplementation may help reduce the rise in IL-6 and CRP plasma concentration levels induced by intense exercise by enhancing the activity of the Se-dependent enzyme GPx. This suggests that Selenium supplementation could boost antioxidant capacity in active individuals.

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**Conflict of Interest**

All authors have no conflicts of interest regarding this article. This research was funded by Directorate of Research, Technology And Community Service, Ministry of Education, Culture, Research And Technology of Indonesia 2022.

**Ethics Statement**

This study was conducted in accordance with ethical guidelines and was approved by the Health Research Ethics Committee at the Faculty of Public Health, Airlangga University, with the reference number: 104/EA/KEPK/2023.

Participants were fully informed and gave their consent, which included details about the research, potential risks, benefits, confidentiality, and their rights. The research strictly adhered to the principles of the Declaration of Helsinki, prioritizing the rights and well-being of participants in all aspects of the study, from design to implementation.

**Author Contribution**

Study design, RJI and TM; Data Collection, RJI, PAN and NR; Statistical analysis, TrM and SRN; Data iterpretation, TM, TrM, NR,; Literature search, RJI, SRN, NR, and PAN. All authors have read and approved the published version of the manuscript

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RESEARCH ARTICLE

# Differences in V̇O2 max Readings Between Treadmill and Cosmed K5 for Elite Boxers

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**Abstract**

**Purpose of the study:** The purpose of this study was to analyze the effectiveness of the accurate and best method for assessment of $VO_2$ max in both treadmill and Cosmed K5 data. **Method:** The subjects of this study included 20 competitive male senior boxers mean 22.81 (SD = 3.59) years, height 178.83 (SD = 8.56) cm, body mass 78.28 (SD = 12.54) kg, and body mass index BMI 24.43 (SD = 3.45) kg/m$^2$, with a range of 17.5 years and respective variances. Boxers have 5-10 years of competitive experience. Analyzing the data, descriptive statistical methods, descriptive statistical indicators, paired samples t-tests, independent samples t-tests analyses, and effect size calculations (Cohen's d) were used, with a significance level of $p < 0.05$. **Findings:** The results showed that there was a statistically significant increase of $VO_2$ max. from pre- to post-training measurement ($p < 0.01$), respectively, in both treadmill and Cosmed K5. The $VO_2$ max values with the treadmill were higher compared to those of the Cosmed K5 method; the absolute change value of 13.4% with K5 measurements was greater compared with the absolute change of 8% for the treadmill. **Conclusion:** The main findings of this study are that improvements of $VO_2$ max values with Treadmill in $VO_2$ max are slightly greater than those reported with the Cosmed K5 method. The results of this study serve to change the concept that applying a special training program, such as HIIT, these exercises can improve performance levels of aerobic capacity and oxygen uptake.

**Keywords**
Interval Training, V̇O$_2$ max, Boxing

## INTRODUCTION

Physical exercise is recognized as an important tool in increasing the energetic cost, which is estimated by measuring oxygen uptake (Vianna et al., 2011). Regular exercise is well known to improve health and reduce a number of risk factors for chronic disease (Myers et al., 2015). Boxing is a sports branch which requires dynamic and static features (Evrim et al., 2019), and as such it serves as a basic for biomechanical analysis and it is closely related to high levels of kinetic variables development, which is distinguished from other types of sporting activities. Implementation of the sport of boxing takes several elements of main conditions, namely anaerobic endurance, strength, speed, accuracy, mental elements that include courage and tenacity (Akhmad et al., 2021), as well as the cardiovascular endurance, muscle strength, flexibility, power, balance, coordination and response time. Training status has recently been identified as an important factor for the development of strength during concurrent training, especially when resistance and aerobic training are performed within the same session (Petre et al., 2023).

Resistance training (RT) is a potent stimulus to the neuromuscular system, for muscle

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hypertrophy and strength gain (Ozaki et al., 2013), which is known to have positive effects on health (Paoli et al., 2017), High Intensity Interval Training (HIIT) is a sustainable and effective method for improving Cardiorespiratory Fitness (CRF), which is proven to produce equal or greater improvements in CRF when compared to other training exercises. (Martin-Smith et al., 2020).The training process should take advantage character loads pronounced aqnaerobik physiological during which prevailing energy processes anaerobic against those aerobic (process anaerobic alaktik, at 10%, anaerbik process lactic glikolitik, 60% and aerobic process, to the extent 30%), (Bushati, 2020). High-intensity interval training (HIIT) may be a feasible and efficacious strategy for improving health-related fitness in young people (Costigan et al., 2015).

The combination of exercise training modalities improves body composition and cardiovascular fitness (Ho et al., 2012; Shaw & Shaw, 2009). The $VO_2$ max in response to interval training (IT) or combined IT and continuous training (CT) is reported in many studies, and it is well accepted that the increases in $VO_2$ max with training are due to increases in cardiac output and peripheral oxygen extraction (Bacon et al., 2013). Cardiorespiratory endurance has long been recognized as one of the fundamental components of physical fitness (Kukeli & Skënderi, 2018). A study had suggested that a circuit -based whole-body aerobic resistance training program can elicit a greater cardiorespiratory response and similar muscular strength gains with less time commitment compared with a traditional resistance training program combined with aerobic exercise (Myers et al., 2015).

Endurance exercise is classically performed against a relatively low load over a long duration, whereas strength exercise is performed against a relatively high load for a short duration (Hughes et al., 2018). Endurance training leads to adaptations in both the cardiovascular and musculoskeletal system that supports an overall increase in exercise capacity and performance (Brooks, 2012). There are two types of endurance. Aerobic endurance is one of the basic physical skills in terms of sports performance as well as health in athletes. In aerobic endurance the athlete always performs the activity in the presence of oxygen. In anaerobic endurance the activity is fast, dynamic and of short duration, so it is more specific to team sports and martial arts, while the aerobic endurance is more specific to long-duration sports. Most athletes need a good aerobic base before focusing on anaerobic endurance, typical for their sport (Bompa & Carrera, 2015). Exercise with intensity close to maximal oxygen consumption ($VO_2$ max) represents the best stimulus to develop aerobic capacity (Delextrat & Martinez, 2014). Circuit training is a more effective option for improving aerobic endurance in Bina Darma futsal players. Choosing the right type of sport can increase the aerobic endurance ( Satria et al., 2024).

The level of endurance depends on the effectiveness of the cardiorespiratory system, the indicator of which is expressed as the maximal oxygen intake ($VO_2$ max), or maximal aerobic capacity, which is the maximum capacity of an individual's body to transport through circulatory system and use of oxygen in motor muscles (Habibi et al., 2014). The aerobic capacity is measured through direct and indirect methods. Direct methods include using treadmill, ergometer and Cosmed K5 which are more accurate and expensive, whilst the indirect method include the formulas and heart rate (HR) variable. $VO_2$ max is the body's ability to consume oxygen maximally during activity and training and it is calculated in ml/kg/min using specific laboratory tests (Ridho et al., 2020). Increasing $VO_2$ max will improve player performance in matches (Russell et al., 2016), and they who have large $VO_2$ max have the supply and creation of energy to move without limits, have a recovery period that is very fast so that athletes can work long hours without experiencing significant fatigue, and high $VO_2$ max and skills are needed to complete at the international level (Ridho et al., 2020).

Some authors concluded that the general metabolism is mainly aerobic (average of 85%), emphasizing the importance and considering the level of aerobic fitness in boxing as a determinant of performance, and although Olympic boxing is a full contact combat sport, the results of these studies were important and represented a first step that should be reinforced by future studies (Arseneau, et al., 2011; Thomson et al., 2020). In order to obtain the most accurate measurements, foreign authors have measured oxygen consumption in the conditions of a boxing match, although it remains difficult to perform due to the presence of the mask which must be worn on the face during the match. In these studies the authors attempted to challenge this problem by directly measuring oxygen

consumption during a semi-contact boxing match. The aim of this study is to analyse the effectiveness of the accurate and best method for measurement of $VO_2$ max in both treadmill and Cosmed K5, performed with Interval training method.

## MATERIALS AND METHODS

### *Participants*

The subjects of this study included 20 competitive male senior boxers mean 22.81 (SD= 3.59) years, height 178.83 (SD = 8.56) cm; body mass 78.28 (SD = 12.54) kg and body mass index BMI 24.43 (SD = 3.45) kg/m$^2$, with a range of 17.5 years and respective variances, as shown in table 1. Boxers have from 5-10 years competitive experience. All participants were amateur boxers competing according to the standards of the Association Internationale de Boxe Amateur (AIBA) and they were among the best of their categories in the competition analyzed. From the category of seniors, the bronze medalist in the world, 2 Balkan championships and the national championship were included.

### *Ethics statement*

This research has met ethical rules. Research ethical approval was obtained from the UST Ethics Committee for Scientific Research with project number 978/2, approved date 14/05/2024. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

### *Instrument*

The study was performed in Physiologi Laboratory of Sports University of Tirana and all data were recorded in its licensed equipment's. Theo main apparatuses utilized for studying endurance performance were: a physician beam scale, Height body was measured using "Health o Meter" Professional, Model 500KL-BT;ISO 13485:2016; Pelstar, LLC, USA. Aparatur Tanita Body Compositon Monitor BF511. Aparatur Treadmill T200M COSMED aparatur Cosmed K5. The standard Treadmill & Cosmed K5 testing protocol were used to collect the data and the spss program was used.

### *Procedure*

### *Treadmill*

Initially the boxers will warm up in the gym normally like any training session for 30-35 min then they will go to the laboratory and start testing on the Treadmill track, in the first 3 minutes they will walk at 8 km·h$^{-1}$ and incline 0%. Thereafter, speed will increase by 2.5% in ascent km·h$^{-1}$ every 2 minutes until exhaustion (Vianna et al., 2011). The objective is to determine $\dot{V}O_2$ max, HRmax, of boxers. The temperature and relative humidity of the environment in the laboratory where the test will take place will be around 21°C, the same as in the first test carried out in the gym. After completing both phases of testing at the beginning of the study and at the end of the study, a comparison of the results will be made between the $\dot{V}O_2$ max test performed through simulated boxing 3 x 3 min performed in the gym under competition conditions with the Fitmat Pro device and the test of $\dot{V}O_2$ max performed in laboratories with Treadmill equipment according to Astrand's protocol.

### *Cosmed K5*

Both study groups will undergo testing and it will be carried out in two phases at the beginning of the study and at the end of the study. The tests will be done on different days where the V̇O2 max will be measured first through the Cosmed K5 device. The testing will be carried out during a training session where the athletes will first start with the warm-up that they do every day in training for about 30-35 min. Then the mask will be placed which is connected to the fitmate pro device and the test will begin with 3 rounds of 3 minutes each with a 1 minute break between rounds, the same as in match conditions. Upon giving the command, the boxer will start the semi-contact simulated boxing, working with the commands given by the trainer by holding the paddles, at rest, the boxer will sit the same way as during a boxing match. The temperature and relative humidity of the environment in the gym where you want to take place the test will be around 18-23°C.

### *Training*

### *First test*

The training programs lasted 12 weeks and involved 3 weekly RT sessions. After all testing procedures were completed, subjects were randomly assigned to two groups: control group (n = 10) exercised with only with TRT exercises and experimental group (n = 10) with only HIRT program, as shown in Table 1. The procedure in this

study consisted of three phases: the first phase, initial. Both groups training period involved three workout days/or session per week. In this phase, the pretest data of biomechanical variables for both groups experimental and control group were collected, with the hypotheses that the pretest data of the two groups data didn't have a significant difference on average values.

***Training Methods***

The experimental group implements the Continuous Method where the physical-motor action is applied non-stop, in long periods of time and at a relatively low speed. This method was developed through running in several ways, depending on the discipline of boxing:

Slow running mode; where the training unit lasted 45-50 min and pulse/min at 145-150.

Mode with medium pace; where the training unit lasted 30-40 min and heart rate/min at 155-160.

Fast-paced mode; where the training unit lasts 20-30 min and pulse/min at 160-165.

The Fartlek method was implemented with running segments, with variable distances and speeds, according to the boxer's condition and desire. It was organized mainly in two ways, according to boxing requirements:

With great extension; from 50-60 min; with pulse 140-150 rr/min

With mese extension; from 30-40 min., with a pulse of 160-170 rr/min

Mountain training; it was organized as a specific process of preparation for endurance in certain deadlines and in special environments, at high altitudes above sea level. Experience has shown that this training method promotes the "hypoxia" process, which is associated with the increase of red blood cells and blood hemoglobin and, therefore, improves the metabolic and functional aerobic activity of the boxer's organism. The control group performed treadmill exercise.

***Past –Test***

Following two distinct training approaches (HIRT program group experimental and TRT exercises group control), the data post-test for both groups was gathered and subjected to spss statistical techniques.

***Statistical Analysis***

Sample characteristics were analyzed applying descriptive statistics to the data using the IBM SPSS Statistics version 29.0.2.0. Analyzing the data descriptive statistical methods, descriptive statistical indicators, paired samples t-test and independent samples t-tests analyses were used. Mean values and their respective standard deviations were calculated for numerical variables. The data analysis techniques include: the normality Kolmogorov-Smirnov test, to determine whether the data has a normal distribution, and the Levenie's test for the homogeneity of variation. Shapiro Wilks test was used to test the normality of distributions for the measured variables, which corresponded to a normal distribution ($p > 0.05$). The distribution of data variance between the two post-test in both measurements methods was found homogenous, based on the Levenie's test result, which showed a significance value of $p > 0.05$. Paired samples t-test was conducted to determine whether there was a variable difference between VO2 max in the data taken in each method from pre-test and post-test measurements, whilst the independent samples t-test was used to compare the difference of the $VO_2$ max variable between two post-test measurements in treadmill and Cosmed K5 for the same boxers. Effect size calculations (Cohen's d) were used to determine the meaningful of the observed differences, with a significance level of 5% ($p < 0.05$).

## RESULTS

The study was completed on 20 male elite boxers of Albanian national team. Table 1 gives the descriptive statistics of the results which have been reported in pre and post mean values ± SD. Mean values for their physical characteristics were: age: 22.81 ± 5.59 years; height 178.83 ±8.56 cm; weight 78.28 ±12.54 kg; and body mass index (BMI): 24.43± 3.41 kg/m$^2$.

The results show that there was a statistical significance increase of $VO_2$ max. from pre- to post-training measurement ($p < 0.01$) respectively, in both treadmill and Cosmed K5. The aim of this study was to analyse the effectiveness of the accurate and best method for assessment of $VO_2$ max in both treadmill and Cosmed K5 in the data taken from pre-test and post-test measurements. Table 1 shows the anthropometric and $VO_2$ max variable statistics, range and variances of all variables. It is noticed that there are variances in mean for both groups. As it is noticed by the results, the mean values $VO_2$ max are lower for the Cosmed K5 compared with the treadmill measurements.

**Table 1.** Descriptive statistics of anthropometric and $VO_2$max variable

| Variable | Range | Min. value | Max. value | Mean value | Mean SD | SD value | Variance |
|---|---|---|---|---|---|---|---|
| Age (years) | 17.50 | 18.00 | 35.50 | 22.8133 | 1.44347 | 5.59054 | 31.254 |
| Height (cm) | 22.0 | 170.00 | 192.00 | 178.831 | 2.1542 | 8.5693 | 14.782 |
| Weight (kg) | 39.50 | 62.50 | 102.00 | 78.2867 | 3.23980 | 12.54767 | 157.44 |
| BMI | 11.40 | 19.70 | 31.10 | 24.4333 | .89302 | 3.45867 | 11.962 |
| VO2.T1 | 18.90 | 42.50 | 61.40 | 54.9667 | 1.42300 | 5.51124 | 30.374 |
| VO2.T2 | 22.30 | 51.70 | 74.00 | 59.7467 | 1.36235 | 5.27634 | 27.840 |
| VO2.Cos.1 | 22.60 | 30.80 | 53.40 | 47.1600 | 1.58195 | 6.12685 | 37.538 |
| VO2.Cos.2 | 11.30 | 49.00 | 60.30 | 54.5133 | .99608 | 3.85781 | 14.883 |

Table 2 gives the descriptive statistics of both methods, in terms of mean values, including min and max values, as well as the mean difference between pre-test and post-test measurements. The difference of $VO_2$ max in both tests, treadmill and Cosmed K5 is increased after interval training method. The measures of Treadmill showed a difference of 4.78 mlmol/kg/min, between pre-test and post-test mean, while the value of $VO_2$ max in Cosmed K5 measurements was increased more compared to those of treadmill, with a value of 7.35 mlmol/kg/min for the pre-test and post-test mean difference. The post-test mean difference between two methods of measurements gives a value of 5.23 mil/mol. The interval training method that was used by the experimental group and the routine training that was developed by the control group.

**Table 2.** Descriptive statistics of VO2 treadmill & cosmed K5 measurements

| Variable | Data | Treadmill | | | | Pre-test-post-test mean difference | Post-test mean difference |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Mean | SD | | |
| $VO_2$ max. (mlmol/kg/min) | Pre-test | 42.50 | 61.40 | 54.9667 | 5.51 | 4.78 | 5.23 |
| | Post-test | 51.70 | 74.00 | 59.7467 | 5.27 | | |
| | COSMED K5 | | | | | | |
| | Pre-test | 30.80 | 53.40 | 47.1600 | 6.12 | 7.35 | |
| | Post-test | 49.00 | 60.30 | 54.5133 | 3.85 | | |

The paired samples t-test and independent samples t-test are analysed for tests. The paired samples t-test in the table 3 has identified the differences in pre-test and post-test data, showing that p-value ($p < 0.001$) is related with a significant difference between them.

**Table 3.** Paired samples t-test for pre-test & post-test for treadmill & cosmed K5 measurements

| Pairs of Variable VO2 | Pre-test-Post-test | Paired differences | | | | | t-value | df | Sig. 2-tailed p-value |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Std. error mean | 95% Confidence Lower | 95% Confidence Upper | | | |
| Pair1 VO2.T1-VO2.T2 | Treadmill | -4.78000 | 3.03508 | .78365 | -6.46077 | -3.09923 | -6.100 | 18 | <.001 |
| Pair1 VO2.Cos.1-VO2.Cos.2 | Cosmed K5 | -7.35333 | 3.75516 | .96958 | -9.43287 | -5.27379 | -7.584 | 18 | <.001 |

Table 4 gives the paired Samples effects size, which is estimated using the denominator and expressed in terms of Cohen's d coefficient with the Hedges' correction.

**Table 4.** Paired samples effect sizes

| Paired Samples Effect Sizes | | | | | |
|---|---|---|---|---|---|
| Pair of variables | Coefficients | Standardizer[a] | Point Estimate | 95% Confidence Interval Lower | 95% Confidence Interval Upper |
| Pair 1: VO2.T1 - VO2.T2 | Cohen's d | 3.03508 | -1.575 | -2.331 | -.795 |
| | Hedges' correction | 3.21075 | -1.489 | -2.203 | -.751 |
| Pair 2: VO2.Cos.1 - VO2.Cos.2 | Cohen's d | 3.75516 | -1.958 | -2.825 | -1.068 |
| | Hedges' correction | 3.97251 | -1.851 | -2.670 | -1.010 |

Table 5 gives the independent samples t-test for the post-test data for both $VO_2$ max treadmill and K5 measurements.The results show that there is a significant difference between the post-test data of the experimental group and control group.

**Table 5.** Independent samples t-test for the post-test data of the treadmill and cosmed K5 measurements

| Variable | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | t-value | df | p-value | | Mean Difference | Std. Error difference | 95% Confidence | |
| | | F | Sig. | | | | | | | Lower | Upper |
| $VO_2$ Max. | Equal variances assumed | .256 | .617 | 3.101 | 18 | .002 | .004 | 5.2333 | 1.6876 | 1.7763 | 8.6903 |
| | Equal variances not assumed | | | 3.101 | 25.641 | .002 | .005 | 5.2333 | 1.6876 | 1.7619 | 8.7047 |

Table 6 gives the Independent Samples effects sizes, which is estimated using the denominator and expressed in terms of Cohen's d coeeficient with the Heges' and Glass's corrections.

**Table 6.** Independent samples t-test effect sizes for the post-test data of the treadmill and cosmed K5 measurements

| Independent Samples Effect Sizes | | | | | |
|---|---|---|---|---|---|
| Variable | Coefficients | | | 95% Confidence Interval | |
| | | Standardizer[a] | Point Estimate | Lower | Upper |
| $VO_2$ max. | Cohen's d | 4.62182 | 1.132 | .349 | 1.898 |
| | Hedges' correction | 4.75041 | 1.102 | .340 | 1.846 |
| | Glass's delta | 3.85781 | 1.357 | .469 | 2.212 |

The difference of $VO_2$ max after training program between Treadmill and Cosmed K5 measurement was a value of 5.23 mil/mol, which shows that training program was proven to increase the physiological variable of $VO_2$ max in this study.

## DISCUSSION

The present study was undertaken to analyse the effectiveness of the best and correct method for assessment of VO2 max in both treadmill and Cosmed K5, performed with interval method training program, for improving Vo2 max in elite female boxers. The t-test SPSS analysis was used to compare the pre-test – post-test data statistically for changes from initial to final tests for each method applied for the estimation of $VO_2$ max variable. Based on the results of this study, the value of $VO_2$ max in methods (treadmill and Cosmed K5) was statistically increased after a 12 week HIIT program. After this training program $VO_2$ max variable for treadmill measurements was increased respectively by a value of 4.78 mlmol/kg/min. Meanwhile the $VO_2$ value for the Cosmed K5 measurements was increased by a value of 7.35 mlmol/kg/min. The difference in mean values for $VO_2$ values from the post-test data of the two methods showed a significant value of $VO_2$ by 5.23 mlmol/kg/min.

The paired samples t-test for pre-test & post-test for treadmill point out these results: t(38) = -6.100; p <.001, statistically significant and for the Cosmed K5 measurements the results are respectively: t(38) = -7.584; p <.001, statistically significant. For the paired Samples t-test, the effects size is a measure of how large this effect was and it standardizes the mean difference. It was estimated using the denominator and expressed in terms of Cohen's d coefficient. The results of the pre- to post-test measurements for the treadmill, gives the Cohen's d value, which uses the sample standard deviation of the mean difference, whilst the Hedges' correction uses the sample standard deviation of the mean difference -1.489, and a correction factor of 3.21075. The Cohen's d = -1.575, shows that that the difference was really big

and this effect is very strong, While the results of the pre- to post-test measurements for the Cosmed K5, gives the Cohen's d = -1.958 and the Hedges' correction of 3.97251 and a correction factor of -1.851. In the second case, the Cohen's value of d = -1.958 shows that this efefct was extremely strong, and as a consequence more powerful that in the treadmill measurements. This conlusion can be supported by expressing the changes of the mean differences as a percentage. So, the increased value of 4.78 mlmol/kg/min for pre to post-test mesurements for treadmill was about 8%, while the increased value of 7.35 mlmol/kg/min for pre to post-test measurements for Cosmed K5 was 13.4%, with an additional difference of 5.4% more compared to treadmill.

The results taken from the Levene's test: $p = 0.617 > 0.05$ shows that it is not significant, which means that the equal variances assumed for both two tests in Treadmill and Cosmed measurements. The results reported from the Independent samples t-test for the post-test data of the treadmill and Cosmed K5 measurements, showed that the mean value of the $VO_2$ max of treadmill measurements was 59.74 (SD = 5.51) and that of Cosmed K5 measurements was 54.51 (SD = 3.85). This difference was statistically significant, $t(38) = 3.101$; $p < 0.05$.

The effect size for the independent simples t-test for the post-test data for both methods is estimated using the denominator, but in this test, The Cohen's d coefficient uses the pooled standard deviation. The Hedges correction uses the pooled standart deviation of 1.102, and a correction factor of 4.75041, whilst the Glass's delta uses the sample standard deviation of the control with a value of 1.357, which means the second group. The Cohen's d = 1.132, shows that that the difference was really big and this effect is very strong. This result can be confirmed by the post-test mean difference between two methods of measurements with a value of 5.23 mlmol/kg/min, which can be expressed as 8.75 %.

The main findings of this study is that improvements of $VO_2$ max values with Treadmill in $VO_2$ max are slightly greater than those reported with the Cosmed K5 method. Even though the $VO_2$ max values with Treadmill are higher compared to those of the Cosmed K5 method, the absolute change value of 13.4 % with K5 measurements is greater compared with the absolute change of 8% for treadmill. This change is a consequence of the effect of training on the cardiovascular responses to maximal exercises, in which the changes that are induced by physical training, are specific to the muscles involved in that in.terval method training.

The results of this study are in a line with another study which demonstrated that the average oxygen uptaken for international athletes ranges from 55-68 ml/kg/min (Slimani, et al., 2019). A good maximal consumption of oxygen, clearly illustrates that a person's level of physical fitness also has a $VO_2$ max and good physical fitness in an athlete, can prevent or minimize the possibility of injury, and using effective training methods has a difference compared to conventional training program in improving $VO_2$ max (Ridho et al., 2020). Although the aerobic capacity varies at different workloads, there are several methods to evaluate and estimate work intensity (Habibi et al., 2014). Previous studies have reported after applying special training programs with moderate interval intensity can improve the $VO_2$ max and aerobic performance levels (Kukeli & Skënderi, 2018). A meta -analysis study has suggested that endurance exercise training studies frequently show modest changes in $VO_2$ max with training and very limited responses at some subjects, and longer intervals combined with high intensity continuous training can generate marked increases of $VO_2$ max in almost all relatively young adult (Bacon et al., 2013).

The results of this study are also consistent with those of other investigations, which have shown that high intensity training in the form of special soccer games can increase aerobic capacity ($VO_2$ max), (Seeger, 2016). The results of the present study show that HIIT program were effective in increasing $VO_2$ max.at the national elite boxers. Based on the data obtained, we believe that VO2max was substantially lower in Cosmed K5 than in treadmill method. Considering previous studies, that also indicated lower ˙VO2 values in BBB at high intensities and a superior validity of the K5 in DMC mode (Winkert et al., 2021), the authors conclude that the Cosmed K5 is the accurate and the best mode to measure VO2max in athletes, and it should be selected.

***Discation***

The results of the present study suggest that, the HIIT composed by functional training, have the most benefit form improving maximal oxygen uptake. Based on the results of this study, and their statistical significance, it was found that the value of $VO_2$ max in methods (treadmill and Cosmed K5)

was statistically increased after a 12 week HIIT program. The estimated mean change in the Vo max data, showed an increased value of 4.78 mlmol/kg/min for pre to post-test mesurements for treadmill was about 8%, compared to the increased value of 7.35 mlmol/kg/min for pre to post-test measurements for Cosmed K5 was 13.4%, with an additional difference of 5.4% more compared to treadmill.

The main findings of this study is that improvements of $VO_2$ max values with Treadmill in $VO_2$ max are slightly greater than those reported with the Cosmed K5 method. Even though the $VO_2$ max values with Treadmill are higher compared to those of the Cosmed K5 method, the absolute change value of 13.4 % with K5 measurements is greater compared with the absolute change of 8% for treadmill. The results have verified that the Cosmed K5 is very effective and it is highly recommended to use widely for the other interests group or sports disciplines that not involve maintaining stable body position, but sports that require a verygood coordination, agility and flexibility. As a conclusion, the results taken from the $VO_2$ max measurements from treadmill and Cosmed K5 methods revealed that is the accurate and the best mode to measure VO2max at athletes, and it should be selected. We hope and believe that this study will help other researches to prove and to apply Cosmed K5 as the accurate method of $VO_2$ max. measurement. In summary, this study indicates there are differences between two methods of measuring $VO_2$ max at elite boxers. These findings suggest that the Cosmed K5 method is adequate for estimation of $VO_2$ max.

***Impact of the Study***

The results of this study serve to change the concept that applying a special training program, such as HIIT, these exercises can improve performance levels of aerobic capacity and oxygen uptake. More studies are needed to investigate the validity of this method, which include other samples also in different disciplines as well as active or no active subjects. It is also it is important to involve other interests' groups as comparative groups and to evaluate this effect using regimes which allow generating the most possible physiological adaptions, so that the effectiveness of $VO_2$ max with Cosmed K5 can be confirmed.

***Study Limitations***

However, there are some limitations, which need to be validated for the future researches. These limitations include: the size of the sample used, so it is necessary to involve a wider sample size, including subjects of different ages and weights, in order to see the results over a longer period of time and to reduce comparisons between them.

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This research was unfunded. No author has any financial interest or received any financial benefit from this research.

**Conflict of interest**

We declare that the article we have written is not involved in any conflict of interest.

**Ethics Statement**

This research has met ethical rules. Research ethical approval was obtained from the UST Ethics Committee for Scientific Research with project number 978/2, approved date 14/05/2024.

**Author Contributions**

Study design, MB and AB; Data collection, MB and SB; Statistical analysis, AB and OK; Data interpretation, MB, AB and SB. Literature search, MB, SB and OK. All authors have read and approved the published version of the manuscript.

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RESEARCH ARTICLE

# Active Students are Healthier and Happier than Their Inactive Peers: of First Year Students Studying in Kuwait University: A Cross-Sectional Survey

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**Abstract**

**Purpose:** The purpose of the current study was to evaluate the impact of PA on the health and happiness of first-year students at the College of Education, Kuwait University. **Methods**: The final analysis of the cross-sectional study included 1454 male and female students. Happiness was evaluated using the Short Depression and Happiness Scale (SDHS), and PA was assessed using the International Physical Activity Questionnaire-Short Form (IPAQ-SF). Statistical analysis of the data was performed using the SPSS. Mann-Whitney U test and ANOVA test were used to compare PA levels between genders and happy and depressed groups. **Results**: Happiness was high in 83% of the students and low in 17%. PA levels were high in the students, with a median total PA among the participating students of 1810.9 MET-minutes/week. Male students were more active, with a median total score of 2402 MET-minutes/week, compared to females, with a median total score of 2312 MET-minutes/week. A significant association was observed between happiness and PA levels among the students. Statistically significant differences were found for PA and happy students ($p = 0.001$), and statistically significant differences were found for PA and depressed students ($p = 0.02$). **Conclusions**: The happiness among most first-year students was high, with a slight difference between males and females. The levels of PA among these students were high, especially among males. PA levels were significantly associated with happiness among first-year students. Thus, active students were happier and healthier than inactive students.

**Keywords**
Physical Activity, Healthier, Happier, Exercise, Education Students, Inactive, Active People

## INTRODUCTION

Physical inactivity is widespread and increasing throughout the world and is a worrying global health problem as it leads to the death of 2 million people annually (Dabrowska-Galas et al., 2013; Lohana et al., 2023; Nishanthi et al., 2024). In 2022, the WHO (World Health Organization ) confirmed that 27.5% of adults, 81% of adolescents, and 60% of the world's population do not perform daily physical activities (PA) according to the levels approved by the WHO (Lohana et al., 2023; WHO, 2022). Therefore, as a result of a sedentary lifestyle, approximately 500 million people in the world are at risk of contracting non-communicable diseases during the period from 2020 to 2030 (Nishanthi et al., 2024). Consequently, the WHO has sought to focus on increasing levels of PA and reducing the increasing prevalence of physical inactivity, especially among adults globally by 2030 (Nishanthi et al., 2024; WHO, 2019).

The PA is defined according to the WHO as physical movements performed by skeletal muscles through the consumption of energy and includes movement and work of a person (Grujičić et al., 2022; Nishanthi et al., 2024). Also, the PA works to reduce infectious diseases and improve physical and mental health (Grujičić et al., 2022; Nishanthi et al., 2024). Among the physical health benefits of regular PA is the prevention of serious diseases

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including cardiovascular disease, cancer, obesity, diabetes and osteoporosis (Murphy et al., 2018; Warburton et al., 2006). PA has many benefits related to mental health, including reducing the level of stress, and anxiety, and reducing depression, in addition to enhancing academic performance and cognitive function, especially among university students (Burhaein et al., 2024; Murphy et al., 2018; Gomez-Pinilla & Hillman, 2013). Despite the importance of PA and its health benefits, approximately 31.1% of adults are physical inactivity, and studies have confirmed that physical inactivity was prevalent among university students at a high rate between 23% and 44% (Murphy et al., 2018; Murphy et al., 2019). The transition of students from secondary school to university is considered one of the most important stages that adults go through because it involves physical, social, emotional, and academic changes, in addition to independence from parents (Kwan et al., 2012; Lavados-Romo et al., 2023; Murphy et al., 2018). All of these changes directly affect students' health behaviors and PA, therefore it was necessary to focus on PA behaviors that benefit students physically, cognitively, and socially (Murphy et al., 2018; Murphy et al., 2019).

Enrolling young students in university increases their exposure to many behaviors that affect health, such as malnutrition, following an unhealthy diet that contains a large amount of salt and is rich in energy, smoking, and lack of daily PA (Grujičić et al., 2022; Kolobarić et al., 2020). These behaviors can also lead to obesity (Bull et al., 2020). Many studies have confirmed that 20%- 40% of university students worldwide are overweight (Grujičić et al., 2022; Mahmoud & Taha, 2017; Štefan et al., 2017; Rabanales-Sotos et al., 2020). Therefore, PA which includes various body movements, whether recreational or non-recreational, is very important, especially for first-year university students (Lohana et al., 2023). Where this activity leads to a feeling of happiness and comfort, increases energy production, and reduces the risk of chronic diseases, obesity, psychological illness, and premature death (Bull et al., 2020; Golightly et al., 2017). The PA also effectively ensures students' growth and healthy development and improves their level of thinking and learning in the 1st year of university (Grujičić et al., 2022; Bull et al., 2020). Furthermore, many studies have confirmed that happiness and a feeling of comfort are related to PA, and there is good relationship with a positive between them that affects the physical and mental health of a person (Fisher et al., 2019; Richards et al., 2015; Sabatini, 2014). In addition, low levels of PA among university students may be due to time constraints and various academic activities that lead to a loss of energy (Fisher et al., 2019). PA is also considered important from an academic standpoint in universities for 1st year students, as it is directly linked to academic performance. Studies have shown that students who engage in the PA regularly achieve higher grades (Fisher et al., 2019; Trockel et al., 2000).

Many studies have been concerned with identifying and evaluating the effect of PA on the health and happiness of medical college students and their academic performance in many countries (Dabrowska-Galas et al., 2013; Fisher et al., 2019; Grujičić et al., 2022; Lohana et al., 2023; Nishanthi et al., 2024). According to our review of previous studies, we did not find a study that addressed the impact of activity on the happiness of first-year students in the College of Education. Although, PA has an impact on all college students because it affects their health, academic performance, and happiness levels (Lohana et al., 2023; Richards et al., 2015). Moreover, the levels of happiness and physical, mental, and psychological health of students are determined by their well-being associated with their regular practice of PA (Gülgösteren, 2023; Lohana et al., 2023; Munir & Nazuk, 2019).

