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A Cross-Sectional Study Of Physical Fitness Index By Using Modified Harvard Step Test In Taekwondo Athletes

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ABSTRACT

Background: Taekwondo is known for its unique rapid, high, and spinning kicks. The sport's movement patterns are thought to be quite taxing on the majority of participants' muscle groups. It is believed that the most significant element influencing athletic performance is physical fitness. physical fitness is the capacity to exercise for extended periods of time. Growing physical fitness is getting greater attention as a result of the rising popularity of martial arts among youth and their desire to enhance their own performances. The importance of physical fitness has been discussed throughout human history, especially in the Vedas. However, exercise physiology is a relatively new topic with room for more study.

Method: In this cross-sectional study, seventy five participants with mean age 21.35 (± 2.55) Taekwondo Athletes were included. They were assessed for physical fitness by using modified Harvard step test and Physical Fitness Index.

Result: It was observed that from total 75 participants 39 were male i.e; 52% and 36 were female I.e; 48%. So statistically the ratio of gender distribution is almost equal. It was seen that out of total 75 participants the mean age of participants was 21.35 (± 2.55). According to study the mean value of years of practice is 4.26 (± 2.34) of all 75 participants. And mean value of hours of practice is 1.73 (± 0.45). However, it describes that these figures shed light on the individuals, overall traits, including their degrees of experience and fitness. Male and female fitness index scores do not differ significantly, according to the p-value (0.5918), indicating that gender has no bearing on physical fitness levels in this sample.

Conclusion: According to the study's findings, physical fitness levels are mostly determined by factors such as age, years of practice, and practice hours. Although men perform somewhat better than women in the "Good" fitness category, the differences are not statistically significant, suggesting that gender is not a significant factor in fitness on its own. In order to improve general physical health, the study emphasises the significance of regular exercise, equitable opportunities, and organised fitness programs. To learn more about what makes people as fit as possible, future studies might look into other aspects including nutrition, lifestyle choices, and certain forms of exercise.

Keywords: *Taekwondo Athletes, Physical fitness, Modified Harvard step test.*

1. INTRODUCTION

The martial art of taekwondo originated in Korea [(1)]. The World Taekwondo Federation (WTF) was established in 1973, which marked the beginning of taekwondo's evolution as a martial art. The World Taekwondo Federation, which places a strong focus on athletic performance and competition, and the International Taekwondo Federation (IFT), which promotes a more conventional style of taekwondo, are now in charge of these two organisations. [(10)] It is becoming more and more well-liked globally. Twenty-five years ago, taekwondo was chosen as the most popular youth sport on American campuses. t. [(1)] Growing physical fitness is getting greater attention as a result of the rising popularity of martial arts among youth and their desire to enhance their own performances. It is believed that the most significant element influencing athletic performance is physical fitness [(1)]. Concern has recently been raised about the younger generation's sedentary lifestyle and lack of physical

activity. [9] Some sources claim that a specific body type, age, and physical build are necessary for taekwondo. [1] Taekwondo is known for its unique rapid, high, and spinning kicks. The sport's movement patterns are thought to be quite taxing on the majority of participants' muscle groups. [8]. The elements of oxygen transport and the working muscles' oxidative process determine aerobic fitness. Another definition of physical fitness is the capacity to exercise for extended periods of time. [4] Athletes have fluctuations in their anatomical, muscular, metabolic, and hormonal development rates.[4] The ability of the heart, lungs, blood, muscles, and other organs and organ systems to transport and use oxygen is reflected in cardiovascular fitness. [6]. According to estimates, cardiovascular illnesses account for 9.4 million deaths annually, making them the leading cause of mortality [9]. Physical inactivity is a contributing factor in around 3.3% of fatalities. The Harvard Step Test (HST) evaluates a person's physical fitness, and the Physical Fitness Index helps gauge a person's capacity for muscular effort and recuperation [9]. The importance of physical fitness has been discussed throughout human history, especially in the Vedas. However, exercise physiology is a relatively new topic with room for more study. [9].

