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Table of Contents

ORIGINAL RESEARCH PAPERS

LASE Journal of Sport Science • 2025/2
https://doi.org/10.25143/lase_joss.v16i2

LASE Journal of Sport Science • 2025/2 • Pages **1**–11
https://doi.org/10.25143/lase_joss.v16i2.01

Goal-Scoring Differences Between Male and Female Floorball Players in the Swedish Super League

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Abstract

The aim was to investigate sex differences regarding shooting position, shooting technique, and shot placement preceding open-play goal scoring in the Swedish Super League (SSL) in floorball. Video recordings of 3751 goals were analysed to determine the goal scorers' positions on the pitch when they took the shots and which type of shots they used. In addition, the placement of the ball when it entered the goal was determined. The proportion of goals from the playing zone closest to the goal was higher for women ($P < 0.001$), whereas the relative number of goals from the playing zones to the left of the goal and from the central playing zone farthest from the goal was higher for men (all $P < 0.001$). Women used wrist shots and backhand shots more frequently to score goals than men (both $P < 0.01$); conversely, the proportion of goals scored using slap shots and volley shots was higher for men (both $P < 0.001$). In terms of shot placement, the percentage of goals scored in top-left corner was higher for male players ($P < 0.05$). Hence, there are sex-related goal-scoring differences in SSL and the findings may inform coaches in refining tactics and training.

Keywords: Sex difference, video analysis, unihockey, shooting technique

Introduction

Floorball is a team sport that is played in 3 × 20 min periods on a 40 × 20 m pitch enclosed by a 0.5-m high boards (Swedish-Floorball-Federation, 2022a). The objective of the game is to score goals by shooting the ball into the opposing teams goal using a floorball

stick, and each team has one goalkeeper and five outfield players on the pitch under normal match conditions (Swedish-Floorball-Federation, 2022a). Substitutions are permitted both during active play and at stoppages and players are rarely on the pitch for more than a minute before being substituted (Swedish-Floorball-Federation, 2022b).

Floorball is characterized by frequent variations in movement intensity, requiring players to perform repeated high-intensity sprints while simultaneously performing complex motor tasks such as dribbling, passing, and shooting (Paavilainen, 2007b; Swedish-Floorball-Federation, 2022b). Recently, the Swedish Floorball Federation published a report on the speed and movement dynamics of floorball players in the Swedish Super League (SSL) for men and women based on data collected from matches during the 2017/18 season using a local positioning system (Swedish-Floorball-Federation, 2022b). The average total distance covered by male SSL players were 2835 m for forwards and 2690 m for defenders, whereas female offensive and defensive SSL players cover an average distance of 3210 m and 2839 m, respectively; however, irrespective of the playing position, male players covered a greater distance at running speeds above 18 km/h, with male defenders (193 m) and forwards (270 m) covering more distance than female defenders (106 m) and forwards (175 m) (Swedish-Floorball-Federation, 2022b).

A key tactical element in floorball is the ability to rapidly transition from defensive to offensive play following ball recovery (Kauppi et al., 2018). This transition is often facilitated by a long pass to an unmarked teammate, enabling a quick shot on goal. This strategy is enabled by the absence of an offside rule in floorball (Kauppi et al., 2018). In organized attacks, players run trying to draw the defensive players out of position to create passing and shooting opportunities (Paavilainen, 2007b). The attacking team can take shots from several zones of the pitch using different shooting techniques (e.g., wrist shot, drag shot, slap shot, backhand shot) to score goals (Paavilainen, 2007b). Goals are mainly scored through shots (Kauppi et al., 2018). The type of shot taken depends on various factors, including the specific game situation, offensive objectives, shooting distance, the presence of defenders, and the time available to execute the shot (Gómez, Prieto, Pérez, & Sampaio, 2013; Paavilainen, 2007b).

Analyses of shot origins leading to goals in the men's Floorball World Championships in 2016, 2018, and 2022 indicate that more than 60% of goals resulted from shots taken within the two central playing zones directly in front of the goal (Kauppi et al., 2018; Malina, 2019; Zderčík, 2024). Further analysis of the goal scored showed that the goal scorer was typically under minimal or no defensive pressure at the moment of the shot (Kauppi et al., 2018). Moreover, most common goals were preceded by defensive errors, and the time from ball recovery to the execution of the goal-scoring shot ranged from 1 to 3 seconds (Kauppi et al., 2018).

Regardless of whether a goal results from an organized offensive play or a counterattack, floorball players must have a good passing accuracy to enable rapid shot attempts (Paavilainen, 2007b). Moreover, another crucial aspect influencing success in floorball is shooting efficiency, indicating that less than 20% of the shots that go through the defensive blocks and remain within the goal frame result in a goal (Prieto-Gómez, Pérez-Tejero, &

Gómez, 2013). An understanding of whether male and female players favour different shot types, target specific goal areas differently, or shoot from different positions could help coaches and players develop more effective offensive and defensive tactics and training strategies. However, to our knowledge, no previous research has investigated whether male and female elite-level players shoot from different positions, use different types of shots, and/or target specific goal areas differently when scoring goals during open play (i.e., even strength, power play, or box play goal). Therefore, this study aimed to investigate sex differences regarding shooting position, shooting technique, and shot placement preceding open-play goal scoring in the SSL.

Materials and methods

Video analyses

An observational analysis of the goals scored during the SSL season 2022/23 was conducted to fulfil the purpose of the study. A total of 4040 goals were scored, with 1811 goals in the women's SSL and 2229 goals in the men's SSL. Video clips of match highlights available, through a monthly fee, on a public domain (SportExpressen Play: https://livesport.expressen.se/innebandy/ssl) were used to determine the goal scorer's shooting position and shooting technique as well as shot placement when scoring open-play goals. The videos were analysed by one observer who had 13 years of experience as a floorball player. The observer completed an analysis protocol for each goal and if some of the variables were hard to judge, the match sequence in question was paused and/or replayed to be accurate in determining the player's shooting position, shooting technique and shot placement.

Shooting position

To determine the position on the pitch from where the goal-scoring shot was taken, the offensive half of the pitch was divided into six playing zones from the midline to the extended goal line (Figure 1). The definition of the playing zones was retrieved from previous research studies in floorball (Gómez et al., 2013; Prieto-Gómez et al., 2013). The size of the two central zones (4C and 5C) was 5.00 × 8.25 m, whereas the size of the four outer zones (4R, 5R, 4L, and 5L) was 7.50 × 8.25 m. All goals scored from a shooting position on the defensive half of the pitch and behind the extended goal line were excluded from the statistical analyses.