Given the active role that colleges and universities can play in promoting PA, which has been shown to increase happiness levels and is linked to student well-being. Accordingly, the current study aimed to assess the effect of physical activity on PA on the health and happiness of first-year students at the College of Education, Kuwait University. It was expected that students who practice sports and PA would have higher levels of health and happiness than their inactive peers who have a low level of PA.

## MATERIALS AND METHODS

### *Study Design, Setting, and Participan*

The design of the current study is based on the descriptive cross-sectional survey method and was conducted from October 2022 to January 2023 among students at the College of Education, Kuwait

University in Kuwait. A random sample of first-year students from various departments of the College of Education, of both genders, was selected. The sample size was 1454 (female & male) students, ages bteween 18 and 30 years. The consent informed was taken from all participants after the author explained the aim and importance

This study was approved by the scientific and ethics committee of the Department of Curriculum and Instruction, Kuwait University (Ref:19/25/October 2022-19). Also, written informed team consent was obtained from all participants before starting the study. Participants provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

***Study Tool and Procedures***

The current study relied on three questionnaires to obtain data. The first questionnaire included questions related to information about the basic sociodemographic characteristics of the participating students (gender, age, marital status, field of study first-year, work, height, weight, and body mass index (BMI)). The students were classified according to BMI values based on the WHO reference values, which are (<18.5) underweight, (18.5 ≥ BMI <25) normal weight, (25 ≥ BMI <30) overweight, or (≥30) obese (WHO, 2000).

The second questionnaire related to participants' happiness was the Short Depression-Happiness Scale (SDHS) (Joseph et al., 2004). The literature studies have reported that Cronbach's alpha has values for the SDHS scale ranging from 0.77 to 0.92 (Joseph et al., 2004). The SDHS questionnaire measures the level of happiness among participants. The students' answers were recorded, and the total score for the scale was calculated according to the recommended values , which ranged from 0 to 18 (Joseph et al., 2004). Participating students answered the SDHS questions, and their answers were scored based on the previous seven days. According to the total scores of the participating students on the SDHS scale, they were divided into two groups. Students who received a total score of 10 or greater than 10 joined the happy group, and those who received a total score of less than 10 joined the depressed group. The SDHS scale scores and the cutoff of 10 between depression and happiness were determined according to the suggestion of Joseph et al. (Joseph et al., 2004).

The third questionnaire related to the participants' PA behaviors was the International Physical Activity Questionnaire Short Form (IPAQ-SF) (Craig et al., 2003). The IPAQ-SF scale is the tool with test reliability and validity, with Cronbach's alpha reaching 0.8, and that is confirmed by previous studies (Craig et al., 2003; Papathanasiou et al., 2009; Murphy et al., 2017), and is validated and reliable for measuring PA for the population aged (15-69 years) (Craig et al., 2003; Murphy et al., 2017). The IPAQ questionnaire measures how much participation students of PA perform in their daily lives. The questionnaire contains 27 questions for PA that include five sections. The first section is related to the job and consists of 7 questions; the second section is related to transportation and consists of 6 questions; the third includes 6 questions related to taking care of family issues, addresses housework, and house maintenance; the fourth includes 6 questions related to entertainment, leisure time and sports; and the fifth includes two questions related to the time the individual spends sitting. Participating students answered the PA questions and their answer was scored based on the previous seven days. In addition, in the PA questionnaire, frequency, duration, and intensity were recorded as (number of days/week), (minutes/day), and (moderate or vigorous), respectively. Activities are approved and taken into consideration if they are implemented within a time of no less than 10 minutes. According to the protocol of the IPAQ-SF scale, the participating students were classified into three groups according to their levels of PA (high, moderate, and low) (IPAQ Research Committee, 2005).

***Statistical Data Analysis***

Various statistical analyses of the data were performed, coded, and entered into the statistical

analysis program SPSS (IBM, version 23). Demographic characteristics were analyzed by descriptive statistics (frequency and percentage), and views of the study sample variables were described by means and standard deviations. Mean total scores for PA (in MET minutes/week), sitting time calculated by sitting time during the week (in minutes/week), and SDHS were compared between the genders of the participating students using the Mann-Whitney U and ANOVA analysis test. A t-test was used to compare PA levels between genders and happy and depressed groups. Statistical significance can be obtained if the p-value is <0.05. To determine the association and relationship between SDHS score and PA score chi-square test of independence was used.

## RESULTS

Table 1 presents the results of the sociodemographic characteristics of the participants. A total of 1454 students from different fields of the College of Education participated in this study 1310 (90%) were females, and 144 (10%) were males. The participants' ages ranged from 18 to 30 years, with an average age of 22 years. The majority of the participants (92%) were between 146 and 169 cm in height, and 68% weighed between 40 and 79 kg. Regarding the BMI, 47% of the participants were normal weight and 44% of them were overweight (Table 1).

**Table 1.** Socio-demographic characteristics data of first-year of Education College students (N =1454)

| Variables | Categorization | Frequency (n) | Percentage (%) |
|---|---|---|---|
| **Gender** | Male | 144 | 10% |
| | Female | 1310 | 90% |
| **Age** | 18 - 24 | 1145 | 79% |
| | aged ≥25 | 309 | 21% |
| **Marital status** | Single | 992 | 68% |
| | Married | 462 | 32% |
| **Study field of first-year students** | Social science | 285 | 20% |
| | Islamic sciences | 165 | 11% |
| | Linguistics and kindergarten | 690 | 47% |
| | Science and Mathematics | 314 | 22% |
| **Work** | Working | 194 | 13% |
| | Not working | 1260 | 87% |
| **Height (cm)** | 146- 169 | 1334 | 92% |
| | ≥ 170 | 120 | 8% |
| **Weight (kg)** | 40-79 | 987 | 68% |
| | ≥ 80 | 467 | 32% |
| **Body mass index (BMI) k/m$^2$** | Normal weight (18.5- 24.9) k/m$^2$ | 687 | 47% |
| | Overweight (25- 29.9) k/m$^2$ | 645 | 44% |
| | Obesity ≥ 30 k/m$^2$ | 122 | 9% |

Table 2 presents the results of the differences in the variables (age, weight, and BMI) according to the gender of the participating students. The results display that there is a difference between these variables according to gender, as it is noted that females were younger than males. While males were significantly taller and heavier, and the BMI of males was slightly higher than that of females (Table 2)

**Table 2.** Characteristics of data of first-year education college students by gender

| Variables | Total (N= 1454) | | Females (n=919,1310) | | Males (n=535,144) | | p-value |
|---|---|---|---|---|---|---|---|
| | Median | Mean ± SD | Median | Mean ± SD | Median | Mean ± SD | |
| **Age (years)** | 22 (18-28) | 22±2.0 | 21.5 (18-25) | 21.7±2.5 | 22 (18-28) | 22.3±1.5 | 0.002** |
| **Height (cm)** | 164 (146-186) | 167±9.5 | 163 (146-178) | 162.9±3.2 | 171 (154-186) | 170.8±6.3 | <0.001*** |
| **Weight (kg)** | 64 (40-110) | 166±6.7 | 59 (40-95) | 58.5±4.6 | 73 (65-110) | 72.8±2.1 | 0.001** |
| **BMI (kg/m$^2$)** | 23 (18.5-38) | 23±3.9 | 22.8 (18.5-38) | 22.7±1.6 | 23.3 (19.5-37.4) | 23.1±2.3 | 0.002** |

BMI, Body mass index, SD=Standard deviation, p-value significant at *** <0.001 and ** <0.01

Regarding the happiness assessment of the participating students, the results showed that the majority of them (83%) reported that their level of happiness was high (83% of females; 17% of males) with a total median SDHS score was (15.5). While unhappiness or Depression levels were lower for (17%) of the participants (17% of females; 22% of males), with a total median SDHS score of (8), which is a value less than 10 (Table 3).

**Table 3.** Results of the SDHS happiness scale among first-year of education college students

| Students participant | | Frequency (n) | Percentage (%) | SDHS Score | | |
|---|---|---|---|---|---|---|
| | | | | Median | Minimum - Maximum | Mean ± SD |
| **Female** | Happy | 1089 | 83% | 15 | 8-18 | 14.2 ± 2.5 |
| | Depressed | 221 | 17% | 8 | 5-8 | 7.4 ± 1.65 |
| | Total Females | 1310 | 100% | 15.5 | 5-18 | 13.6 ± 4.6 |
| **Male** | Happy | 112 | 78% | 14.5 | 10-18 | 14.8 ± 1.7 |
| | Depressed | 32 | 22% | 9 | 8-9 | 8.3 ± 0.83 |
| | Total Males | 144 | 100% | 14 | 8-18 | 13.8 ± 3.4 |
| **Total** | Happy | 1201 | 83% | 15.5 | 10-18 | 14.8 ± 3.2 |
| | Depressed | 253 | 17% | 8 | 5-9 | 7.8 ± 1.9 |
| | Total | 1454 | 100% | 15 | 5-18 | 13.9± 3.8 |

SD=Standard deviation

**Table 4.** Results of the PA values assessed by IPAQ-SF scale among first-year of education college students gender, happy, and depressed group

| Students participant | | PA values (MET-minutes/week) assessed by IPAQ-SF | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Walking Intensity | | | Moderate Intensity | | | Vigorous Intensity | | | Total Intensity | | |
| | | M | Min - Max | Mean ± SD | M | Min - Max | Mean ± SD | M | Min - Max | Mean ± SD | M | Min - Max | Mean ± SD |
| **Female** | Happy (n, %) (1089,83) | 577.25 | 0-4158 | 723.3 ± 854.39 | 340 | 0-2880 | 797.2 ±1056.4 | 1200 | 0-2880 | 1145.8 ±986.2 | 2398 | 165-5973 | 2401.2±1415.5 |
| | Depressed (n, %) (221,17) | 689 | 0-1386 | 714.4 ±753.5 | 210 | 0-2880 | 584.3 ±804.31 | 0 | 0-800 | 172.4 ±352.8 | 768 | 0-3026 | 1251.1±1415.3 |
| | Total Females (n, %) (1310,100) | 587.8 | 0-4158 | 718.9 ± 773.9 | 300 | 0-2880 | 704.2 ±1014.5 | 0 | 0-2880 | 345.6±482.1 | 2203 | 0-5973 | 2156.3±1397.24 |
| **Male** | Happy (n, %) (112,78) | 1146 | 0-4158 | 1204 ± 1396.7 | 240 | 0-4320 | 591.4 ±734.35 | 960 | 0-3840 | 1101.± 987.8 | 2685 | 165-10212 | 3156.8±2015.42 |
| | Depressed (n, %) (32,22) | 452 | 0-2772 | 667.3 ± 632.4 | 180 | 0-2880 | 501.2 ±814.12 | 0 | 0-800 | 167.2 ±332.4 | 652 | 0-3026 | 1281.6±1334.4 |
| | Total Males (n, %) (144,100) | 452 | 0-4158 | 778.5 ±794.52 | 210 | 0-4320 | 563.3 ±846.26 | 840 | 0-3840 | 395.2±502.3 | 2402 | 0-10212 | 3256.2±2107.3 |
| **Total** | Happy (n, %) (1201,83) | 944 | 0-4158 | 1156.8 ± 13066 | 300 | 0-4320 | 785.8 ±901.16 | 960 | 0-3840 | 1243.2±1311.3 | 2455 | 165-10212 | 2851.4±1879.12 |
| | Depressed (n, %) (253,17) | 579 | 0-4158 | 815.7 ± 874.5 | 210 | 0-2880 | 526.7 ±864.17 | 0 | 0-800 | 181.1±364.7 | 924 | 0-3026 | 1056.3±1263.25 |
| | Total (n, %) (1454,100) | 598 | 0-4158 | 785.3± 824.8 | 300 | 0-4320 | 781.2 ±913.53 | 920 | 0-3840 | 1043.5±1151.6 | 1848 | 0-10212 | 2387.1±2415.23 |

M (Median),

Regarding the assessment of the PA of the participating students, the results showed that the majority (81%) reported that their level of PA was high, with the median total score for PA in MET-minutes/week among the participating students being 1810.9. The results of the analysis of PA assessed by the IPAQ-SF scale and its domains of walking intensity, moderate intensity, and vigorous intensity show that most participating students had high PA. Thus burning more calories during PA. The participants' calorie burning and energy expenditure occurred most during vigorous-intensity activity, followed by walking and moderate-intensity activity with total medians of 920, 598, and 300 MET-minutes/week, respectively (Table 4). Also, the results showed that male students were more PA with a median total score for PA and energy expenditure of 2402 MET-minutes/week, compared to females whose median total PA and energy expenditure was 2312 MET-minutes/week. Male students engaged more in vigorous-intensity activity and had a median total score for this activity of 840 MET minutes/week, compared to females who had a median total score

for vigorous-intensity activity of 0 MET minutes/week. Finally, happy students were more PA than depressed students, with median total scores of PA in MET minutes/week being 2398 for happy females and 2685 for happy males, while they were 768 and 652 for depressed females and males (Table 4).

**Table 5.** Results of the relation between happiness and PA levels among first-year education college students

| SDHS parameter | PA values (MET-minutes/week) assessed by IPAQ-SF | | | p - value |
|---|---|---|---|---|
| | Median | Minimum - Maximum | Mean ± SD | |
| Happy (83%) | 2455 | 165-10212 | 2851.4 ± 1879.12 | 0.001** |
| Depressed (17%) | 924 | 0-3026 | 1056.3 ± 1263.25 | 0.02* |
| Total (100%) | 1848 | 0-10212 | 2387.1 ± 2415.23 | 0.03* |

SD=Standard deviation, p-value significant at ** <0.01 and * <0.05

Concerning determining the relationship between happiness measured by the SDHS and PA levels measured by the IPAQ-SF among participating students, the results showed that there is a correlation between the SDHS parameter and PA levels. Statistically significant differences were found in the total median of PA was 2455 MET-minutes/week and happy students (p = 0.001). Also, there were statistically significant differences in the total median of PA was 924 MET-minutes/week, and depressed students (p = 0.02) (Table 5).

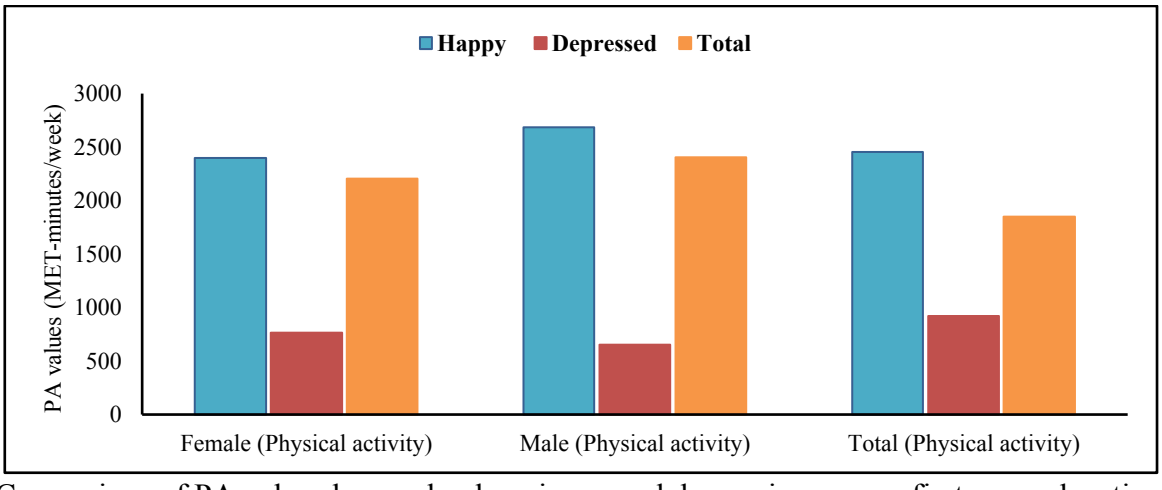


**Figure 1.** Comparison of PA values by gender, happiness, and depression among first-year education college students.

Out of a total of 1454 students, 1201 (83%) were happy students with high PA, and 253 (17%) were depressed students with moderate PA. The PA of happy females was lower than that of happy males. While the difference in moderate PA between depressed females and males was slight as shown in (Fig. 1).

## DISCUSSION

Happiness and PA are important factors and are a pattern of healthy lifestyles for people, especially students (Bahrami et al., 2011; Dabrowska-Galas et al., 2013). Due to feeling happy and maintaining the recommended levels of PA, students feel satisfied with themselves and life, enhancing learning and the ability to solve problems (Bahrami et al., 2011). The current study examined the relationship between happiness and physical activity between students and the difference between active and inactive students. The results showed that most students in the College of Education at Kuwait University were happy, indicating that students' mental and psychological health was good compared to depressed students. This outcome is consistent with previous studies on assessing the happiness of first-year (Alhuthil et al., 2022; Fisher et al., 2019; Lohana et al., 2023; Murphy et al., 2018). This result can be explained by the fact that most of the participating students belonged to the departments of languages, kindergarten, science, and mathematics, which are fields in which students do not suffer from pressure due to being busy studying

most of the time and the difficulty of the academic subjects compared to medical students. On the other hand, students' free time helps them practice physical and sports activities that raise their level of happiness and satisfaction.

The finding that most students were happy and only 19% were unhappy can be justified because the participating students were in their first year of university studies, so their happiness levels were high. A study by Silva confirmed this result, and Figueiredo-Bragawhere found that 1st- and 2nd-year students had higher levels of happiness than 3rd- and 4th-year students [32]. In addition, the high happiness levels between students in our study indicate that their health is good compared to those with low happiness levels. This is what previous studies have confirmed: that there is a positive association between happiness and health and that healthy students are happier compared to depressed students (Jiang et al., 2022; Murphy et al., 2018; Silva & Figueiredo-Braga, 2018).

The findings of our study indicated that most students had high levels of physical activity, with a small number (19%) of students having low of physical activity levels. This result may be because students have sufficient opportunities and time to practice weekly PA. In addition, the well-being of students in Kuwait plays an important role in the availability of designated places for practicing sports inside and outside the university. Furthermore, our study was the first study to our knowledge that included students from colleges other than the Colleges of Medical and students from different fields of study. Also, this result was consistent with a study conducted by Fagaras et al. in Romania, where they measured the PA of university students from various fields of study and found that the PA levels of students were high (Fagaras et al., 2015). Our results also indicated that male students were more PA than females. This may be because male students have the opportunity to go outside and engage in vigorous PA. It was also observed from the results that female students were not engaged in vigorous PA, and therefore, males had more PA levels. This outcome is consistent with the results of other studies that reported that male university students were more PA than female students (Fisher et al., 2019; Fagaras et al., 2015; Hadimani et al., 2018; Nishanthi et al., 2024).

Furthermore, our outcomes indicated that PA practiced by first-year students was significantly associated with happiness, and happy students had high levels of PA compared to their unhappy peers who had low levels of PA. Also, active and happy students had good mental and physical health because PA and happiness are related to the students of mental and physical health (Fisher et al., 2019; Hamer et al., 2009; Murphy et al., 2018). Similarly, for many other studies, a study conducted by Richards et al. showed the relationship between PA levels and happiness among students. They found that there was a positive relationship and a significant association between happiness and PA (Richards et al., 2015). Another study conducted by Piqueras et al. in Chile highlighted the relationship between students' exercise, PA, and happiness, and they found that there was a positive and moderate association between daily and regular exercise and happiness (Piqueras et al., 2011). The results of another study conducted in Cyprus found that weekly PA among first-year medical students was positively associated with happiness (Fisher et al., 2019).

Finally, the high levels of PA and happiness among the majority of first-year students from several departments at the College of Education at Kuwait University may be due to several reasons. These reasons include university-related reasons, such as the campus layout and study schedule that allows students to move around the campus and thus increase levels of PA, and external reasons, such as family and the well-being that students experience in a country like Kuwait. All of these factors may have contributed to the increased happiness level of the majority of students, and only a small number of them suffered from depression and inactivity. On the other hand, there may be many factors associated with the college environment, the activities students engage in, satisfaction with the educational aspect, and other factors that may be important and interesting topics for opening up wide areas for researchers to conduct further future studies.

***Conclusion***

In conclusion, the level of happiness among most first-year students of the College of Education was high, with a slight difference between males and females. The levels of PA among these students were high, especially among males. The vigorous intensity of PA was found among males, but not among females. In addition, PA levels were significantly associated with happiness among first-year students studying at Kuwait University. The study showed that when comparing students with

depression to happy students, depressed students had lower levels of PA, and thus active students were happier and healthier than inactive students. According to our review, we did not find a study conducted on students at Kuwait University from different departments to identify and evaluate the relationship between levels of happiness and PA among first-year students and their impact on their health. The study results showed the importance of PA in promoting the physical and mental health of university students. Which increases levels of happiness that make students enjoy life satisfaction and raise their levels of academic performance. Therefore, future studies should seek to determine the relationship between PA and happiness among university students in a more comprehensive and detailed manner.

### *Ethical considerations*

This study was approved by the scientific and ethics committee of the Department of Curriculum and Instruction, Kuwait University (Ref:19/25/October 2022-19).

### *Conflict of interest*

The authors declare no conflicts of interest.


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### *Author Contributions*

Study conception and design: SA, HB; Data Collection: SA, HB, SA; Analysis and Interpretation of results: SA, HB, SA; Draft manuscript preparation: SA, HB, SA; All authors reviewed the results and approved the final version of the manuscript.

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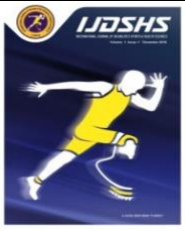

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RESEARCH ARTICLE

# Comparison of Physical Fitness of Students between Sport Education Model and Conventional at Junior High School 3 Lembang

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**Abstract**
The aim of this study was to see the differences in learning outcomes of students who study using the sports education model and compare it with conventional learning in terms of physical fitness.at Junior High School 3 Lembang. This study used experimental design with randomized control group pretest-posttest design. The population of this study was 7 classes with a total of 280 students, which determined using random techniques. Sampling using Random Technique from the 7 classes, so that class 7C and 7D with each class numbering 40 students determined as samples. A Balke Test was employed as the instrument in hope that this test could describe students' fitness. Findings shows that the physical fitness at the experimental group obtains P Values -21.292 with Sig. 0.000 and the control group obtains a P Values -0.678 with Sig. 0.502. This means that there was an increase in physical fitness in the experimental group that learned using the sports education model, while in the control group doesn't. The difference result using independent t Test towards physical fitness obtains P Values 16.619 with Sig. 0.000. The Conclusion is the sports education model in experimental group has better towards physical fitness than in the control group. Thus, it can be recommended completing this study of using the sports education model in terms of such aspects as strength, endurance, agility, speed, and balance for further research and it is expected that teachers be able to apply their creativity when using the sports education model.

**Keywords**
Sports Education Model, Conventional, Physical Educatin, Physical Fitness

## INTRODUCTION

At this time, teachers are required in physical education learning to present creative learning by combining it with learning models that they understand (Ginanjar et al., 2024) to meet the students' needs for development and growth. However, it is found that students of Junior High School 3 Lembang still uses a conventional model, a teacher-centered, when learning physical fitness. This learning has somehow been slowly abandoned (Ginanjar et al., 2023) because it leads to students' passive behaviors which may impact to reduce students' activity in the classroom. If this situation continues, a negative impact on students' physical fitness might seem to appear. It can be seen that students who have low levels of physical fitness usually get tired easily when doing physical activities. If this is allowed by physical education teachers, then students will be lazy to exercise and will give rise to several problems related to low levels of fitness.

Increased risk of obesity due to lack of movement (Chen et al., 2024; Zhou et al., 2024). Increased risk of heart disease, diabetes and hypertension (Moreno-Díaz et al., 2024; Pati et al., 2025). Potential to cause mental problems such as anxiety, depression, stress and other mental disorders (Haapala et al., 2024) because students interact less socially and get less entertainment such

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as pleasure and joy when students learn physical education (Kumari et al., 2024). Furthermore, another problem comes to rise in physical education learning at Junior High School 3 Lembang regarding fitness material when the teacher asks the male and female students to run for 20 minutes in turns. This approach is clearly ineffective because the students become passive for 20 minutes. Hence, a new breakthrough is needed in physical education learning particularly on fitness material for Junior High School 3 Lembang, which can benefit students' physical fitness development (Xu et al., 2023).

Basically, the problems that occur can be solved by the teacher himself when he has a high level of creativity and is able to solve existing problems. Several things can be done by physical education teachers such as Modifying the equipment used as a means of learning (Adank et al., 2024). Developing learning media that can attract interest and increase student learning motivation (Nanda et al., 2024). Making improvements to the classroom arrangement such as arranging formations when studying or modifying class rules during learning (Astuti et al., 2024). Using a learning model that is appropriate to the material presented to students. The use of this learning model is very crucial because if the teacher is able to master it properly, then creativity and good planning will arise, planned and right on target (Pill et al., 2024). The mastery of physical education teachers on learning models is also seen as being able to support the exploration of appropriate learning styles and systems when they teach in the classroom.

Sports education learning model could be the solution for physical education teachers in order to provide this fitness material. Conceptually, students have equal and balanced learning opportunities in this sports education learning model. Their activities are focused on six main components: seasons, team affiliations, official competitions and training, records, celebrations and peak events (Ginanjar et al., 2019). Physical education teachers Junior High School 3 Lembang also need to align the basic fitness aspects to anachieve. Using model-based learning, it is however important to know that the sports education model needs harmonizing since it is usually applied in games like football, basketball, and volleyball. This sports education model applying harmonized content can therefore motivate students' learning in physical education

Research on sports education models in physical fitness material is still limited in number. The main advantage of sports education model compared to conventional model is characterized by the existence of six main components: seasons, team affiliations, official competitions and training, recordings, celebrations, and peak events (André & Hastie, 2017; Farias et al., 2017; A. Ginanjar et al., 2019). Having an in-depth understanding, physical education teachers would likely to achieve the desired results applying this model (Bessa et al., 2021; Harvey et al., 2020). This model implementation can be adjusted to the needs of physical education teachers, concerning student fitness in this sense (Blagus et al., 2023; Tendinha et al., 2021).

Conceptually, it cannot be denied that in this sports education model, students must play an active role according to agreement with their teammates, for example managers, coaches and scoring. Student activity during learning creates positive motivation and indirectly increases collaboration among students (Alvi & Gillies, 2023). Teachers must also be able to provide good direction during physical education lessons using the sports education model. Apropriate instructions and responsibilities shoul be given to students for choosing the warm-ups, types of exercises and cool-downs that suit them for practice. Obviously, this is very interesting as students will be actively and creatively involved during physical education learning on fitness material. This role is crucial due to the competitive nature of this sports education learning model especially regarding the teacher's knowledge and experience while guiding students to achieve learning goals and outcomes (Kao, 2019; Liao et al., 2023). This really needs to be conveyed by teachers to students so that the need for physical fitness development can be met.

## MATERIALS AND METHODS

### *Participant*

This research follows ethical standards and received approval from the Ethics Committee of Universitas Negeri Jakarta No.515 /UN39.14/ PT.01.05/VI/2024 on June 10, 2024. Participants are provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research is strictly adhered to the ethical principles of the

Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures. The characteristics of the participants are as follows.

**Table 1.** Characteristics of the research subjects

| Variables | Experimental | | Control | |
|---|---|---|---|---|
| | Male Mean ± SD | Female Mean ± SD | Male Mean ± SD | Female Mean ± SD |
| **Age (years)** | 13±0.0 | 13±0.0 | 13±0.0 | 13±0.0 |
| **Height (cm)** | 1.45±0.13 | 1.40±0.14 | 1.44±0.15 | 1.41±0.15 |
| **Weight (kg)** | 38.85±3.07 | 36.55±3.69 | 40.90±2.85 | 36.80±3.43 |
| **BMI (kg/m$^2$)** | 19.07±4.23 | 19.21±3.86 | 20.41±4.68 | 19.00±4.04 |

Based on Table 1, the author divided the students at Junior High School 3 Lembang into male and female in each group. There were 20 male and female students in each group. For the Age category, the mean was 13, standard deviation 0.00. For the Height category in the male experimental group, the mean was 1.45, standard deviation 0.13 and for women, the mean was 1.40, standard deviation 0.14. Meanwhile, for the male Control group, the mean was 1.44, standard deviation 0.15 and for women, the mean was 1.41, standard deviation 0.15. For the Weight category in the male experimental group, the mean was 38.85, standard deviation 3.07 and for women, the mean was 36.55, standard deviation 3.69. Meanwhile, for the male Control group, the mean was 40.90, standard deviation 2.85 and for women, the mean was 36.80, standard deviation 3.43. For the Body Mass Index category in the male experimental group, the mean was 19.07 (Normal), standard deviation 4.23 and for women the mean was 19.21 (Normal), standard deviation 3.86. Meanwhile, for the male control group, the mean was 20.41 (Normal), standard deviation 4.68 and for women the mean was 19.00 (Normal), standard deviation 4.04.

The age stated in the questionnaire was filled in by the research participants and the author only needs to include it. But, the other components were measured by the author before the research was conducted. Height was measured using a meter and weight was measured using an electric scale. After that, the author calculated the BMI of the research participants manually, so that the research would be balanced.

In addition, students at Junior High School 3 Lembang level have several unique characteristics because they are in a transition period from children to adolescents. During this period, students usually have a high curiosity about things that are new to them and begin to develop their abilities to be able to achieve as high as possible. However, during this period, physical education teachers at school also need to be aware because several problems often arise, such as;

Body Mass Index imbalance (Moreno-Díaz et al., 2024). Being in an unstable period so that mental problems are often found (Yan et al., 2024)such as being depressed, isolated or inferior due to various factors such as appearance and family economic conditions (Zhong et al., 2024). Uncontrolled emotional reactions (Haapala et al., 2024). So that the active role of physical education teachers is needed (Li, 2025) to direct students to activities that are beneficial for the growth and development of students.

***Design***

In this study using a randomized control group pretest-posttest design (Creswell, 2018), as can be seen in table 2. The population of this study was 7 classes with a total of 280 students, which were determined using random techniques (Creswell, 2018). Sampling using Random Technique from the 7 classes, so that class 7C and 7D with each class numbering 40 students were determined as research samples. To determine the experimental and control group, it was also determined using Random Technique.

**Table 2.** The Experimental research design (Creswell, 2018)

| Class | Pretest | Treatment | Posttest |
|---|---|---|---|
| Eksperiment | O1 | X1 | O3 |
| Control | O2 | X1 | O4 |

A Balke Test was used as the instrument, in the hope that this test can describe students' fitness before and after this research was carried out. A different learning model would be implemented for physical education learning process with this physical fitness material. Class 7C would learn using the sports education model, while class 7D used the conventional model at Junior High School 3 Lembang. The learning lesson described in the table 3.

**Table 3.** Physical education learning lesson using the sports education and conventional model

| The Sports Education Model | Lesson |
|---|---|
| • Introduction to Physical Fitness<br>• Explanation of Assessment Criteria<br>• Identifying Coach for each Team<br>• Team Selection and Team Name<br>• Explanation of the rules for Student<br>• Pretest Physical Fitness using Balke Test. | **1** |
| • Students warm up.<br>• Physical fitness training in the team (push-up, sit up, squat jumps, jump rope 10 minutes and running for 10 minutes)<br>• Games related to physical fitness in the team | **2-4** |
| • Students warm up in groups.<br>• Physical fitness training within the team (push-up, sit up, squat jumps, jump rope 10 minutes and running for 10 minutes)<br>• Regular Season (3 vs 3) team physical fitness competition (Best 3 taken). | **5-7** |
| • Students warm up in groups.<br>• Preparation of the entire team for the final match.<br>• Competition between teams (push-up, sit up, squat jumps, jump rope 10 minutes and running for 10 minutes) | **8-10** |
| • Strengthening the concept of sports education model in the context of physical fitness.<br>• Awards and celebration.<br>• Posttest Physical Fitness | **11** |
| **Conventional Model** | **Lesson** |
| • Introduction to Physical Fitness<br>• Pretest Physical Fitness | **1** |
| • Physical fitness exercises according to the teacher's instructions (push-up, sit up, squat jumps, jump rope for 10 minutes and running for 10 minutes) | **2-4** |
| • Physical fitness exercises according to the teacher's instructions, for example (push-up, sit up, squat jumps, jump rope for 10 minutes and running for 10 minutes) | **5-7** |
| • Physical fitness exercises according to the teacher's instructions, for example (push-up, sit up, squat jumps, jump rope for 10 minutes and running for 10 minutes) | **8-10** |
| • Strengthening the concept of physical fitness.<br>• Posttest Physical Fitness using Balke Test. | **11** |

***Procedure***

First, the author communicated with the physical education teacher team and the Principal of Junior High School 3 Lembang. Second, the author then asked the Dean of the Faculty of Sports Science, Universitas Negeri Jakarta to carry out research, prepare ethical consent and prepare research equipment. The consent must also be notified by parents that the students were involved in the research within the period from 16 June to 31 July 2024. The students involved must obtain consent from their parents as indicated by filling out the procedures of the Jakarta State University Ethics Committee completely. Third, the author determined the population of Junior High School 3 Lembang students and determined the sample using the simple random technique. Fourth, the author prepared the equipment for Balke Test implementation carried out after the briefing at the first meeting. Fifth, the author then carried out the treatment using the sports education model in the experimental group and the conventional model in

the control group. The treatment process was given twice a week. The experimental group was carried out on Tuesday and Thursday while the control group was on Wednesday and Friday. There would be 11 meetings to be carried out with duration of 90 minutes each. This arrangement was designed to keep participants focused on the material provided. Factors that interfere with the results of the physical fitness test could be minimized since there was no contact or communication among fellow treatment participants in each group. Sixth, the author processed and analyzed the data.

***Data Collection***

The first physical fitness data was obtained from students by conducting an initial test at the first meeting after the briefing. The test used was Balke, by running for 15 minutes. Five students were selected to do the running in each period for having a more accurate calculation of the distance traveled. The running was executed at Sinapeul field with a standard distance for running competitions was. The second physical fitness data was carried out at the 11th meeting after strengthening related to physical fitness in each class. It applied the same implementation as the first test. The author then continued to process the data having received the result of data collection.

***Statistical Analysis***

In this study the author used microsoft office-excel and IBM SPSS Statistics v.26 to process the data. To answer the hypothesis is done by using the Paired t-test and Independent t-test. As a data prerequisite test, a normality test was carried out using the Kolmogorov-Smirnov test and a homogeneity test using the Lavene test. the results can be seen in tabel 4.