Recent assessments on the subject have highlighted the paucity of information about the factors influencing youth activity. While the evidence is beginning to accumulate, it is still few and equivocal, indicating that encouraging enough physical activity during childhood and adolescence may have a lasting impact into adulthood. [5] It is well known that athletes must possess a high level of aerobic fitness. According to earlier studies, adults may benefit from using more recent game-based conditioning that includes movement and skill-specific tasks, such as small-sided games, or more conventional aerobic conditioning methods, such as high-intensity interval and moderate-intensity continuous training. However, there hasn't been much attention paid to aerobic fitness training for young athletes who play sports, and due It is probably different for them than for adults due to maturational differences. The approach uses physiological factors linked to normal growth and maturation to identify "windows of trainability," or times of enhanced and accelerated physical development. Since this ability is crucial for recovery, delaying the onset of fatigue and allowing for the continuation of high-intensity exercise during play, it is mostly based on an individual's degree of aerobic fitness [3]. The aim of present study is therefore planned to study PFI in both male and female Taekwondo athletes with modified HST along with statistical subdivision to classify the score relatively on a moderate number of subjects. The method used to evaluate aerobic fitness through step testing is based on the fact that each person recovers at a different rate, with highly conditioned people showing greater recuperative capacity than untrained ones. Johnson et al. created the Harvard step test to evaluate a person's level of physical fitness. The Harvard Step Test is used to evaluate a person's aerobic fitness and cardiovascular system's response to physical exertion, as well as to evaluate their physical potential prior to sports training, training program design, and the efficacy of sports programs. [11]

The Harvard step test was utilised in several of those studies to show how knee joint angle, step height, and leg length impact vo2max values. It involves stepping up and down a 20-inch (50.8-cm) high step thirty times each minute. A more fit person recovers more quickly and experiences fewer heart rate increases. The Harvard step test's 20-inch step is designed for western anthropometry. This is high for Indians, who tend to be shorter in stature. Therefore, in the modified Harvard step test that is used in India, the step height is lowered to 16.5 inches, or 41 cm. Upon completion, they were instructed to sit, and the total number of pulses was counted from 1 to 1½ minutes, then from 2 to 2½ minutes, and lastly from 3 to 3½ minutes. Additionally, the physical fitness index equation is used to determine the fitness index score. The long-form Physical Fitness Index (PFI) is calculated by dividing the test length (in seconds) by the total of the heartbeats during the recuperation periods (in seconds). The PFI acquired in this investigation was computed using the equation from the Harvard Step Test in this test The researcher used the same standard of Harvard step test with modifying the height of the step according to the knee joint angle as follows: the height of the step should start with 35cm and up to be connected with the angle of the knee joint when and only when it's 90º sharp as it will guarantee that all participants are performing the test without any overload according to the height of all participants and to concern the individual discrepancies when the test is done attempting to raise its validity and reliability[11].

2. METHODOLOGY

An Observational Cross sectional study conducted on Taekwondo athletes from academies from both male and female from Fighters academy and SEOUL's academy, Kolhapur. Using Convenience Sampling method for a duration of 1.5 years. Study subjects were selected fulfilling inclusion and exclusion criteria.

Inclusion criteria: Age 18-35 years, all gender. exclusion criteria: Individual having any cardio-respiratory disorder, Recent surgeries, Musculoskeletal disorders.

Materials: Wooden step of 16 inch, Weighing machine, Chair, Stopwatch, Metronome app.

The present study is done in 75 participants. The study type here is observational study. Participants were selected as per the inclusion and exclusion criteria and all the participants who were fulfilling the inclusion criteria were assessed by using modified Harvard step test and physical fitness index. The participants who fulfilled the inclusion criteria were selected for the study and those who couldn't meet the inclusion criteria were excluded from the study.

The study was conducted from September 2024 – March 2025. The study was conducted in Taekwondo Athletes both male and female from Fighters academy and SEOUL's academy, Kolhapur. After approved the study protocol by Research Ethical

committee of D. Y. Patil Education society, Kolhapur. The whole Research / Research protocol was explained to the participants. After receiving their written and oral consent participants were included in the study.