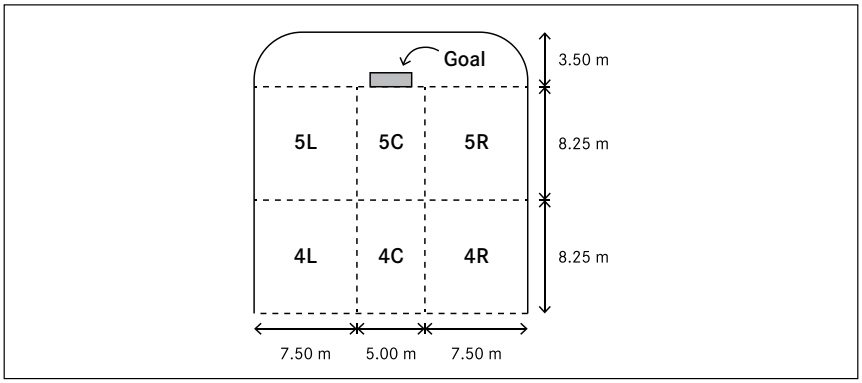

Figure 1 **Overview of the floorball pitch, where the six playing zones in the offensive half are marked out from which the shooting position of the goal scorer is determined**

Shooting technique

The shooting technique for each goal-scoring shot was determined, and the results for the six most common shooting techniques in floorball were used in the subsequent statistical analyses. The types of shots that were included in the analyses were wrist shot (WS), drag shot (DS), slap shot (SS), backhand shot (BS), volley shot (VS), and half-volley shot (HVS). All goals emanating from Zorro shots, penalty shots, shots in an empty goal, or goals preceded by feint of the goalkeeper were excluded from the statistical analyses.

Shot placement

The variable shot placement categorises the position of the ball when it enters the plane built up by the goal frame.

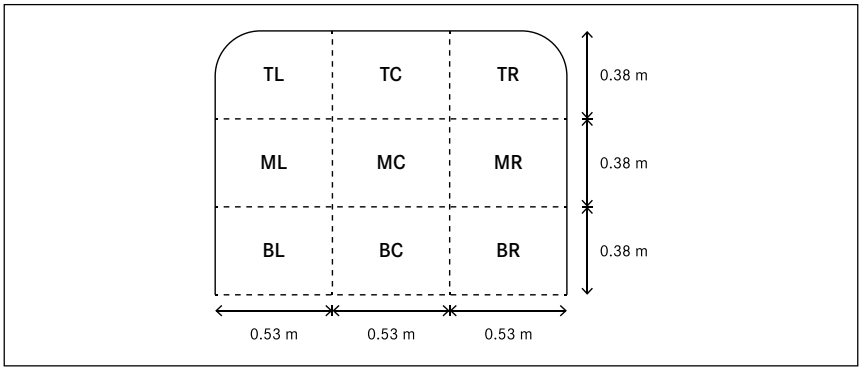

Figure 2 **The goal with nine shot-placement zones indicating the position of the ball when it enters the goal from the players' point of view, where T is top, M is middle, B is bottom, L is left, C is centre, and R is right**

The height of the goal is 1.15 m, and the width is 1.60 m, with a radius of 0.10 m between the goalpost and the crossbar (Figure 2). The goal plane was divided into nine equally-sized shot-placement zones with a combination of horizontal zones (top (T), middle (M), and bottom (B) and vertical zones (left (L), centre (C), and right (R)); for example, the top-left shot-placement zone is abbreviated as TL.

Statistical analysis

To determine sex differences in goal scoring in the SSL regarding shooting position, shooting technique, and shot placement, chi-square (X2) tests for independence were used. If a sex difference was found for a specific category, X2 tests for goodness of fit were used to determine which shooting position(s), shooting technique(s), and shot placement(s) that differed between men and women. Effect sizes were calculated to enable more informative inferences from the results. The phi coefficient (ϕ) and Cramer's V were used for the X2 tests with degrees of freedom equal to 1 or greater than 1, respectively. The substantial effects for ϕ and V were divided into more fine-graded magnitudes as follows: $0.10 \leq \phi$ and $V < 0.30$ corresponded to a small effect size, $0.30 \leq \phi$ and $V < 0.50$ corresponded to a medium effect size, and ϕ and $V \geq 0.50$ corresponded to a large effect size (Cohen, 1988). For all statistical analyses, the results were assumed to be significant at an alpha level of 0.05. The statistical analyses were conducted using IBM SPSS Statistics software, version 29 (IBM Corporation, Armonk, NY, USA).

Results

A total of 3743 goals (men: 2045 goals, women: 1698 goals) fulfilled the criteria that all three variables were possible to identify in the video clip, and it was an open-play goal. Hence, approximately 93 % of all goals scored during the 2022/23 women's and men's SSL season were included in the analyses.

Differences in the shooting positions

There was a significant sex-related difference in the distribution of shooting positions when scoring goals in SSL ($X2\,(df = 5, N = 3743) = 37.0$; $P < 0.001$; $V = 0.10$) (Figure 3). The post-hoc tests investigating differences between men and women for specific playing zones showed that there were significant differences for shooting positions 4L ($X2\,(df = 1, N = 196) = 5.89$; $P = 0.015$; $\phi = 0.17$), 4C ($X2\,(df = 1, N = 471) = 8.06$; $P = 0.0045$; $\phi = 0.13$), 5L ($X2\,(df = 1, N = 593) = 3.92$; $P = 0.048$; $\phi = 0.049$), 5C ($X2\,(df = 1, N = 1655) = 18.1$; $P < 0.001$; $\phi = 0.10$). For the former three positions (i.e. 4L, 4C, and 5L), men had a higher proportion of scored goals. Conversely, for the latter position (i.e., 5C), the observed number of goals exceeded the expected count for women. No significant difference between sex was found for the two shooting positions in the right corridor, i.e., 4R ($X2\,(df = 1, N = 175) = 0.13$; $P = 0.72$; $\phi = 0.027$) and 5R ($X2\,(df = 1, N = 653) = 0.92$; $P = 0.34$; $\phi = 0.038$).

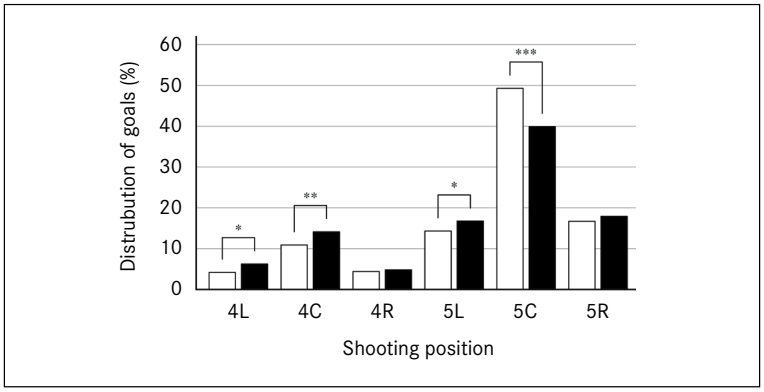

Figure 3 **Distribution of goals for each shooting position, where white and black bars represent women and men, respectively.**

Significant sex-related differences are reported as:
* for P < 0.05; ** for P < 0.01; and *** for P < 0.001

Differences in the shooting techniques

A significant difference in the distribution of shooting techniques used to score goals was found between men and women (X^2 (df = 5, N = 3758) = 65.9; P < 0.001; V = 0.13) (Figure 4).

