



Effect of Different Lower Limb Stretching Exercises on Flexibility among Table Tennis Players

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Abstract

This research aims to examine the effectiveness of Sit-and-reach flexibility on lower limbs in table tennis players. An experimental study was conducted to evaluate the impact of lower limb exercises on flexibility among 35 school-aged table tennis players at the Adarsha Vidhaya Mandir Table Tennis Club in two phases: pre-phase(before training of Sit-and-reach for flexibility) and post-phase (after training). Data were analyzed using paired sample tests between pre and post-phases. The finding suggests that regular lower limb stretching significantly improves flexibility in table tennis players, which in turn enhances performance and reduces the risk of injury. The sit and reach test shows that the mean test differs before stretching (M=17.60, SD=9.076) and after stretching exercise (M=20.31, SD=8.014) at the 0.05 level of significance, which demonstrates the effectiveness of the intervention. This research provides valuable insights into the strength of lower limb flexibility in enhancing the performance of table tennis players.

Keywords: Lower limb stretching exercises, flexibility, table tennis players, Physiotherapy

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Introduction

Table tennis is a sport played worldwide using small paddles and a lightweight, hollow ball on a stationary table. It is a fast-paced game that requires quick reactions, precision, and repetitive movements. Players need to possess agility, quick reflexes, and accurate footwork. The sport involves high-intensity movements that can put a strain on the lower body. If the lower limbs lack flexibility, there is a significantly higher risk of muscle strains, sprains, and joint injuries.

Flexibility refers to the muscle motion and connective tissues at a joint that makes the ability to move freely through a full range of motion (Plowman, 2013). It is the range of motion (ROM) around a specific joint or group of joints (Walker, *Ultimate Guide to Stretching & Flexibility*, 2019). In flexibility, there is also stretching, which symbolizes a physical activity performed to allow improved joint range of motion. There are various forms of *stretching* such as static stretch (passive and active), proprioceptive neuromuscular facilitation, ballistic stretch, and dynamic stretch (Garber et al., 2011).

The flexibility can be measured through laboratory tests and field tests. In lab tests, there are controlling settings with specifically designed devices, which is costly. At the same time, field tests can be used in sports clubs, schools, or fitness clubs easily. Field tests for flexibility have been used in various ways: the shoulder stretch (sometimes called the zipper), trunk lift (assesses both flexibility and muscle fitness), and sit-and-reach (assesses low-back and hamstring flexibility) have been used, as have modifications of these tests. Amongst, the *sit-and-reach* test is famous for requiring a person to flex the hip to touch the toes (Figure 1). Such a test's reliability is consistently high.

Having sufficient flexibility in the lower limbs is essential for athletes, particularly in sports like table tennis. It enables them to perform dynamic movements, maintain balance, and enhance their overall performance. In table tennis, where quick and precise movements are crucial, adequate lower limb flexibility allows players to execute these actions efficiently. Additionally, improved flexibility helps prevent injuries, making it a vital aspect of training for table tennis players. Table tennis players can enhance their flexibility through various lower limb

stretching exercises. Targeting areas such as the hamstrings, quadriceps, calves, and hips can significantly improve a player's performance on the court. Static stretching, which involves holding a stretch without movement for a certain period, is effective in increasing muscle length and range of motion. This type of stretching is best used as part of a warm-up before training sessions or matches, as well as for cool-down routines afterward. One scientific method to assess flexibility is the Sit and Reach Test, which measures the linear flexibility of the hamstrings and lower back. This test was introduced in 1952 by Wells and Dillon and is commonly used to evaluate flexibility (Physiopedia, 2025).

This research aims to provide valuable insights for coaches, trainers, and athletes regarding the relationship between lower limb flexibility and various performance indicators in table tennis. By understanding this relationship, proper training protocols can be developed. Limited flexibility can make it difficult to reach low balls or execute wide lateral movements effectively. Static stretching after training or exercise helps to improve flexibility and prevent muscle tightness. However, the study focused solely on assessing flexibility and did not explore the effects of stretching.

Figure 1: Sit and Reach test demonstration



Source: Sit and Reach Test Measurement Demonstration | Fit Test Flexibility Assessment – YouTube- Right Side Photo & Field Photo(Left)

Literature Review

This document reviews some theories related to flexibility. Elasticity theory, proposed by Moller in 1926, refers to a material's ability to return to its original shape or size after being stretched or deformed. This theory can be applied to understanding the lower limb flexibility of table tennis players. By incorporating specific exercises and stretches into their training routines, players can improve their flexibility, range of motion, and overall performance on the table. Similarly, the Muscle Stretch Reflex Theory explains that when a muscle is suddenly stretched—such as when tapped with a reflex hammer—it triggers a reflexive contraction known as the stretch reflex. This theory illustrates how the body reacts with a reflexive contraction in response to sudden muscle stretching. In table tennis, having good muscle stretch reflexes can enhance players' reaction times and agility. Additionally, maintaining lower limb flexibility through regular stretching exercises is essential for optimal performance and injury prevention (Hsieh, 2017). The Muscle Stretch Reflex Theory explains that when a muscle is suddenly stretched—such as when it is tapped with a reflex hammer—it triggers a reflexive contraction known as the stretch reflex. This theory illustrates the body's automatic response to sudden muscle stretching. In table tennis, good muscle stretch reflexes can enhance reaction times and agility. Moreover, maintaining lower limb flexibility through regular stretching exercises is essential for players to perform at their best and to prevent injuries (Hsieh, 2017).