Initially the participant was explained about the study. Before starting with the study a written consent was taken from the participant in the language in which the participant is comfortable. Participants privacy was maintained here in this study.

Modified Harvard step test was performed by participants. The participants were instructed to step up and down on a 16inch high step for five minutes or until exhaustion on a beat of metronome app which is 30 steps up and down in a minute. After the step test pulse rate of participants were taken after the break of one minute after every one minute for three times. The collected data was calculated in the formula of Physical Fitness Index and the score was considered according to rating. Detailed demographic data was taken such as Name, age, gender, years of practice and hours of practice.

3. PROCEDURE

The study protocol was presented for approval in front of institutional ethical committee and protocol committee of D. Y. Patil College of Physiotherapy, Kolhapur. After that concerning subject was approached and purpose of study was explained. Written consent was taken from subjects willing to participate. A cross-sectional study of physical fitness index in Taekwondo athletes by using Modified Harvard step test." It is a cross-sectional study which was done on Taekwondo athletes. Subjects were selected from Taekwondo academies and assessed with the help of modified Harvard step test and Physical fitness index.

The subject steps up onto, and back down from the step at a rate of 30 completed steps per minute (one second up, one second down) for 5 minutes or until exhaustion. Exhaustion is defined as when the client cannot maintain the stepping rate for 15 continuous seconds. Subject should wear light weighted clothes. During step up and step-down arms moved naturally like in ordinary walk. For proper dozing of frequency of step up and step down we used metronome. [11] The subject should be directed to lead off with same foot each time and not to use alternate legs [9] The subject immediately sits down on completion of the test, and the total number of their pulse rate is counted from 1 to 1½ minutes after finishing and from 2 to 2½ minutes after finishing and finally from 3 to 3½ minutes after finishing. Physical Fitness Index.

Scoring: the clients fitness index score is then determined by the following equations. Fitness Index = (100 x test duration in seconds) divided by (2 x sum of heart beats in the recovery periods). Eg. if the total test time was 300 seconds (if the client completed the whole 5 minutes), and their number of heart beats between 1-1½ minutes was 90, between 2-2½ it was 80 and between 3-3½ it was 70, then the fitness index score would be: (100 x 300) / (240 x 2) = 62.5. Considering the inclusion and exclusion criteria subjects was requested to participate in study. The nature of the study was explained to the subjects those willing to participate was included. A written consent was taken from all the subjects. A brief demographic data including name, age, gender, as per data collection sheet was recorded. The interpretation of the study was done on the basis of outcome measures score recorded during this study. This study was concluded by statistical analysis of outcome measures.

Fig No. 3 Subject Performing Harvard Step Test

4. RESULTS

It was seen that out of total 75 participants the mean age of participants was 21.35 (± 2.55).

It was observed that from total 75 participants 39 were male i.e; 52% and 36 were female I.e; 48%. So statistically the ratio of gender distribution is almost equal.

This distribution guarantees balanced insights from additional analysis by displaying about equal representation of males and females in the sample.

Descriptive statistics

The general characteristics of the participants are shown in table no. 1

For important factors like age, years of practice, practice hours, and physical fitness index scores, the dataset offers summary statistics. These variables' means and standard deviations (S.D.) are as follows:

Variable	Mean	S.D.
Age	21.35	2.55
Years of practice	4.26	2.34
Hours of practice	1.73	0.45
Physical fitness index score	92.83	10.94