**Table 4.** The result of normality and homogeneity

| **Group** | **Kolmogorov-Smirnov Test** | **Sig.** |
|---|---|---|
| Pretest Experimental | 0.086 | 0.200 |
| Posttest Experimental | 0.101 | 0.200 |
| Pretest Control | 0.086 | 0.124 |
| Posttest Control | 0.132 | 0.076 |
| **Group** | **Lavene test** | **Sig.** |
| Experiment X Control | 8.667 | 0.004 |

Table 4 shows the results of the Kolmogorov-Smirnov test in the experimental group pretest obtained Statistical Value 0.086, Sig. 0.200 and posttest obtained Statistical Value 0.101, Sig. 0.200. While in the control group pretest obtained Statistical Value 0.086, Sig. 0.124 and posttest obtained Statistical Value 0.132, Sig. 0.076. Because the Sig. value is more than 0.05, all data from the experimental and control groups are normally distributed. The results of the Lavene test of the experimental group and control group for the physical fitness variable obtained Statistical Value 8.667, Sig. 0.004. Because the significance value is less than 0.05, the physical fitness variables of the experimental and control groups are homogeneously distributed.

## RESULTS

In this section, the results of the research that has been conducted will be explained.

**Table 5.** The result of balke test at junior high school 3 lembang

| **Variables** | **Experimental** | | | **Control** | | |
|---|---|---|---|---|---|---|
| | **Male Mean ± SD** | **Female Mean ± SD** | **Total** | **Male Mean ± SD** | **Female Mean ± SD** | **Total** |
| **Result of Pretest** | 50960 | 46600 | 975560 | 40750 | 39550 | 80300 |
| | 2548±639.96 | 2330±402.10 | 2439±538.96 | 2038±544.56 | 1978±36.68 | 2008±541.19 |
| **Conversion of Pretest** | 793 | 743 | 1536 | 676 | 662 | 1338 |
| | 40±7.34 | 37±4.61 | 38*±6.18 | 34±6.24 | 33±6.31 | 33*±6.21 |
| **Result of Posttest** | 85630 | 77910 | 163540 | 2766.67 | 40210 | 81710 |
| | 4282±361.83 | 3896±256.20 | 4089±366.01 | 138.33±38.29 | 134.03±29.60 | 2043±507.76 |
| **Conversion of Posttest** | 1190 | 1102 | 2292 | 684 | 670 | 1354 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 60±4.15 | 55±2.94 | 57*±4.20 | 34±6.59 | 33±5.09 | 34*±5.82 |

Table 5 shows that result at Experimental pretest male shows total score 50960, mean 2548 and standard deviation 639.96. For Convertion values shows that total 793, mean 40 and standard deviation 7.34. Meanwhile at Experimental pretest female shows total score 46600, mean 2330 and standard deviation 402.10. For Convertion values shows that total 743, mean 37 and standard deviation 4.61. Experimental pretest Total shows total score 975560, mean 2439 and standard deviation 538.96. For Convertion Total values shows that total 1536, mean 38 and standard deviation 6.18.

The result at Experimental posttest male shows total score 85630, mean 4282 and standard deviation 361.83. For Convertion values shows that total 1190, mean 60 and standard deviation 4.15. Meanwhile at Experimental posttest female shows total score 77910, mean 3896 and standard deviation 256.20. For Convertion values shows that total 1102, mean 55 and standard deviation 2.94. Experimental posttest Total shows total score 163540, mean 4089 and standard deviation 366.01. For Convertion Total values shows that total 2292, mean 57 and standard deviation 4.20.

The result at Control pretest male shows total score 40750, mean 2038 and standard deviation 544.56. For Convertion values shows that total 676, mean 34 and standard deviation 6.24. Meanwhile at Control pretest female shows total score 39550, mean 1978 and standard deviation 36.68. For Convertion values shows that total 662, mean 33 and standard deviation 6.31. Control pretest Total shows total score 80300, mean 2008 and standard deviation 541.19. For Convertion Total values shows that total 1338, mean 33 and standard deviation 6.21.

The result of pretest at Control posttest male shows total score 2766.67, mean 138.33 and standard deviation 38.29. For Convertion values shows that total 684, mean 34 and standard deviation 6.59. Meanwhile at Control posttest female shows total score 40210, mean 134.03 and standard deviation 29.60. For Convertion values shows that total 670, mean 33 and standard deviation 5.09. Control posttest Total shows total score 81710, mean 2043 and standard deviation 507.76. For Convertion Total values shows that total 1354, mean 34 and standard deviation 5.82. For further data processing, the total mean value of the combined male and female from the experimental and control groups is used. To make it easier to describe the results, it can be seen in figure 1.

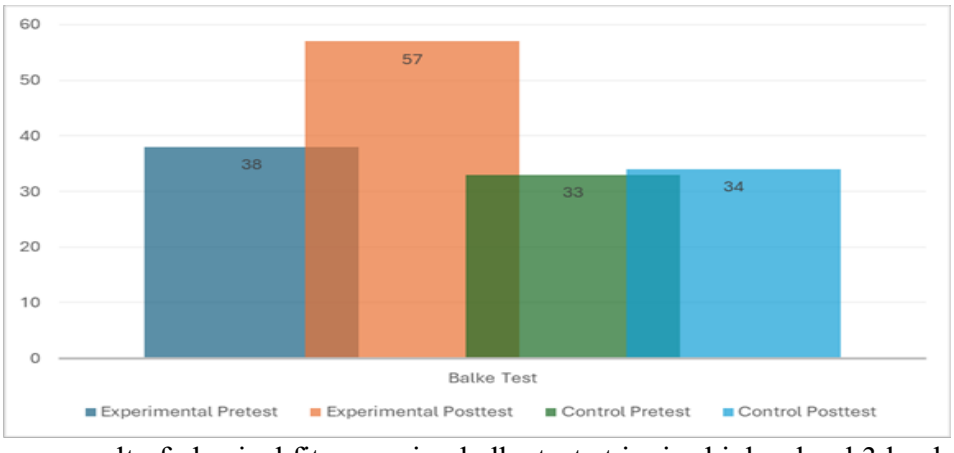


**Figure 1.** The Average result of physical fitness using balke test at junior high school 3 lembang

Figure 1 shows the average results of physical fitness using the Balke test at Junior High School 3 Lembang. It can be seen that the pretest experimental group obtained an average score of 38 and a posttest of 57. While the pretest control group obtained an average score of 33 and a posttest of 34.

Table 5 shows the results of the paired physical fitness test. In the experimental group, obtained P Values -21.292, Sig. 0.000 and the control group obtained P Values -0.678, Sig. 0.502. This means that there was an increase in physical fitness in the experimental group who learned using the sports education model while in the control group there was no increase in physical fitness. The results of the independent t-test of physical fitness obtained P Values 16.619, Sig. 0.000. This means

that physical education learning using the sports education model in the experimental group has a better effect on physical fitness than in the control group who learned using the conventional model.

**Table 5.** Paired and independent t test

| Paired Test | P Values | Sig. |
|---|---|---|
| Experimental | -21.292 | 0.000 |
| Control | -0.678 | 0.502 |
| **Independent t Test** | **P Values** | **Sig.** |
| Experimental >< Control | 16.619 | 0.000 |

## DISCUSSION

Based on the results, the following will discuss the findings in this research.

***There is an Influence of the Sports Education Model toward Physical Fitness Program***

Physical education learning using this Sports Education model has several advantages, including that being characterized by 1) Season, 2) Recording, 3) Competition, 4) Affiliation, 5) Peak event and 6) Celebration (Siedentop, 1998). The learning process is fun and challenging for students so that aspects i.e. courage to retry, tenacity, sincerity and persistence would indirectly appear in students. This is a reflection students' positive attitudes formation. Using the Sports Education Model make students become more enthusiastic to get better result during the learning (Gutiérrez et al., 2020), having goal to enhance the achievement of superior physical education learning experiences.

In physical fitness material at Junior High School 3 Lembang, each student is given a responsibility for doing a series of physical activities such as walking, running, jumping, push ups and sit-ups, and other activities that are considerably capable of improving physical fitness by physical education teachers. Even though it only uses a simple game format in physical education learning with comprehensive physical fitness material (Putranto et al., 2023) and students have high levels of independence (Gutiérrez et al., 2020) than the usual conventional models since the learning is very competitive and important for students' physical fitness (Meesters et al., 2019). This make students can learn physical fitness simultanelously to promote students' physical activity (Cupeiro et al., 2020). While learning physical fitness material, students are usually reluctant to be actively involved because they are lazy to move and clean themselves after sweating. Having applied this sports education model, they feel joyful (Quiñonero-Martínez et al., 2023) to learn physical education on physical activity material. The use of sports education model will enable teachers to train students' physical activity abilities (Solihin et al., 2022) through a series of physical activities that generate high enthusiasm. The students feel is the result of physical fitness can increase students' interest in physical education learning itself.

The physical education learning using the sports education model will cause students to be more diligent for a try with high curiosity and to study seriously (Alvi & Gillies, 2023; Gambo & Shakir, 2023). Students are also accustomed to preparing their learning equipment independently, doing exercises that are in accordance with the needs of their group also tidying up their equipment with full responsibility. Every process that has been experienced equips students with important aspects in learning, namely the courage to retry, tenacity, sincerity and persistence, which become the goals of physical education learning are highly expected by physical education teachers (Boroughani et al., 2023; Zimmerman, 2000). This positive attitude of students does not appear suddenly, but is trained and made a habit during learning and is a reflection of a good learning planning from physical education teachers. This attitude is built because the students are motivated to learn more in terms of sports and develop responsibility so that learning in the classroom can be managed more effectively (Choi et al., 2021). Through this sports education model, students are directed to be able to achieve learning objectives optimally, in an easy, fast, and fun way regardless of reducing the pleasure of competing so that they learn with the absence of any psychological burden.

***There is no Influence of Conventional Models toward Physical Fitness Program***

During physical education learning using this conventional model at Junior High School 3

Lembang, the teacher's role in leading learning is very dominant. In addition, it usually applies a lecture with drilling or repetition stretegies as the method during the learning process. It drives boredom and less interest to the students. This situation can be seen during learning in which teachers play a more active role in preparing equipment and cleaning up the learning equipment used. This is also regarded as an ineffective and inefficient learning concept due to the lack of active involvement of students during physical education learning on physical fitness material because they are not used to being active in order to fulfill their physical fitness. Whereas in several studies, active involvement of students in physical fitness material (A. Ginanjar et al., 2021) is a must. It is very necessary to support the concept of health related to quality of life which is expected to last long in students. Another aspect to consider is the interaction during learning where students practically only interact with the teacher in this conventional model. This occurs because the learning tends to be authoritarian, centered on the physical education teacher so that students are not much involved and do not play an active role in physical activity (Hastie et al., 2017; Wallhead et al., 2021) which makes it very difficult to achieve the goals.

In relation, the condition at Junior High School 3 Lembang had an appropriate strategy is needed to achieve the physical activity the students need for making them inspired to learn independently. In a conventional model, an inherent guidance process is needed. Reinforcements in the form of positive feedback must be done more by teachers to strengthen students (Persico et al., 2023). Conventional models that prioritize the dominant role of teachers accompanied by repetitions in the learning process sometimes make students feel lazy and assume that the learning is not interesting for students. The impact on physical education teachers is that it is very difficult to apply an attitude of independence, creativity and the formation of a strong soul during physical education learning (Lim et al., 2023). Based on this view, the teacher's role that is too dominant does not necessarily make learning outcomes better because of the lack of planning and interaction among students during learning (Ojeda et al., 2019). If this process is allowed to continue, it will be very difficult for students to bring up and train the positive attitudes expected in physical education learning such as problem-solving skills, independence, tenacity, and responsibility. Thus, it still requires an inherent guidance process to make the students able to solve the problems they face.

***The Sports Education Model Gives A Better Influence towards Physical Fitness than Conventional Model***

Physical education learning on this physical fitness material at Junior High School 3 Lembang considered very suitable and provides a high opportunity for students to likely involved and improve their fitness levels. The physical education learning using this sports education model tends to train students to always be persistent and diligent during the learning process. They will always obey their teacher's orders when being given assignments to be completed on time (Sulz et al., 2024).

This is the initial attitude that occurs during learning which signiries students' active involvement. After they give rise to a high level of awareness, the students might not be objected for they are used to doing every task given by their teacher. Using the sports education learning model, students are given freedom and practice solving problems found in learning (Moreno-Díaz et al., 2024b). This is clearly not found in conventional models of physical education learning. The learning process is monotonous with many repetitions in an authoritarian style during physical fitness material. This happened because monotonous in their learning (Dervić et al., 2018), students who study physical fitness using this conventional model are required to find for themselves some of the learning materials needed without knowing and understanding their needs (Nuñez Enriquez & Oliver, 2021). Learning activities are more determined by the teacher's own thought process, which causes students to only carry out their learning without understanding the meaning contained in physical education learning itself (Murphy et al., 2021). Doing physical activities regularly, students' needs will be met if the learning uses the sports education model. This happens because well-designed and well-directed learning will make it easier for students to carry out every instruction and direction from the physical education teacher (Figueroa-Cavero et al., 2024; Gao & Tasnaina, 2024).

The physical fitness using the sports education model at Junior High School 3 Lembang can increase students' enthusiasm for learning. This condition can motivate them due to interesting

learning. If supported by the existence of tight competition with fellow team members and matches between teams, each student will compete to be the best (Liebendörfer et al., 2023; Park et al., 2023). Another interesting thing is that the more exciting learning that will take place following the match season and the peak event. Indeed, such condition is found to be inversely proportional for students who learn with conventional models. Students appear less enthusiastic to learn well, less than optimal in doing the movements instructed by the teacher and some students still look a little confused and need further explanation (Lan et al., 2020). This is because students are only given instructions being ignorant with the meaning and usefulness of the movement. It is compounded by teachers who are authoritarian and give instructions in a high tone. This makes some students anxious with and afraid of practicing wrong movements. When they learn by repetition in physical fitness material, students may come to frustration unconsciously, as they cannot integrate the concepts given. The teacher unfortunately does not guide students to solve problems either (Boshoff-Knoetze et al., 2023; Muljana et al., 2023).

Concerning student's viewpoints, physical education learning using conventional models, especially in physical fitness material, seems to be monotonous because they all work alone and there is no social interaction and cooperation among fellow students. It impacts a lack of critical thinking skills for problem solving, fear of taking risks and having low responsibility (Albani et al., 2023; Poitras et al., 2023). Physical education teachers to use learning models that can inspire students to be more enthusiastic about sports and physical activities, whether carried out at school through physical education programs or off school through physical activities and other sports activities. Physical education teachers can use the sports education model in this physical fitness material, which is for some students very much avoided. Physical education learning using the sports education model can motivate students to indirectly carry out scientific processes and be actively involved in intensive social interaction processes despite having some for reinforcement from the teacher (Al Mamun & Lawrie, 2023; Zheng et al., 2023). Physical education teachers can present growth enthusiastic to learn, explore, find the core of the problem and find solutions to problems. Using the sports education model, students are given the opportunity to gain knowledge through the process of observation and investigation, as well as the implementation of the knowledge that has been obtained in order to find solutions or answers independently (Rueda et al., 2023; Yang et al., 2023). When this process has emerged, the teacher must be aware and able to direct students and maintain student motivation while learning physical education (Heikkinen et al., 2023; Wu et al., 2023). Through this interesting physical education learning, it is hoped that it can develop students' abilities and be beneficial for their future, especially to improve their quality of life.

## Conclusion

The sports education model at Junior High School 3 Lembang has been proven to have a better influence on student fitness levels. Meanwhile, physical education learning using conventional models does not have a significant influence on student fitness. So, it is recommended that teachers be able to master it, because students can obtain good physical fitness. To implement this, it requires a support from adequate infrastructure as well as full the schools and related parties in particular for physical education using this sports education learning model. Thus, it can for further research be recommended completing this study in using the sports education model related to other aspects such as strength, endurance, agility, speed, and balance. Also, the physical education teachers are expected to be able to apply their creativity when using the sports education model.

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## Ethics Statement

The study protocol was approved by the Ethics Committee of the Universitas Negeri Jakarta No.515/UN39.14/PT.01.05/VI/2024 and dated on June 10, 2024.

## Conflict Of Interest

The author declares that there is no conflict.

## Author Contribution

Conception and design of the study, SG, S, TR; Data Collection, SG, TR; Data analysis and interpretation, SG, S, TR; Drafting the article and/or its critical revision, SG, S; Final approval of the version to be published, SG, S, TR. All authors have

read and agreed to the published version of the manuscript.

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RESEARCH ARTICLE

# Impact of Dominance in Early Functional Mobility in Stroke Survivors

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**Abstract**

**Purpose** : Stroke is a major cause of mortality and causes significant impairment of functional mobility, regardless of whether it affects the dominant or non-dominant side, can increase future health risks. Our study purpose was to determine the impact of dominance in functional mobility impairment on stroke survivors. **Methods:** The research was conducted at Krishna College of Physiotherapy, Karad, involving 132 stroke patients, both male and female, with either left or right side affected by stroke. Participants were selected by random sampling based on predefined inclusion and exclusion criteria. They were evaluated using the Functional Independence Measure Scale (FIMS) and the Barthel Index Scale (BI). Collected data were analysed by SPSS version 26.0. **Results:** The study evaluated about functional mobility impairment on the dominant and non-dominant sides on the 1st and 45th day post-stroke. For Barthel index assessment, group B had significant improvement ( $p < 0.0001$ ) than group A($p<0.2846$) There was more improvement of Functional Mobility seen in the group B ($p < 0.0001$) for Functional Independence Measure ) affected Stroke survivors than compared to group A ($p=0.0004$) for Functional Independence Measure). Between group analysis for post test measurements was ($p<0.0001$) for both BI and FIMS showing significant differences. **Conclusion:** This study revealed that, 45 days post-stroke, functional mobility was significantly impaired in survivors of stroke with dominant side affected compared to the non-dominant side.

**Keywords**
Activities of Daily Living, Dominant Hemisphere Functional Mobility, Hand Dominance, Neurorehabilitation

## INTRODUCTION

Stroke is a major cause of long-term disability worldwide. The main risk factors contributing to stroke are elevation in the blood pressure, diabetes mellitus, smoking, and lack of physical activity. These risk factors can be modified by improving lifestyle (Katan & Luft, 2018). A reduced ability to perform daily living activities and functional mobility post-stroke is termed as residual impairment, and it primarily affects transfer tasks, such as a person's ability to walk, transfers from bed to chair, stair climbing, and maintaining independence. Majority of the stroke survivors experience cognitive impairment.

As per a previous study, it was seen that young adults show low function of hand dominance in unimanual task and perform the activity bimanually, contrary to that, older adults perform lateralized actions predominantly right hand. This bilateral brain activation involves activity of corpus callosum. It plays an important role in structural changes according to increase in age. When the motor evoked potential was recorded, young adults less frequently use their dominant hand compared to older adults. Also crossed minus uncrossed times i.e when the stimulus is in the left visual field, the right hand responses and vice versa. It is interhemispheric transfer time related to corpus callosum. It is longer in older adults and shorter in younger adults as it is related to dominant hand strength. So, they concluded the changes in callosum with age can affect the interhemispheric

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transfers in older adults (Dolaş & Toptaş Demirci, 2023). According to a previous study, 70% stroke survivors have cognitive deficits as per the type and time of the stroke. In the severely affected cases, which may lead to dementia (Rost et al., 2022). Around 40% of patients cannot perform daily activities (Ihle-Hansen et al., 2012; Lee et al., 2021). Inactivity and restriction-induced by decreased functional mobility impact the daily life of stroke survivors. This results in increase in rates of morbidity and mortality. Most stroke survivors face inability to perform the daily life tasks, ultimately decelerating the quality of life (Ellepola et al., 2022). Important factors that explain mobility restriction are the challenge of walking with a fear of falling and poor balance control (Chatterjee et al., 2018). Early impairment in functional mobility is more significant in patients after a stroke on dominant as well as non-dominant sides. Cognitive impairment occurring after three months of stroke is correlated with a decrease in the ability of daily living activities (Lo Coco et al., 2016). Cognitive motor interference occurs when performing cognitive activities and motor tasks simultaneously, resulting in decreased performance in one or both activities compared to performing each task independently (Plummer et al., 2013: Öztuna & Işık, 2023).

Right hemisphere stroke survivors may experience left-side weakness/paralysis, sensory impairment, visual problems, spatial problems concerning depth perception and direction (e.g., up-down, front-back), an inability to localize or recognize body parts, difficulty understanding and finding objects, problems in ADLs, behavioral changes, lack of concern about the situation, impulsivity, inappropriateness, and depression (Plummer et al., 2013). Left hemisphere stroke survivors may endure right-side weakness or paralysis, sensory impairment, language and speech comprehension issues, vision impairments (e.g., inability to view the right visual field of each eye), diminished ability to solve problems and reason, and behavioral changes such as depression, caution, and unwillingness. They may also have an impaired ability to read, write, and learn information, along with memory issues (Bonato M et al., 2019). If a person with a stroke is affected on their dominant side, it causes more difficulty compared to the non-dominant side. It becomes difficult to perform ADLs from the non-dominant side because of less habituation and muscle weakness. The dominant hand is faster, more precise in movement, and has better control over fine movements, with stronger and more developed muscles (Sarikaya et al., 2017).

A stroke can have a serious negative effect on a person and on the ability to perform various ADLs. For the initial period following stroke i.e two months, patients regain most of their independence in executing simple everyday tasks. Yet, throughout the subacute and chronic stages of the stroke, patients can still have issues performing simple hand movements, and these issues may last for years (Hillis & Tippett, 2014). Upper extremity function is the most commonly affected domain after stroke. The primary impairments in the hemiparetic extremity are spasticity, weakness and in the later stages contractures. This mostly affects activities of daily living which was performed by the patient independently before stroke. It is important to evaluate the severity of impairment so that it will be helpful to recover the patient with proper counselling and physiotherapy rehabilitation. This study aims to evaluate the impact of dominance in early functional mobility in survivors of stroke (Gunduz & Toprak, 2019).

## MATERIALS AND METHODS

The research study aimed to assess the impact of dominance on early functional mobility in stroke survivors. The study was conducted at Krishna College of Physiotherapy, Karad .

***Procedure***

The Institutional Ethical Committee of Krishna Vishwa Vidyapeeth has granted ethical permission for this research (No. 047/2022-2023). Participant provided informed risks, consent, with the volunteer form covering research details, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

***Participants***

Particularly lottery method was used. Numbers were written on the chits. Participant was asked to pick the chit. Group A involved odd numbered participants and even numbered participants involved in the group B. One hundred and thirtytwo participants included in the study. Stroke survivors were participants of the study included (within a year post-stroke), above 55 years

of age, including both males and females. Patients with any type of upper limb fractures, psychological complications, or neurological conditions apart from stroke were not included. Out of 132 participants, 16 participants didn't attend the follow-up assessment. So out of 116 participants who completed the assessment, 58 were involved in the group A, 58 were involved in group B.

In the study, it was shown that the pre and post assessment was taken on 1st day and 45th day. The duration fo protocol was of 6 weeks. So, before initiating the protocol and after completion of protocol, assessment of the patient was taken with the taken outcome measures. Detailed information regarding patient's daily activities, hand preference, task completion was taken. Procedure flowchart is given below.

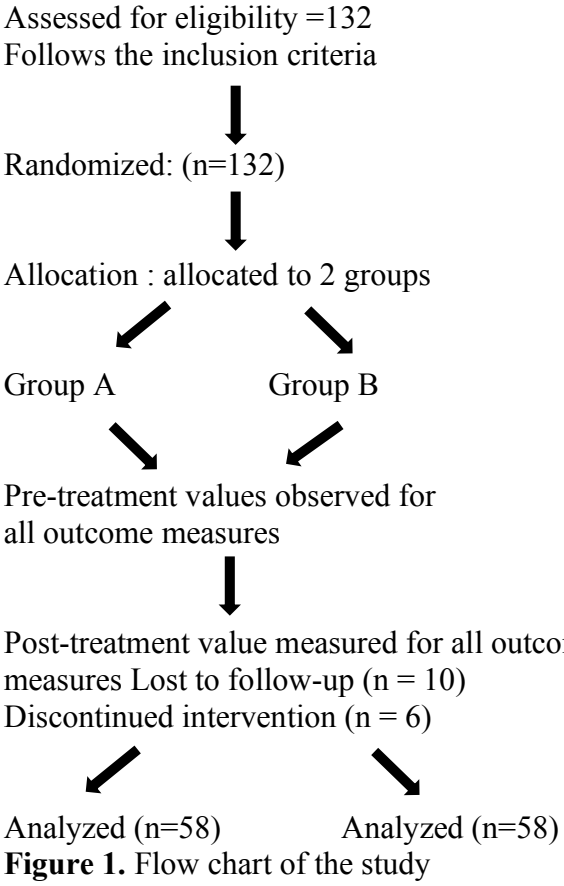


**Figure 1.** Flow chart of the study

**Intervention Given:**

Neurophysiological approach for stroke rehabilitation:

***Roods Approach***

Roods sensory motor training was given to the arm which includes – A rapid brushing or light touch on the skin, along with tapping on the muscle tendon or belly, is used to stimulate or inhibit neuromuscular responses. Techniques used were stroking, brushing and sustained stretching of upper limb.

***Facilitation of Normal Movement Patterns***

For eg. opening and closing the fingers, wrist flexion and extension. Grasp and release technique was given like picking up a cup and put it on a table.

-Passive movements of upper limb, then progress to active assisted movements of upper limb and then active movements.

-Task specific training involves the activities which need to be performed frequently and repetitively. The task should be with specific functional goal for eg. Grasping, picking up an object etc. All the tasks should perform within the available range of motion and voluntarily. For eg. peg board activity, in which board of various shapes is placed on the table. Patient is asked to correctly place the particular piece on the shape with the hand affected. While doing these tasks, commands should be given by the therapist to facilitate learning. Strengthening – isometric, eccentric and concentric muscle contractions induced exercises can be given. These exercises progressed with thera bands, rubber bands for shoulder, elbow and wrist movements. These exercises should be performed at low speed and on alternate days (Winstein et al., 2004)

***Motor control learning – There are various principles used to implement motor control which are***

1.Repetitive practice: It includes extended work episodes with no or very short rest periods. It should be vigorously performed on the affected limb.

2. Variable practice: It provides variability during training sequence. Some studies showed that variability induces increased neuronal activity which stimulates motor learning.

3. Increasing difficulty: It is better for the patient if one task is getting progressed after certain days as per the performance. One fixed task can not result in better outcome. Progression should be given to the patient. Based on these principles, various exercises were given to the affected upper limb of the patient including activities of daily living. (Ullah et al., 2020)

The treatment protocol was followed for 6 weeks and it was given 5 days a week. Pre and post test measurements includes Barthel index and FIMS that were used as an outcome measures before and after intervention. With the help of these scales, we assessed functional mobility of these patients on 1st and 45th day for group A (with dominant side), for group B (with non-dominant side).

### *Data Collection Tools*

An observational and assessment study was taken in detail using the FIMS and Barthel Index. Printouts of the scales were provided in the patient's local language and scoring was recorded of each participant. Before filling out the scale scores, relatives and the patient provided informed consent. Information was obtained about the patient's hand dominance (which hand they preferred pre-stroke for basic activities like eating and writing). The scale had two sections: the first section included the information of the patients (name, age, gender), and the other section included tasks of functional mobility and ADLs, and accordingly, the scores were noted.

### *Functional Independence Measure Scale (FIMS)*

This scale includes measures of independence in self-care (activities like eating, grooming, bathing, dressing), sphincter control (bladder and bowel management), transfers (from bed, chair, wheelchair, toilet, tub, shower), locomotion (walking or wheelchair use, stair climbing), communication (comprehension and expression), and social cognition (social interaction, problem-solving, memory). It comprises a total of 18 items. Each item is scored on a scale of 7 points. A higher score indicates greater independence, while a lower score indicates the need for more assistance. According to the score, there are three levels of categorization: complete dependence, modified dependence, and independence (Brosseau et al., 1996)

### *Barthel Index*

This scale includes ten components related to daily activities. Important aspect of this scale is to evaluate the patient's ability to perform activities independently. It involves 10 components, which consist of basic activities related to daily life like bathing, feeding, ability to do grooming and dressing independently, bowel and bladder management, toilet use, transfers (from bed to chair and back), mobility (on level surfaces), and stairs. The total score for the scale is 100 points. Each activity is rated according to the patient's performance with the following marks: 0 = dependent, 5 = major help (physical), 10 = minor help (verbal or physical), 15 = independent. A lower score indicates greater dependency, while a higher score indicates less dependency (Ohura et al., 2017).

### Statistical analysis

After collecting the data, it was entered into a Microsoft Excel sheet and evaluated with SPSS 26.0 software (SPSS Inc., Chicago, IL, USA). Paired t-test was used for analysis of before and after assessment values of a group (within the group analysis). Unpaired t- test was used for the between group analysis. The level of significance was set at $p \leq 0.05$. (Madjarova et al., 2022). The calculation of sample size was done by using this formula: 4pq/L^2 (p= positive factor/prevalence, q =100-p, L= allowable error)

## RESULTS

**Table1**.Demographic variables

| Demographic variables | N | Percentage |
|---|---|---|
| **Age** | | |
| 55-65 | 52 | 44.8 |
| 66-75 | 39 | 33.6 |
| 76-85 | 16 | 13.7 |
| 86-95 | 9 | 7.7 |
| **Gender** | | |
| Male | 67 | 57.7 |
| Female | 49 | 42.2 |
| **Dominance** | | |
| Right | 116 | 100% |
| Left | 0 | 0 |
| **Comorbidities** | | |
| Hypertension | 45 | 38.7 |
| Diabetes Mellitus | 42 | 36.2 |
| Obesity ( BMI : >30 ) | 51 | 43.9 |
| **Side affected by stroke** | | |
| Right | 58 | 50 |
| Left | 58 | 50 |

The main aim was to determine the impact of functional mobility on dominant and non-dominant side-affected stroke survivors. Two scales were used to assess functional mobility and determine which side is more prone to early loss of ADL (activities of daily living) functions. This study was performed among 116 participants. All participants and their relatives cooperated with the assessment procedure (Table 1).

The treatment protocol was given for 6 weeks after the pre assessment was taken in detail. At the end of the 6 weeks, post assessment was done on the basis of outcome measures taken and the results were interpreted as given below.

***Interpretation***

Table 1 includes the demographic variables of these participants: there were 49 females (42.2%) and 67 males (57.7%). They were divided according to age groups. The first group consists of 55-65 years of age & includes 52 participants. The second group consists of 65-75 years of age & includes 39 participants, the third group consists of 76-85 years of age & includes 16 participants, fourth group consists of 86-95 years of age & includes 9 participants

**Table 2.** Comparison of 1st day and 45th day of dominant side

| Group A (Dominant Side) | BI (1st Day) | BI (45th Day) | FIMS (1st Day) | FIMS (45th Day) |
|---|---|---|---|---|
| | Pre | Post | Pre | Post |
| Mean | 5.758 | 5.396 | 22.96 | 18.673 |
| Standard Deviation | 1.895 | 1.544 | 1.533 | 0.733 |
| Sample Size | 58 | 58 | 58 | 58 |
| Std.errorof mean(SEM) | 0.2488 | 0.2027 | 0.2126 | 0.1017 |
| Lower 95% conf.limit | 5.260 | 4.990 | 22.534 | 18.469 |
| Upper 95% conf.limit | 6.257 | 5.803 | 23.389 | 18.877 |
| Minimum | 4 | 1 | 20 | 18 |
| Median(50th percentile) | 5 | 5 | 23 | 19 |
| Maximum | 13 | 8 | 26 | 20 |
| Paired t-value | 1.080 | | 19.622 | |
| p value | 0.2846 | | 0.0004 | |

Barthel Index (BI), Functional Independence Measure Scale (FIMS)

Total 116 Participants with right side dominance were taken. Given the age groups chosen for the study, it was also important to check for systemic illnesses such as diabetes, hypertension, and obesity. In all, there were 45 hypertensive patients, 42 patients with diabetes mellitus, and 51 obese patients. The side affected by the stroke was given. 58 participants (50%) with the right side affected and 58 participants (50%) with the left side affected are included.

***Interpretation***

Table 2 explains the comparison of 1st day and 45th day for the dominant side affected. It involves 58 patients with dominant i.e right hand affected and by the results, it showed that the dominant side is more impaired on the 45th day post-stroke.

**Table 3**. Comparison of 1st and 45th day of Non- dominant side

| Group B (Non-Dominant Side ) | BI (1st Day) | BI (45th Day) | FIMS (1st Day) | FIMS (45th Day) |
|---|---|---|---|---|
| | Pre | Post | Pre | Post |
| Mean | 5.741 | 8.086 | 22.155 | 22.843 |
| Standard Deviation | 1.906 | 1.848 | 1.517 | 1.461 |
| Sample Size | 58 | 58 | 58 | 58 |
| Std.error of mean(SEM) | 0.2503 | 0.2426 | 0.1896 | 0.1826 |
| Lower95% conf.limit | 5.240 | 7.600 | 21.746 | 22.479 |
| Upper 95% conf.limit | 6.243 | 8.572 | 22.504 | 23.209 |
| Minimum | 4 | 5 | 19 | 19 |
| Median(50th percentile) | 5 | 8 | 22 | 23 |
| Maximum | 13 | 14 | 25 | 26 |
| Paired t value | 11.514 | | 6.157 | |
| p value | <0.0001 | | <0.0001 | |

Barthel Index (BI), Functional Independence Measure Scale (FIMS)

***Interpretation***

Table 3 explains the comparison of 1st day and 45th day for the Non-Dominant side and the results show that the non-dominant side is less impaired on the 45th day post-stroke after assessing by both the scales ($p<0.0001$).

**Table 4.** Between group analysis for group A and group B (BI)

| | Pre - Assessment Values | | | | | Post- Assessment Values | | | |
|---|---|---|---|---|---|---|---|---|---|
| **BI** | Group A | Group B | t value | p value | **BI** | Group A | Group B | t value | p value |
| Mean | 5.758 | 5.741 | 0.0482 | >0.9617 | Mean | 5.396 | 8.806 | 10.784 | <0.0001 |
| SD | 1.895 | 1.906 | | | SD | 1.544 | 1.848 | | |

Barthel Index (BI)

The dominant side was impaired on the 45th day. For the Barthel index, the dominant side of the patient was affected. The mean for BI on 1st day was 5.758 and on the 45th day, it was 5.396. For FIMS, on the 1st day, it was 22.96, and on the 45th day, it was 18.673. For the assessment of BI, on the first day, the mean was 5.741 and on the 45th day, it was 8.086. For FIMS, the mean was 22.155 for the 1st day and 22.843 for the 45th day.