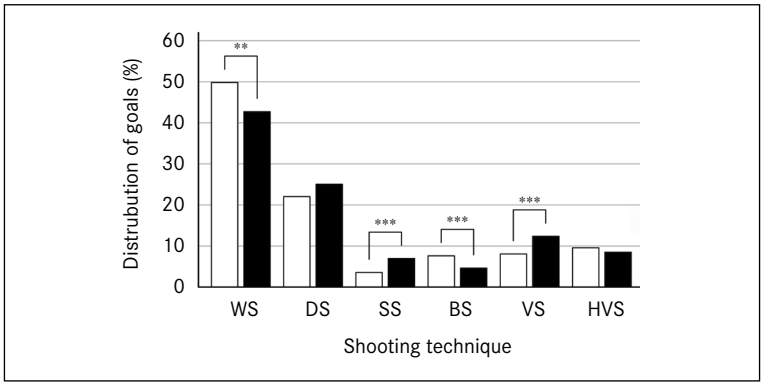

Figure 4 **Distribution of goals for each shooting technique, where white and black bars represent women and men, respectively.**

Significant sex-related differences are reported as:
** for P < 0.01; and *** for P < 0.001

The relative number of goals scored by using WS (X^2 (df = 1, N = 1716) = 10.4; P = 0.0012; ϕ = 0.078) and BS (X^2 (df = 1, N = 223) = 12.1; P < 0.001; ϕ = 0.23) were higher in women compared to men. However, the proportion of scored goals was higher for men than women for SS (X^2 (df = 1, N = 203) = 21.8; P < 0.001; ϕ = 0.33) and VS (X^2 (df = 1,

N = 386) = 16.8; P < 0.001; ϕ = 0.21). No significant sex-related difference was found for either DS (X2 (df = 1, N = 883) = 3.73; P = 0.053; ϕ = 0.065) or HVS (X2 (df = 1, N = 332) = 1.07; P = 0.30; ϕ = 0.057).

Differences in the shot placements

There was a significant difference in the distribution of shot placement when goal scoring of men and women was compared (X2 (df = 8, N = 3758) = 15.7; P < 0.001; V = 0.06) (Figure 5). The proportion of score goals in TL was higher in men than women (X2 (df = 1, N = 553) = 6.51; P = 0.011; ϕ = 0.11). No significant sex-related differences were found for the other eight shot-placement zones (X2 (df = 1, N = 311–530) = 0.00067–3.47; P = 0.98–0.062; ϕ = 0.0016–0.090).

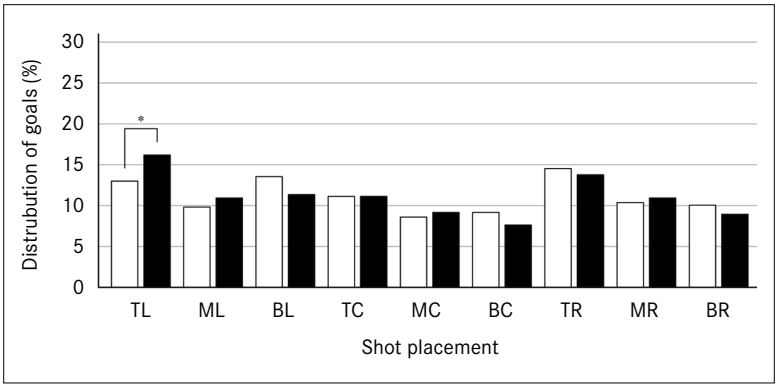

Figure 5 **Distribution of goals for each shot placement, where white and black bars represent women and men, respectively.**

Significant sex-related differences are reported as: * for P < 0.05

Discussion

The current study provides novel insights into the sex differences in goal scoring in elite-level floorball, where sex-related differences in shooting position, shooting technique, and shot placement were analysed. The results of this study demonstrate that there are differences between women and men in all three categories. The proportion of goals scored from the playing zone closest to the goal was higher for women, whereas the relative number of goals from the playing zones to the left of the goal and from the central playing zone farthest from the goal was higher for men. Regarding shooting technique, women used WS and BS more frequently to score goals than men. Conversely, the proportion of goals scored using SS and VS was higher for men. For eight out of nine shot-placement zones, no difference in the distribution of scored goals was found; however, the percentage of goals scored in the TL was higher for male players.

It has previously been suggested that the shooting technique chosen by the player depends on several variables, including shooting distance, time available to execute the shot, and position of the defenders and goalkeeper (Gómez et al., 2013; Paavilainen, 2007b). For both women and men, the highest number of goals was scored from playing zone closest to the goal (i.e., 5C) (Figure 3); this corroborates findings from previous studies that indicate this zone yields the greatest number of goals scored in international floorball matches for men (Gómez et al., 2013; Prieto-Gómez et al., 2013). In the current study, the number of scored goals per shooting position was reduced with increased distance to the goal, where 4L and 4R had the lowest percentage of the total distribution of goals. Together, these results are in agreement with shooting-position statistics from the World Championships for men in 2016, 2018, and 2022, where the greatest number of goals was scored from a shooting position close to the goal (Kauppi et al., 2018; Malina, 2019; Zderčík, 2024). Similarly, the prevalence of goal-scoring by elite male ice hockey players in the Swedish Hockey League was higher for the shooting zone closer to the goal (Lignell, Rago, & Mohr, 2020). Together, these findings suggest that it is important for floorball players to create opportunities to shoot in the playing zone 5C.

It could be anticipated that goal scoring from playing zone 5C does not place the same demands on the speed of the shot compared to the shooting positions further away from the goal. The shooting-position difference related to women's higher percentage of goals scored from 5C is likely a result of their greater use of WS and BS to score goals. These two shooting techniques are considered fast (i.e., a short travelled trajectory of the stick before the ball is hit) and unpredictable for the goalkeeper, respectively (Paavilainen, 2007a); therefore, WS and BS are appropriate techniques to score goals from relatively short distances. The importance of having a short release time to score goals has also been emphasized in ice hockey, where short release time was associated with a higher efficiency than shots with a longer release time (Lignell et al., 2020).

The relative number of goals scored by men from shooting positions 4L, 4C, and 5L was higher than the corresponding percentages for women. As the distance to the goal increases, players tend to rely more on shooting techniques that can generate higher ball speeds. This approach reduces the goalkeeper's time to react and likelihood of saving the shot. The shooting technique SS have been found to generate higher ball speeds than DS and WS (van den Tillaar, 2018). These results are in line with results that SS had higher puck speed than WS in ice hockey independent of sex (Wu et al., 2003). Moreover, skilled male ice hockey players had approximately 50% higher puck speeds than skilled female ice hockey players for both SS and WS (Wu et al., 2003). Correlations between upper-body strength variables and shot speed has been shown in ice hockey (Bezák & Pridal, 2017; Wu et al., 2003). It could be expected that this relationship also is apparent in floorball, where male players are generally able to produce higher stick speeds and thereby higher ball speeds than female players due to a greater strength. Hence, the high ball speed generated when SS is used could explain the findings that men utilize a higher number of SS to score goals and score from a larger distance more frequently than women. Men's greater proportion of VS as the goal-scoring shooting technique is more difficult to explain, but it could

be speculated that elite male players have better eye-hand coordination than elite female players. This speculation is supported by sex differences reported in other sports, where male athletes have been found to have better eye-hand coordination than their female counterparts (Dane & Erzurumluoglu, 2003; Haryanto, Becerra-Patino, & Padli, 2023). The underlying explanation for the sex-related differences that were found in the current study is most likely linked to the physiological and technical differences between elite-level female and male players (Swedish-Floorball-Federation, 2022b); hence, the higher game pace in the men's SSL is most likely reflected by male players' higher running speeds, greater accuracy, and higher ball speeds when passing and shooting.