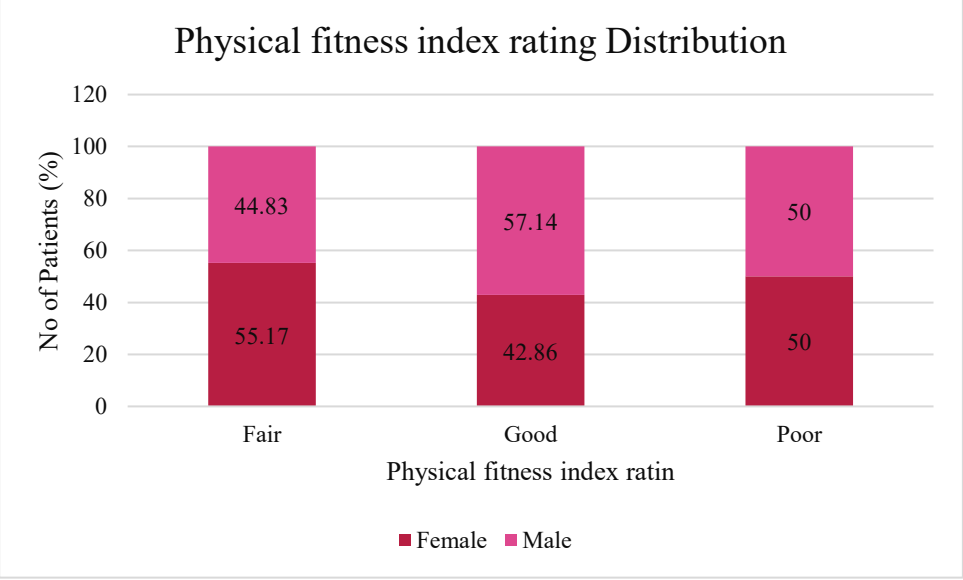
Table no. 1 General Characteristics of Participants

According to study the mean value of years of practice is 4.26 (± 2.34) of all 75 participants. And mean value of hours of practice is 1.73 (± 0.45). However, it describes that these figures shed light on the individual's overall traits, including their degrees of experience and fitness.

The majority of participants were young people, as shown by their mean age of 21.35 years and standard deviation of 2.55. This implies that the study's primary target audience is young people, who are frequently linked to higher levels of physical stamina and fitness. With a standard deviation of 2.34 and an average of 4.26 years of practice indicated, the majority of people had a modest level of physical training experience. With a standard deviation of 0.45 and an average of 1.73 hours of practice each day, the data points to a reasonably regimented and regular training schedule for the participants.

Physical Fitness Index rating by Gender

The following is a summary of how physical fitness index ratings were distributed among gender groups: Male and female fitness index scores do not differ significantly, according to the p-value (0.5918), indicating that gender has no bearing on physical fitness levels in this sample.



Graph no.1 Physical Fitness Index Rating by Gender

A wide variety of fitness levels among participants was reflected in the physical fitness index score, which had a mean of 92.83 with a standard deviation of 10.94. The study divided participants into three fitness index rating groups EXCELLENT, FAIR, GOOD, and POOR—in order to examine how these ratings differ by gender.

The ratings for female participants were as follows: 16 (55.17%) were classified as "Fair," 18 (42.86%) as "Good," and 2 (50%) as "Poor."

Thirteen (44.83%) of the male participants fell into the "Fair" group, twenty-four (57.24%) into the "Good" category, and two (50%) into the "Poor" category.

5. DISCUSSION

In previous study, the authors assessed the physical development and aerobic fitness of 51 adolescents male participants those who are practicing Taekwondo. However, most participants had normal body mass index, in which 30% were overweight and 13% were underweight. So 33% were exhibited significant deviation in weight to height ratio compared to standard centile charts. All participants had average aerobic capacity; so according to study, those participants with normal BMI outperformed peers with abnormal BMI in harvard step test. All findings highlight the importance of maintaining proper body proportions for optimal aerobic performance in young Taekwondo athletes [(1)].

One more study highlights that, anaerobic lactic power, explosive strength (particularly in stretch-shortening cycle movements), agility, and aerobic power, are the main factors that distinguish successful elite Croatian female taekwondo athletes. Although there were minor variations in height and body composition, these characteristics did not significantly affect performance. Superior maximum running speed, ventilators anaerobic threshold, and lateral agility were displayed by more successful athletes, indicating that rapid direction changes and high intensity, short duration energy output are essential in taekwondo. In order to improve competitive performance, these result highlights the necessity of training regimens that prioritise building explosive power, agility, and anaerobic capacity [(8)].