***Interpretation***

Table 4 explains the analysis between pre assessment values of both the groups and post assessment values of both the groups. Post assessment values were extremely significant for both the groups, Group A (dominant side affected) and group B (Non-dominant side affected) were evaluated.

**Table 5.** Between group analysis for group A and group B (FIMS)

| | Pre - Assessment Values | | | | | Post- Assessment Values | | | |
|---|---|---|---|---|---|---|---|---|---|
| **FIMS** | Group A | Group B | t value | p value | **FIMS** | Group A | Group B | t value | p value |
| Mean | 22.96 | 22.155 | 2.8465 | <0.0052 | Mean | 18.673 | 22.843 | 18.743 | <0.0001 |
| SD | 1.533 | 1.517 | | | SD | 0.733 | 1.461 | | |

Functional Independence Measure Scale (FIMS)

***Interpretation***

Table 5 explains the analysis between pre assessment values of both the groups and post assessment values of both the groups. Post assessment values were extremely significant for both the groups, Group A (dominant side affected) and group B (Non-dominant side affected) were evaluated.

## DISCUSSION

Recently, especially in the post-COVID era, it is seen that there is an increase in stroke cases, which affects the functional tasks of daily living. A decline in functional mobility is a recognized residual impairment post-stroke and it involves activities like bed transfer or maintaining dependence while performing activities. Functional mobility is considered a major problem resulting in dependency after a stroke. So it is very important to regain functional mobility after stroke. Furthermore, given the importance to functional mobility post-stroke, we undertook a research to determine the effect of dominance on functional mobility in stroke survivors (Buvarp et al., 2020).

If the left hemisphere is affected by a stroke, opposite side (right) would be affected, resulting in symptoms including complete right-side paralysis, speech and language difficulties, memory loss, and

For BI, p value was <0.0001 post assessment. The results concluded, there is significant difference in the post assessment values of group A and group B. Dominant hand affected more on 45$^{th}$ day as patient was not able to utilize the dominant hand in the post-stroke phase.

For FIMS, p value was <0.0001 on 45th day. The results concluded, there is significant difference in the post assessment values of group A and group B. Dominant hand affected more on 45th day as patient was not able to utilize the dominant hand in the post-stroke phase.

sluggish behaviour. Conversely, if the right hemisphere is impacted by the stroke, the other side (left) will be affected, resulting in symptoms like complete left-side paralysis, memory loss, and vision issues. Moreover, there is a significant loss of muscle tone, which impacts mobility as spasticity or flaccidity (Mani et al., 2013).

In the present study, we had included the stroke survivors as study samples. As the sample included both right and left hemispheric strokes, the patients experienced higher cortical deficits like Aphasia. In some patients, there was a difficulty in speaking as the speaking speed was slight slow. In some patients, left sided neglect was present i.e. lack of awareness or attention seen to the left side of the body in some patients. Constructional apraxia: some patients were not able to draw, copy or construct the figures, diagrams or objects. Left sided sensory impairment: Some patients had numbness or reduced sensation to left side (Cramer et al., 2023; Hoffman et al., 1997).

There are various research studies performed on the post stroke rehabilitation of upper limbs. In one study, Constraint induced movement therapy (CIMT) after stroke showed significant effect in stroke patients. It involves the treatment of more affected hand by restraining the other i.e less affected hand. The treatment consists of vigorous exercises for affected hand. The less affected hand can be constrained by cast or mitt. This therapy helps to focus on the more affected part and that will help the stroke patients to recover faster. The results of this study showed that arm motor activity was improved after giving CIMT and had lasting effects on stroke patients (Langan & van Donkelaar, 2008).

An implication of motor relearning program in hemiparetic stroke patient was considered effective as concluded in a previous study. The treatment session was given for 3 days per week with duration of 1 hour. The treatment was given to shoulder, elbow, forearm with 16 torques. The torque and force levels progressed from proximal to distal. At the end of 8 weeks, the patient had positive outcomes in the terms of strength and coordination. In the present study, right side dominant study samples were taken. Treatment protocol was given for 6 weeks targeting the affected limb. In the case of right hand, the functional mobility was impaired more than the non-dominant side as it was habitual side of hand for the patient before stroke to perform any type of activity. So, the patient had difficulty in performing tasks when the dominant side was impaired compared to non-dominant side post stroke (Bourbonnais et al., 1997).

This study involved 116 stroke survivors and was conducted by using FIMS and BI assessment scales. Although this method is more efficient and cost-effective, a small degree of bias as unconscious patients were not taken from the study. By the interpretation of results, it was seen that while assessing for FIMS, the side which is dominant was impaired on 45th day (p=0.0004). For BI , the dominance was impaired on 45th day (p=0.2846). For the nondominant hand, while assessing for both FIMS and BI, it was not affected (p<0.0001). According to the findings of present study, it is stated that if the dominant side is affected, stroke patients experience more impairment and below-average performance in ADLs. if the hand impaired is dominant, because of its habitual use in the pre-stroke phase, the patient will attempt to use the hand as a part of habit frequently. The non-dominant hand is less used in activities like writing, eating, etc. pre-stroke, so to involve the non-dominant hand in performing the activities is a crucial task for the therapist to train the patients.

According to a previous study, individuals with stroke at a chronic stage experience difficulties in ADLs. The patients hospitalized for treatment post first stroke were involved. Various tools involving box and block tests, functional dexterity tests, and dynamometers were used. It concluded that ADL improved over time but the less affected UE remained below norms but some of the percentage of participants perceived it. The function of less affected upper extremity and more affected upper extremity, both contributes to independence. In this study, the dominant hand was affected on the 45th day of assessment, as it was habitual in the pre-stroke phase. The non-dominant hand was not affected as participants didn't prefer that hand for performing daily activities in the pre-stroke phase (Hmaied et al., 2022).

In a previous study by Jenny K. Rinehart, it was stated that after right hemisphere damage, the ipsilesional arm was used more frequently. Left

hemisphere damage patients used both arms while performing activities. In this study, a hand-held dynamometer was used to check grip strength, as well as the Fugl-Meyer Upper Extremity Motor Score for assessment. The study results didn't give an explanation of right hand preference in patients with right hemisphere damage. In this research, after evaluating both hands with FIMS and BI, it was stated that more impaired side was dominant and usually preferred for activities, affecting daily life more severely. The non-dominant hand is used less than dominant hand in the pre-stroke phase and is, therefore, less impaired (Rinehart et al., 2009).

The study conducted previously included the patients with right and left hemispheric lesions who had upper extremity complications. The participants with right-hand dominance were given bimanual training which was nonprogressive and also included auditory cueing. After one and half months, both groups improved in the Fugl - Meyer Upper Extremity test but only patients with lesions at left hemisphere showed the improvement in Wolf Motor Arm Test. The conclusion was right arm impairment showed more improvement post-treatment than the left arm as the right arm was dominant. In this study, dominant hand is more impaired on the 45th day post-stroke compared to non-dominant side, it will cause difficulty in performing activities post-stroke because it was more frequently used in the pre-stroke phase by individuals (Waller & Whitall, 2005).

A previous study by Provins et al. concluded that healthy individuals prefer to use their dominant arm more frequently during daily activities, as evidenced by improved arm-pointing accuracy, speed of movement and precision. However, the side impaired is non-dominant, individuals may use it less as the hand preference will be dominant side, which may cause difficulty to promote its use in therapy. As per the results of this study, the hand impaired was dominant on the 45th day when assessed by FIMS and BI. The non-dominant hand was not affected on the 45th day when assessed by FIMS and BI. The dominant hand was more oftenly used for the tasks in the pre-stroke phase so it will be more difficult for the patient to perform the tasks by using it post-stroke. So the patient will use the nondominant hand which will cause difficulty as it is not frequently used in daily life (Provins, 1997).

Previous research by Harris JE et al. stated that there is less impairment on the dominant side post-stroke than on the non-dominant side. The study included participants aged 50 years with one time stroke incidence . The Fugl-Meyer Motor Impairment Scale (FMA) used to evaluate arm motor recovery. The side which was dominant experienced less pain despite severe impairment because, in the pre-stroke condition, the dominant hand was frequently used during daily activities, resulting in less pain than the non-dominant side. Also, ADL tasks involving both hands had less contribution from the dominant hand or used the non-paretic side to perform tasks (Harris &Eng, 2006). In this study, after assessing patients with FIMS and BI on the first and 45th days, dominant side function was reduced post-stroke as it is habitual for a person to perform activities by dominant side in the pre-stroke condition as per the detailed assessment for dominance. It becomes difficult for the person to utilize the non-dominant hand post-stroke as the participant didn't use it as first hand preference to perform the activities in the pre-stroke phase. Additionally, suppose the dominant side is affected post stroke, In that case, individuals can get motivated to use that hand during recovery. In the present study, it is stated that impairment of the dominant hand will affect daily activities more and may cause inconvenience to patients (Katz and Rymer, 1989).

Stroke rehabilitation aims to maximize training benefits and enable individual patients to reach their full potential to achieve the highest level of physical and psychological performance. Physiotherapists face a challenge in accurately predicting the level of disability the patient will eventually experience at an early post-stroke stage to facilitate the best stroke rehabilitation and appropriate discharge planning and resource implementation. Early and vigorous physiotherapy should be initiated at the early stages in people affected by a stroke on the dominant side. Hence, treatment approaches can be executed more specifically as per the side of stroke.

Strengths of the study: The ADLs-specific task activities will encourage the patient's ambulation during this duration. Focusing on dominance's impact on early functional mobility will lead to quicker recovery times and improved long-term mobility for stroke survivors. Allows for better education and expectation management for patients and their families regarding the potential challenges and recovery process.

***Limitations***

The study was performed in a single geographical area. In future, it can be conducted in multiple areas and with large sample size.

***Conclusion***

Overall, it is evident that if a stroke affects to dominant side, the functional mobility is significantly reduced as the individual is habitual to the dominant hand use more in the pre stroke phase. Also, majority of the patients are not aware of the process and the implications of functional mobility impairment. It is important to educate the stroke survivors and to raise awareness about the early loss of functional mobility after a stroke. Comprehensive evaluation of the impairment should be done for upper extremity in post stroke phase. As per the affected extremity involvement, ADLs focus therapy and bimanual task training should be involved to encourage the use of both hands. To encourage the patients about home exercise programs that can performed independently and also educate his or her family members about the impairment.

***Clinical Implications***

Recognizing the dominant side impairment may have greater impact on mobility. Early and intensive rehabilitation can be initiated. Therapist can focus on activities that are particularly challenging for patients with dominant side impairments. Emphasizing the importance of dominant side recovery can lead to better planning of long term care, aiming to restrore independence.

***Conflict of interest***

We affirm that the article we have authored does not involve any conflict of interest.

***Ethics Statement***

The Institutional Ethical Committee of Krishna Vishwa Vidyapeeth has granted ethical permission for this research (No. 047/2022-2023).

***Author contributions***

Conception and design of the study, KG,SS ; Data collection, KG,SA; Data analysis and interpretation, SS,SA; Drafting article and critical revision, SS,SA,KG. All authors have read and approved the published version of the manuscript.

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RESEARCH ARTICLE

# Impact of the COVID-19 Lockdown on Food Habits, Body Weight, and Physical Activity in School-Aged Students

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**Abstract**
The COVID-19 pandemic, caused by the SARS-CoV-2 virus, represents a significant health crisis, particularly affecting individuals' physical and mental well-being across all ages, especially students. This study seeks to assess how the COVID-19 lockdown affected food consumption, body weight, physical activity, and sleep patterns among Algerian students. A cross-sectional survey was conducted with 128 students, averaging 17.99 years old, featuring questions on demographics, body measurements, food habits, and lifestyle changes during the lockdown. Data analysis was performed using SPSS version 23, employing methods such as the Student's t-test, Spearman's correlation, and the Chi-square test to describe the results. Findings revealed a notable disparity in overweight rates ($p<0.001$), with females at 25.93% and males at 10.64%. Furthermore, 29.63% of females reduced their food intake, while 34.04% of males increased theirs ($p=0.003$). During the lockdown, 23.46% of females gained weight, contrasting with 35.8% who lost weight. There were notable and statistically significant differences between the sexes, with $p<0.001$. Physical activity levels were 17.19% higher on school days compared to during the lockdown. Sports activity and walking durations were significantly greater for males than females ($p<0.001$). Conversely, the mean sleep duration of students during the COVID-19 lockdown was 7.33±1.16 hours, with significant differences observed between sexes ($p<0.001$) These findings provide a valuable foundation for future research exploring the impact of COVID-19 on populations. They offer insights that may inform policy-making, public health strategies, and further academic studies.

**Keywords**
COVID-19, Food Intake, Sports Activities, Students, Body Weight, Sleep Duration

## INTRODUCTION

The first detection of COVID-19 was in Wuhan, China, at the end of December 2019. This virus was quickly spread and exported to the globe in March 2020, and it was declared a pandemic by the World Health Organization (Villani et al., 2021: Dolaş & Toptaş Demirci, 2023). Algeria was the most severely impacted country in Africa, following South Africa, Egypt, and Morocco. On March 23rd, 2020, according to the Algerian health minister's declaration, phase 3 was started with 2718 cases and 384 deaths (Lounis, 2021). During this period, the daily life and education sectors were disturbed by the COVID-19 pandemic (Schröpfer et al., 2021). To ensure the smooth running of studies, teachers and students have used social platform sites (such as Facebook, Instagram, YouTube,

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WhatsApp, and Twitter) and educational online platforms (Ghounane, 2020). However, the online teaching methodology used to ensure physical distancing and stop the spread of the virus can result in depression and anxiety (Schröpfer et al., 2021).

Stress can be caused by a variety of factors, including the environment or a person's internal perception. It can produce anxiety with or without other negative emotions and feelings, like depression, sadness, and pain, with the development of potential psychological disorders (Shahsavarani et al., 2015). Stress can be classified into two types: episodic acute stress and chronic acute stress. The first one is a recurring type of stress that happens over and over. The second can be thought of as never-ending stress that relentlessly wears on you. It can appear due to situational responses and circumstances beyond your control, such as poverty or a toxic job. Persons feeling chronic acute stress require help because it can affect human health, causing heart problems, strokes, or even cancer (Hena et al., 2020).

Students lives are accompanied by stress, which can affect their lives and also their academic performance (Edjah et al., 2020; Kaya & Demirci, 2024). Sometimes, minimal stress can generate positive student results; however, uncontrolled stress can induce a negative effect on health. A previous study reported that female students were more influenced by academic stress than male students (Rana et al., 2019). Furthermore, stress can increase appetite and craving, disturb sleep, and decrease physical activity. The presence of these factors plays a key role in weight gain and obesity (Geiker et al., 2018). It was reported that the increase or decrease in energy intake was related to the severity of stressors, sex, and other factors.

Physical activity can be very beneficial in the event of a pandemic and in the prevention of infectious diseases (Chastin et al., 2021). Sport or exercise can have a positive or negative impact on the immune system, depending on the type of workout, intensity, and duration. Moderate exercise seems to help compensate for the negative effects that aging has on the immune system (Forte et al., group, and by twenty-five students from the same school before the inclusion phase. In addition, face-to-face interviews were conducted by members of research groups highly experienced in conducting interviews (Figure 1). The survey was distributed to all students present at the high school (128 students). The designers of this questionnaire 2022). It is suggested that physical activity can improve vaccine response; therefore, acquired immunity may be higher in an active population (Chastin et al., 2021). Recently, it has been demonstrated that COVID-19 can decrease mobility, walking, and physical activity, and increase sedentary behavior (Park et al., 2022). Thus, this study aimed to explore how the COVID-19 lockdown influenced food intake, body weight, physical activity, and changes in sleeping habits among high school students preparing for the baccalaureate exam.

## MATERIALS AND METHODS

### *Participants*

This survey was done at the high school of Colonel Ali Tounsi in the center of Relizane (Northwest Algeria) between April, 8th to 15th, 2021 during the COVID-19 lockdown period. The study included only students in the third year (preparing for the baccalaureate exam) from both sexes (Male and Female) with a mean of age 17.99±0.89 years old. A total of 128 students, comprising 81 females and 47 males, participated in this study, accounting for 92% of the 139 students subscribed to the third year.

### *Study Design*

In this cross-sectional study, a survey questionnaire was prepared to collect information about students. Subjects were voluntarily enrolled and had given their consent to participate. The data was collected through face-to-face interviews with students. It was divided into four parts; part 1: demographic and general information (age, sex); part 2: anthropometry parameters (body weight, height, waist, and hip); part 3: food intake (food intake frequency, effects of COVID-19 lockdown, and stress baccalaureate on food intake); and part 4: physical activity (sports activity, number of sessions per week, walking daily duration, and number of sessions per week.) and sleeping (sleep duration). The developed questionnaire was checked for comprehension, validity, and reliability, pre-tested by all members of the research (Authors) excluded from this study, students with: i). eating disorders (Inherited obesity, Anorexia nervosa, Bulimia Nervosa, etc.), ii). physical restrictions and iii). other pathologies treated with medications that could interfere with eating or physical activity. The study team coded the data, added it to the database, and then verified, updated,

and validated it. The use of all information was used anonymously, and all data was kept private.

***Research Procedure***

The preparation phase includes securing research permits from the Department of Education and the school, along with organizing essential tools and equipment like digital scales and a stadiometer. Following this, a briefing is held for the research assistants responsible for data collection. The data collection process involves measuring and recording each student's weight, height, waist circumference, and hip circumference in rotation. Furthermore, the assistants document details about students' food intake, body weight, physical activity, and sleep patterns.

***Collection of Data Anthropometry***

A calibrated balance was used to measure body weight to the nearest 100 g (Terraillon, Croissy-sur-Seine, France). Standing height was measured in centimeters using a studio meter positioned on a wall. The circumferences of the waist and hips were measured to the nearest 1 mm using a 0-220 cm measuring tape. The circumference of the waist was measured at mid-height between the lower rib and the iliac crest, while the circumference of the hip was measured at the highest circumference around the buttocks. Body mass index (BMI) was calculated by dividing the weight (in kilograms) by the height squared (in meters squared) (Hadri et al., 2024; WHO, 2024; Yusuf et al., 2024). Corpulence was defined as underweight (BMI < 18.0 kg/m2), normal (BMI = 18.5-24.9 kg/m2), overweight (BMI = 25.0-29.9 kg/m2), and obese (BMI ≥ 30.0 kg/m2), according to the BMI values.

***Food Intake And Body Weight Data***

As shown in Figure 1, food intake was evaluated by the student's declaration of normal, an increase or a decrease under COVID-19 lockdown and baccalaureate stress. Students were asked to report any changes in their food intake compared to their usual dietary habits before the COVID-19 lockdown and during the period of baccalaureate. The body weight evolution during the COVID-19 lockdown was also recorded using three situations: lost weight, gained weight, and no change (or stable body weight). Participants were asked to select the situation that best represented them before and during the stage of confinement and during the period of baccalaureate. Students were able to discern any changes in their body weight before and after the confinement period by participating in physical activity sessions, during which they had several opportunities throughout the school year to measure their weight.

***Physical Activity and Sleeping Data***

Physical activity during lockdown (sports activity, number of sessions per week, walking daily duration, and number of sessions per week) was evaluated by the student's self-declaration using modified (Hadri et al., 2022; Romero-Blanco et al., 2020). Furthermore, we assessed sleep quality and duration using specific questions selected from the Pittsburgh Sleep Quality Index Questionnaire (Luciano et al., 2021).

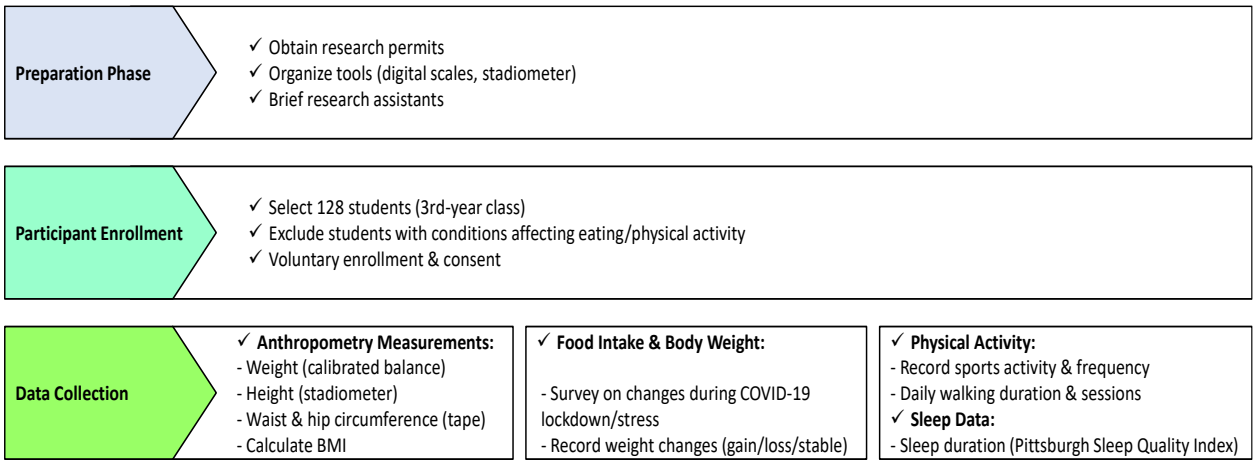


**Figure 1.** Research procedure flowchart: assessing the impact of COVID-19 on student health and behavior

***Statistical Analysis***

The data were represented by mean ± SD (standard deviation), percentage, and frequency. When the conditions of normality and homogeneity of the variances were observed using Shapiro-Wilk's test, means were compared between males

and females using a student's t-test for anthropometry indicators (weight, height, BMI (total and for the four categories separately: underweight, normal weight, overweight, and obese), waist and hip circumferences), physical activity (sports activity, walking daily duration), and sleeping (sleep duration). Relationships between body weight and physical activities were evaluated by the calculation of Spearman's correlation coefficient. The chi-square test was used to compare between percent and frequency (food intake, body weight variation, and physical activity). All data analyses were carried out using SPSS software (IBM SPSS Statistics, Version 23.0. Armonk, NY, USA). The level of significance was fixed at $p<0.05$.

## RESULTS

**Table 1:** Anthropometry of students by sex during the pandemic

| Parameters | Total (N=128) | Female (N=81) | Male (N=47) | p-value |
|---|---|---|---|---|
| **Anthropometry (Mean ± SD)** | | | | |
| **Weight (kg)** | 60.05 ± 10.19 | 58.43 ± 9.72 | 62.84 ± 10.48# | <0.001 |
| **Height (m)** | 1.67 ± 0.09 | 1.62 ± 0.06 | 1.75 ± 0.08# | <0.001 |
| **BMI (kg/m²)** | 21.64 ± 3.43 | 22.28 ± 3.42 | 20.55 ± 3.19# | <0.001 |
| **Waist circumference (cm)** | 76.88 ± 8.56 | 75.94 ± 8.81 | 78.5 ± 7.94# | <0.001 |
| **Hip circumference (cm)** | 94.51 ± 7.72 | 94.29 ± 6.98 | 94.88 ± 8.92# | <0.001 |

N: sample size; SD: Standard Deviation; BMI: Body mass index; # indicates a significant difference between males and females (Students t-test, $p<0.05$).

**Table 2:** BMI weight status categories of students during the pandemic

| BMI weight status categories | Total (%) | Female (%) | Male (%) | p-value |
|---|---|---|---|---|
| **Underweight : <18.5 kg/m²** | 18.75 | 13.58 | 27.66# | <0.001 |
| **Normal weight : 18.5-24.9 kg/m²** | 60.16 | 59.26 | 61.7# | <0.001 |
| **Overweight : 25-29.9 kg/m²** | 20.31 | 25.93 | 10.64# | <0.001 |
| **Obese : ≥ 30 kg/m²** | 0.78 | 1.23 | 0 | / |

BMI: Body mass index; # indicates a significant difference between males and females (Students t-test, $p<0.05$).

### *COVID-19 Lockdown Stress Period and Food Intake*

According to the data provided by the questionnaire, the daily number of students' meals during the COVID-19 lockdown was 1.89±1.2 meals. The mean number of meals consumed by males was higher than for females ($p<0.001$), which represented 2.15±1.4 and 1.74±1.1 meals per day, respectively. During the COVID-19 lockout, 26 (20.31%) out of the total students included (128 students) claimed a reduction in their food intake, and the number of students who declared an increase in their food intake was 35 (27.34%), while 67 students (52.34%) had a stable food intake. According to statistical analysis, the impact of COVID-19 stress on food intake varied by sex ($p=0.003$, table 3). Female students decreased their food intake more than males students, which is represented by the rates of 29.63% vs. 4.26%, respectively. A higher rate of increase in food intake was observed in males compared to females (34.04% vs. 23.46%, respectively).

### *Impact of COVID-19 Lockdown on Body Weight*

An important change in body weight showed during the COVID-19 lockdown compared to the period before the COVID-19 lockdown ($p<0.001$, table 4). Female students were more affected by the change in their body weight. The weight gain was reported at a rate of 35.8%. However, 23.46% of females had lost weight, while 40.74% of females had a stable weight. Except for one male student who declared weight loss, the body weight of males seems not to have been affected by the COVID-19 lockdown.

**Table 3:** Effect of the COVID-19 lockdown and baccalaureate stress on food intake

| | Food intake during COVID-19 lockdown N (%) | | | |
|---|---|---|---|---|
| | **Decrease** | **Increase** | **No change** | **p-value** |
| **Female** | 24 (29.63%) | 19 (23.46%) | 38 (46.91%) | 0.003* |
| **Male** | 2 (4.26%) | 16 (34.04%) | 29 (61.7%) | |
| **Total** | 26 (20.31%) | 35 (27.34%) | 67 (52.34%) | |

N: Sample size; *: Indicate a significant difference between males and females (Chi-square test, p<0.05).

**Table 4**: Body weight variation during COVID-19

| | **Lost weight** | **Gained weight** | **No change** | **p-value** |
|---|---|---|---|---|
| **Female N (%)** | 19 (23.46%) | 29 (35.8%) | 33 (40.74%) | <0.001* |
| **Male N (%)** | 1 (2.13%) | 0 | 46 (97.87%) | |
| **Total N (%)** | 20 (15.63%) | 29 (22.66%) | 79 (61.72%) | |

N: sample size; *: Indicate a significant difference between males and females (Chi-square test, p<0.05).

**Table 5:** Physical activity and sleeping duration during COVID-19 lockdown

| | **Total** | **Female** | **Male** | **p-value** |
|---|---|---|---|---|
| **Duration of sports activity (hour)*** | 1.01±0.64 | 0.64±0.29 | 1.36±0.69# | <0.001 |
| **Duration of walking (hour/day)**** | 0.47±0.29 | 0.46±0.24 | 0.5±0.36# | <0.001 |
| **Frequency of sports activity (Session/week)** | | | | |
| | **1 session** | **2 sessions** | **3 sessions** | **More** | **p-value** |
| **Female** | 22 | 8 | 2 | 1 | <0.001## |
| **Male** | 7 | 12 | 9 | 6 | |
| **Total** | 29 | 20 | 11 | 7 | |
| **Physical activity under the COVID-19 lockdown**N (%)** | | | | |
| | **Increase** | **Decrease or no change** | | |
| **Female** | 40 (49.38%) | 41 (50.62%) | | |
| **Male** | 26 (55.32%) | 21 (44.68%) | | |
| **Total** | 66 (51.56%) | 62 (48.44%) | | |
| **Physical activity during the school year**N (%)** | | | | |
| | **Increase** | **Decrease or no change** | | |
| **Female** | 52 (64.2%) | 29 (35.8%) | | |
| **Male** | 36 (76.6%) | 11 (23.4%) | | |
| **Total** | 88 (68.75%) | 40 (31.25%) | | |

N: sample size. * Data of the athletic students. ** Data of all students. # Indicate values that are significantly different between males and females (Student t-test, p<0.05).##: Indicate a significant difference between males and females (Chi-square test, p<0.05).

***Physical Activity and Sleeping During the COVID-19 Lockdown***

In this study, physical activity was defined as an indoor and outdoor sports activity, or walking during the COVID-19 lockdown. The number of athletic students was 67 (52.34%), while 61 (47.66%) students did not practice any sports activity. The frequency of sports activity was significantly higher in males than in females (Table 5). The majority of female students practiced one session of sport per week. According to table 5, the duration of the sports per session in males was higher than in females (1.36 hours vs. 0.64 hours, respectively; p<0.001). The mean time of walking was also higher in males than in females, which was represented respectively by 0.5±0.36 hour/day and 0.46±0.24 hour/day. During the school year (from September 2020 to April 2021), students increased their physical activity by 17.19% compared to the total COVID-19 lockdown (From March 2020 to August). Moreover, a positive correlation was recorded between body weight and physical activity (r=0.304; p= 0.013).

In addition, the sleep patterns of the students varied between 6 hours or less and 9 hours or more (Table 6). It was found that 33.59% had 6 hours or

less of sleep, 22.66% had 7 hours, 21.09% had 8 hours, and 22.66% had 9 hours or more throughout the day. The sleep pattern for females and males is more clearly illustrated in table 6. The daily sleeping time of females (7.45±1.12 hours) was significantly higher than that for males (7.26±1.18 hours).

## DISCUSSION

This study aimed to evaluate the effect of the stress due to COVID-19 lockdown and baccalaureate exams on food intake and body weight variation. During the COVID-19 lockdown, results from this study showed that 1/5 (20.31%) of students were underweight, while obesity was represented by a rate of 0.78%. Moreover, the analyses of the collected data indicated that a quarter of females were underweight, while 1/10 of males were underweight. In contrast, 27.66% of males and 13.58% of females were underweight. Females were more affected by the body weight variation than males. Weight gain for females was perceived at 35.8%, and weight loss was perceived at 23.46%. In a recent study, it was shown that weight gain was reported in 38% and weight loss was reported in 22.8% among included Peruvian adults during the COVID-19 lockdown (Rojas Huayta et al., 2022). In Saudi Arabia, the COVID-19 quarantine was implicated in the weight gain of 38% and the weight loss of 26% among subject participants using an online questionnaire (Bakhsh et al., 2021). In the same country, students' BMI showed that 32% increased their weight, 22% lost weight, and 46% maintained the same weight during the COVID-19 crisis (Jalal et al., 2021). In Bangladesh, the prevalence of overweight for adult participants was 30.5% before the COVID-19 pandemic, and it increased to 34.9% during the pandemic (Akter et al., 2022). Morocco, like other countries, was affected by COVID-19, and according to Boukrim et al., more than a quarter of the students with a high education were overweight or obese during lockdown (Boukrim et al., 2021), while the same rate was observed for females in this study. Furthermore, three months of COVID-19 lockdown increased the number of overweight and obese Lebanese students by 5.2% (Zoghbi et al., 2022).

In this study, a positive correlation was reported between body weight and sports activity but not with walking, which can be explained by the importance of sports activity to increase the lean mass of the human body. In 2016, Klemmer et al. observed an increase in the lean body mass of participants due to sports activity (Kemmler et al., 2016). The type of effort or exercise was implicated in lean body mass construction. The measurement of the lean mass using dual-energy X-ray absorptiometry (DXA) showed that the handball players had the highest values in lean mass in comparison to the swimmers and football players (Ubago-Guisado et al., 2017).

In these findings, the stress of COVID-19 and the baccalaureate exam can affect the food intake behavior of high school students. More than half of the female students increased or decreased their food intake under the COVID-19 lockdown. On the one hand, males were the most affected by the increase in food intake, and they had a higher number of meals than females. On the other hand, the stress of the baccalaureate changed the food intake of all students (67.19% of the students decreased their food intake and 32.81% of students increased it). In line with the findings of Demirci et al., food consumption was disturbed in Turkish high school students during COVID-19 compared to the period before COVID-19, and more meals were cocked at home (Demirci et al., 2021). According to an Italian investigation, eating habits were recorded for 1841 participants out of 3533 participants during the COVID-19 pandemic.

The perception of hunger and satiety was affected by more than half of the participants: 17.7% had less appetite, while 34.4% had more appetite (Di Renzo et al., 2020). In 2019, a study was conducted by Bhavani and Prabhavathy Devi to investigate the impact of stress on the food intake of Indian college students. It was found that 47% and 29.9% of subjects consumed more and less food at stressful times, respectively, and that around 37.5% consumed more food in sight of their favorite foods (Bhavani & Prabhavathy Devi, 2019). Students who had perceived high levels of stress increased unhealthy eating behaviors, such as eating prepared meals and snacking (Caso et al., 2020; Choi, 2020; Oh et al., 2023).

In addition, our data showed that the athletic students were represented at a rate of 52.34% (67 students out of 128 students). Physical activity levels during the social distancing period were lower than those during the pre-pandemic period (Puccinelli et al., 2021). Our finding showed that there was no gender effect on physical activity,

which was in concordance with the results reported by Mohd Hakim et al. (Mohd Hakim et al., 2021). We also investigated the number and duration of the sports sessions and observed that males had more sports sessions and longer sessions than females. In addition, walking time was higher for males than for females. The low physical activity of females explains the most important part of the weight gain and the high BMI of females. From a previous study, moderate to intense daily physical activity can be decreased by 42.5%, from an average preschool duration of 80.18 minutes per week to a post-secondary duration average of 46.13 minutes per week (Grimes et al., 2022; Grimes et al., 2022). Recently, Bielec and Omelan reported a vigorous physical activity decrease in female students following an online survey (Bielec & Omelan, 2022), and inactivity affected males more negatively than females during lockdown (Atiković et al., 2020).

Results from this questionnaire reported that the females sleeping time was higher than that of the males, and the general mean sleep duration was 7.33±1.16 hours/day. An on-line survey conducted over six months showed that 36.5% of Nigerian students changed their sleep patterns during COVID-19 (Ellakany et al., 2022). In our findings, the sleep pattern during quarantine varied from 6 hours or less to 9 hours or more. The sleep pattern of the Iranian students during the school closure following the COVID-19 pandemic varied from 5 hours to 12 hours. It was reported that 13.4% of students had 5 or fewer hours of sleep, 13% had 6 to 8 hours, 12.8% had 9 to 10 hours, 7.3% had 11 to 12 hours, and 53.5% had above 12 hours of sleep per day (Ranjbar et al., 2021). In southern England, students' bedtime and waking time were later, and sleep duration was longer in 2020 than in the 2019 survey (Illingworth et al., 2022). On the other hand, a longer sleep period was significantly associated with better health characteristics, although this has been balanced by a combination of depressive symptoms with poorer health-related features and increased caffeine intake (Albrecht et al., 2022).