In all three vertical shot-placement zones, the top zone (i.e., TL, TC, and TR) had the highest percentage of scored goals for both women and men except for women in the left vertical shot-placement zone, where the relative number of scored goals was higher for BL than TL (Figure 5). This exception contributes to the sex difference regarding the distribution of goals scored in TL, where the proportion of goals scored in the top-left corner of the goal was higher for men. In a previous study, it was reported that in international floorball matches between two teams classified as "high-quality teams", the relative number of goals scored using shots categorised as "high shots" was greater compared to matches between teams with different quality standard (Gómez et al., 2013). The shot speeds for SS, DS, and WS were found to decrease when the floorball players aim at a point approximately 0.9 m above the floor compared to an aiming point with a height of 0.1 m; however, the accuracy of the shots was not affected by the target height, shooting technique, or ball speed (van den Tillaar, 2018). The shot accuracy in floorball was found to be significantly better when players looked at the target with their feet pointing towards the goal compared to shots taken with their feet in a parallel position (Lazzeri, Kayser, & Armand, 2016). Hence, to be able to score from a long distance, both accuracy and speed of the object (i.e., the ball in floorball and puck in ice hockey) need to be optimal, as well as release parameters such as shaft flexing and blade orientation (Michaud-Paquette, Pearsall, & Turcotte, 2009). However, irrespective of sex, a substantial portion of the training should be devoted to enhancing shooting speed and accuracy across all types of shooting techniques, thereby improving the players' goal-scoring capacity.

A previous systematic review concluded that there is a scientific lack of knowledge about floorball (Tervo & Nordström, 2014), and the majority of the published studies is within the field of sports medicine. The current study is the first study that has investigated sex-related goal-scoring differences in floorball, thereby contributing to the scientific knowledge and the body literature in the sport. The strengths of the study lie in the large number of goals that have been analysed and its focus on goal scoring in SSL, which is arguably the best floorball league in the world for both women and men. In this context, it is worth noting that the current study analysed only the goal-scoring action from the time of the shot to the time the ball went into the goal. Hence, unsuccessful goal-scoring attempts were not included in the analyses. Consequently, the study's results do not provide an objective assessment of the most effective goal-scoring actions in relation to overall shot attempts. Future studies are warranted to analyse which type of shots should be used

from specific positions on the pitch and where in the goal the player should aim to improve the probability of scoring a goal. Moreover, it would also be of great interest to investigate which actions precede goal scoring. Information from these future studies could, together with the results in the current study, provide valuable knowledge to floorball coaches in their decision of team tactics.

Conclusions

The results of the current study show that there are significant sex-related goal-scoring differences in SSL. The proportion of the total number of goals scored from the playing zone closest to the goal was higher in women, and in line with this finding, it was found that female players used WS and BS to score goals to a higher degree than male players. Male players had a higher proportion of goal-scoring shots from longer distances to the goal, and they also used SS more frequently than women, probably because SS is the shooting technique that could generate the highest ball speeds. No sex-related differences were observed in eight of the nine shot-placement zones. A significant difference between the sexes was found only in the TL zone, where men scored more frequently than women. The findings in the current study may help coaches and players in developing effective offensive and defensive tactics and training strategies.

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LASE Journal of Sport Science • 2025/2 • Pages 12–20
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ORIGINAL RESEARCH PAPERS

Habitual Physical Activity, BMI and Aerobic Capacity Among Office Employees

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Abstract

Health impairments can compromise occupational performance, thereby diminishing productivity when individuals are unable to meet job demands. Reduced aerobic capacity is specifically associated with a diminished ability to perform prolonged tasks, as lower cardiorespiratory fitness restricts both endurance and physiological efficiency. The aim of the study is to assess the habitual physical activity and aerobic endurance and BMI of office workers and to find relationship among parameters. Methods: 51 office workers participated in the study (89% women and 11% men, with a mean age of 42.2 ± 10.1 years). Data was collected using the short version of the International Physical Activity Questionnaire (IPAQ) and the 6-Minute Walk Test (6-MWT). The questionnaire process and the collection of data

from the 6-MWT of respondents took place anonymously, with the permission of the Research Ethics Committee of Rīga Stradiņš University. Mathematical statistics (descriptive statistics and Spearman Rank correlation) were used. This research was funded by the framework of the Plan of the European Union Recovery and Resilience Facility and the State budget grant RSU/LSPA-PA-2024/1–0013. The results have shown that 41% of office workers do not participate in vigorous physical activities, while 19% participate in them two days a week. On the other hand, 19% of office workers do not participate in moderate physical activities during the week. The results of the 6-MWT study indicate that 88% are healthy people, and the average result of the 6-minute walk test (6MWT) in the group was 516.82 meters. The participants spend on average 472.92 minutes sitting per day, which corresponds to approximately 7 hours. There is a correlation between the time spent participating in moderate physical activities and the distance covered in the 6-MWT test, and the longer the employees sit, the less distance covered in the 6-MWT. Conclusions: the study examined the relationship between daily levels of moderate physical activity, sedentary time, and aerobic endurance, emphasizing the necessity for office employees to reduce prolonged sitting. The findings suggest that, moving forward, multifaceted strategies will be required to effectively encourage physical activity within workplace settings.

Keywords: physical activity, BMI, aerobic endurance, office workers

Introduction

Over the past several decades, sedentary behavior has emerged as one of the most pressing public health challenges, given its strong association with numerous adverse health outcomes. Office employees devote a substantial proportion of their working hours to sedentary desk-based activities (Maphong & Sriramatr, 2023; Ryan et al., 2011).

Prolonged sedentary behavior, when coupled with insufficient levels of physical activity, considerably increases the risk of developing non-communicable diseases and contributes to increased premature mortality among this population group (Ekelund et al., 2020; Prince et al., 2019; Stamatakis et al., 2019; León-Muñoz et al., 2013).

In 2023, the World Health Organization (WHO) indicated that cardiovascular diseases remain the leading global cause of mortality, responsible for roughly 17.9 million deaths annually, with coronary heart disease accounting for over 80% of these cases. Additionally, it is estimated that nearly 80% of premature cardiovascular-related deaths stem from modifiable and preventable risk factors, such as poor dietary habits and inadequate levels of physical activity. (WHO, 2023).

Most of the previous research has demonstrated that regular physical activity and aerobic exercise exert beneficial effects on cardiovascular health and cardiac function (Lee, 2024; Ji et al., 2022; Emerenziani et al., 2017; Mundwiler et al., 2017). Habitual physical activity has a significant positive impact on both BMI and aerobic capacity among office employees. Regular engagement in physical activity, even at moderate levels, can lead to reductions in BMI (Genin et al., 2018) and improvements in VO_2max (Amalia et al., 2022; Alkhatib, 2015), contributing to better overall health and reduced risk of chronic diseases.