The study which highlights the need to modify the traditional Harvard step test to make more suitable for Indian stature. According to authors, people with physical limitations are frequently overlooked in traditional fitness tests, which might result in erroneous judgements of their functional capacity. In order to provide a more inclusive and flexible approach to evaluating cardiovascular endurance, the researchers changed the test's parameters, including step height, length, and intensity. Their adjustments guarantee a safer and more accurate assessment of students physical ability by enabling them to take the exam without suffering undue stress due to a variety of medical issues [(11)]

Additionally, the results highlight the value of tailored physical education programs, especially for kids with health issues. With a more accurate evaluation of endurance levels thanks to the redesigned exam, teachers may create individualised training plans that suit each student's skills. This method encourages physical activity within reasonable bounds, which supports long-term health gains in addition to fostering a more comprehensive fitness evaluation. The researchers come to the conclusion that making these changes to fitness tests can improve the tracking of students' physical growth and general health, which will eventually increase the efficacy of physical education programs for people with health issues [(11)].

The Harvard Step Test's validity and reliability in predicting VO_2max are investigated in this study, taking into account the impact of step height depending on knee joint angle. The author points out that conventional test administration frequently use a set step height, which might not be equally appropriate for people with various body proportions and joint mechanics. The study sheds light on how different step heights impact VO_2max predictions and cardiovascular response, which helps to maximise the test's accuracy. According to the results, modifying step height based on knee joint angle may improve test reliability and provide a more accurate and customised evaluation of aerobic fitness.

Furthermore, because an incorrect step height might result in an underestimating or overestimation of VO_2 max, the study highlights the significance of biomechanics aspects in fitness testing. According to the findings, a customised approach to step height decreases test result variability and increases consistency in evaluating cardiovascular endurance. Because it enables more precise fitness assessments across a range of demographics, this has applications in sports science and physical education. The Harvard Step Test's application and efficacy in evaluating aerobic capacity are improved by adjusting it to take knee joint angle into account, according to the author, which makes it a more trustworthy instrument for researchers and fitness experts. So as for it is necessary to raise awareness about physical fitness. After explaining about the study the demographic data was taken.

The analysis presented provides insight into the relationship between age, years of practice, hours of practice, and physical fitness among individuals, with a specific focus on gender-based differences. The data highlights key trends in physical fitness index scores, gender distribution, and practice duration, allowing us to draw meaningful conclusions about the fitness levels of the participants.

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levels of the participants.

According to research, sustained physical exercise over a number of years can help people become more physically fit. The youthful age of the participants and their modest level of practice experience suggest that the participants may still be reaching their maximum level of fitness. Furthermore, disparities in practice hours imply that different people commit to training to varying degrees, which may account for discrepancies in fitness index scores.

Male and female fitness levels do not differ statistically significantly, according to the p-value of 0.5918. This implies that, in spite of certain physiological variations, the general levels of fitness for the sexes are comparable. Nonetheless, a somewhat greater percentage of men than women are classified as "Good" fit, which may be related to variations in training volume, muscle composite on or physical activity levels.

According to earlier research, women may make up for men's generally higher aerobic capacity and muscular mass by being more flexible and resilient. This dataset's rather balanced distribution lends credence to the notion that training time, intensity, and consistency rather than gender alone—have a greater influence on fitness levels.

In terms of gender distribution, there were about equal numbers of men and women in the study: 36 women (48%) and 39 men (52%). It is possible to compare male and female participants fairly and without major bias thanks to this balanced sample.

6. CONCLUSION

According to the study's findings, physical fitness levels are mostly determined by factors such as age, years of practice, and practice hours. Although men perform somewhat better than women in the "Good" fitness category, the differences are not statistically significant, suggesting that gender is not a significant factor in fitness on its own. In order to improve general physical health, the study emphasises the significance of regular exercise, equitable opportunities, and organised fitness programs. To learn more about what makes people as fit as possible, future studies might look into other aspects including nutrition, lifestyle choices, and certain forms of exercise.

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