Limitations of this study include that research has been conducted with participants living in the city center; consequently, it is necessary to interpret its results carefully, and the generalization of these results to all Algerian high school students should be more cautious. The majority of Relizane's regions were under lockdown, which limited our travel to develop this survey. Relizane is a rural city, and the access of the students to the internet was almost very difficult, which prevented us from putting the questionnaire online. In this study, the impact of stress during school on body weight and sleeping was not evaluated due to the short duration of the questionnaire. Objective measurements were not available, such as changes in the levels of body hormones under stress.

***Conclusion***

Our findings indicated that high school students' food intake was influenced by the stress associated with the COVID-19 pandemic and the baccalaureate exams. This stress affected eating habits in both genders. Additionally, the weight of female students was impacted by pandemic-related stress. Males were generally more active than females, participating in more sports sessions and spending longer durations on physical activities, including walking. The lockdown created a unique situation where boredom and stress could disrupt athletes' routines and lead to unhealthy eating habits.

To mitigate the negative health effects of stress, various strategies can support students, such as balancing study and leisure time, improving time management, engaging in regular exercise, and practicing relaxation techniques like meditation and yoga. The limited access to sports activities during the lockdown should be supplemented with home-based physical activities.

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***Conflict of interest***

We affirm that the article we have authored does not involve any conflict of interest.

***Ethics Statement***

This research ethical approval was obtained Research from The Local Ethics Committee and the Data Protection Board (DPB) of the University of Relizane on January 18th, 2021 under the project code D04N01UN480120230001.

***Author Contributions***

Study design, HZ and BM; Data collection, HZ and BM; Statistical analysis, HZ, BS, BM, BB, KR and SSH; Data interpretation, HZ, BS, BM, BB, KR and SSH; Literature search, HZ, BS, BM, BB, KR and SSH. All authors have read and approved the published version of the manuscript.

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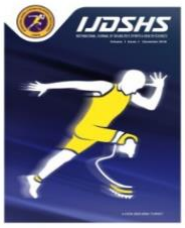

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RESEARCH ARTICLE

# The Effects of Anxiety on the Performance of Tennis and Table Tennis Players

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**Abstract**
Athletes' performance is influenced by numerous factors, among which anxiety is a significant one. This study investigates the effects of anxiety on the performance of tennis and table tennis players, considering various influencing factors. The scale method, a quantitative research approach, was employed in the study. A total of 186 tennis and table tennis players aged between 8 and 20 years participated, consisting of 113 Boys and 73 Girls players. The Sport Anxiety Scale 2 (SAS-2) was used to collect data. This scale is a 15-item, 3-subdimension, 4-point Likert-type tool. Higher scores on the scale indicate higher levels of anxiety among the participants. Data were analyzed using SPSS 25 software, with parametric tests applied due to the normal distribution of the data. Significant differences in sports anxiety levels were found among tennis players based on weekly training frequency and sports age ($p<0.05$). For table tennis players, a significant difference was observed based on sports age ($p<0.05$). However, no significant differences were found in sports anxiety levels based on gender, weekly training frequency for table tennis players, or across the two disciplines ($p>0.05$). The study concludes that sports anxiety does not vary by gender, that the anxiety levels of table tennis and tennis players are similar, and that individuals with greater sports experience tend to exhibit higher levels of sports anxiety.

**Keywords**
Sports, Anxiety, Table Tennis, Tennis

## INTRODUCTION

Sports can be defined as activities involving individual competition or structured contests between two teams, conducted within specific rules (Temel, 2019). The competitive nature of sports directly impacts athletic performance, significantly influencing the outcome of competitions (Reilly, 2001). Among the various factors influencing athletes' performance, psychological factors hold a critical role in determining success (Bayraktar & Kurtoğlu, 2009). Psychological factors encompass several sub-factors, with anxiety emerging as a pivotal element that significantly affects athletic performance (Ölçücü & Dereceli, 2023). Even when physically prepared, athletes may experience underperformance or failure due to insufficient psychological readiness, such as difficulty managing stress and maintaining focus (Brewer, 2009; Konter, 2006). Anxiety, often regarded as a negative factor in sports performance (Eysenck, 1996), manifests in various forms (Singh et al., 2016). When managed effectively, anxiety can have positive effects, enhancing focus and performance (Taylor & Gregory, 2002). However, uncontrolled anxiety may lead to adverse outcomes, including behavioral disorders (Cüceloğlu, 2006). Therefore, maintaining an optimal level of anxiety is essential for achieving peak athletic performance (Suinn, 1987).

Tennis and table tennis are disciplines that require both physical skills and mental resilience

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(Uluç, 2022). Success in these sports depends not only on technical abilities but also on the ability to cope with stress and maintain focus during high-pressure situations. Despite this, limited research has explored the anxiety levels of tennis and table tennis athletes and how these affect their performance.

This study aims to investigate the anxiety levels of tennis and table tennis athletes with respect to demographic factors (gender, sports age, and sports discipline) and training habits (number of weekly training sessions). Additionally, it seeks to compare the effects of these sports disciplines on anxiety levels and to contribute to identifying the psychological support needs of athletes. Our hypothesis is that sports anxiety will vary according to demographic factors.

## MATERIALS AND METHODS

### *Participant*

This study employed the scale method, one of the quantitative research approaches. The sample for the study was selected using a non-random sampling method (Gravetter & Forzano, 2012). A sample size calculation was performed, determining that participation from 150 players would suffice within a 10% confidence interval. Ultimately, 186 players participated in the study. The sample comprised 85 table tennis players (44 Boys, 41 Girls) and 101 tennis players (69 Boys, 32 Girls) aged between 8 and 20 years. This study was approved by the Çanakkale Onsekiz Mart University Ethics Committee (Approval No: 15/55, dated October 24, 2024). Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.The age distribution of players by sports discipline is presented in Table 1.

**Table 1**. Age distribution of players according to their sports discipline

| | N | Min | Max | X | S.S |
|---|---|---|---|---|---|
| **TableTennis** | 85 | 8 | 15 | 11,82 | 1,820 |
| **Tennis** | 101 | 13 | 20 | 15,76 | 1,756 |
| **Total** | 186 | 8 | 20 | 13,96 | 2,654 |

### *Data Collection Tools*

For data collection, the Sport Anxiety Scale 2 (SAS-2) was used. Originally developed by Smith et al. in 1990 and revised in 2006 (Smith et al., 2006; Smith et al., 1990), the scale was adapted into Turkish by Karadağ and Aşçı (2020).

SAS-2 is a 4-point Likert scale consisting of 15 items and three sub-dimensions. The minimum score is 15, and the maximum score is 60, with higher scores indicating higher levels of anxiety. Cronbach's alpha coefficients for this scale were reported as 0.65 for the somatic anxiety subscale, 0.78 for the worry subscale, and 0.67 for the concentration disruption subscale.

### *Data Analysis*

Statistical analyses were conducted using SPSS 25. A normality test revealed that the data were normally distributed (-1 to +1) (Hair et al., 2013), justifying the use of parametric tests. For this study, Cronbach's alpha values were calculated as follows: somatic anxiety subscale (0.812), worry subscale (0.744), concentration disruption subscale (0.798), and overall scale (0.712).

## RESULTS

The findings of the study are summarized in Tables 2–8. No significant differences in anxiety levels were found between table tennis and tennis players based on their sports discipline ($p>0.05$) (Table 2). No significant differences in anxiety levels were found among table tennis players based on gender ($p>0.05$) (Table 3). No significant differences in anxiety levels were found among tennis players based on gender ($p>0.05$) (Table 4).

Significant differences were observed in the anxiety levels of table tennis players based on years of sports experience ($p<0.05$). For the somatic anxiety subscale, differences were identified between players with 1–3 years and 8+ years of experience. For the worry subscale and overall scale scores, differences were found between players with 1–3 years and 8+ years, and 4–7 years and 8+ years of experience. Players with 8+ years of experience exhibited higher anxiety scores (Table 5).

Significant differences were observed in the anxiety levels of tennis players based on years of sports experience ($p<0.05$). For the somatic anxiety subscale, differences were identified between players with 1–3 years, 4–7 years, and 8+ years of

experience. For the concentration disruption subscale, differences were found between players with 4–7 years and 8+ years of experience, with those having 4–7 years of experience showing higher anxiety scores (Table 6). No significant differences were found in the anxiety levels of table tennis players based on the number of weekly training sessions (p>0.05) (Table 7). Significant differences were observed in the anxiety levels of tennis players based on the number of weekly training sessions (p<0.05). For the concentration disruption subscale, differences were found between players training 1–2 times per week and those training 3–4 times per week, with the former group exhibiting higher anxiety scores (Table 8).

**Table 2.** Analysis of the anxiety levels of the players participating in the study according to their branches

| | | N | X | S.S. | t | P |
|---|---|---|---|---|---|---|
| **Somatic Anxiety** | Table Tennis | 85 | 9,529 | 2,938 | ,471 | ,638 |
| | Tennis | 101 | 9,316 | 3,171 | | |
| **Worry** | Table Tennis | 85 | 11,976 | 4,535 | ,904 | ,367 |
| | Tennis | 101 | 11,405 | 4,072 | | |
| **Concentration Disruption** | Table Tennis | 85 | 9,870 | 3,172 | -,230 | ,818 |
| | Tennis | 101 | 9,970 | 2,732 | | |
| **Total of Scale** | Table Tennis | 85 | 31,376 | 8,662 | ,557 | ,578 |
| | Tennis | 101 | 30,693 | 8,047 | | |

*p<0.05

**Table 3.** Analysis of anxiety levels of Table Tennis players participating in the study according to gender

| | | N | X | S.S. | t | P |
|---|---|---|---|---|---|---|
| **Somatic Anxiety** | Girls | 41 | 9,414 | 2,966 | -,346 | ,730 |
| | Boys | 44 | 9,636 | 2,942 | | |
| **Worry** | Girls | 41 | 12,487 | 4,544 | 1,003 | ,319 |
| | Boys | 44 | 11,500 | 4,526 | | |
| **Concentration Disruption** | Girls | 41 | 9,829 | 3,089 | -,115 | ,909 |
| | Boys | 44 | 9,909 | 3,283 | | |
| **Total of Scale** | Girls | 41 | 31,731 | 8,879 | ,363 | ,717 |
| | Boys | 44 | 31,045 | 8,545 | | |

*p<0.05

**Table 4.** Analysis of anxiety levels of tennis players participating in the study according to gender

| | | N | X | S.S. | t | P |
|---|---|---|---|---|---|---|
| **Somatic Anxiety** | Girls | 32 | 9,750 | 3,698 | ,934 | ,352 |
| | Boys | 69 | 9,115 | 2,903 | | |
| **Worry** | Girls | 32 | 12,062 | 4,457 | 1,105 | ,272 |
| | Boys | 69 | 11,101 | 3,877 | | |
| **Concentration Disruption** | Girls | 32 | 10,156 | 3,091 | ,464 | ,644 |
| | Boys | 69 | 9,884 | 2,569 | | |
| **Total of Scale** | Girls | 32 | 31,968 | 9,433 | 1,086 | ,280 |
| | Boys | 69 | 30,101 | 7,316 | | |

*p<0.05

**Table 5.** Analysis of anxiety levels of Table Tennis players participating in the study according to their age at playing sports

| | | N | X | S.S. | F | P | Post-Hoc |
|---|---|---|---|---|---|---|---|
| **Somatic Anxiety** | 1-3 Sport Age | 36 | 8,972 | 2,323 | 3,254 | ,044 | |
| | 4-7 Sport Age | 43 | 9,627 | 3,222 | | | 1-3 Sport Age – 8+ Sport Age |
| | 8+ Sport Age | 6 | 12,166 | 3,060 | | | |
| | Total | 85 | 9,529 | 2,938 | | | |
| **Worry** | 1-3 Sport Age | 36 | 11,833 | 4,423 | 3,468 | ,036 | 1-3 Sport Age – 8+ Sport Age |
| | 4-7 Sport Age | 43 | 11,465 | 4,610 | | | |
| | 8+ Sport Age | 6 | 16,500 | 1,760 | | | 4-7 Sport Age – 8+Sport Age |
| | Total | 85 | 11,976 | 4,535 | | | |
| **Concentration Disruption** | 1-3 Sport Age | 36 | 9,777 | 3,034 | 1,743 | ,181 | |
| | 4-7 Sport Age | 43 | 9,627 | 3,258 | | | |
| | 8+ Sport Age | 6 | 12,166 | 2,926 | | | |
| | Total | 85 | 9,870 | 3,172 | | | |
| **Total of Scale** | 1-3 Sport Age | 36 | 30,583 | 7,695 | 4,136 | ,019 | 1-3 Sport Age – 8+ Sport Age |
| | 4-7 Sport Age | 43 | 30,720 | 9,043 | | | |
| | 8+ Sport Age | 6 | 40,833 | 6,615 | | | 4-7 Sport Age – 8+Sport Age |
| | Total | 85 | 31,376 | 8,662 | | | |

**Table 6.** Analysis of anxiety levels of tennis players participating in the study according to their sport age at playing sports

| | | N | X | S.S. | F | P | Post-Hoc |
|---|---|---|---|---|---|---|---|
| **Somatic Anxiety** | 1-3 Sport Age | 42 | 9,119 | 3,069 | 2,983 | ,045 | 1-3 Sport Age – 8+ Sport Age |
| | 4-7 Sport Age | 32 | 10,343 | 3,356 | | | |
| | 8+ Sport Age | 27 | 8,407 | 2,858 | | | 4-7 Sport Age – 8+ Sport Age |
| | Total | 101 | 9,316 | 3,171 | | | |
| **Worry** | 1-3 Sport Age | 42 | 11,785 | 3,904 | ,399 | ,672 | |
| | 4-7 Sport Age | 32 | 11,343 | 4,068 | | | |
| | 8+ Sport Age | 27 | 10,888 | 4,414 | | | |
| | Total | 101 | 11,405 | 4,072 | | | |
| **Concentration Disruption** | 1-3 Sport Age | 42 | 9,809 | 2,530 | 2,930 | ,048 | |
| | 4-7 Sport Age | 32 | 10,843 | 3,070 | | | 4-7 Sport Age – 8+ Sport Age |
| | 8+ Sport Age | 27 | 9,185 | 2,402 | | | |
| | Total | 101 | 9,970 | 2,732 | | | |
| **Total of Scale** | 1-3 Sport Age | 42 | 30,714 | 7,655 | 1,888 | ,157 | |
| | 4-7 Sport Age | 32 | 32,531 | 8,504 | | | |
| | 8+ Sport Age | 27 | 28,481 | 7,821 | | | |
| | Total | 101 | 30,693 | 8,047 | | | |

*p<0.05

**Table 7.** Analysis of anxiety levels of Table Tennis players participating in the study according to the number of weekly training sessions

| | | N | X | S.S. | F | P |
|---|---|---|---|---|---|---|
| **Somatic Anxiety** | 1-2 Training Sessions | 28 | 9,214 | 2,282 | 1,510 | ,227 |
| | 3-4 Training Sessions | 30 | 9,100 | 2,916 | | |
| | 5+ Training Sessions | 27 | 10,333 | 3,464 | | |
| | Total | 85 | 9,529 | 2,938 | | |
| **Worry** | 1-2 Training Sessions | 28 | 12,535 | 4,533 | ,339 | ,714 |
| | 3-4 Training Sessions | 30 | 11,833 | 4,441 | | |
| | 5+ Training Sessions | 27 | 11,555 | 4,750 | | |
| | Total | 85 | 11,976 | 4,535 | | |
| **Concentration Disruption** | 1-2 Training Sessions | 28 | 9,821 | 2,855 | ,021 | ,979 |
| | 3-4 Training Sessions | 30 | 9,966 | 3,662 | | |
| | 5+ Training Sessions | 27 | 9,814 | 3,013 | | |
| | Total | 85 | 9,870 | 3,172 | | |
| **Total of Scale** | 1-2 Training Sessions | 28 | 31,571 | 7,135 | ,070 | ,932 |
| | 3-4 Training Sessions | 30 | 30,900 | 9,348 | | |
| | 5+ Training Sessions | 27 | 31,703 | 9,574 | | |
| | Total | 85 | 31,376 | 8,662 | | |

*p<0.05

**Table 8.** Analysis of anxiety levels of tennis players participating in the study according to the number of weekly training sessions

| | | N | X | S.S. | F | P | Post-Hoc |
|---|---|---|---|---|---|---|---|
| **Somatic Anxiety** | 1-2 Training Sessions | 46 | 9,956 | 3,438 | 1,828 | ,166 | |
| | 3-4 Training Sessions | 34 | 8,647 | 2,592 | | | |
| | 5+ Training Sessions | 21 | 9,000 | 3,286 | | | |
| | Total | 101 | 9,316 | 3,171 | | | |
| **Worry** | 1-2 Training Sessions | 46 | 11,304 | 4,391 | ,288 | ,751 | |
| | 3-4 Training Sessions | 34 | 11,176 | 3,896 | | | |
| | 5+ Training Sessions | 21 | 12,000 | 3,741 | | | |
| | Total | 101 | 11,405 | 4,072 | | | |
| **Concentration Disruption** | 1-2 Training Sessions | 46 | 10,695 | 2,950 | 3,103 | ,049 | 1-2 Training Sess. -3-4 Training Sess. |
| | 3-4 Training Sessions | 34 | 9,382 | 2,348 | | | |
| | 5+ Training Sessions | 21 | 9,333 | 2,536 | | | |
| | Total | 101 | 9,970 | 2,732 | | | |
| **Total of Scale** | 1-2 Training Sessions | 46 | 31,956 | 9,177 | 1,173 | ,314 | |
| | 3-4 Training Sessions | 34 | 29,205 | 7,048 | | | |
| | 5+ Training Sessions | 21 | 30,333 | 6,688 | | | |
| | Total | 101 | 30,693 | 8,047 | | | |

*p<0.05

## DISCUSSION

According to the findings, no significant differences were observed in the sport anxiety levels between table tennis and tennis players ($p>0.05$). To date, no studies have specifically compared table tennis and tennis players in the literature. However, existing research has primarily focused on comparisons between individual and team sports, various sport disciplines, win-loss scenarios, or categorical variables within a single sport (Abrahamsen et al., 2008; Rocha & Osorio, 2008; Gonçalves & Belo, 2007). The sport anxiety levels reported in these studies are consistent with the findings of this study. For instance, a study on tennis players reported mean scores of 9.40 for somatic anxiety, 12.76 for worry, and 9.58 for concentration disruption (Ramis et al., 2013).

No significant differences were observed in sport anxiety scores based on gender for both table tennis and tennis players ($p>0.05$). However, these findings differ from those reported in the literature, where gender differences are frequently highlighted (Hardy & Jones, 1994). For example, prior studies have consistently found that Girls players experience higher levels of sport anxiety than Boyss (Filaire et al., 2009; Abrahamsen et al., 2008). This discrepancy may stem from the interplay of cognitive, somatic, and behavioral components of anxiety, which can vary across individuals (Cheng & McCarthy, 2018). Additionally, factors such as competitive success, psychological resilience, and self-confidence may also influence anxiety levels (Chapman et al., 1997). Although no statistically significant differences were found in this study, the mean scores suggest that Girls tennis players exhibited higher anxiety levels than their Boys counterparts. Supporting this, previous research has shown that cortisol levels in Girls players significantly increase after competitions (41.8 nmol/l) (Filaire et al., 2009). Moreover, gender differences in anxiety levels may depend on the outcome of the competition, with losing players often displaying higher anxiety levels than winners (Ntoumanis & Jones, 1998; Jones et al., 1993).

The findings related to sport experience also differ from those in the literature. While both this study and previous research identified significant differences, the observed trends were opposite. In this study, anxiety levels increased with greater years of sport experience, whereas the literature suggests that anxiety levels tend to decrease as sport experience increases (Bedir et al., 2023; Fernandes et al., 2020; Erbaş, 2005). This discrepancy could be attributed to factors such as the age at which players began their sport, burnout levels, or the desire to quit sports (Toy & Korkmaz, 2023).

In terms of weekly training frequency, the findings of this study are consistent with the literature. Players with fewer weekly training sessions exhibited higher anxiety levels compared to those who trained more frequently. Previous studies indicate that increased experience and training can help reduce anxiety. Additionally, factors such as lack of motivation during training and varying levels of burnout may contribute to heightened anxiety. Players facing these challenges tend to participate less frequently in training sessions, which in turn may elevate their anxiety levels (McCarthy & Barker, 2009; Malouff et al., 1992; Tobacyk & Downs, 1986).

There are some limitations in this study. The first of these is that the study included 186 people. This creates a limitation in terms of the generalization of the study. Another limitation was that anxiety was determined by a survey method. For future studies, more samples can be examined and laboratory tests can be applied to determine anxiety.

### *Conflict of Interest*

No potential conflict of interest relevant to this article was reported.

### *Ethics Statement*

This study was approved by the Çanakkale Onsekiz Mart University Ethics Committee (Approval No: 15/55, dated October 24, 2024). All procedures were conducted in accordance with the Helsinki Declaration.

### *Autor Contributions*

Design of the Study: AC, AŞ and BA; Data Gathering: AC; Statistical Evaluation: AŞ; Data interpreting: AC and AŞ; Writing of the Manuscript: AŞ and BA; Search of the Literature: AC, AŞ and BA. Each author has reviewed the final draft of the manuscript and given their approval.

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RESEARCH ARTICLE

# Effectiveness of Chiropractic Application in Individuals with Cervical Disc Herniation: A Randomized Controlled Trial

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**Abstract**

**Purpose:** The objective of this study was to investigate the impact of chiropractic intervention on the severity of neck pain, functional capacity, and disability level in individuals with cervical disc herniation. **Method:** The study population comprised of 50 individuals with cervical disc herniation who met the inclusion criteria. The participants were randomly assigned to two groups: an intervention group (n=26) and a control group (n=24). All participants received conventional physiotherapy five days a week for four weeks. In the intervention group, in addition to conventional physiotherapy, chiropractic adjustment using a diversified technique for cervical disc herniation was applied twice a week for four weeks. The McGill Melzack Pain Questionnaire (MMPQ), the Neck Disability Index (NDI), and the Bournemouth Neck Questionnaire (BNQ) were employed to evaluate the neck pain, functionality, and disability levels of both groups before and after treatment. **Findings:** The combination of conventional physiotherapy and additional chiropractic intervention proved to be an effective approach for reducing neck pain and disability levels while enhancing functionality in individuals with cervical disc herniation post-treatment ($p<0.001$). Nevertheless, no notable discrepancies were discerned between the control and chiropractic intervention groups ($p>0.05$). **Conclusion:** The application of chiropractic principles and practices was observed to result in a notable diminution of both neck pain and disability levels among those presenting with cervical disc herniation, together with an enhancement of functional abilities. Therefore, this approach may be considered as a potential alternative to existing treatment options for the management of individuals with cervical disc herniation.

**Keywords**
Neck Pain, Cervical Manipulation, Chiropractic, Physiotherapy, Diversified Technique

## INTRODUCTION

A cervical disc herniation frequently manifests as severe neck pain, shoulder impingement, and nerve discomfort. This health issue has the potential to significantly impair the quality of life of affected individuals, necessitating long-term pain management strategies (Binder, 2007).

Neck pain is a costly and widely recognized condition. There is currently no consensus among experts in the field regarding the optimal treatment plan for patients with neck pain (Kazeminasab et al., 2022). A rehabilitation program for neck pain is typically initiated following a brief period of rest and immobilization. The modalities employed include a range of motion exercises, strengthening exercises, ice, heat, ultrasound, and electrical stimulation therapy (Eubanks, 2010). While several treatment options exist for cervical disc herniation, the number of studies in the literature about this condition is comparatively limited, particularly in comparison to the extensive research conducted on the lumbar region (Yilmaz Menek et al., 2024). Although no single intervention has been proven to be more effective than others for treating neck pain, manual therapy, which includes joint mobilization and manipulation, has been shown to improve outcomes in patients with neck pain (Blanpied et al., 2017; Hidalgo et al., 2017). In recent years, there

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has been a notable increase in the prominence of chiropractic treatment as a modality in alternative medicine. This is largely due to its potential for restoring spinal health and alleviating pain. The objective of chiropractic treatment is to achieve proper alignment of the spine through the utilization of manual manipulation techniques, which can have a beneficial impact on the nervous system (Dinich, 2013). Chiropractic spinal manipulation is a form of medical care that focuses on treating disorders affecting the neuro-musculoskeletal structure, with a particular emphasis on conditions that affect the spine (Gevers-Montoro et al., 2021). A spinal adjustment is typically defined as the application of a high-speed, low-amplitude controlled thrust to a spinal segment (Henderson, 2012).

There is evidence to suggest that manipulation is an efficacious method for the treatment of neck pain when compared with placebo or other conventional treatments (Bronfort et al., 2001; Giles & Muller, 2003; Wood et al., 2001). Moreover, a meta-analysis of individuals with chronic neck pain demonstrated that chiropractic treatments yielded favourable outcomes with respect to pain severity and functionality (Bryans et al., 2014). Nevertheless, it is noteworthy that a number of studies have failed to demonstrate a statistically significant reduction in neck pain (Bronfort et al., 2001). Further research is required to gain a deeper understanding of the efficacy of manipulation for neck pain, utilizing reliable and valid outcome measures that are sensitive to the multifaceted nature of this condition (Bale & Newell, 2005). The findings of this study will be of benefit to the physiotherapy profession, providing valuable insight and guidance for future researchers on the use of chiropractic techniques in the treatment of cervical disc herniation. The objective of this study was to investigate the impact of chiropractic intervention on the severity of neck pain, functional capacity and level of disability in individuals with cervical disc herniation. It was hypothesised that chiropractic care would result in a reduction in neck pain and disability, and an increase in functionality, in individuals with cervical disc herniation.

## MATERIALS AND METHODS

### *Study Design*

The study was conducted at the FED Physiotherapy Clinic between the dates of August 2023 and January 2024.

### *Ethical Implications*

The approval was taken from the Üsküdar University Non-Interventional Research Ethics Committee (reference number 61351342/July 2023-21). Also, written informed Team consent was obtained from all participants before starting the study. Participant provided informed consent, with the voluntary form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

### *Determination of sample size*

Once the study design was complete, a power analysis was conducted to determine the appropriate sample size. A total of 50 individuals were selected as the sample size for the study, to determine the medium effect size (f=0.25 effect) at the alpha significance level of 95% power (0.05), using the G*Power Version 3.1.6 program. This was based on the assumption that the difference would be statistically significant. A total of 50 individuals who had volunteered to participate in the study were included. The study was conducted as a single-blind, randomized controlled trial following the ethical principles outlined in the Declaration of Helsinki.

### *Randomization and blinding*

The study was conducted as a single-blind, randomized, controlled trial following the established principles of research design. The evaluation was conducted by an assessor who was unaware of the participants' group assignments. The study was designed as a randomized parallel-group trial. Randomization was achieved through the use of a lottery system among the participants. Individuals who met the criteria for inclusion in the study were divided into two groups: an intervention group (n=26) and a control group (n=24). The study was concluded with the participants. Figure 1 illustrates the flow of participants throughout the study.

### *Participants*

The study participants were patients who had been diagnosed with cervical disc herniation by a neurologist. This diagnosis was reached following a neurological examination, a clinical physical examination, and a radiographic evaluation. The patients were then referred to the Physiotherapy Clinic.

To be eligible for inclusion in the study, participants were required to be between the ages of 20 and 50 years, have experienced neck pain for a minimum of three months, and have volunteered to participate. Individuals with concurrent orthopedic or neurological disorders, in addition to cervical problems, a history of trauma in the neck region, recent participation in a physiotherapy program within the last six months, vertebrobasilar arterial insufficiency, hysteria, hypoconrium, or who were presented as a patient were excluded from the study.

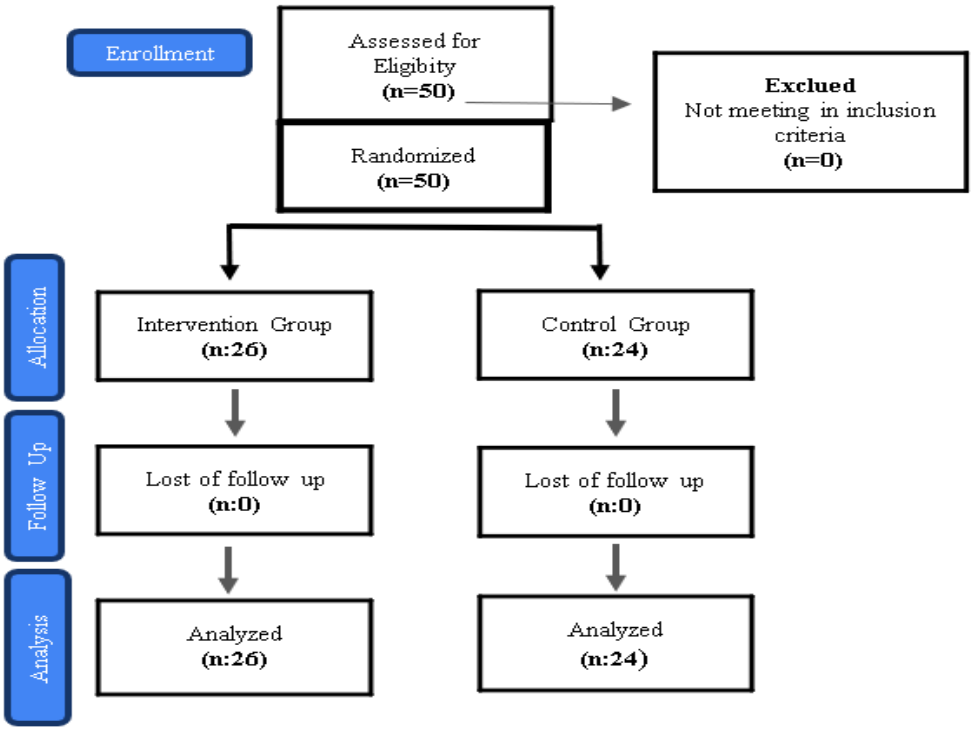


**Figure 1.** CONSORT flow diagram of the participants.

***Intervention and procedure***

The intervention and subsequent procedure were conducted following the established criteria of the study, which involved the randomization of participants into two distinct groups: the intervention group (n=26) and the control group (n=24). Conventional physiotherapy, comprising transcutaneous electrical nerve stimulation (TENS), hot packs, and ultrasound applications, was administered five days a week for four weeks to all participants. The control group did not receive any additional intervention. In the intervention group, in addition to conventional physiotherapy, chiropractic adjustment utilizing a diversified technique for cervical disc herniation was applied two days per week for four weeks. Before and following the intervention, both groups were evaluated using the McGill Melzack Pain Questionnaire, the Neck Disability Questionnaire, and the Bournemouth Neck Questionnaire to assess neck pain, functionality, and disability, respectively. All treatment procedures were performed by a physiotherapist who was a chiropractic specialist.

***Chiropractic Practice***

In this application, the individual was situated on the drop table stretcher in a supine position with their arms positioned on the abdomen. The physiotherapist then proceeded to place the index finger of one hand on the spine bone and fix the head of the person by holding the occiput bone with the other hand. The subject's neck was subjected to lateral flexion, slight flexion, and rotation following the procedure to be performed on the corresponding side. The application was conducted at a high velocity with a low level of intensity.

***Data Collection Tools***

***Sociodemographic and Clinical Information Form***

The participants were asked to provide information regarding their demographic characteristics, including gender, age, educational status, and marital status.

***McGill Melzack Pain Questionnaire (MMPQ)***

MMPQ was developed by Melzack and Targerson in 1971 (Melzack & Torgerson, 1971). The validity and reliability of the aforementioned have been evaluated in our country (Kuguoglu et al., 2003). The MMPQ is comprised of four sections. In the initial section, the subject is required to indicate the location of the pain on the provided diagram of the human body. Additionally, they must specify whether the pain is originating from the skin by marking the corresponding letter "D," if it is present on the body surface, by marking the letter "Y," or if it is both on the skin and on the surface, by marking both the "D" and "Y" letters. The second part comprises 20-word groups that analyze pain in terms of sensory, perceptual and evaluative aspects. Each group comprises two to six words, which describe different aspects of pain. The individual is then required to select the word cluster that is most appropriate for their pain and to indicate which word within that cluster is the most accurate description of their pain. The third section pertains to the temporal aspects of pain. The third section comprises word groups designed to ascertain the continuity and frequency of pain, as well as the factors that serve to increase or decrease pain. The fourth section comprises five-word groups, ranging from "mild" pain to "unbearable" pain, which are used to ascertain the severity of the pain experienced. The MMPQ enables the location of the pain, the sensation it creates in the individual, its relationship with time, its intensity and the level of pain that can be experienced by the individual to be determined (Melzack, 1987).

***Neck Disability Index (NDI)***

The NDI is comprised of ten items, which are as follows: (1) pain intensity, (2) personal care, (3) lifting loads, (4) reading, (5) headaches, (6) concentration, (7) work life, (8) driving, (9) sleep, and (10) leisure activities. Four of the items pertain to subjective symptoms, while the remaining six items relate to activities of daily living. In each section, patients are presented with six different options (A, B, C, D, E, and F) that they can use to rate the condition of that section. The options are assigned a value of 0, 1, 2, 3, 4, or 5, respectively. In accordance with the established criteria, the minimum score on the NDI is 0, and the maximum score is 50. In the NDI, a score of 0-4 is defined as indicating the absence of disability, 5-14 as indicating the presence of mild disability, 15-24 as indicating the presence of moderate disability, 25-34 as indicating the presence of severe disability, and 35+ as indicating the presence of total disability. The NDI, which was derived from the Oswestry Low Back Pain Questionnaire by Vernon and Mior (Vernon & Mior, 1991) and adapted to the cervical region, was translated into Turkish and subsequently subjected to a validity and reliability study by Aslan et al. (Aslan et al., 2008).

***Bournemouth Neck Questionnaire (BNQ)***

The BNQ is a questionnaire that assesses various aspects of pain, and its impact on daily life. It evaluates pain intensity, social and functional abilities, anxiety and depression, cognitive and behavioral aspects of fear-avoidance beliefs, and coping strategies for pain. The BNQ comprises seven questions, with responses scored on a numerical analog scale ranging from zero to ten. The maximum score that can be obtained from the questionnaire is 70, with a high score indicating a high level of pain (Bolton & Humphreys, 2002). The Turkish validity and reliability of the test were evaluated (Yılmaz et al., 2019).