Another study found that different exercises (Thanasilungkoon et al., 2022) significantly decreased BMI values within four weeks. There is a negative correlation between BMI and physical activity levels. Higher levels of physical activity are associated with lower BMI. Employees with higher physical activity levels had lower BMI compared to those with lower activity levels (Rafatifard et al., 2019; Pal et al., 2014). Lower aerobic capacity and problems with a body mass index are associated with reduced ability to sustain intensive tasks, as it limits endurance and efficiency.

However, contrasting evidence suggests that prolonged or excessive engagement in aerobic exercise may contribute to the development of cardiovascular pathologies and impair cardiac performance, potentially leading to cardiac dysfunction (Martinez et al, 2021).

It is also important to distinguish sedentary behavior from physical inactivity, as individuals may meet the recommended levels of physical activity for their age group while still spending a substantial proportion of their time engaged in sedentary pursuits (León-Muñoz et al., 2013; Patel et al., 2010).

Therefore, the aim of the research is to assess habitual physical activity, aerobic endurance, and BMI of office workers and to find relationship among parameters.

Materials and Methods

51 office workers participated in the study; 89% were women and 11% were men, with a mean age of 42.2±10.1 years.

The collecting of physical activity data was completed using the short version of the International Physical Activity Questionnaire (IPAQ: short form). The evaluation of respondents' aerobic capacity was made using the 6-Minute Walk Test (6-MWT). Additionally, BMI data was collected. Mathematical statistics (descriptive statistics and correlation) were used.

The questionnaire process and the collection of data from the 6-MWT and BMI of the respondents took place anonymously, with the permission of the Research Ethics Committee of Riga Stradiņš University.

This study was part of the project "Multidisciplinary approach for the development of sustainable habit of regular physical activity among sedentary workers" (RSU/LSPA-PA-2024/1–0013), which was funded by the framework of the Plan of the European Union Recovery and Resilience Facility and the State budget (Nr.5.2.1.1.i.0/2/24/I/CFLA/005).

Results

Vigorous physical activities were performed on average 1.42 times per week (Std. Dev. 1.550), with an average duration of 47.3 minutes per session (Std. Dev. 58.9). 41% did not engage in vigorous physical activities at all.

Moderate physical activities were performed on average 2.25 times per week (Std. Dev. 2.1), with an average duration of 58.7 minutes per session (Std. Dev. 57.7). 19% of respondents did not engage in moderate physical activities.

Walking for at least 10 minutes without a break was reported on average 4.5 days per week (Std. Dev. 2.1), with an average duration of 64.7 minutes per day (Std. Dev. 55.9). However, 1.9 % of respondents did not walk for at least 10 minutes at all, and 9.4 % walked only once per week. Notably, 32 % of respondents walked at least 10 minutes every day.

Participants spent on average 472.92 minutes sitting per day, which corresponded to approximately 7 hours (Std. Dev. 183.5). A total of 58 % of respondents reported sitting for more than 7 hours each day.

The average body mass index (BMI) in the group was 26.9 (Std. Dev. 5.6), which is higher than the normal BMI range (18.5–24.99) and is classified as overweight (25–29.9). 37.7 % had a normal BMI. 5.6 % had a reduced BMI. 54.7 % had an elevated BMI.

Table 1

Aerobic endurance of the office workers

Characteristics of the functional class according to the 6-MWT	Distance covered	Number of respondents
Functional class – no physical activity limitations, with daily activities not causing fatigue, palpitations, or shortness of breath.	More than 550 m	30 %
Functional class – slight limitation of physical activity – individuals feel comfortable at rest, but ordinary physical activities may cause fatigue, palpitations, or shortness of breath.	425–550 m	57 %
Functional class – physical activity limitation – individuals feel well at rest, but even activities less demanding than daily routines may cause fatigue, palpitations, or shortness of breath.	Less than 425 m	13 %

The results of the 6-MWT study indicate that 88 % are healthy people, as the average result of the 6-minute walk test (6MWT) in the group was 516.82 meters (Std. Dev. 87.5).

Several weak but statistically significant correlations were identified among the analyzed indicators, indicating interrelationships and potential interactions between the studied variables (see Figure 1, Figure 2, Figure 3).

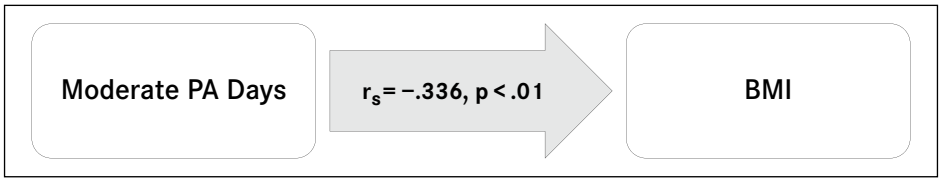

Figure 1 **Correlation between moderate physical activity days per week and BMI**

The respondents who engaged in moderate physical activity on a greater number of days per week demonstrated a more favorable body mass index (BMI). Analysis revealed that individuals engaging in moderate physical activity on more days per week exhibited significantly lower BMI values compared to those who were less active.

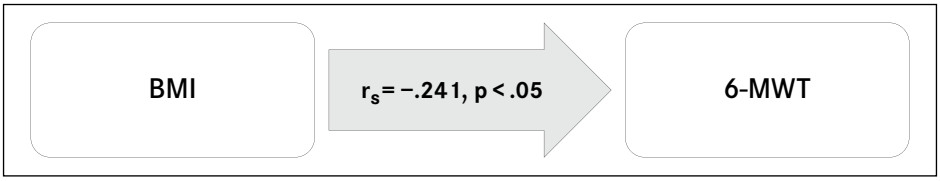

Figure 2 **Correlation between BMI and the result in 6-MWT**

Respondents with a higher body mass index (BMI) covered a shorter distance in the six-minute aerobic endurance test. Participants with higher BMI values tended to cover less distance during the six-minute endurance test, suggesting that higher body mass may be associated with reduced aerobic capacity.

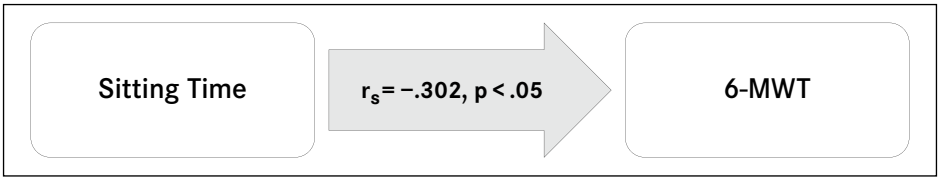

Figure 3 **Correlation between time spent sitting and the 6-MWT result**

Participants who spent more time sitting during the day covered a shorter distance in the six-minute walk test, indicating a lower level of aerobic endurance and a reduced functional capacity. The findings indicate a negative association between sedentary behavior and functional performance, reflecting diminished participants' aerobic endurance and functional capacity.

Discussion

Participants in this study reported an average daily sitting duration of 472.9 minutes (approximately 7.9 hours), and 58% of them indicated sitting for more than seven hours per day. These results are comparable with recent large-scale investigations demonstrating that office employees typically spend 8–9 hours daily in a sedentary way (Leskinen et al., 2025; Park et al., 2024). Although the average sedentary time in the current sample was slightly lower than the global mean, it still represents a substantial health concern, given the established links between prolonged sitting and increased metabolic and cardiovascular risk (Maphong & Sriramatr, 2023).