Likewise, Muscle extensibility theory refers to the capacity of muscles to stretch and lengthen, playing a crucial role in overall flexibility. This flexibility directly affects the range of motion around a joint. To prevent muscle imbalances and enhance recovery, it is important to stretch both before and after engaging in physical activity (Huang et al., 2019). The sliding filament theory explains the mechanism by which muscles contract to generate force. In table tennis, flexibility in the lower limbs is essential for performing quick and agile movements. Regular stretching exercises can significantly improve lower limb flexibility in table tennis players, thereby enhancing their overall performance in the game.

The empirical literature suggests that improving lower limb flexibility can provide several benefits for table tennis players. Increased

flexibility in the hip, knee, and ankle joints allows players to achieve deeper lunges and lower squat positions. This enhancement improves their ability to generate power for shots and maintain a low center of gravity, resulting in better stability. The concept of muscle extensibility theory highlights the importance of muscles being able to stretch and lengthen, which is essential for overall flexibility and determines the range of motion around a joint. To prevent muscle imbalances and facilitate recovery, it is crucial to stretch both before and after playing or training (Huang et al., 2019). Revista (2023) argues that incorporating lower limb flexibility exercises into table tennis training can significantly enhance both static and dynamic flexibility in athletes, positively impacting their sensitivity quality and performance levels.

Hsu (et al., 2020) study found significant improvements in flexibility, power, ball speed, and agility among elite table tennis players. This program included resistance and plyometric training, flexibility exercises, and agility drills. Visas (2015) study concluded that static stretching neither improves nor diminishes performance in table tennis players. In contrast, dynamic stretching has been shown to enhance performance. This indicates that static stretches performed before playing table tennis do not offer any additional benefits for performance. However, incorporating dynamic stretches into a warm-up routine may lead to improved performance for table tennis players.

Objective and Methods

The purpose of this research study is to examine the effectiveness of stretching exercises by sit and reach test among table tennis players. The study employs a paired sample experimental design, which includes a pre-test and a post-test of the same group of players. An intervention on lower limb flexibility was assessed. The pre-test was done before providing training on static stretching for flexibility and the post-test refers to after training on flexibility. The hypothesis was assumed that intervention shows a positive relationship between stretching exercise on Table tennis players.

Population and sample of the study: The study population includes all table tennis players who are actively training at the Adarsha Vidya Mandir Table Tennis Club in Manbhawan, Lalitpur, Nepal. There are a total of 35

players who regularly practice at the club, so a census method was used to conduct the study.

Experimentation: The experiment was carried out in two phases. Participants were assessed in a pre-test (before training regarding the lower limb flexibility) and a post-test (after training) their flexibility using the sit-and-reach test. The sit-and-reach tests are widely used by coaches to evaluate constrained flexibility (Ayala, 2012). The experimental group participated in a 12-week flexibility training program. The following procedures were followed to experiment: participants were divided into two groups based on gender- male and female. Each group engaged in lower limb flexibility training that included stretching exercises specifically designed to target the key muscle groups involved in table tennis movements. Every training session consisted of a warm-up, stretching exercises, the main workout, and a cool-down period. The workout focused on stretching the hamstrings, quadriceps, hip flexors, calves, and ankles, with the goal of improving overall lower limb flexibility. Static stretching techniques were incorporated into the routine.

Data gathering tools: A questionnaire for general information, along with sit and reach tests, was used to assess participants' general information and flexibility. A structured questionnaire was developed to gather data on participants' demographic information, training background, skill levels, physical condition, mental health, economic status, and lifestyle habits. The questionnaire featured straightforward primary inquiries, secondary follow-up questions, and Likert scaling patterns.

Data collection procedures: Participants underwent pretesting prior to the stretching intervention. After a 12-week intervention period, all participants were post-tested using the Sit and Reach test. Data were collected through direct measurements and self-reports. Additionally, participants completed questionnaires to gather information about their training routines, injuries, history, and perceived performance levels.

Data analysis: The descriptive statistics and independent 't' test were used to make findings using SPSS-17 Software and were expressed as frequency, percentage, mean and standard deviation. To evaluate changes in lower limb flexibility within each group before and after training, a paired t-test was conducted.

Results and analysis

For the study, sit and reach tests were carried out in two phases-pre and post-phases. Pre-phase test was done before training regarding the static stretching training for flexibility, and a post-test was carried out after training. The Sit and Reach Test Measurement was performed which is widely recognized to measure flexibility. The sit and reach test, described by Wells and Dillon in 1952, is widely recognized as a general measure of flexibility, particularly for the lower back and hamstring muscles(refer to Figure 1).