***Statistical Analysis***

The data obtained from the study were analyzed using the SPSS (Statistical Package for Social Sciences) 29.0 package program. Before undertaking the analyses, the suitability of the numerical data for normal distribution was evaluated through the utilization of Shapiro-Wilk and Skewness and Kurtosis tests. The results of the analysis demonstrated that the data were normally distributed. However, the observation values of the variables in the study were found to be below 30. Consequently, non-parametric tests were employed for the aforementioned analyses. Categorical data were presented as frequencies and percentages, while numerical data were presented as means, standard deviations, medians, minimums, and maximums. In the course of data analysis, the Mann-Whitney U test was employed for two-group comparisons, while the Kruskal-Wallis test was utilized for variables comprising more than two categories. All tests were conducted with a statistical significance level of $p<0.05$.

## RESULTS

No statistically significant differences were observed in the distribution of gender, age, marital status, and educational status variables between the intervention and control groups (Table 1) ($p > 0.05$). No statistically significant difference was observed

between the groups in the MMPQ, NDI, and BNQ pre-treatment, post-treatment, and post-treatment difference values ($p>0.05$). A statistically significant difference was observed between the MMPQ, NDI, and BNQ values of the intervention and control groups before and after treatment ($p<0.05$).

**Table 1.** Statistics of demographic characteristics of the participants

| Variable | | Intervention Group (n=26) | Control Group (n=24) | P value |
|---|---|---|---|---|
| | | n (%) | n (%) | |
| Gender | Woman | 13 (50) | 13 (24.2) | 0.768[b] |
| | Man | 13 (50) | 11 (45.5) | |
| Age (years) | 20-30 | 13 (50) | 15(62.5) | 0.392[a] |
| | 31-40 | 12 (46.2) | 9 (37.5) | |
| | 41 and more | 1 (3.8) | 0 (0) | |
| Marital status | Married | 8 (30.8) | 7 (29.2) | 0.902 |
| | Single | 18 (69.2) | 17 (70.8) | |
| Education status | High school and before | 4 (15.4) | 15 (62.5) | 0.803[a] |
| | University | 11 (42.3) | 9 (37.5) | |
| | Master's degree | 11 (42.3) | 0 (0) | |

$p<0.05$; Chi-Square Test; a: Fisher Exact Test; %: percentage, n: number of individuals

**Table 2.** Comparison of mcgill melzack pain questionnaire, neck disability ındex, and bournemouth neck questionnaire scores within and between groups

| Variable | | Intervention Group (n=26) | Control Grouo (n=24) | |
|---|---|---|---|---|
| | | X±SD (Min-Max) | X±SD (Min-Max) | P value |
| MMPQ | BT | 67.15±8.34 (51-85) | 66.04±7.65 (50-77) | 0.734 |
| | AT | 65.85±8.53 (50-86) | 64.5±7.74 (49-76) | 0.756 |
| | p[c] | <0.001 | <0.001 | |
| | BT | 67.15±8.34 (51-85) | 66.04±7.65 (50-77) | 0.734 |
| NDI | BT | 14.38±7.12 (5-32) | 12.08±7.26 (1-27) | 0.259 |
| | AT | 9.42±6.7 (0-24) | 7.21±6.16 (0-20) | 0.205 |
| | p[c] | <0.001 | <0.001 | |
| | AT-BT | 4.96±1.54 | 4.88±1.83 | 0.968 |
| BNQ | BT | 31.35±13.14 (11-66) | 27.13±12.41 (13-63) | 0.129 |
| | AT | 23.65±13.81 (7-60) | 20.08±13.63 (7-59) | 0.206 |
| | p[c] | <0.001 | <0.001 | |
| | AT-BT | 7.69±2.38 | 7.04±2.27 | 0.280 |

[c]:Wilcoxon Test; n: number of people¸ X: Mean, SD: Standard Deviation; Min: Minimum; Max: Maximum; BT: Before Treatment; AT: After Treatment; MMPQ: McGill Melzack Pain Questionnaire; NDI: Neck Disability Index; BNQ: Bournemouth Neck Questionnaire

$p<0.05$; Whitney [b]:Mann-U Test;

## DISCUSSION

The objective of this study was to examine the impact of chiropractic intervention on the prevalence and severity of neck pain, as well as on functional capacity and disability level in individuals diagnosed with cervical disc herniation. The findings of the study indicated that chiropractic treatment resulted in a reduction in neck pain and disability, as well as an improvement in functionality, in individuals with cervical disc herniation. Nevertheless, no discernible difference was noted between the control group, who received conventional physiotherapy, and the intervention group, who received chiropractic treatment in addition to conventional physiotherapy.

Cervical disc herniation is defined as the protrusion of nucleus pulposus material through the annulus into the spinal canal. The degeneration of the disc is typically a painless process, with pain only occurring when the disc exerts pressure on pain-sensitive structures, such as the dura or nerve root (Ombregt, 2013). It has been shown that cervical intervertebral disc degeneration can lead to neck pain **(**Peng & DePalma, 2018**).** The presentation of neck pain in individuals with cervical disc herniation is characterized by the presence of pain caused by the disc herniation, which is perceived in the neck and radiates to the head, scapula, and arm (Risbud & Shapiro, 2014). Neck pain represents one of the primary causes of disability (Uthman, 2016; Tabassum & Azim, 2024). The majority of individuals presenting with neck pain continue to experience this symptom with a clinically variable course, exhibiting fluctuations in pain intensity and disability (Blanpied et al., 2017). Neck pain is a prevalent issue encountered in outpatient settings, representing approximately 18 to 23% of primary concerns in chiropractic practice (Beliveau et al., 2017; Cohen & Hooten, 2017). Given the diversity of diagnostic, assessment and treatment approaches to neck pain in chiropractic practice, it is crucial to develop a consistent approach that is based on the best available evidence in order to ensure optimal patient care (Bussières et al., 2016).

The conclusion that spinal manipulation has little effect when compared to no treatment or other non-invasive complementary and alternative medical treatments is supported by the strongest evidence. There is conflicting evidence regarding the superiority of other complementary and alternative therapies over sham treatments or other treatments, despite the fact that they have generally been found to be superior to the no-treatment group (Cohen, 2015; Katkat & Doğanel, 2024). Furthermore, the efficacy of chiropractic adjustments for the treatment of neck pain in patients with cervical disc herniation remains poorly understood (Bale & Newell, 2005; Zuo et al., 2019). Therefore, we thought that our present study can provide a significant contribution to the existing literature on this topic.

Vernon et al. applied a manipulation technique to the cervical region. Their findings indicated that a greater proportion of patients reported an improvement in pain with the sham procedure than with the real manipulation. However, no statistically significant differences were observed between the two groups in terms of pain, pain threshold, or range of motion (Vernon et al., 2012). Furthermore, a systematic review indicated that in eight of the 21 studies that evaluated cervical spinal manipulation and a type of sham-controlled manipulation, the control procedure resulted in a mean change that fell below the clinically insignificant and clinically significant minimal threshold (Vernon et al., 2011). A further study demonstrates that manipulative adjustment is an efficacious method for alleviating pain in patients with chronic mechanical neck pain, with the beneficial effects persisting for three months (Lin et al., 2013). A systematic review of the literature revealed that there is moderate evidence to suggest that spinal manipulative therapy for chronic neck pain is more efficacious than physiotherapy and general practitioner care (Bronfort et al., 2004). A review of high-quality randomized controlled trials on the mobilization and manipulation of mechanical neck pain demonstrated robust evidence that such techniques, when combined with exercises, are beneficial for the treatment of acute or chronic neck pain with or without headache (Gross et al., 2015). Additionally, another study demonstrated that the manipulation resulted in a notable reduction in neck pain and disability in patients presenting with unilateral or central neck pain (Masaracchio et al., 2013). In other studies examining the effects of spinal manipulation on neck pain and disability at varying chronicity levels, it was observed that the manipulated group exhibited improvement, yet no discernible difference was noted between the two groups (Kim, 2010; Miranda et al., 2015). The

improvement in self-reported neck pain and disability observed in our study is consistent with the findings of previous research. It is hypothesized that manual manipulation may reduce the pressure on the nervous system by providing spinal alignment (Dinich, 2013). The findings of this study indicate that there is no statistically significant difference between the control group, who received conventional physiotherapy, and the intervention group, who received chiropractic in addition to conventional physiotherapy, in terms of neck pain, disability level and functionality. It is our contention that further research is required in the form of large-scale studies with longer follow-up periods and larger sample sizes in order to ascertain the true impact of these methods. In addition, it is possible that other biopsychosocial factors may also contribute to neck pain and disability. The use of only one chiropractic technique may also have influenced the results. Further neurophysiological studies are needed to better understand the effects of this treatment method on pain mechanisms. We assert that the role of individual factors was prominent in our study and that the heterogeneity of responses to treatment among individuals requires consideration of individual differences and disease specificity. It is recommended that future studies be designed and conducted to identify such patient subgroups. Furthermore, future research should comprehensively evaluate the therapeutic effects, side effects, and costs of manipulation in comparison to other common treatments for neck pain. The incorporation of superior diagnostic instruments for pre- and post-assessment purposes would facilitate greater precision in the evaluation of its effects. Long-term follow-up studies are required to ascertain the long-term effects of manipulation and the recurrence rate of disc displacement. Furthermore, single blinding and randomization were performed in our study. However, the lack of double blinding can be considered as a limitation. The planning of larger double blinding studies that evaluate in more detail the genetic, biomechanical, and psychosocial factors that determine the effectiveness of chiropractic treatment, plan individualized patient-specific treatment, and evaluate its long-term effects are of great importance in this context. Further research is, therefore, required to provide a more complete understanding of the effect of these treatment strategies for individuals with cervical disc herniation.

### *Conflict of Interest*

We declare that the articles we write are not involved in any particular conflict of interest and adhere to the Declaration of Helsinki.

### *Ethics Statement*

This study followed the guidelines outlined in the Declaration of Helsinki.The approval was taken from the Üsküdar University Non-Interventional Research Ethics Committee (reference number 61351342/July 2023-21).

### *Author Contributions*

Research Design, NU,ÖŞ; Research Data Input, NU, ÖŞ, BDH; Statistical Data Analysis, NU, ÖŞ; Data Processing, NU,ÖŞ, BDH; Manuscript Preparation, NU, ÖŞ, BDH; Journal Literacy, NU, ÖŞ, BDH. Each author has reviewed the final draft of the manuscript and given their approval.

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RESEARCH ARTICLE

# Exploring the Impact of Shuttlecock Feeder-Based Training on Biomechanical Characteristics in Para-badminton Athletes

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**Abstract**

**Purpose:** The study intended to investigate the impacts of four weeks of shuttlecock feeder machine-based training with biomechanical parameters on the playing ability of para-badminton players. **Methods:** Para-badminton sports classes, six wheelchair players (WH1) in the first classification and ten wheelchair players (WH2) in the second classification, together with a total of sixteen beginner badminton players from the Coimbatore region in Tamil Nadu State, were the subjects of this study. The experimental group (EG; n = 8) and the control group (CG; n = 8) were the two equal groups in which the subjects were randomly allocated. Kinovea software-based assessment on the angle of contact - pre and post-contact phase through Y1 Sports Camera was utilized. Following the pretest, the trainer administered four weeks of intervention to the experimental group, and meanwhile, a mid-test was conducted. A post-test was executed for the experimental group after a one-week intervention through a Badminton Robot V – 328 (Badminton Shuttlecock Feeder Machine). The data gathered for the control and experimental groups on the specified criterion variables, namely playing ability, pre and post-shuttlecock contact angle, and prior, during, and after data, were subjected to statistical analysis of Repeated measures ANOVA. **Findings:** There was a progressive improvement in both playing ability and biomechanical variables after the pre-test, during ($p < 0.01$) and post ($p < 0.01$) intervention. **Conclusion:** The results indicated that the badminton shuttlecock feeder-based intervention promotes playing ability among Para-badminton players.

**Keywords**
Para-Badminton, Shuttlecock Feeder Machine, WH1 Sport Class Wheelchair Players, Biomechanical Parameters

## INTRODUCTION

A new form of badminton acclimated to physically disabled athletes is para-badminton. Similar rules as conventional badminton with tailored changes to accommodate the specially abled players. This sport gained recognition as a contesting sport for athletes with functional limitations or mobility changes to the opportunity to demonstrate their skills and engage in top-tier competition. Like Pullela Gopichand, who is the prototype of Indian badminton, Gaurav Khanna has heaved para-badminton out of obscurity and into the limelight and is credited for a steep rise for Indian para-badminton to a podium finish by making a clean-sweep by procuring medals at international levels. One of the world's most recognized paralympic sports involving rackets is para-badminton. Para-badminton is a specific badminton variation designed for athletes with disabilities in which they can compete (Purnama & Doewes, 2022). Parasports entail being “parallel to able-bodied sports or events involving sport” (Ungerer, 2018). Every individual with a disability engages in sporting activities on limitations imposed by their physical or mental impairment (Aitchison et al., 2022). All paralympic sports establish a functional classification system for physical disabilities

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(Katkat & Doğanel, 2024; Ungerer, 2018; Webborn, 2012; Tweedy, 2011). This system places para-athletes in certain sporting classes according to functional capabilities and particular evaluations (Purnama & Doewes, 2022). The classification system intends to ensure that paralyzed individuals succeed in sports despite their disability, which depends on certain tests to qualify disabled athletes into specific categories (Tweedy, 2011; Beckman, 2017). This system warrants fairness in competition by considering functional skills (Ungerer, 2018). There are six sporting classes governed by the Badminton World Federation (BWF), an apex body of Para-badminton: "WH1 and WH2 for wheelchair users, SL3, SL4, and SU5 for ambulant players, and SH6 for short stature" (BWF, 2024). Those categories of limitations are eligible for para-badminton participation: "decreased muscle strength, decreased range of motion, athetosis, hypertonia, ataxia, limb deficiency, differences in limb length, and short stature". The classification systems are designed to ensure fairness in competition and to allow the entry of para-athletes with various forms of disability in sports (Ungerer, 2018; Webborn, 2012; Tweedy, 2011).

Examination of the training method applying biomechanical principles is crucial for assisting athletes in reaching the pinnacle of technical proficiency. It can offer essential concepts for resolving specific issues during technique improvement and explain the cause-and-effect relationship between distinct phases of motor movement (Fernandez-Fernandez, 2009). Understanding that the systemic unity at every level of motor movement determines the outcome of an action is made possible by biomechanics principles (De Oliveira Mota Ribeiro, 2020). Accordingly, Steininger et al. (2021) claimed that because of the game's requirements, which include a smaller playing field, quick sports, rapid movement volume, and shuttlecock strikes, para-badminton players needed to develop stroke skills. Thus, this research aims to clarify the biomechanics of the playing ability of wheelchair Para-badminton players.

The analysis of match elements and performance success indicators in traditional badminton is becoming increasingly popular in the realm of sports performance (Chiminazzo, 2018). Collecting data on the number of strokes taken during games is valuable in developing training prescription parameters tailored to individual performances (Fernandez-Fernandez, 2009). Real-time matches through video analysis allow for extracting objectively analyzed information, which produces helpful feedback for coaches and players to enhance their performance (Phomsoupha, 2015). Very few studies in Para-badminton have applied the optimization of techniques, scientific evaluation of training, and match scouting in a real-time environment. Due to technological innovation, its application has grown day by day, and its impact on sports is inevitable. Virtual reality and robotics are a few of them that are applied in sports to enhance the potential of athletes. Badminton Robot: V – 328 (Badminton Shuttlecock Feeder Machine) is a device designed to automatically feed shuttlecocks in various trajectories, including high lobs, flat shots, and angled shots, with a predetermined angle of release, velocity, and frequency per minute, simulating real-game scenarios. In Para-badminton, such feeder machines and assistive technology-based research are possible means to add a quantum of knowledge to Para-badminton discipline and provide helpful feedback for coaches and players to enhance their performance (Phomsoupha, 2015).

Figure 1 interprets Clarivate Analytics on Web of Science, Science Direct, and Scopus global information providers emphasize that only 26 articles were published globally on Para-badminton from 2006 to 2024; only two articles were related to the biomechanical area of study. Purnama and Doewes (2022) analyzed several biomechanical factors of the badminton forehand smash in standing classification disabled players, including the angles of the elbow, shoulder, arm, hip, knee, torso, and ankle, as well as angular speed, shuttlecock speed and kinetic energy, force, and power.

The research participant, Suryo Nugroho, an international Indonesian Para-badminton player, provided insights into the physical capabilities and performance of para-badminton players with standing upper classification (SU5). Strapasson et al. (2021) attempted to compare and characterize the technical and temporal aspects of classes WH1 and WH2.

During the first round of the 2018 Brazil Para-badminton Championship, twenty-three men's singles matches from the WH1 and WH2 classes were recorded and evaluated. In terms of points, more significant victories in WH1 resulted from the net lift and service. The shots that culminated in winning points that occurred most frequently were

drop-shot and clear (WH1) and net-shot and drop-shot (WH2). A research gap has not yet revealed the biomechanical components of wheelchair para-badminton. This investigation intends to examine the training with an assistance badminton shuttlecock feeder that instils significant changes in acquiring playing abilities based on biomechanical characteristics.

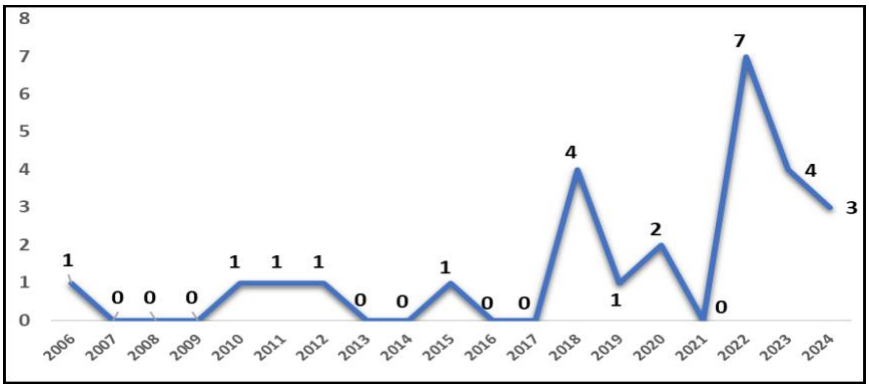


**Figure 1.** Year-wise distribution of articles on Para-badminton

Reviewing studies from 2006 to 2024 framed the research questions listed below. Based on the study's objectives, the research questions were framed as How does shuttlecock feeder-based training influence the biomechanics of stroke execution in Para-badminton athletes? and what significant technical advancements in the playing over time on biomechanical parameters? What advantage can be derived by using badminton shuttlecock feeder machines in propelling the performance of the specially abled population? Investigate the transferability of feeder machine advantages to Real Game Situations.

***Objectives of the study***

The following objectives were framed as;

The primary objective focused on the evaluation of effect size due to the Shuttlecock feeder-based training on playing ability among novice Para-badminton athletes over a period of time.

The secondary objectives include designing and developing drills related to increasing the propulsive ability of the wheelchair along with handling the badminton racket with biomechanical characteristics such as the angle of pre and post-shuttlecock contacts.

## MATERIALS AND METHODS

***Study Participants***

According to the guidelines provided by the World Badminton Federation (BWF) for Para-badminton sports classes, six wheelchair players (WH1) in the first classification and ten wheelchair players (WH2) in the second classification, together with a total of sixteen 25-33 age ranged beginner male badminton players from the Coimbatore region in Tamil Nadu State, were the subjects of this study. In the experimental group (EG; n = 8) and the control group (CG; n = 8), the subjects were randomly allocated into two equal groups. Prior to the experiment, the subjects were instructed about the badminton rules and regulations. All selected subjects were novices in wheelchair handling and wheelchair propulsion. Table 1 shows the sports classes of selected subjects.

**Table 1.** Sport classes of selected subjects

| Classification | Description | Number of Subjects | |
|---|---|---|---|
| | | Experimental Group (n = 8) | Control Group (n = 8) |
| Wheelchair 1 (WH 1) | "Players in this class require a wheelchair to play badminton. Players in this Sport Class usually have impairment in both lower limbs and trunk function" (Source: BWF, 2024). | 3 | 3 |
| Wheelchair 2 (WH 2) | "A player in this class could have impairment in one or both lower limbs and minimal or no impairment of the trunk. Players are required to play on a wheelchair" (Source: BWF, 2024). | 5 | 5 |

***Ethical Information***

The Avinshilingam Institutional Human Ethics Committee approved this study (Ref: IHEC/22-23/PE-02). Furthermore, the participants gave written informed consent before commencing the study. After providing informed consent, the voluntary form included research details, risks, benefits, confidentiality and participant rights. The research followed ethical significance by delivering participants' declaration in the design, procedures and confidentiality measures regarding participants' rights and well-being.

***Research Tool***

Badminton Robot: V – 328 (Shuttlecock Feeder Machine) was utilized in this study. Each corner of the badminton singles court was marked with four arcs with 20 centimetres of radius and numbered 1,2,3,4 and 5. In the marked half-court, the shuttlecock feeder machine was placed. The shuttle feeder machine was loaded with 20 shuttlecocks, each of 4 champers, and 60 shuttles were fired at 5 meters per second. For short serve, the machine was set at a height of 5 feet with an angle of 15 degrees. The machine was set at the same height for deep serve but with an angle of 45 degrees. The first cock would be a right corner short serve, the second cock would be a left extreme deep serve, the third cock would be a left corner short serve, and the fourth cock would be a right extreme deep serve to the Para-badminton player, as shown in Figure 2. Subsequently, this cycle repeats up to 60 shuttlecocks (comprised of three trials; for each 20 shuttlecocks, the player is supposed to play). The players were expected to propel the wheelchair to play the shuttlecock against the machine and try to place the cock in the marked area numbered 1,2,3,4 and 5 of any four corners of the court. For 60 shuttlecocks, which had all been around 5 minutes of play and a consecutive series of three shuttlecocks, the test would be terminated if the player did not respond. No restriction was made to secure the points by which the player can execute badminton strokes such as drop shots, smashing, high clear and flick shots. Out of three trials, the best one will be selected as the score. The calibration of the feeder machine has been checked and ensured before the test was administered.

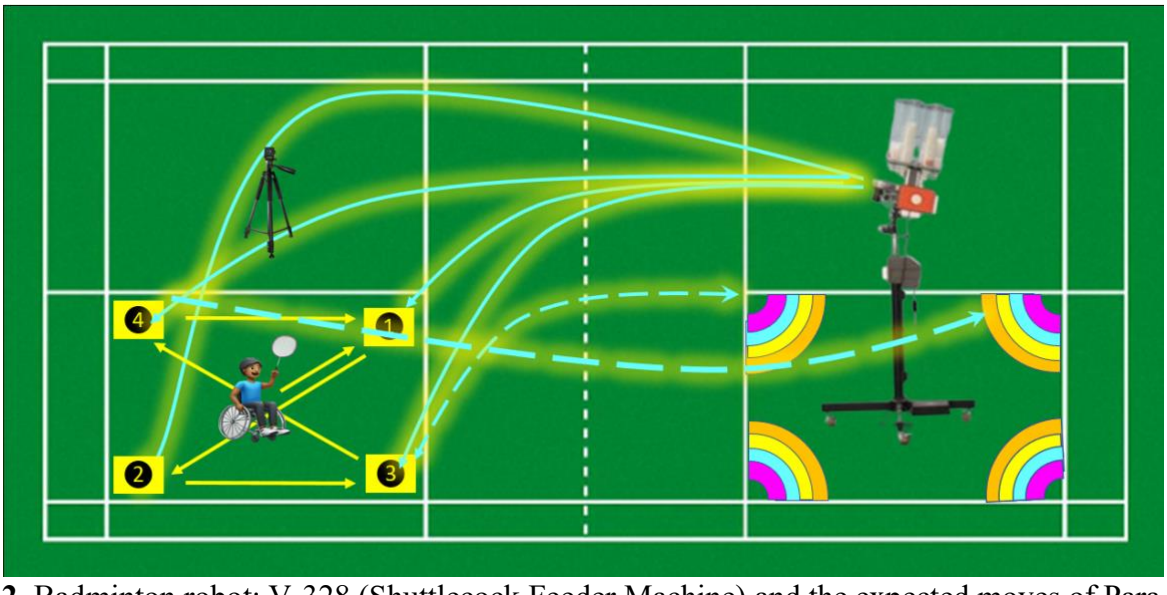


**Figure 2.** Badminton robot: V-328 (Shuttlecock Feeder Machine) and the expected moves of Para-Badminton Wheelchair Player

***Training Phases***

In wheelchair badminton, both offensive and defensive players must perform forward and backward propulsion successively to contact the shuttle. With these views, the French Short Serve test is modified into a combination of clear, drop, smash, block, lift, and push skills toward the opponents' court-targeted corner areas, as shown in Figure 3. The researchers executed the examination on a standard wooden badminton court. This study consists of three phases, namely the pre-test phase, where the selected subjects from the experiment group and control group players underwent 20 shuttle services towards the opponent court towards the four corners, each consisting of a marking 5, 4, 3, 2, and 1-point area within the stationary position (without propulsion). Each area has 20 shuttles and a maximum of (20 * 5) 100 points made by the

tester. The pre-test completed by all the selected samples before the intervention obtained a total score of 100 points. In each stage, the camera with 90 frames per second (Y1 Sports Camera) has been placed perpendicular to the plane of action (adjacent to the badminton racket handling side of the player) 12 feet at 1.20 meters high from the ground level.

The dominant side of the hand had placed three reflective markers (Wrist, Elbow, and shoulder joint) with a diameter of 15 mm. Assess the angle between the wrist, elbow, and shoulder joints before shuttle contact and after the contact phase. The Kinovea open-source software extracted biomechanical parameters from the recorded film trips.

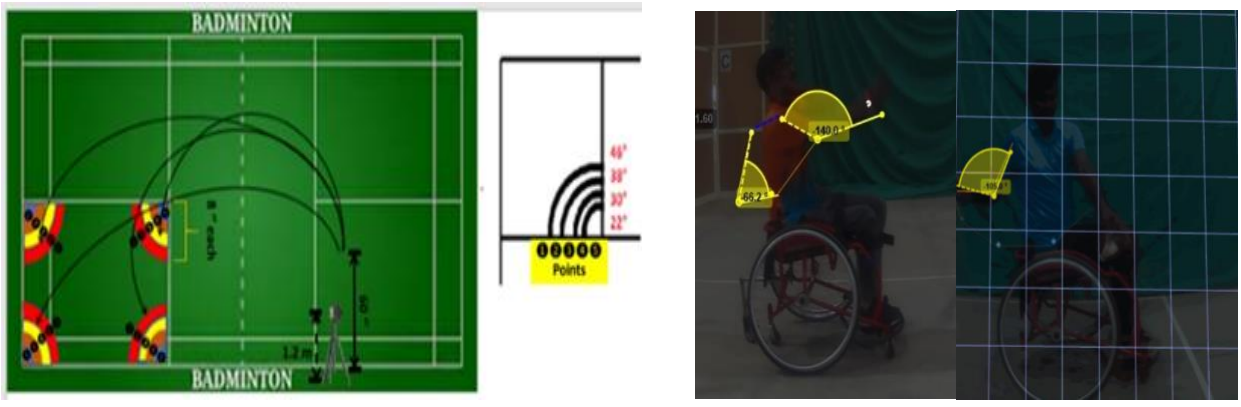


**Figure 3.** Playing ability assessment & camera placement and kinovea software output on pre - post shuttlecock contact angle

After the pretest phase, only the experimental group exposed to 3 weeks (excluding Monday, six days per week) of target-based clear, drop, smash, block, lift and push skills in terms of drills were given. Every day, in the morning session, a one-hour training comprises strokes with a flat (offensive clear) and rising trajectory (defensive clear) towards the rear and back of the opponent's court. Along the drills, in the third week of the second phase, the experimental group was exposed to Badminton Robot V – 328 (Badminton Shuttlecock Feeder Machine) in a stationary position (without propulsion). The control group wasn't exposed to any special training. In the second phase, during the intervention, the same assessment of playing ability as done during pretest procedures was made for both the control (n = 8) and experiment (n = 8) groups. After the second phase, the experiment group exclusively experienced one week of intervention using the Badminton Robot V – 328 (Badminton Shuttlecock Feeder Machine), which exposed them to predetermined velocity and angle of release with propulsion. In contrast, the control group did not receive any specialized training. The sum of the 60 shuttles' placement in the marked area as 1, 2, 3, 4, and 5 on any corner as secured as their respective scores out of that marked area where the shuttlecock placed considered zero marks. Right after the intervention, the researcher administered the post-test assessments.

**Table 2.** Variables and test items

| Pre-test (Before Intervention) | | Mid-test (During Intervention) | | Post-test (After Intervention) | |
|---|---|---|---|---|---|
| Playing Ability (100 points) Angle of pre-contact phase and post-contact phase | | Playing Ability (100 points) Angle of pre-contact phase and post-contact phase | | Playing Ability (100 points) Angle of pre-contact phase and post-contact phase | |
| EXG | CG | EXG | CG | EXG | CG |
| No Specific Training | No Specific Training | 1st Two Weeks – Drills and 3rd Week – V 328 – without propulsion | No Specific Training | Fourth Week – V 328 – with propulsion | No Specific Training |

### *Statistical Analysis*

In experimental and control groups, sixteen Para-badminton players underwent pre-, mid, and all the selected variables, the descriptive statistics of mean and standard deviation are computed before, during, and after the interventions. The repeated measures Analysis of Variance (ANOVA) with Partial Eta Squared evaluated the effect size of different times of pre-mid-post interventions on playing ability and the pre-and post-shuttlecock contact angle. Estimated marginal means were analysed by plotting a line graph. IBM SPSS version-29 was utilized for all the statistical computations for all cases, setting the significance level at 0.05.

post-tests on playing ability with and without shuttlecock feeder machine intervention, as shown in Table 2. For

## RESULTS

Table 3 presents descriptive statistics indicating the mean and standard deviation values of playing ability out of 100 points before, during, and after the intervention. It shows that the control group remains constant, whereas the experiment group gradually progressed to a maximum of 78 out of 100 points from 51 points.

**Table 3.** Descriptive statistics of playing ability

| Variable | Group | Mean | Std. Deviation (±) |
|---|---|---|---|
| Playing Ability before | Experiment | 50.88 | 4.993 |
| | Control | 48.06 | 4.403 |
| Playing Ability during | Experiment | 71.25 | 3.379 |
| | Control | 50.60 | 4.057 |
| Playing Ability after | Experiment | 78.36 | 6.567 |
| | Control | 50.73 | 2.885 |

Table 4 displays the results of a repeated measures ANOVA that assessed the mean difference in playing ability before, during, and after the intervention over a period. The result of the ANOVA indicated that a significant time effect, Wilk's Lambda = 49.36; F (1,14) = 112.5; $p < 0.01$, $\eta 2 = 0.89$, yield significant evidence that the shuttlecock feeder-based training influences the playing ability of Para-badminton athletes. Figure 4 duplicated the Estimated Marginal Means of Playing Ability that acknowledged the positive impact of training on playing ability.

**Table 4.** Repeated measures ANOVA between subjects effects on playing ability

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared ($\eta^2$) |
|---|---|---|---|---|---|---|
| Between | 3482.1 | 1 | 3482.1 | 112.51 | .000** | 0.889 |
| Within | 433.3 | 14 | 30.948 | | | |

Significance = *p < 0.05; **p < 0.01

From Table 5, Descriptive statistics imply the mean and standard deviation values of the pre-contact angle before, during, and after the intervention. It clearly shows that the control group remains almost the same mean value. In contrast, the experiment group gradually decreased from a maximum of 120 degrees to 59 degrees on pre-contact of shuttlecock angle.

**Table 5.** Descriptive statistics on pre-contact angle over a period of time-before, during and after intervention

| Variable | Group | Mean | Std. Deviation (±) |
|---|---|---|---|
| Pre-Contact angle before | Experiment | 118.76 | 4.008 |
| | Control | 120.75 | 1.394 |
| Pre-Contact angle during | Experiment | 100.41 | 3.931 |
| | Control | 119.00 | 4.940 |
| Pre-Contact angle after | Experiment | 59.28 | 2.185 |
| | Control | 121.83 | 5.475 |

Table 6 displays the results of repeated measures ANOVA to assess the mean difference in pre-contact shuttlecock angle over time-before, during, and after the intervention. The result of the ANOVA indicated that a significant time effect, Wilk's Lambda = 197; F (1,14) = 640.9; $p < 0.01$, $\eta 2 = 0.97$, yield significant evidence that the shuttlecock feeder-based training influences the pre-contact angle of shuttlecock of Para-badminton athletes. Figure 4 duplicated the Estimated Marginal Means of the shuttlecock's pre-contact angle that acknowledged the intervention period's positive impact on the shuttlecock's pre-contact angle.

**Table 6.** Repeated measures ANOVA between subject's effects on pre-contact angle of shuttlecock

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared ($\eta^2$) |
|---|---|---|---|---|---|---|
| Between | 9216.9 | 1 | 9216.9 | 640.9 | .000** | .979 |
| Within | 201.4 | 14 | 14.4 | | | |

From Table 7, descriptive statistics imply the post-contact angle's mean and standard deviation values before, during, and after the intervention. It clearly shows that the control group remains almost the same mean value. In contrast, the experiment group gradually decreased from a maximum of 153 degrees to 139 degrees on the pre-contact of the shuttlecock angle. The analysis utilized repeated measures ANOVA to assess mean differences in post-contact shuttlecock angle over time, specifically before, during, and after the intervention.