The mean distance achieved in the 6-minute walk test (6-MWT) was 516.8 meters (SD = 87.5), corresponding to a moderate level of functional aerobic performance. Compared with contemporary normative values for healthy adults, which typically range from 580 to 610 meters and show gender-related differences favoring men (Delbressine et al., 2023; Yeung et al., 2022), our results suggest slightly lower endurance levels among office workers. This difference is most likely related to the higher mean BMI and increased

sedentary behavior habits observed in this population, both of which have well-documented negative effects on cardiovascular efficiency and muscular function. The finding aligns with existing literature showing that regular moderate exercise helps maintain a healthy weight by improving metabolic rate, muscle mass, and energy balance. Encouraging more frequent moderate activity could thus be an effective public health strategy for weight management.

The mean BMI among participants was 26.9 (SD = 5.6), indicating that the majority of respondents fell into the overweight category. More than half (54.7 %) had an elevated BMI, mirroring trends observed in other occupational groups. Park et al. (2024) similarly reported that extended sitting and low physical activity were associated with a greater prevalence of overweight and obesity among workers. Consistent with this, our findings revealed that the individuals who engaged in moderate-intensity activity on more days per week tended to have lower BMI values, supporting previous evidence that regular physical activity contributes to healthier body composition (Leskinen et al., 2025). Conversely, higher BMI was linked with shorter 6-MWT distances, confirming a well-established inverse relationship between body mass and aerobic performance.

The identified negative association between sitting duration and 6-MWT outcomes aligns with existing evidence showing that prolonged sedentary behavior independently predicts lower aerobic fitness and diminished cardiorespiratory function (Strauss et al., 2021; Maphong & Sriramatr, 2023; Park et al., 2024). Similar relationships have been documented by Leskinen et al. (2025), who found that longer uninterrupted sitting periods among office workers corresponded with poorer walking capacity and reduced overall physical condition. These results suggest that not only total sitting time, but also the pattern of sedentary bouts may influence functional ability.

Recent research provides encouraging evidence that workplace-focused interventions can mitigate sedentary time and improve related health indicators. Strategies such as adjustable sit-to-stand desks, scheduled movement breaks, and computerized prompts have been shown to effectively reduce sitting time and promote light-intensity activity during working hours (Rouyard et al., 2025; Wang et al., 2024). Our findings further emphasize the importance of integrating environmental and behavioral components to encourage movement throughout the day and enhance aerobic fitness in office settings.

Taken together, the observed combination of elevated BMI, extended sedentary time, and moderate aerobic performance (Hua & Yang, 2014) underscores the necessity for multifaceted, workplace-level strategies to counteract inactivity. Systematic reviews have highlighted that interventions involving ergonomic redesign, supportive management policies, and behavioral approaches are among the most effective, reducing sedentary time by approximately 30–40 minutes per day (Rouyard et al., 2025; Wang et al., 2024). Encouraging regular movement throughout the workday, rather than relying solely on structured exercise, may therefore play a key role in improving aerobic capacity, functional ability, and overall health among office employees.

Future research should focus on identifying effective strategies to encourage regular movement and integrate physical activity throughout the workday. Specifically, studies are needed to evaluate the impact of multi-level interventions in workplace settings.

Conclusions

The relationship between daily physical activity, sedentary time, BMI and aerobic endurance highlights the critical importance of reducing prolonged sitting among office workers.

Evidence consistently indicates that extended sedentary behaviour not only diminishes physical fitness but also contributes to an increased risk of metabolic and cardiovascular complications.

Therefore, encouraging regular movement and incorporating physical activities throughout the workday can play a pivotal role in improving overall health outcomes and functional capacity within this population.

Looking ahead, the development and implementation of comprehensive, multi-level interventions will be essential to effectively promote physical activity in workplace settings. Such strategies may include ergonomic redesign of office environments, organizational policies supporting active breaks, and behavioural change programmes aimed at fostering sustainable lifestyle modifications.

Collectively, these measures could significantly reduce sedentary time and enhance employees' aerobic endurance, productivity, and well-being.

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LASE Journal of Sport Science • 2025/2 • Pages **21**–32
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ORIGINAL RESEARCH PAPERS

Personality Traits of Romanian Sports Managers: Preliminary Findings

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Abstract

Personality traits analysis represents an essential tool for training and even selecting effective managers in sports organizations. The purpose of the research was to investigate the Big-Five personality characteristics of Romanian sports managers. A total of forty-five experienced (ESM) and future managers of sports organizations (FMSO), aged between 21 and 60 years old, took part in the study. The Mini-IPIP questionnaire was used to measure Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Imagination/Intellect. Using the t-test for independent samples, the differences between the two groups of sports managers (ESM and FMSO) were verified. Even if no statistically significant differences were found ($p > 0.05$), subtle differences in term of Big-Five personality traits were observed: ESM tend to be slightly more extroverted and agreeable, while FMSO registered slightly higher results for intellect/imagination dimension and on conscientiousness. Next, data analysis (Mann-Whitney test) revealed significant differences in the level of conscientiousness between: Romanian experienced managers (men) and women ESM ($p = 0.035$), and between experienced sports managers over 40 years of age and ESM between 25 and 40 years ($p = 0.020$). Men sports

managers reported a higher level of self-discipline and are more goal oriented (the influence of cultural factors and social expectations associated with gender were discussed), while considering neuroticism and intellect/imagination sub-scales the differences were almost non-existent, based on ESM' gender. Also, higher scores for conscientiousness were observed in older sports managers, while no significant differences were found according to managers' marital status and family situation (with or without children).

Keywords: Big-Five model, personality features, sports managers, sports organizations

Introduction

In recent decades, sport has become not only a recreational activity, but also a global industry with a significant impact on the economy, society, and culture. In the context of the rapid evolution of the sports industry and the increasingly complex demands faced by managers in this field, investigating the personality features of sports managers is particularly important. Sports managers must adjust their leadership style according to the situations inside the organization, according to the individual needs of employees, knowing that leadership involves not only control but also the ability to inspire others (Scott, 2014). Beyond technical knowledge or business strategies, the personality of those who lead sports organizations has a decisive influence on the organizational climate, adaptability, and motivation of employees. Personality traits are "an important determinant of long-term success in sport" (Allen et al., 2013), influencing communication and the well-being experienced by employees of sports organizations.