In this test, an individual sits on the floor with their legs stretched straight ahead. It specifically assesses the flexibility of the lower back and hamstrings and is considered a valid test for these areas. The reliability of the sit and reach test is influenced by the amount of warm-up allowed and whether consistent procedures are followed each time the test is conducted. Most norms for sit and reach testing are based on scenarios without any prior warm-up. However, the best results are typically achieved after a warm-up. If a warm-up is implemented, it's crucial to have a standardized warm-up routine and test order, ensuring the same conditions are repeated for each testing session. The measurement between pre-test and post-test results was compared using a paired sample test.

Table 1: Profile of Respondents(Players)

Socio-demographic	% (N)
Sex	
Male	65.7 (23)
Female	34.3 (12)
Age in yrs	
10-15	77.1 (27)
>15	22.9 (8)
Height in cm	
130-150	45.7 (16)
151-170	45.7 (16)
>170	8.6 (3)
Weight in kg	

25-40	28.6 (10)
41-55	45.7 (16)
>55	25.7 (9)
N	100 (35)

Table 1 shows that 65.7 percent of the respondents were male and 34.3 percent of female. The age is categorized into two groups: ages between 10 and 15 account for 77.1 percent whereas, above 15 years represent 22.9 percent. The mean age is 13.5 years. Similarly, the height is categorized into three groups; 45.7 percent of the respondents belong to 130-150 cm, in the same way, 45.7 belong to 151-170 cm, and 8.6 belong to above 170 cm. Likewise, the weight is also categorized into three groups; 28.6 percent belong to 25-40 kg, 45.7 percent belong to 41-55 kg, and 25.7 percent belong to above 55 kg. All respondents were supported by their families to play table tennis. The injured incident was also inquired; 31.4 percent of the respondents were found injuries incident. Among them, 20.0 percent were male, whereas 11.4 percent belonged to female.

The sit and reach test shows that the mean test differs before stretching ($M=17.60$, $SD=9.076$) and after taking stretching ($M=20.31$, $SD=8.014$) at the 0.05 level of significance.

The mean difference is statistically significantly different from zero.

$$t\text{-value} = -4.584$$

The critical value at 34 degrees of Freedom and 0.05 significance level is 2.032

$$t\text{-value} > \text{Critical value}$$

$$4.584 > 2.032$$

The mean difference of -2.714 is statistically significantly different from zero. A paired sample t-test was conducted to evaluate the impact of the flexibility of the lower limb among table tennis players. In the sit and reach test, the mean test before stretching was as $M=17.60$, $SD=9.076$, and after taking stretching, it was as $M=20.31$, $SD=8.014$ at the 0.05 level of significance, and $t(34) = -4.584$, $n=35$, $p < 0.05$, 95% CI for mean

difference: -3.918 to -1.511, $r = 0.923$. On average, post post-test result was greater by 2.714 points before the stretching.

The study investigated the effects of different lower limb stretching exercises on flexibility among table tennis players. Flexibility was measured using specific tests before and after the stretching intervention. Results indicated that static stretching led to significant improvements in flexibility, as evidenced by a range of motion tests for the hip, knee, and ankle joints static stretching exercises showed that enhancing lower limb flexibility beneficial for improving flexibility among table tennis players. The flexibility increase improves muscular strength which helps in the exercise (Arnold, 2020).

Conclusions and Implications

Table tennis players can greatly benefit from a variety of lower limb stretching exercises that enhance their flexibility. Regular stretching of the hamstrings, quadriceps, calves, and hips can improve a player's overall flexibility and performance on the table tennis court. Prioritizing flexibility through consistent stretching can be a game-changer for players aiming to elevate their skills and excel in the sport. A sit-and-reach test was conducted among the participants to assess the flexibility of their lower limbs. Kilit et al. (2019) study concluded that static stretching neither improves nor decreases performance, while dynamic stretching can enhance the performance of table tennis players. This indicates that static stretches before playing table tennis do not offer any benefits in terms of performance. However, incorporating dynamic stretches into a warm-up routine may lead to improved performance for table tennis players. The development of lower limb muscles plays a significant role in movement control and stability as well as sports injury prevention in table tennis performance(He et al., 2022).

In conclusion, improving flexibility in the lower limbs can enhance players' agility, range of motion, and overall performance on the table tennis court. Beyond the physical advantages of better flexibility, incorporating various stretching exercises can also positively impact a player's mental well-being. Stretching increases blood flow to the muscles, reduces tension, and promotes relaxation, all of which contribute to

improved mental focus and clarity during training sessions and matches. Additionally, increased flexibility in the lower limbs helps prevent muscle imbalances, lowers the risk of strains or tears, and supports long-term musculoskeletal health. This study claims that regular stretching exercises for lower limb flexibility in table tennis can significantly improve performance and reduce injury risk. This study suggests that effective training for coaches and table tennis players can develop more effective outputs.

Conflict of Interest: The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declares the absence of conflicting interests with the funders.

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