**Table 7.** Descriptive statistics on a post-contact angle over a period of time – before, during and after intervention

| Variables | Group | Mean | Std. Deviation (±) |
|---|---|---|---|
| Post Contact angle before | Experiment | 153.85 | 5.287 |
| | Control | 160.49 | 5.965 |
| Post Contact angle during | Experiment | 149.44 | 3.881 |
| | Control | 158.52 | 5.941 |
| Post Contact angle after | Experiment | 139.57 | 2.061 |
| | Control | 161.15 | 4.450 |

From Table 8, the result of the ANOVA indicated that a significant time effect, Wilk's Lambda = 10; F (1,14) = 96.3; $p < 0.01$, $\eta 2 = 0.87$, yields significant evidence that the shuttlecock feeder-based training influences the post-contact angle of shuttlecock among Para-badminton athletes. Figure 4 duplicated the Estimated Marginal Means of the shuttlecock post-contact angles that acknowledged the intervention period's positive impact on the post-contact angle and the overall badminton playing ability

**Table 8.** Repeated measures ANOVA between subjects' effects on the post-contact angle of the shuttlecock

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared ($\eta^2$) |
|---|---|---|---|---|---|---|
| Between | 1856.1 | 1 | 1856.13 | 96.32 | .000** | .873 |
| Within | 269.8 | 14 | 19.27 | | | |

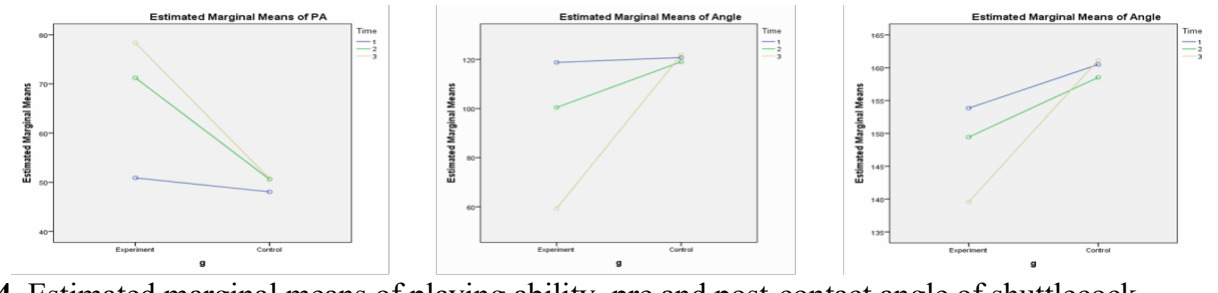


**Figure 4.** Estimated marginal means of playing ability, pre and post-contact angle of shuttlecock

## DISCUSSION

The study investigated the effect of a shuttlecock feeder machine-based training over a period – before, during, and after intervention among two groups, namely the experimental group (EG; n = 8) and the control group (CG; n = 8) on playing ability and biomechanical characteristics. The researcher identified a positive impact on playing ability pre- and post-shuttlecock contact angle. More specifically, the strokes - clear, drop, smash, block, lift, and push increased the propulsion phase due to the shuttlecock feeder machine-based training among the experimental group rather than the control group. The Paralympics marked the debut of para-badminton. This sport is unique because it requires athletes to concentrate on wheelchair propulsion and racket handling (Alberca et al., 2022). Rice et al. (2010) conducted a laboratory-based evaluation of the biomechanics involved in manual wheelchair propulsion. The biomechanical feedback-based learning software is designed to utilize motor learning theory concepts to enable real-time random discontinuous visual display of crucial spatiotemporal and kinetic parameters. This study stressed, more specifically, the positive training effect on the propulsion method by lowering stroke cadence and raising the contact angle at the same time. The software-based assessment clearly provides the means to identify the crucial key factors responsible for success in para-badminton wheelchair sports.

Dellabiancia et al. (2013) investigated the upper body's 3-D kinematic properties and the electromyographic (EMG) signals of deltoid, biceps, triceps, and forearm muscles during wheelchair racing over a roller system. They revealed that the greater push time and angle concerning the propulsion of wheelchairs are more suitable only for endurance-based wheelchair athletes and not suitable for explosive and agile-based wheelchair sports (Chow et al., 2001). Since para wheelchair badminton is one of the agile sports where forward, lateral, and backward propulsion are involved. In terms of sports performance, analysis of match elements and performance success indicators are becoming prevalent in conventional badminton. The measurement of strokes made during games yields valuable data for creating training prescription parameters that are particular to performance (Barreira & Chiminazzo, 2020). Strong badminton skills are a prerequisite for winning, and the smash technique, the basis for many points, is the most thrilling part of badminton matches (Zhang et al., 2016). The lesser the angle during and after the shuttlecock contact, the greater the smash was, in accordance with the previous studies. This study concluded that reducing the error in unwanted movements, reducing the angle when contacting the shuttlecock, and increasing wheelchair propulsion once evoked the required mechanically advantaged counter moves against the opponent in wheelchair para-badminton.

The gadget used to feed the shuttlecock in badminton has been designed to replicate accurate strokes and increase accuracy (De Alwis, 2020). Mimicking the visual search behaviour of competitive match play accelerates the irregular feeding practice routines and improves skill learning and growth in wheelchair badminton players (Smith et al., 2022). Depending on the situation, players may use a combination of stroke angle and strength to perform clears (hitting the shuttlecock to the back of the opponent's court) or drives (fast, horizontal shots). These strokes require a balance to achieve the desired trajectory, which is highly influenced by assistive techno-based training (Chen & Chen, 2009). This study clearly emphasizes that body positioning, release angle, and limb coordination are interconnected elements that impact the overall performance of badminton strokes. The result of this research study relates to the same concept that systematic and repetitive training is essential for players to refine these aspects of their technique, leading to improved shot quality, consistency, and strategic execution on the badminton court (Li et al., 2017).

### *Conclusions*

The badminton shuttlecock feeder-based training positively influenced the playing ability of novice wheelchair para-badminton athletes after the intervention. The pre-and post-shuttlecock contact, along with wheelchair handling and wheelchair propulsion, was also optimized to a greater extent. Shuttlecock feeder-based training using Badminton Robot: V – 328 (Badminton Shuttlecock Feeder Machine) effectively simulates athletes' playing ability and propulsion in Para-badminton. Investigations with large sample sizes on the profile of biomechanical characteristics of various strokes and playing techniques specific to wheelchair Para-badminton were still lacking at an elite level.

Analyzing international wheelchair Para-badminton tournaments requires actively assessing tactical aspects such as game strategies, shot selection, and on-court positioning in a real-time live environment while also considering defensive pressure.

Enhancing research and developing specialized equipment, including customized wheelchairs and racquets designed explicitly for the unique needs and biomechanics of wheelchair Para-badminton players, is recommended. The wheelchair is the most common limiting factor for participation in activities for Paralympic sports. Research should explicitly design wheelchairs for para table tennis to improve stability, mobility, and posture, addressing the sport's specific needs. Suggest researchers actively focus on enhancing stability, mobility, and posture in wheelchairs designed for para table tennis, addressing the sport's specific needs. Further, it is needed to explore the impact of customized equipment on player performance and injury prevention. Since Para-badminton is growing, investigation is essential on how wheelchair-specific factors influence game dynamics.

## ACKNOWLEDGEMENT

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### *Conflict of Interest*

The authors declare that this article has no conflict of interest.

### *Ethics Statement*

This research followed the ethical standard and received approval from the Avinshilingam Institutional Human Ethics Committee with registered numbered Ref: IHEC/22-23/PE-02.

### *Authors Contribution*

Research Design, GN, SPR; Research Data Input, GN, SPR; Statistical Data Analysis, GN; Data Processing, GN; Manuscript Preparation, GN, SPR, MV, KK; Journal Literacy, GN, SPR, MV, KK. Each author has reviewed the final draft of the manuscript and given their approval.

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RESEARCH ARTICLE

# In the Shadow of Double Disadvantage: Turkish Women Athletes' Participation and Representation in Paralympic Games

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**Abstract**

**Purpose**: The Paralympic Games provide a significant platform for the representation of women with disabilities in sports and for overcoming societal prejudices. This study aims to analyze the level of participation of Turkish female Paralympic athletes in the Paralympic Games, the diversity of the sports they participated in, and the number and types of medals they won from a historical perspective. **Method:** A qualitative research method has been adopted, and document analysis was used for data collection. The data were obtained from the official website of the International Paralympic Committee (IPC). The data were categorized into six categories: number of participants, number of medals, type of medals, sports, Turkey's world ranking, and gender-based world ranking. These data were analyzed using descriptive statistical methods, with frequency and percentage analyses applied, and all data were tabulated using Microsoft Excel. **Result:** The findings reveal that, a total of 155 female athletes participated in the Paralympic Games between 2004 and 2024 and won 40 medals during that time (7 gold, 13 silver, 20 bronze), with weightlifting being the sport with the most medals. In terms of female athlete representation, Turkey ranked 104th in 2004, and by 2020, it had risen to 11th place. Regarding the success ranking in the Paralympic Games, Turkey ranked 53rd in 2004 and improved to 23rd in 2024. **Conclusion:** In conclusion, the promotion of gender equality has contributed significantly to increasing the participation of Turkish female Paralympic athletes in sports, thereby making important contributions to the country's success in the Paralympic Games.

**Keywords**
Paralympic Games, Gender Equality in Sports, Women with Disabilities, Double Disadvantage

## INTRODUCTION

It is estimated that around one billion people worldwide experience some form of disability, equivalent to 15% of the world's population (WHO, 2011). Women with disabilities make up a significant proportion of people living with disabilities and have to deal with various inequalities arising from both their gender and their disability (Olenik et al., 1995; Clark & Mesch, 2016; Güven et al., 2019). The intersectional approach explains how individuals' identities interact with each other in such situations and focuses on how the intersection of gender and disability deepens the oppression and discrimination experienced by women (Crenshaw, 1989; Hanlon & Taylor, 2022). Research shows that women with disabilities are more likely to experience violence than men with disabilities and women without disabilities (Ballan & Freyer, 2017; García-Cuéllara et. al., 2023), have higher rates of unemployment (UN Women Turkey & Association of Women with Disabilities, 2024), experience inadequate access to health services (Wisdom et al., 2010; Matin et al., 2021; Naghdi-Dorabati et al., 2024) and face significant gaps in access to educational opportunities (Kumari, 2020). As active members of the society to which they belong, women with disabilities have the right to live as independently as possible, with the highest possible quality of life. A society that does not recognize the

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value of functionally diverse people faces the possibility of losing the full potential that these individuals can offer (Ibargoien et al., 2023).

In order not to lose the talents, skills and opportunities to contribute to society that women with disabilities have, legal arrangements have been made at national and international level (Limoochi & Clair, 2011). These include the United Nations Convention on the Rights of Persons with Disabilities (UN, 2016), the Convention on the Elimination of All Forms of Discrimination against Women (UN, 1979), the 2030 Agenda for Sustainable Development (UN, 2015), the Beijing Declaration and Platform for Action (UN, 1995) and the Universal Declaration of Human Rights (UN, 1948). These policies constitute the basic frameworks at the international level to secure the rights of women with disabilities, ensure gender equality and combat various forms of discrimination against women (Un Women, 2018). One of the organizations that emerged as a result of these international policies is the Women's Sports Committee (WiSC). This committee was established to advise on gender equality issues to ensure the full participation of women and girls at all levels of sport. WiSC develops strategies, proposes policies and monitors the implementation of these policies and strategies to empower women and increase participation in Paralympic sport. In this way, it aims to ensure that women with disabilities have more active and equal opportunities in sport (IPC, 2024).

Considering the inequalities at the intersection of disability and gender, the participation of women athletes with disabilities in sports and their achievements have the potential to transform social norms. Although issues regarding gender and disability awareness has increased in the last three decades, the literature on whether female athletes with disabilities participate in sports on an equal level with male athletes or to what extent they are represented in winning medals at national and international level compared to men is quite limited (Remi et al., 2017; Kirakosyan, 2021; Santos et al., 2024). This study aims to analyze the historical level of participation of Turkish female Paralympic athletes in the Paralympic Games, the diversity of the branches in which they participated, and the number and types of medals they won. Within the scope of the study, it is aimed to obtain data on gender distribution and balance by comparing the participation rates and achievements of female and male athletes. Thus, it is aimed to provide a basis for understanding the representation levels of female Paralympic athletes in a quantitative and historical context and to evaluate the possible effects of their success on gender equality.

## MATERIALS AND METHODS

### *Research Model*

Qualitative research allows researchers to directly access the data source. A detailed description of the research context and the examined phenomena enables the synthesis and interpretation of the obtained information, as well as the formulation of generalizations in this regard (Büyüköztürk, 2011). In this context, the qualitative research method was preferred to provide a detailed description of the situation of Turkish female Paralympic athletes in the Paralympic Games between 2004 and 2024, analyze their development in the historical process, and interpret the obtained data within an objective framework.

### *Collection of Data*

In this study, the document analysis method was used for data collection and evaluation. Document analysis is a data collection method based on the systematic examination of written or visual materials produced in the past and is used to understand historical events, evaluate current processes, or analyze a specific phenomenon in depth (Bowen, 2009). In accordance with the purpose of the research, the data were obtained from the official website (https://www.paralympic.org/) of the International Paralympic Committee (IPC). The use of only official records, rather than newspapers, third-party sources, or non-academic publications, ensured the authenticity and reliability of the documents. The accuracy of the data was confirmed by cross-checking with the reports published by the Turkish Paralympic Committee.

### *Data Analysis*

All data examined in the study were categorized and analyzed using the "Evaluation Form" developed by the researchers. To ensure the content validity of the form, the opinions of two academicians who are experts in the field of sports sciences were consulted, and consistency between their evaluations was observed. The evaluation form consists of six categories: number of participants, number of medals, branch of participation, medal type, Turkey's world ranking, and gender-based country ranking. In the number of

participants category, the number of female and male athletes participating in the Paralympic Games between 1992 and 2024 was calculated separately, and trends of change over the years were identified. In the number of medals category, the medals won by male and female athletes during the same period were analyzed in detail. In the branch of participation and medal type categories, the branches in which female athletes participated between 2004 and 2024 were evaluated, and the distribution of medals across these branches was analyzed to determine in which sports greater success was achieved. In the world ranking category, Turkey's level of success between 2004 and 2024 was identified. In the gender-based country ranking category, Turkey's global position in terms of female athlete representation in the Paralympic Games between 2008 and 2020 was evaluated. The data were analyzed using descriptive statistical methods, with frequency and percentage analyses applied. All data were tabulated using Microsoft Excel, and the findings were visualized for presentation.

## RESULTS

**Table 1.** Paralympic Games participation, branch distribution and medal wins of Turkish women Paralympic athletes between 1960-2024

| Year | Number of female athletes | Branches | Number of medals | Medal types |
|---|---|---|---|---|
| 2004 | 1 | Table Tennis | 0 | - |
| 2008 | 8 | Shooting, Weightlifting, Judo, Table Tennis, Archery | 2 (1 gold, 1 bronze) | Archery (Gold), Table Tennis (Bronze) |
| 2012 | 21 | Athletics, Shooting, Weightlifting, Table Tennis, Swimming, Archery, Judo | 7 (1 gold, 4 silver, 2 bronze) | Weightlifting (Gold, Silver), Table Tennis (Silver), Table Tennis Team (Silver), Judo (Bronze) |
| 2016 | 33 | Wheelchair Tennis, Goalball, Shooting, Athletics, Weightlifting, Judo, Table Tennis, Swimming, Archery | 6 (2 gold, 1 silver, 3 bronze) | Goalball (Gold), Weightlifting (Gold), Table Tennis (Silver), Judo (Bronze), Shooting (Bronze) |
| 2020 | 44 | Swimming, Goalball, Table Tennis, Weightlifting, Judo, Archery, Shooting, Athletics, Badminton, Taekwondo | 8 (1 gold, 2 silver, 5 bronze) | Goalball (Gold), Archery (Silver), Taekwondo (Silver), Weightlifting (Bronze), Swimming (Bronze), Judo (Bronze), Shooting (Bronze) Table Tennis (Bronze) |
| 2024 | 48 | Swimming, Goalball, Table Tennis, Weightlifting, Judo, Archery, Shooting, Athletics, Badminton, Taekwondo, Rowing | 17 (2 gold, 6 silver, 9 bronze) | Goalball (Gold), Archery (Gold, Silver), Taekwondo (Silver, Bronze), Weightlifting (Silver, Bronze), Table Tennis (Silver), Shooting (Silver), Athletics (Silver, Bronze), Swimming (Bronze), Judo (Bronze) |

When Table 1 is examined, it is seen that female athletes participated in the 2004 Paralympic Games for the first time and a total of 155 female athletes took part in these games including the 2024 Paralympic Games. In this period, a total of 40 medals were won, 7 of which were gold, 13 silver and 20 bronze. In 2004, women athletes were represented only in table tennis, but by 2024, they were represented in a wide range of sports such as swimming, goalball, table tennis, weightlifting, judo, archery, shooting, athletics, badminton, taekwondo and rowing.

Figure 1 shows that 90% of the medals were won in individual sports and 10% in team sports (3 gold/golball and 1 silver/table tennis). The branches with the most medals are weightlifting, judo, table tennis, shooting, archery, goalball, taekwondo, athletics and swimming (Figure 1).

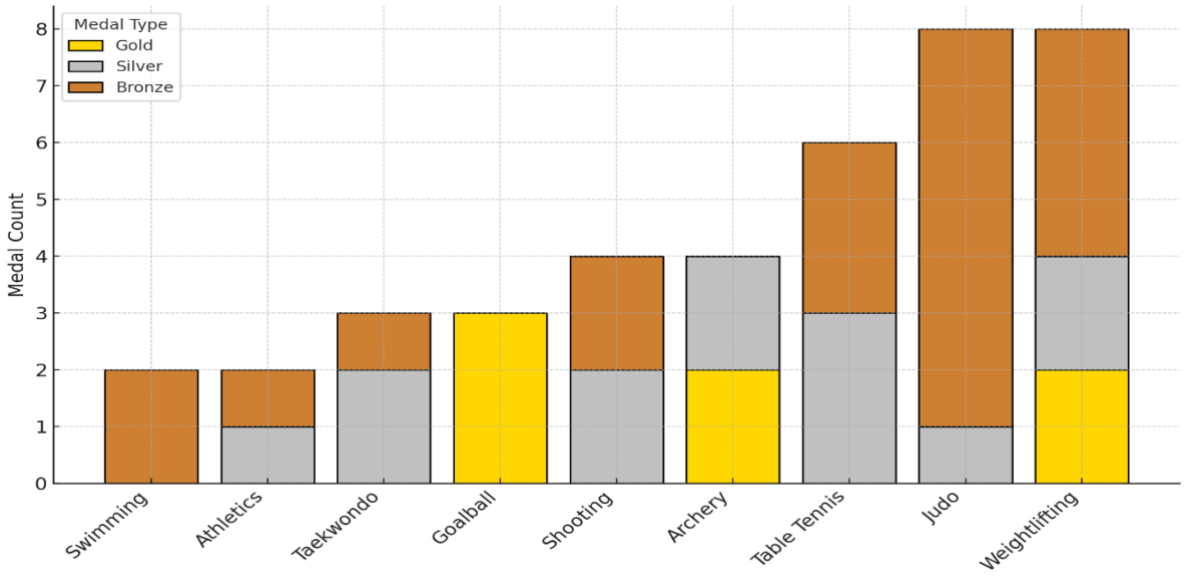


**Figure 1.** Medal distribution of female Paralympic athletes by branch

Figure 2 shows a trend in the number of medals won by male and female athletes between 2004 and 2024. Female athletes surpassed male athletes in the number of medals since 2008 and maintained this momentum until the 2024 Paralympic Games. Although the total number of medals won by male athletes increased until 2024, it did not show as significant an acceleration as the rise of female athletes.

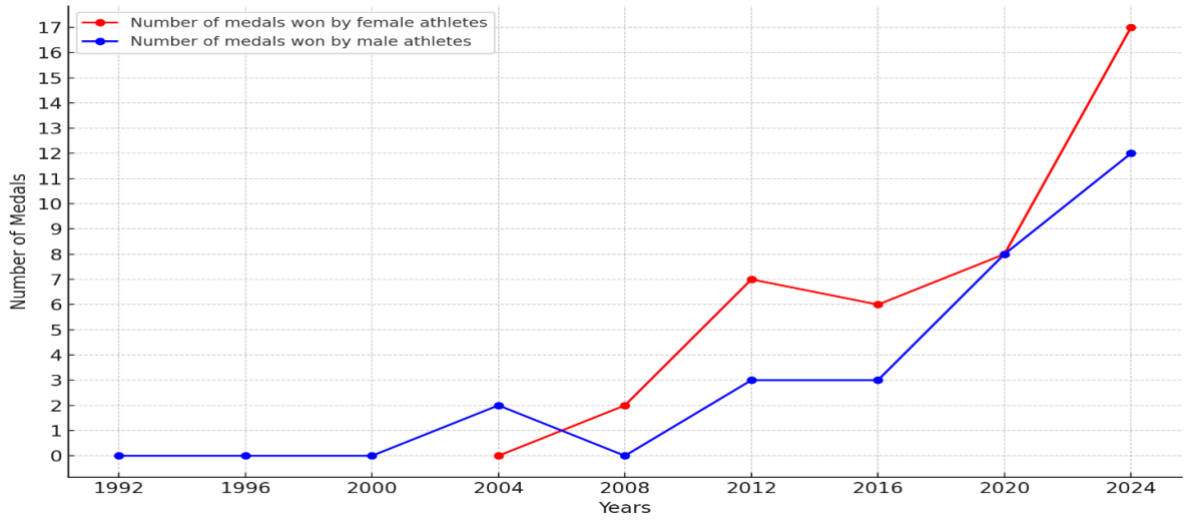


**Figure 2.** Number of medals of male and female athletes by years

Figure 3 shows the number of female and male athletes participating in the Turkish national Paralympic team between 2004 and 2024. The findings reveal that the number of female athletes has shown a significant increase over the years and has equaled that of male athletes. Especially in 2020 and 2024, the number of female athletes exceeded the number of male athletes. The number of male athletes fluctuated over the years, reaching the highest levels in 2012 and 2016, followed by a slight decline. This visualization reveals that a significant improvement has been achieved in terms of gender balance in the Turkish Paralympic national team.

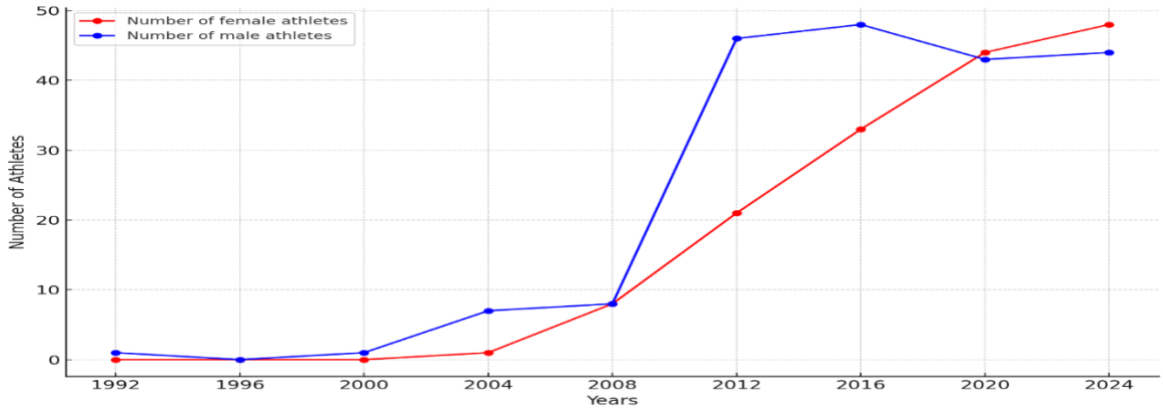


**Figure 3.** Number of male and female athletes participating in Paralympic Games by years

Figure 4 shows the annual trends in the participation percentages of male and female athletes in the Paralympic Games between 2004 and 2024. The findings reveal a reversal in the participation percentages of male and female athletes during this period. While the percentage of female athletes increased steadily, the percentage of male athletes changed at a slower rate.

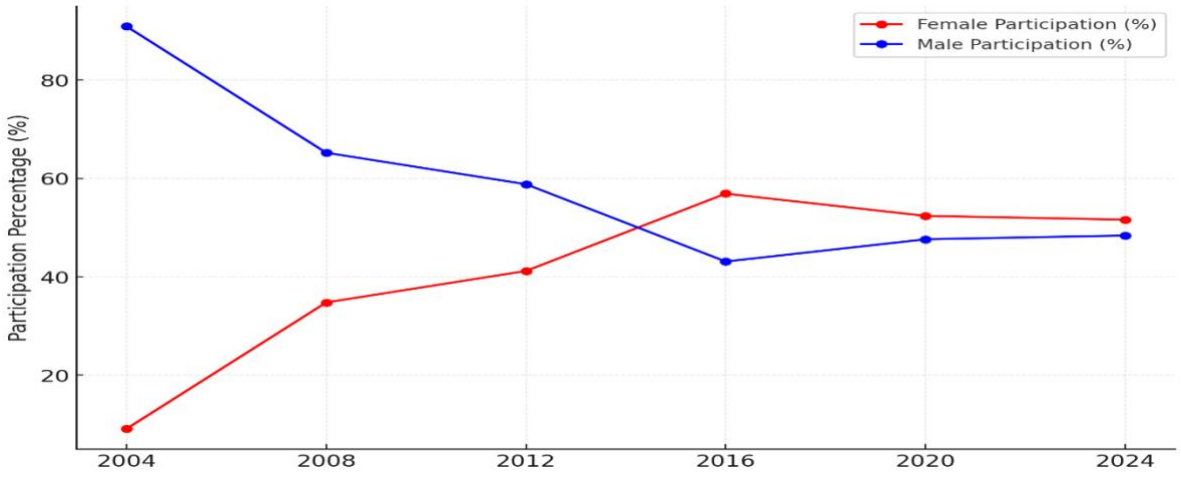


**Figure 4.** Yearly trends in gender participation percentages

Figure 5 shows the in 2008, a total of 146 countries participated in the Paralympic Games and Turkey ranked 38th in terms of female athlete participation. This period shows that Turkey's representation of women athletes in Paralympic sports at the international level is still in its infancy. By 2012, the number of countries participating in the Paralympic Games increased to 164. In this period, Turkey made a significant leap in the participation of female athletes and rose to 17th place. In 2016, with a total of 160 countries participating in the Paralympic Games, Turkey ranked 14th in female athlete participation. This development reflects that the increase in the participation of female Paralympic athletes continues in a sustainable manner. In 2020, the number of countries participating in the Paralympic Games was recorded as 162. In this period, Turkey ranked as high as 11th in female athlete participation and managed to be among the top 15 countries. In 2004, a total of 135 countries participated in the Paralympic Games. Turkey ranked 104th among the countries with female athlete delegations. However, it was not deemed appropriate to include the results of this year in the graphs due to the fact that Turkey was behind many countries in the ranking. On the other hand, a country-by-country breakdown of female athlete participation data for the 2024 Paralympic Games is not available on the official website of the Paralympic Games. This restricts a comprehensive analysis for the relevant period.

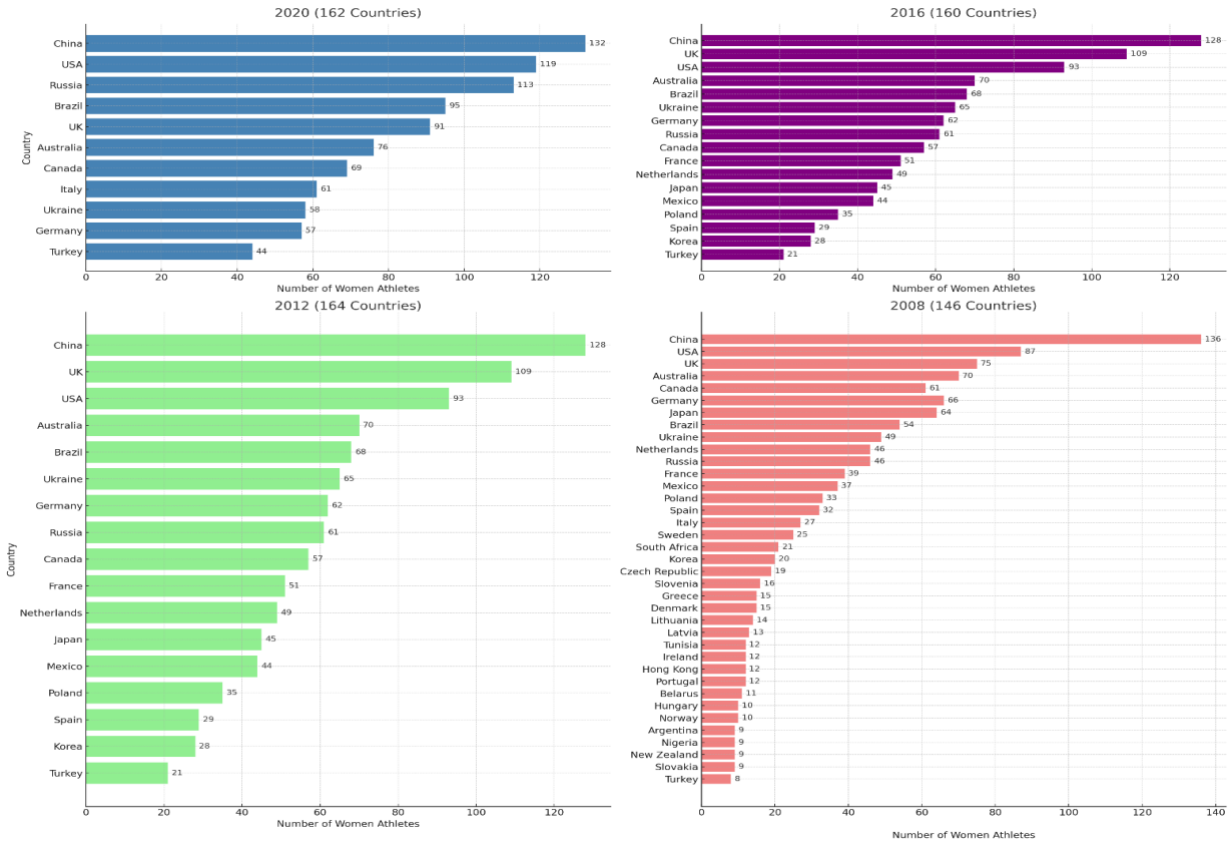


**Figure 5.** Country Rankings in Women Athlete Participation at Paralympic Games: 2008-2020

Figure 6 shows the change in Turkey's world ranking in the Paralympics between 2004 and 2024. It can be seen that there is significant progress in the ranking over the years. From 53rd place in 2004, Turkey rose to 23rd place in 2024. This graph clearly shows how the success of Turkey's Paralympic athletes in the international arena has increased over time. Especially the performance of female athletes has contributed significantly to this rise.

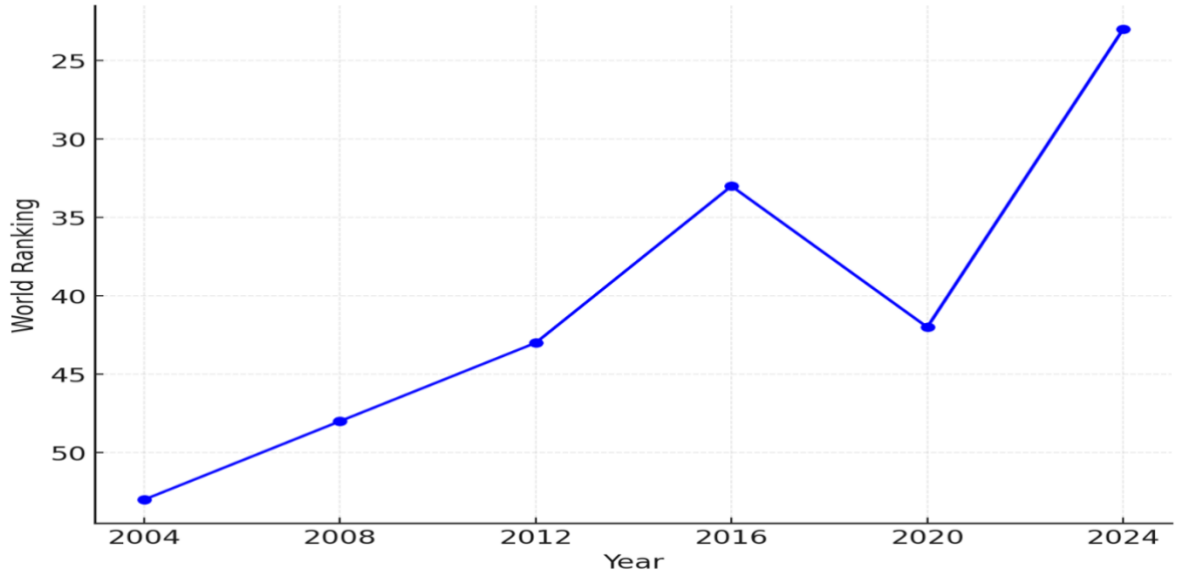


**Figure 6.** Turkey's world ranking in Paralympic Games (2004-2024)

## DISCUSSION

The Paralympic Games were first organized in Rome in 1960 and started with limited branches and participants in order to make people with disabilities more visible in society through sports and turned into an international movement with an expanding range over time (Bailey, 2008). It is thought that the reason for the limited number of branches and participants at the beginning of the Paralympic Games was the lack of communication between the International Olympic Committee (IOC) and International Paralympic Committee (IPC). This situation negatively affected the participation of both male and female athletes in the Paralympic Games. However, with the Paralympic Games being organized in the same city as the Olympics in 1988 (Thompson, 2016) and the development of a stronger cooperation between the IOC and the IPC, a significant increase in the participation of female athletes was achieved. Within the framework of this cooperation, the IPC Sports Council launched the Women's Initiative and emphasized women's right to equal participation in sport through important international initiatives such as the 1994 Brighton Declaration and the 1998 Windhoek Call to Action (De Pauw and Gavron, 2005; Santos et al., 2024). The Paralympics were directly affected by these policies and increased the participation of female athletes in the games. As a result of these developments, the proportion of female athletes in the Paralympics has reached almost equal levels with male athletes. For example, 1,983 of the 4,461 athletes competing in the 2024 Paris Paralympic Games were women (Olympic, 2024). While these international developments have made significant progress towards gender equality by increasing the participation of female athletes in the Paralympic Games, differences have been observed between countries' involvement in this global movement (Santos et al., 2024). Turkey was represented in this global organization for the first time in 1992 with only one male athlete (Alpdoğan, 2022). In 2000, with the dissolution of the Turkish Disabled Sports Federation and the establishment of federations suitable for disability groups (TİESF, 2024), an important development process started regarding Turkey's participation in the Paralympic Games. These developments were followed by the establishment of the Turkish National Paralympic Committee (TMPK) in 2002. With the establishment of TMPK, the organizational structure was strengthened and a sustainable foundation was established in Paralympic sports (TMPK, 2024). As a result of these transformations, women athletes participated in the Paralympics for the first time in 2004 (Alpdoğan, 2022). As of 2024, it is seen that the Turkish women's Paralympic team has reached the highest participation rate ever and gender equality has been at its highest level. This clearly demonstrates that small changes in the organizational structure create big and positive impacts.