Understanding the distinct personality traits that characterize successful sports managers is crucial, given their multifaceted responsibilities in strategic decision-making and daily operational oversight (Güneş & Kılıç, 2024). This profession demands a blend of holistic and detailed attention, requiring adaptability to emergent situations, the capacity for rapid consequential analysis, and the ability to work in an interdisciplinary team (Nørgaard & Sørensen, 2019). Such roles necessitate a particular psychological profile, often attracting and retaining individuals who exhibit specific behavioral patterns and dispositions (Farstad & Arnulf, 2024). For instance, considering the brain dominance of experienced sports managers, it seems that they "use more the lower right quadrant of the brain, being socially oriented individuals, empathetic, expressive and sensitive to others" (Predoiu et al., 2023). In terms of coping strategies, experienced sports managers "accept more easily situations they cannot change and control" and need less compassion and emotional external support in difficult situations at the workplace (Predoiu et al., 2024). Macra-Oşorhean et al. (2011) reported lower values for verbal aggression and irritability in the case of Romanian sports managers, but higher results for guilt and social desirability when managers of sports organizations were compared with their counterparts from other E.U. countries. Following a systematic review of the literature regarding the profile of sports managers, Santos et al. (2022) highlighted competencies such as: integrity, leadership, innovative thinking, specific knowledge, authority's delegation and resource allocation. Not least, sports managers demonstrate a high level of emotional intelligence. They know how to recognize and manage

their emotions, remain motivated in the face of challenges, and use their emotional energy constructively to achieve organizational goals (Predoiu et al., 2021).

Through the Big Five theory, McCrae and Costa offer a structural approach, according to which personality consists of stable and measurable traits that can be observed in various behavioral contexts (McCrae & Costa, 1997). The Big Five model identifies five fundamental dimensions of personality: openness to experience, conscientiousness, extraversion, agreeableness, and emotional stability/neuroticism – abbreviated as OCEAN (McCrae & Costa, 2008). Conscientiousness is strongly associated with planning, responsibility, and goal achievement (Xu & Hao, 2025), essential aspects (in the case of sports managers), for example for budgeting and long-term strategic management. Furthermore, people with a higher level of conscientiousness can weigh the pros and cons more effectively in a specific scenario (El Othman et al., 2020). Emotional stability (low neuroticism) is critical for resilience and effective decision-making under stress (Devin, 2017), while openness to experience, "signified by adaptability and curiosity" (Shuai et al., 2023) could facilitate sports managers' creativity and adaptation to new technologies and strategies. Openness to experience is associated with intelligence, divergent thinking, and broad-mindedness (Dan et al., 2021). Finally, extraversion (characterized by sociability) and agreeableness – marked by cooperativeness and kindness (Kang et al., 2025) can support networking, public representation and conflict resolution within the organizations, through empathy and cooperation. Agreeable individuals create a more pleasant organizational climate, contributing to a higher level of job satisfaction (Aydogmus et al., 2015).

We mention a gap in the literature regarding the Big Five OCEAN personality traits of Romanian sports managers. The very few existing studies focused on personality traits of future (not experienced) sports managers, the values for the Big Five personality traits being at the level of the population mean (Mitrache et al., 2023). It is worth mentioning that the "sanguine" and "phlegmatic" temperamental types (more emotionally stable) dominate in the case of Romanian future sports managers, while aggression, depressive symptoms, irritability, but also sociability is higher in the case of male future sports managers, compared to females (Stănescu et al., 2016).

Materials and Methods

Scope

The aim of the study is to investigate the Big-Five personality traits of Romanian managers within sports organizations.

Hypotheses

H1: There are significant differences between experienced sports managers and future managers of sports organizations in terms of Big Five personality dimensions.

H2: Investigation of personality traits reveals significant differences between experienced sports managers based on gender and age.

H3: There are significant differences between experienced managers in terms of personality traits depending on marital status (married or unmarried) and family situation (with or without children).

Participants

The study involved 45 sports managers and future managers, aged between 21 and 60 years old, distributed as follows:

- 25 experienced sports managers (ESM), 15 males and 10 females, aged between 25 and 60 years;
- 20 future managers of sports organizations (FMSO), 11 males and 9 females, aged between 21 and 30 years old, students in the program – "Management and Marketing in Sports Structures, Activities and Events", within National University of Physical Education and Sports, Bucharest.

The inclusion criterion for managers of sports organizations, in the present study, was a minimum of two years in a management position. However, we mention that only three sports managers have two years of experience, the other managers of sports organizations having between 4 and 21 years of experience (Mexperience = 7.76 years, in the entire sample). The management positions of the participants (within state and private Romanian sports organizations) are: sports manager, sports club president, deputy director and sports club executive director.

Measures

To assess the Big Five factors of personality, the Mini-IPIP questionnaire was used (Donnellan et al., 2006). The Mini-IPIP was translated (for the current study) through retroversion, a procedure used in previous research (Rawat et al., 2023; Piotrowski et al., 2021). The questionnaire measures: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Imagination/Intellect.

The scale has 20 items, with 4 items for each personality dimension. For each factor, the sum of the responses to the corresponding items is calculated. At the same time, we mention 11 items with reverse scoring. Ways of answering: a 5-point scale, from 1 = "Very inaccurate" to 5 = "Very accurate" (3 = "Neither accurate nor inaccurate"). Items example: "Talk to a lot of different people at parties" (Extraversion), "Sympathize with others' feelings" (Agreeableness), "Make a mess of things" (Conscientiousness), "Have frequent mood swings" (Neuroticism), and "Have a vivid imagination" (Imagination/Intellect). McDonald's omega reliability coefficient (ω) was calculated for the present study, for each personality factor, obtaining the following results: $\omega = 0.72$ (Extraversion), $\omega = 0.78$ (Agreeableness), $\omega = 0.70$ (Conscientiousness), $\omega = 0.71$ (Neuroticism), while $\omega = 0.73$ (Imagination/Intellect), emphasizing an acceptable reliability (internal consistency).

Procedure

The study was conducted between November 2024 and April 2025. The Mini-IPIP questionnaire for this research was administered online using Google Forms. All ethical principles were respected: written informed consent was obtained, participants were free to

withdraw from the study at any time, and the data collected was treated with confidentiality, guaranteeing the anonymity of the respondents. The convenience sampling technique (as a recruitment technique, in the case of future sports managers) and, also, the snowball sampling technique (in the case of experienced sports managers) were used.

Statistical Analysis

Analyses were conducted using Jamovi (The Jamovi Project, 2025, Version 2.7). To verify whether there are significant differences between the two groups of sports managers (with and without experience), the independent t-test was used (the significance threshold was set at 0.05). The normality condition was tested using the Shapiro-Wilk test, while p-values higher than 0.05 for the Levene test showed homogeneity of variances (Martin & Bridgmon, 2012). Cohen's d (effect size) interpretation is: 0.8 large effect, 0.5 medium and 0.2 small effect (Hahs-Vaughn & Lomax, 2019). Also, using the Mann-Whitney (U) test (with small samples – Beatty, 2018) the differences between experienced sports managers, based on gender, age, marital status and family situation (with or without children) were tested. The effect size (r) was interpreted as follows: 0.5 large effect, 0.3 medium and 0.1 small effect (Predoiu, 2020).

Results

First, the presence of excessive/extreme values was investigated, an important aspect taking into consideration the absence of a social desirability scale. Following data analysis (box plots), four excessive values were eliminated from further processing, specifically in the case of the factors: conscientiousness (one value, from ESM group), neuroticism (two values, one from ESM group, and one from FMSO group), and intellect/imagination (one value, from ESM group).

Using the t-test for independent samples, the differences between the two groups of managers (ESM and FMSO) were verified, in terms of the Big-Five personality factors. The normality of the distributions was confirmed using the Shapiro-Wilk test ($p>0.05$, Table 1) and, also, the condition of homogeneity of variances was (generally) met (Levene's test, Table 1).