In their early days, the Paralympic Games were insufficient in terms of the number of branches as well as the number of participants. In the 1960s, there were only a limited number of sports branches for individuals with physical disabilities (wheelchair basketball, wheelchair fencing, etc.), while in the following years, the number and diversity of these branches (cycling, rowing, wheelchair tennis, boccia, para-taekwondo, etc.) have increased significantly, and a wide variety of sports branches has emerged in which both female and male athletes can participate (Thompson, 2016; Paralympics, 2024). In the context of Turkey, female Paralympic athletes, who were initially represented only in table tennis, now participate in many different branches such as rowing, taekwondo, badminton, athletics (TMPK, 2024). In particular, branches such as judo and weightlifting, which require physical endurance and are generally considered to be “male-dominated”, are among the fields where Turkish female Paralympic athletes have won the most medals. In addition, taekwondo has become a regular medal-earning discipline for Turkish female athletes since its addition to the Paralympic Games (TMPK, 2024). Internationally, female athletes continue to struggle with gender bias in male-dominated sports. Women are subjected to constant pressure to demonstrate their competence in disciplines such as judo and shooting and face negative attitudes, including being underestimated (Kirakosyan, 2021). Turkey's difference in this context is that its female athletes have largely overcome these prejudices by achieving significant international success in disciplines that require physical endurance. A more comprehensive analysis of the individual experiences of athletes and societal perceptions is needed. It is important to understand the dynamics behind their successes in order to better evaluate the effects of prejudices and the social reflections of these successes on female athletes.

Another finding of the study reveals that Turkish female Paralympic athletes revealed a significant increase in medal wins in recent years. The 2024 Paralympic Games stand out as a period in which Turkish female Paralympic athletes won more medals both historically and in comparison, to male athletes. In fact, the total of 17 medals won by Turkish women athletes at the 2024 Paralympic Games exceeded the total number of medals won by Turkish athletes (men and women) at the Olympic Games organized in the same year (8 medals), a significant achievement (TMOK, 2024; TMPK, 2024). In addition to this general picture of success, it is also observed that Turkish female Paralympic athletes have achieved remarkable successes in the international arena at the individual level. Gizem Girişmen made history as the first female athlete to win a gold medal for Turkey at the 2008 Paralympics. Nazmiye Muratlı's world record gold medal in 2012, becoming the first Turkish athlete to win back-to-back champions in 2016, and Sevilay Öztürk becoming the youngest Turkish athlete to win a medal at the 2020 Tokyo Paralympics show that Turkish women athletes are gaining momentum in the international arena. Their achievements have reinforced not only their individual stories, but also their role as an inspiration for the next generation of athletes. However, despite these individual achievements, Turkey lags behind many countries in the overall medal tally, suggesting the need for stronger support mechanisms at the national level. Although the main goal of the Paralympic Games is inclusion, medal winners are often limited to a select few countries such as the USA, Canada, Germany, China and Australia. These countries win between 9% and 29% of the total medals, while many other countries lag behind, highlighting inequalities in access to Paralympic sport. Social deficiencies, administrative inadequacies and economic deficiencies are among the main reasons for these inequalities (Mauerberg-deCastro et al., 2016). This clearly shows that despite the remarkable individual achievements of Turkish female Paralympians, Turkey needs stronger infrastructure, economic support and strategic planning to improve its overall medal performance. a balanced and fair reflection of all genders in the media. Provide equal incentives and financial support to male and female athletes. Increase women's representation in decision-making and leadership positions,Creating an inclusive organizational culture. These five focus areas are closely interlinked and should be addressed in a holistic approach to increase the representation and success of women athletes with disabilities in sport. Supporting and strengthening the representation of women athletes with disabilities will contribute to both achieving gender equality and increasing opportunities for people with disabilities in sport (Olympics, 2024).

***Conclusion***

When evaluated from an intersectional theory perspective, the success of Turkish female Paralympic athletes, especially in male-dominated sports, clearly reveals their struggle to overcome inequalities experienced on two different axes of discrimination. As a result, this increase in the participation and success of female athletes can be explained by factors such as gender equality policies, increased support programs and projects that encourage participation in sports. While there has been a general stabilization in the participation and medal count of male athletes, the rising performance of female athletes is an important indicator of the changing dynamics in this field. At the international level, in addition to individual achievements, it is anticipated that this progress will be carried further thanks to various regulations and policies put in place.

***Recommendations***

Women athletes with disabilities still face numerous barriers in the world of competitive sport and these challenges have not been fully overcome. Five focus areas, aligned with UN Women's Sport for Generational Equality initiative, provide recommendations to address these challenges. These focus areas are:

To ensure equal participation and representation of women and men athletes. Promote

***Limitations of the Study***

This study provides data on the participation and representation of female Paralympic athletes. However, one of its limitations is the lack of in-depth exploration of individual experiences due to the absence of qualitative interviews. Additionally, the research focuses solely on the Paralympic Games and does not provide information on the representation of female athletes with disabilities in other international organizations, such as Deaflympics and Special Olympics. This limitation restricts a comprehensive assessment of the representation of different disability groups in the field of sports.

### *Conflict of Interest*

The authors declare no conflict of interest. No financial support was received.

### *Ethical Considerations*

Prior to the commencement of the study, ethical approval was obtained from the Ethics Committee of Atatürk University, Faculty of Sport Sciences (E-70400699-050.02.04-2500069051).

### *Author Contributions*

Study Design: SSD, ELİ; Data Collection: SSD; Statistical Analysis: SSD; Data Interpretation: ELİ; Manuscript Preparation: SSD, ELİ; Literature Search: SSD, ELİ. All authors have read and accepted the published version of the manuscript.

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RESEARCH ARTICLE

# Comparison of Covid-19 Fear and Perceived Stress Level in Tennis Players with Positivie and Negative PCR Results at Elazig/Turkiye

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**Abstract**
The purpose of this research was to compare the COVID-19 fear and perceived stress levels of tennis players in Elazığ province who tested positive and negative for PCR. PCR test results were examined considering variables such as gender, education level, age, and years of playing tennis. The research sample was determined using accessible sampling method and consisted of two participant groups, one with PCR positive (4 participants) and the other with PCR negative (16 participants), in the age range of 10-49. A survey technique was used in the research. The participants' levels of stress perception were measured using the "Perceived Stress Scale Long Form (PSS-14)" and the "COVID-19 Fear Scale (FCV-19S)". Due to the non-normal distribution of the data, PCR test distributions based on gender, age groups, education level, and years of playing tennis were presented with cross-tables. Mann-Whitney U test was used to compare COVID-19 fear and perceived stress levels according to gender and PCR test status. The findings of this study indicated a significant difference in the years of playing tennis for female athletes with negative and positive PCR tests ($p = .031 * p < .05$) and for male athletes with negative and positive PCR tests ($p = .005 * p < .05$). It was also found that PCR positive and negative individuals, both females and males, did not differ significantly in terms of COVID-19 fear and perceived stress levels. As a result, the likelihood of testing negative for PCR increases with increasing age groups.

**Keywords**
COVID-19, Pandemic, Tennis, Fear, Stress

## INTRODUCTION

Throughout history, various periods have witnessed the emergence of infectious diseases. In the 21st century, two coronavirus outbreaks, namely SARS-CoV and Middle East Respiratory Syndrome, or MERS-CoV, are the most widespread and deadly global pandemics.

In December 2019, an unusual pneumonia case with previously unseen symptoms was discovered in the city of Wuhan, located in the Hubei province of China. Health authorities promptly initiated measures such as the isolation of individuals suspected of having the disease, close monitoring of those in contact with infected individuals, and the urgent collection of epidemiological and clinical data for disease progression (Wang and Zhao, 2020).

On December 31, 2019, the first case of COVID-19 was reported to the World Health Organization (WHO) by Chinese authorities (Weston and Frieman, 2020). Due to the disease's spread to 160 countries, with more than 200,000 cases and over 8,000 deaths, the WHO declared it a "pandemic." As cases rapidly increased, countries began implementing necessary restrictions. "The coronavirus, which has been the subject of newspaper headlines and news headlines

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in many countries, creates an atmosphere of uncertainty and affects individuals not only physically but also psychologically. Fear, loneliness, boredom, and anger are among the most common emotions experienced by individuals during this period (Ornell, Schuch, Sordi, and Kessler, 2020). The virus's rate of transmission, incubation period, the number of infected individuals, news on social media, and different policies implemented by countries have further intensified feelings of insecurity and fear among individuals. The fear during the pandemic has been shown to increase anxiety and stress levels in otherwise healthy individuals (Barzilay, Moore, Greenberg, Didomenico, Brown, White, Gur, and Gur, 2020). A study examining the fear of contracting or transmitting COVID-19 found that individuals experienced high levels of emotions such as fear, distress, loneliness, anxiety, insomnia, and anger (Shigemura, Ursano, Morganstein, Kurosawa, and Benedek, 2020).

The COVID-19 pandemic not only affects individuals' physical health but also significantly impacts people's mental well-being (Harper, Satchell, Fido, and Latzman, 2020; Satici, Gecet-Tekin, Deniz, and Satıcı, 2021; Yıldırım and Güler, 2020)."During the COVID-19 pandemic, the fear of entering shopping centers or crowded places due to the transmission of the virus from person to person, the fear of encountering infected individuals in healthcare facilities, and the stress of approaching people have been observed as reactions (Doğan and Düzel, 2020; Altunalan et al., 2022). Furthermore, it is known that the implementation of precautions, such as the closure of schools, universities, restaurants, and many factories, has led to people suddenly losing their jobs and income. Unemployment issues and an uncertain future create additional stress and fear among individuals (Fuchs Matonog, Pilarska, Sieradzka, Szul, Czuba, and Drosdzol-Cop, 2020)."

Research studies have shown that age, education level, place of residence, marital status, economic status, and gender are among the factors influencing the fear of COVID-19 (Doğan and Düzel, 2020; Gashi, 2020; Gencer, 2020). Regarding the pandemic, it has been observed that high school graduates are more stressed compared to university graduates, and men are more stressed than women (Doğan and Düzel, 2020). These negative circumstances have also affected social and sporting activities. In response to these adverse conditions, our country has implemented measures such as quarantine, the closure of institutions and organizations, and the enforcement of mask-wearing and social distancing. During the closure period, gyms and sports activities were suspended, and this situation has also affected sports like tennis.

Tennis, among the sports disciplines, stands out as a visually exciting and pleasant activity due to its inclusion of aesthetic movements based on competition. Therefore, it is among the popular sports. It is observed that many individuals participate in tennis competitions that manage to captivate the audience visually, making it a popular sporting event. Tennis, which is also held in many countries around the world, contributes to the tourism potential of the host country. In countries where tennis competitions are held, major organizations and promotions related to sports competitions are carried out. These sports competitions also offer substantial prizes. Tennis, which enjoys great interest in the countries where it is played, provides opportunities for athletes to showcase their abilities thanks to its broad audience base and major events (Ölçücü, Erdil, Bostancı, Canikli, and Aybek, 2012). Furthermore, tennis today ranks among the sports that are practiced both professionally and recreationally (İmamoğlu, 2009). Additionally, tennis is one of the most popular sports in the world, played by 1.12% of the global population (Turner, Beranek, Rogers, Nosaka, Girart, and Cruickshank, 2021).

Unlike many other sports, tennis is played across all age groups. Therefore, it is considered a valuable lifelong sport for maintaining healthy levels of physical activity in middle-aged and older adults. Due to its accessibility across all age groups, it is expected that the COVID-19 pandemic will exert significant pressure on tennis players, leading to psychological issues such as stress and fear. From the athletes' perspective, COVID-19 has not only posed significant health concerns but has also disrupted training and competition schedules due to the fear of infection (Hellewell, Abbott, and Gimma, 2020). Unfortunately, during the COVID-19 pandemic, the reduction in physical activity levels during periods of social isolation and quarantine, along with interruptions in training programs, is likely to have negative effects on respiratory function and exercise capacity in the short and long term.

Additionally, even for athletes who do not contract the disease, the cancellation of competitions and the resulting loss of income have increased pandemic-related stress levels (Bao, Sun, and Meng, 2020).

In light of this information, this study has been prepared to examine the impact of changes in perceived stress levels on the levels of COVID-19 fear among tennis players with both positive and negative PCR test results who continue to play tennis during the pandemic, using certain variables.

The aim of this research is to determine the extent to which the fear of COVID-19 and stress levels of tennis players with positive and negative PCR test results were affected during the COVID-19 pandemic.

## MATERIALS AND METHODS

This section provides information about the research design, location and characteristics of the study, the population and sample, data collection instruments, the data collection process, and data analysis.

***Research Design***

The data collected in this research was gathered at a specific point in time and in a single instance, making the study a cross-sectional research design (Ruane, 2005; Frankel and Wollen, 2005). The research aims to investigate the impact of perceived stress levels on the change in the COVID-19 fear levels of individuals who play tennis, while also exploring how this effect varies based on factors such as PCR testing, gender, age, education, and years of playing tennis. In this regard, the research design can be described as a causal-comparative model since it examines whether the change in the COVID-19 fear levels of individuals who play tennis is attributed to their stress perception, and it also examines whether the measured socio-demographic factors alter the direction, effect, and strength of the interaction between stress and fear.

Descriptive research model is a type of research that aims to describe, explain and interpret the phenomenon or event as it is. Descriptive research generally uses quantitative data collection methods and analyzes the data with descriptive statistics. In this study, descriptive-comparative model, it aims to make comparisons between different groups, conditions, variables or time periods (Buyukozturk, 2016).

***The Research Group***

This research was conducted with 50 athletes who played tennis in the Elazığ province during the COVID-19 pandemic period, between November 2021 and January 2022, and had both positive and negative COVID-19 PCR test results. The population of the research consisted of athletes who played tennis in the Elazığ province during the pandemic period with both positive and negative COVID-19 PCR test results. The research sample was not determined through a systematic sampling method but rather through a complete enumeration based on voluntary participation. Complete enumeration is the examination of all units in the research population (Ergin, 1991). In this context, the participants of the study were composed of amateur and professional tennis players. To account for potential data loss, it was decided to include 10% reserve participants. Therefore, the sample size of the research was determined as 60 participants. The study was completed with the participation of 50 volunteers.

***Data Collection Instruments***

The information about the data collection instruments used in the research is as follows:

***Socio-Demographic Questionnaire:***

This questionnaire aimed to gather information about the participants' gender, age, education level, and occupation. It also included questions related to PCR test results, symptoms exhibited by those who tested positive, accompanying illnesses, and the course of the disease. Additionally, it included questions to determine participants' emotional and behavioral attitudes towards pandemic measures and questions regarding their sports experience before and after COVID-19.

***Fear of COVID-19 Scale (FCV-19S):***

The Fear of COVID-19 Scale was developed by Ahorsu and others (2020) and adapted into Turkish for use in a study titled "Fear of COVID-19 and Positivity: Mediating Role of Intolerance of Uncertainty, Depression, Anxiety, and Stress" by Bakioğlu and others (2020). The scale consists of seven items and has a single subscale. Participants rate each item on a scale from "1: Strongly Disagree" to "5: Strongly Agree." According to Ahorsu and others (2020), the original scale has factor loadings between 0.66 and 0.74, indicating good validity. The Cronbach's alpha internal

consistency coefficient is 0.82, indicating good reliability. Moderate correlations were found with depression (r=0.43), anxiety (r=0.51), perceived infectivity (r=0.48), and germ avoidance (r=0.46) scales. After ensuring the linguistic validity of the Turkish version, confirmatory factor analysis was conducted using the data collected from the sample. The Turkish version had good fit indices ($x^2$/sd=2.45; RMSEA=0.03; CFI=0.99; IFI=0.99; GFI=0.99; AGFI=0.99; NFI=0.99; RFI=0.99; SRMR=0.014). Factor loadings ranged from 0.73 to 0.82. The scale explained 58.86% of the total variance. Internal consistency was high (α=0.88) when examined for internal consistency (Bakioğlu et al., 2020).

***Perceived Stress Scale Long Form (PSS-14):***

This scale was developed by Cohen, Kamarck, and Mermelstein (1983). It consists of 14 items designed to measure how individuals perceive the stressfulness of certain situations in life and is rated on a 5-point Likert scale. Higher total scores indicate higher perceived stress. The reliability and validity analyses of the Turkish long and short forms of the Perceived Stress Scale were conducted by Eskin and others. They found that the internal consistency coefficient of the long form of the scale was 0.84, and the test-retest reliability was 0.87, indicating that the scale is a reliable measurement tool. When the structural validity of the scale was examined using the principal components method, two factors named "insufficiency-self-sufficiency" and "stress / discomfort" were identified. The two-factor structure explained 46.50% of the total variance. The PSS-14 scale had correlation coefficients of 0.45 with the "Life Events List," 0.64 with the "Beck Depression Inventory," -0.43 with the "Rosenberg Self-Esteem Scale," 0.42 with the "Satisfaction with Life Scale," 0.31 with the family subscale of the "Perceived Social Support Scale," and -0.26 with the friend subscale of the "Perceived Social Support Scale" (all $p < 0.01$). Based on these correlation coefficients, the scale has concurrent validity. Therefore, the scale is sufficiently valid for measuring individuals' subjective stress perceptions. Items that need to be reverse-scored are "4, 5, 6, 7, 9, 10, 13" (Eskin et al., 2013).

**Data Collection**

The implementation of this study began after obtaining ethical approval from the Mersin University Social Sciences Ethics Committee following the acceptance of the thesis proposal. The data collection form was pre-tested on five individuals, and it took an average of 20 minutes to complete.

In the research, the most commonly used data collection method, which is the survey technique, was utilized. The survey was conducted between November 2021 and January 2022. Survey forms were sent to the participants who constituted the sample of the research via an online survey platform (Google Forms) link. At the beginning of the data collection form, the purpose of the study was explained to the participants, and their consent was obtained. Participants were informed that their personal information would be protected and that their responses would never be used with their names in any place or at any time. They were then asked to mark the appropriate options. Also This study has been approved by the Mersin University Social and Human Sciences Ethics Committee with decision number 100 on September 7, 2021.

***Data Analysis***

After the data were collected through the online survey tool on Google Forms, they were analyzed using SPSS version 21. Subsequently, a frequency analysis was conducted for the factors in the "general information questionnaire."

The reverse items in the Perceived Stress Scale Long Form were recoded to prepare them for analysis. Then, the scores for each participant on this scale were calculated by summing all the scale items. For participants who left some questions blank, the total score was assigned as the mean score. The responses of each participant to the items of the COVID-19 Fear Scale (FCV-19S) were summed to obtain the total score for the scale, and for participants who did not have a total score calculated, the mean score was assigned.

In statistical analyzes, PCR test distributions based on gender, age groups, education level, and the duration tennis playing experience are shown in cross tables. Since the data do not show a normal distribution, Mann Whitney U test was used to compare COVID-19 fear and perceived stress levels by gender and PCR test status.

## RESULTS

This research, which aimed to examine the effects of the relationship between COVID-19 fear and perceived COVID-19 risk in individuals

playing tennis during the COVID-19 pandemic, was conducted to contribute to the literature related to the pandemic process.

**Table 1:** Participants descriptive Statistics

| | | Female | | | Male | | |
|---|---|---|---|---|---|---|---|
| Variable | Group | Positive | Negative | Total | Positive | Negative | Total |
| Yaş Grupları | 10-18 Years Old | 0 | 0 | 0 | 0 | 1 | 1 |
| | 19-28 Years Old | 6 | 3 | 9 | 4 | 1 | 5 |
| | 29-38 Years Old | 6 | 6 | 12 | 5 | 1 | 6 |
| | 39-48 Years Old | 2 | 1 | 3 | 3 | 5 | 8 |
| | 49 Years and Older | 0 | 1 | 1 | 3 | 2 | 5 |
| | Total | 14 | 11 | 25 | 15 | 10 | 25 |
| Education Level | Primary School | 0 | 1 | 1 | 0 | 2 | 2 |
| | High School | 2 | 0 | 2 | 4 | 1 | 5 |
| | University | 10 | 8 | 18 | 6 | 5 | 11 |
| | Postgraduate | 2 | 2 | 4 | 5 | 2 | 7 |
| | Total | 14 | 14 | 25 | 15 | 10 | 25 |
| Years of Playing Tennis | 0-4 Years | 13 | 5 | 18 | 8 | 1 | 9 |
| | 5-9 Years | 1 | 5 | 6 | 4 | 4 | 8 |
| | 10-14 Years | 0 | 0 | 0 | 3 | 0 | 3 |
| | 15 Years and Over | 0 | 1 | 1 | 0 | 5 | 5 |
| | Total | 14 | 11 | 25 | 15 | 10 | 25 |

**Table 1: Cross-tabulation Analysis of PCR Test Results for Female and Male Athletes by Age *Groups For Female Athletes:***

Chi-square test ($X^2$) = 2.02, degrees of freedom (df) = 3, Asymptotic Significance (Asymp. Sig.) = 0.572. There is no significant difference in the distribution of PCR positive and negative results among age groups for female athletes. The distribution of PCR positive and negative female athletes is not statistically different by age group.

**For Male Athletes:**

Chi-square test ($X^2$) = 5.382, degrees of freedom (df) = 3, Asymptotic Significance (Asymp. Sig.) = 0.250. There is no significant difference in the distribution of PCR positive and negative results among age groups for male athletes. The distribution of PCR positive and negative male athletes by age group is shown. There is no statistically significant difference between PCR positive and PCR negative male athletes.

**Cross-tabulation Analysis of PCR Test Results for Female and Male Athletes by Education Level For Female Athletes:**

Chi-square test ($X^2$) = 2.904, degrees of freedom (df) = 3, Asymptotic Significance (Asymp. Sig.) = 0.407. There is no significant difference in the distribution of PCR positive and negative results among education levels for female athletes. The distribution of PCR positive and negative female athletes by education level is shown. There is no statistically significant difference between PCR positive and PCR negative female athletes.

**For Male Athletes:**

Chi-square test ($X^2$) = 4.351, degrees of freedom (df) = 3, Asymptotic Significance (Asymp. Sig.) = 0.226. There is no significant difference in the distribution of PCR positive and negative results among education levels for male athletes. The distribution of PCR positive and negative male athletes by education level is presented. There is no statistically significant difference between PCR positive and PCR negative male athletes.

**Cross-tabulation Analysis of PCR Test Results for Female Athletes by Years of Playing Tennis:** Chi-square test ($X^2$) = 6.962*, degrees of freedom (df) = 2, Asymptotic Significance (Asymp. Sig.) = 0.031. There is a significant difference in the distribution of PCR positive and negative results among years of playing tennis for female athletes (*p<0.05). The distribution of PCR positive and negative female athletes by years of playing tennis is shown.

**Cross-tabulation Analysis of PCR Test Results for Male Athletes by Years of Playing Tennis:**

Chi-square test ($X^2$) = 12.963**, degrees of freedom (df) = 3, Asymptotic Significance (Asymp. Sig.) = 0.005. There is a significant difference in the distribution of PCR positive and negative results among years of playing tennis for male athletes (**p<0.01). The distribution of PCR positive and negative male athletes by years of playing tennis is presented. Male athletes who played tennis for 0-4 years have higher PCR positive rates, while the highest PCR negative rate is observed among male athletes who played tennis for 15 years and above.

**Table 2.** Comparison of COVID-19 Fear and Perceived Stress Levels of Female Athletes with PCR Negative and Positive Test Results

| Variables | Group | N | Mean | SD | Min. | Max. | MWU | z | Asymp. Sig. |
|---|---|---|---|---|---|---|---|---|---|
| COVID-19 Fear | Positive | 14 | 20,07 | 7,51 | 11,00 | 34,00 | | | |
| | Negative | 11 | 20,00 | 6,37 | 10,00 | 29,00 | 77,000 | ,000 | 1,00 |
| | Total | 25 | 20,04 | 6,89 | 10,00 | 34,00 | | | |
| Perceived Stress Level (PSL) | Positive | 14 | 23,00 | 3,92 | 16,00 | 29,00 | | | |
| | Negative | 11 | 24,36 | 5,18 | 17,00 | 35,00 | 66,500 | -,577 | ,564 |
| | Total | 25 | 23,60 | 4,47 | 16,00 | 35,00 | | | |
| PSL Inadequate Self-Efficacy Subscale | Positive | 14 | 23,64 | 2,92 | 19,00 | 28,00 | | | |
| | Negative | 11 | 22,00 | 5,51 | 15,00 | 32,00 | 47,500 | -1,624 | ,104 |
| | Total | 25 | 22,92 | 4,24 | 15,00 | 32,00 | | | |
| PSL Stress/Discomfort Perception Subscale | Positive | 14 | 18,64 | 5,23 | 10,00 | 29,00 | | | |
| | Negative | 11 | 22,09 | 4,95 | 11,00 | 31,00 | 45,500 | -1,730 | ,085 |
| | Total | 25 | 20,16 | 5,30 | 10,00 | 31,00 | | | |

Table 2: Comparison of COVID-19 Fear and Perceived Stress Levels Between Female Athletes with PCR Negative and PCR Positive Results. There were no statistically significant differences found between female athletes with PCR positive and negative results in terms of mean values for COVID-19 fear, perceived stress level, inadequate self-efficacy perception, and stress/discomfort perception variables.

**Table 3:** Comparison of COVID-19 Fear and Perceived Stress Levels in Male Athletes with Negative and Positive PCR Test Results.

| Variables | Group | N | Mean | SD | Min. | Max. | MWU | z | Asymp. Sig. |
|---|---|---|---|---|---|---|---|---|---|
| COVID-19 Fear | Positive | 15 | 17,47 | 6,12 | 7,00 | 26,00 | | | |
| | Negative | 10 | 18,90 | 10,83 | 7,00 | 42,00 | 72,500 | -,139 | ,889 |
| | Total | 25 | 18,04 | 8,14 | 7,00 | 42,00 | | | |
| Perceived Stress Level (PSL) | Positive | 15 | 21,40 | 5,12 | 12,00 | 31,00 | | | |
| | Negative | 10 | 23,30 | 9,12 | 15,00 | 48,00 | 73,500 | -,084 | ,933 |
| | Total | 25 | 22,16 | 6,88 | 12,00 | 48,00 | | | |
| PSL Inadequate Self-Efficacy Subscale | Positive | 15 | 22,47 | 3,46 | 16,00 | 29,00 | | | |
| | Negative | 10 | 24,40 | 8,58 | 15,00 | 42,00 | 73,500 | -,084 | ,933 |
| | Total | 25 | 23,24 | 5,96 | 15,00 | 42,00 | | | |
| PSL Stress/Discomfort Perception Subscale | Positive | 15 | 19,60 | 5,12 | 10,00 | 31,00 | | | |
| | Negative | 10 | 20,90 | 8,44 | 11,00 | 42,00 | 72,000 | -,167 | ,867 |
| | Total | 25 | 20,12 | 6,51 | 10,00 | 42,00 | | | |

Table 3: Comparison of COVID-19 Fear and Perceived Stress Levels in Male Athletes with Negative and Positive PCR Test Results. There were no statistically significant differences found between male athletes with positive PCR results and those with negative PCR results in terms of mean values for COVID-19 fear, perceived stress level, inadequate self-efficacy perception, and stress/discomfort perception variables.

Within the scope of the research objective, the results of 34 participants who were PCR positive and 16 participants who were PCR negative, aged between 10 and over 49 years, and living in the Elazığ province are provided below:

There is no statistically significant difference in the distributions of male and female athletes between PCR-negative and PCR-positive groups.

There is no statistically significant difference in the distributions of age and education levels among female and male athletes in both PCR-negative and PCR-positive groups. The likelihood of athletes testing PCR-positive increases statistically significantly as the years of playing tennis increase, both in females and males. COVID-19 fear and perceived stress levels do not differ between PCR-positive and PCR-negative individuals in both females and males.

## DISCUSSION

This study was conducted to examine the relationship between the fear of COVID-19 and perceived COVID-19 risk among individuals who play tennis during the pandemic. In this context, data were collected from individuals playing tennis in Elazığ province, and an applied research method was followed.

Discussion on the Results of Descriptive Findings Regarding COVID-19 Diagnosis In order to control the COVID-19 pandemic, rapid and accurate detection of the disease is crucial (Bhadra, Jiang, Kumar, Johnson, Hensley, & Ellington, 2015). Globally, COVID-19 diagnosis is made through the examination of samples obtained from nasopharyngeal and oropharyngeal swabs in the laboratory. Currently, the gold standard method used for COVID-19 diagnosis is the RT-PCR test. RT-PCR results generally turn positive a few days (2-8 days) after infection (Lee, Baek, Kim, Choi, Song, & Ahn, 2017). According to the results obtained, the time it takes for individuals with COVID-19 infection to return to tennis, the time spent exercising weekly before COVID-19 infection, the time spent exercising weekly after COVID-19 infection, taking vitamin supplements after COVID-19 infection, adhering to hygiene rules, wearing masks regularly, avoiding crowds, changes in dietary habits, and the impact of the coronavirus on themselves were found to be influential variables. Since no similar research has been found in the relevant literature, the results of the study are considered important. However, the limited sample size of the study is a limitation of the research. Based on the results obtained, it can be said that the gender of the participants does not have an effect on PCR positive or negative status. Since no similar research has been found in the relevant literature, the results of the study are considered important. However, the limited sample size of the study is a limitation.

Discussion on the Results of the Relationship Between Perceived COVID-19 Fear and Socio-Demographic Variables during the COVID-19 Pandemic Risk perception affects health behaviors against diseases with unpredictable outcomes, such as COVID-19 (WHO, 2020). The average COVID-19 risk scores of the tennis-playing individuals who participated in the research were not different between women and men in both PCR negative and positive groups. According to the results obtained, it can be said that the perceived COVID-19 risks of the participants are at a moderate level. In the relevant literature, it is observed that the COVID-19 risk scores perceived by the participants in this study parallel the findings obtained in different sample groups in the studies conducted by Yıldırım and Güler (2020), Jaspal et al. (2022), Yanez et al. (2020), Caserotti et al. (2021), Yorguner et al. (2021), Yıldırım et al. (2021), and Yıldırım and Güler (2021). It was found that there was no statistically significant difference between all participants included in the research according to PCR test results in terms of their perceived COVID-19 risks. Since a limited number of similar studies have been found in the relevant literature, it can be said that the result obtained is due to the limited number of samples.

It was found that there was no statistically significant difference in COVID-19 risks among the participants included in the study according to their gender. While Yıldırım and Güler (2020), Rodriguez-Besteiro et al. (2021), Yıldırım et al. (2021), and Yıldırım and Güler (2021) stated that the gender variable is effective in the COVID-19 risk levels in their studies conducted with different sample groups, Jaspal et al. (2020) and Caserotti et al. (2021) reported that it was not effective, similar to the results of this study. These results can be considered variable in terms of sample size and sample groups. It was found that there was no significant relationship between the age groups of the participants and their COVID-19 risk levels. Since researches conducted by different sample groups, such as Cihan et al. (2020), Huynh (2020), Iorfa et al. (2020), Yıldırım and Güler (2020), Caserotti et al. (2021), and Yıldırım et al. (2021), have reported that there is a relationship between age groups and COVID-19 risk levels, this does not overlap with the results of this thesis. It is

thought that the reason for the difference in the results obtained in the research is the small sample size of the participants forming the sample of the research. It was found that there was no significant relationship between the education levels of the participants included in the research and COVID-19 risk. Since researches conducted with different sample groups, such as Huynh (2020), Iorfa et al. (2020), Yıldırım and Güler (2020), and Yıldırım et al. (2021), have reported a relationship between education levels and COVID-19 fear levels, this does not overlap with the results of the research. It is thought that the reason for the difference in the results obtained in the research is the small sample size of the participants forming the sample of the research.

It was observed that individuals included in the research who had fewer years of playing tennis had generally shorter tennis experience, and those who had longer tennis experience protected themselves from the coronavirus disease. Although there is a positive relationship between the age factor and being PCR positive, it suggests that experienced tennis players in this thesis adhere to hygiene rules sufficiently and have strong immune systems. Since no similar research has been found in the relevant literature, the results of the study are considered important. However, the limited sample size of the study is a limitation.

Discussion of the Results of the Relationship Between COVID-19 Fear Levels and Perceived COVID-19 Risk Although fear is defined as a negative emotion from a psychological perspective, it is an important factor that prompts individuals to engage in protective behaviors in various situations. It is reported that pathologically low levels of fear increase risk-taking behavior and even hinder protective behaviors by increasing risk perception among individuals during the COVID-19 pandemic (Harper et al., 2021). The prolonged duration of the COVID-19 process and the still high mortality rate affect individuals' fear of COVID-19 and perceived risk levels (Sperling, 2021). In the literature, individuals' cognitive and emotional risk perceptions related to COVID-19 are positively associated with protective behaviors against COVID-19. However, excessive perceived risk is reported to be associated with various psychological health problems such as fear, anxiety, stress, death anxiety, decreased life satisfaction, sleep disturbances, suicide attempts, and ineffective coping (Yıldırım and Güler, 2021). It was found that there was a positive low-level significant relationship between the perceived COVID-19 risk and the perceived risk of the participants included in the research. In a study conducted by Harper et al. (2021), it was reported that there was a positive and moderate correlation between COVID-19 fear and perceived risk. In the literature, other studies have also reported a positive correlation between COVID-19 fear and perceived risk (Ahorsu et al., 2020; Li et al., 2020).

**Recommendations**

To make the results of the study more meaningful, a larger number of participants should be included in the research. In this regard, similar research can be conducted by involving a greater number of athletes to achieve more comprehensive findings. In this sense, conducting similar research with different sample groups can make the results of the study more comprehensive and generalizable. The research design can be applied to individuals participating in different sports disciplines. While there has been an increase in studies in the literature that examine the effects of COVID-19 fear and perceived risk levels on athletes in different sports disciplines, no studies focusing on individuals who play tennis have been found. Therefore, research can be conducted to explore the relationship between tennis players and COVID-19 with various variables. Young tennis players may exhibit some differences based on their developmental stage. Research can be conducted on male and female athletes regarding the effects of COVID-19 in the context of their respective developmental stages.

**Conflict of interest**

There is no conflict of interest with any author. Additionally, no financial support has been provided to any author.

**Ethics Committee**

This study has been approved by the Mersin University Social and Human Sciences Ethics Committee with decision number 100 on September 7, 2021.

**Author Contributions**

Contribution has been made from the design stage of the study to the implementation stage, from data collection to statistical analysis and interpretation. The authors have read and accepted the published version of the article.

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