Table 1

Shapiro-Wilk (normality) and Levene's test for homogeneity of variances

Personality traits	$p_{Shapiro-Wilk}$	p_{Levene}
Extraversion	0.291	0.012
Agreeableness	0.173	0.389
Conscientiousness	0.246	0.228
Neuroticism	0.456	0.799
Imagination/Intellect	0.144	0.908

Table 2

Results of the t-test for independent samples – personality factors

Personality traits	t	df	p	Effect size	
Extraversion	0.868	43.0	0.390	Cohen's d	0.260
Agreeableness	1.308	43.0	0.198	Cohen's d	0.392
Conscientiousness	−0.977	42.0	0.334	Cohen's d	−0.296
Neuroticism	−0.552	41.0	0.584	Cohen's d	−0.170
Imagination/Intellect	−1.288	42.0	0.205	Cohen's d	−0.390

Since the alpha threshold is greater than 0.05 (Table 2), there are no statistically significant differences between the two groups of sports managers. However, the descriptive analysis highlights subtle differences that may be relevant in practice (Table 3). Specifically, ESM tend to be slightly more extroverted and agreeable, suggesting a greater orientation towards effective cooperation. On the other hand, FMSO scored slightly higher on the intellect/imagination dimension and on conscientiousness indicating a predisposition towards creative thinking and openness to new ideas.

Table 3

Descriptive statistics – personality traits

Sports managers		Extraversion	Agree-ableness	Conscien-tiousness	Neuroticism	Imagination/ Intellect
N	ESM	25	25	24	24	24
	FMSO	20	20	20	19	20
Mean	ESM	13.3	15.4	15.7	10.6	15.0
	FMSO	12.8	14.6	16.4	10.9	15.6
Median	ESM	13	15	16.0	11.0	15
	FMSO	13.0	14.5	17.0	11	15
SD	ESM	1.41	2.04	2.78	2.04	1.65
	FMSO	2.21	2.52	2.06	2.27	1.64

Notes: ESM: Experienced sports managers, FMSO: Future managers of sports organizations

Next, using the Mann-Whitney (U) test, the differences between experienced managers were investigated according to gender and age (ESM between 25–40 years, and ESM over 40 years of age), in relation to the five major personality factors.

Table 4

U test — differences based on gender and age

Personality traits	U – gender	p	r	U – age	p	r
Extraversion	56.5	0.308	0.246	62.0	0.389	−0.205
Agreeableness	68.0	0.716	0.093	68.0	0.602	−0.128
Conscientiousness	34.0	0.035	0.514	31.5	0.020	−0.559
Neuroticism	68.0	0.929	0.028	57.0	0.409	−0.202
Imagination/ Intellect	64.0	0.742	0.085	66.0	0.767	0.076

The result obtained ($p = 0.035$, Table 4) indicates a statistically significant difference between men ($M = 16.7$, $SD = 2.40$) and women ($M = 14.2$, $SD = 2.70$) in terms of conscientiousness, with an effect size of $r = 0.51$, reflecting a strong effect (a strong difference between male sports managers and female managers in terms of conscientiousness). It seems that Romanian experienced sports managers (men) reported a stronger tendency towards self-discipline and goal orientation, compared to experienced women sports managers. In terms of neuroticism and intellect/imagination, the differences based on gender are almost non-existent. Also, a significant (and strong) difference in the level of conscientiousness ($p = 0.020$, $r = 0.55$ — Table 4) was found between ESM over 40 years of age ($M = 17.0$, $SD = 2.14$) and ESM between 25 and 40 years ($M = 14.5$, $SD = 2.82$).

Not least, using the U test, the differences between experienced sports managers were verified according to marital status (married or unmarried), and family situation (with or without children), in relation to the Big-Five personality traits.

Table 5

Mann-Whitney test — differences based on marital status and family situation

Personality traits	U marital status	p	r	U family situation	p	r
Extraversion	65.5	0.505	−0.16	72.0	0.801	-0.06
Agreeableness	66.5	0.546	−0.14	59.5	0.347	-0.22
Conscientiousness	61.0	0.539	−0.15	50.5	0.229	-0.29
Neuroticism	70.5	0.953	−0.02	63.0	0.637	-0.11
Imagination/ Intellect	63.0	0.615	−0.12	67.0	0.812	-0.06

Data analysis revealed no significant differences between married and unmarried ESM and, also, between experienced sports managers who have children and those without children, in terms of the five major personality factors ($p > 0.05$, Table 5). However, some slightly differences were observed: ESM who have children tend to exhibit higher levels of

conscientiousness (M = 16.3, SD = 2.50) and agreeableness (M = 15.8, SD = 1.97), compared to ESM without children (M = 14.9, SD = 3.02 – conscientiousness, respectively M = 15.0, SD = 2.14 – agreeableness). Also, married sports managers registered slightly higher levels of conscientiousness (M = 16.0, SD = 2.34) and agreeableness (M = 15.7, SD = 2.02), compared to unmarried ESM (M = 15.3, SD = 3.23 – conscientiousness, M = 15.2, SD = 2.12 – agreeableness).

Discussion

The personality of sports managers represents a combination of psychological traits, interpersonal styles, and leadership behaviors that influence how they manage people, organizations, and high-pressure situations in the sporting context. With all the changes and challenges in the field of sport, such as digitisation, audience diversification and globalisation, there is a constant demand for the development of managers who not only understand the technical aspects of sport, but also the psychological and social dimensions of sports management.

In the first stage of the present study, experienced sports managers were compared with future managers in terms of personality characteristics (the Big Five model). Data analysis revealed differences which, although not statistically significant, may be of practical importance in the context of human resource selection and training, in the field of sport. More exactly, experienced managers scored slightly higher on extraversion and agreeableness, indicating a slightly higher level of sociability and cooperation in interpersonal relationships. Interestingly, in terms of conscientiousness, future sports managers obtained slightly higher values. This result may reflect an increased desire of FMSO to demonstrate efficiency, organization and responsibility (essential characteristics in the professional training stage), or can be interpreted in terms of increased motivation for performance and professional validation. At the same time, FMSO scored slightly higher on the intellect/imagination dimension, indicating a predisposition towards creative thinking and openness to new ideas. However, in the absence of statistically significant differences between ESM and FMSO, we mention that Romanian future managers in the field of sport are well suited to the specifics of the job, combining personal responsibility with a proactive attitude and openness to innovation, manifesting (at least with regard to the five major factors of personality) the necessary characteristics for a successful career in sport management.

Next, the personality traits of experienced sports managers were investigated according to gender, age, marital status and family situation (with or without children). The Big Five model application to experienced sports managers, particularly concerning the above mentioned variables, represents an area requiring investigation. Therefore, the current study aimed to bridge this gap by examining how the Big Five personality traits manifest differently between male and female sports managers, according to managers' age, marital status or family situation – recognizing that these traits can significantly impact leadership efficacy and organizational performance. A significant difference in the level of conscientiousness was found between Romanian experienced managers (men) and women ESM, in favor of men, which are more goal oriented and show a higher

self-reported discipline. This difference may be influenced by contextual and cultural factors, professional roles, or social expectations associated with gender. It seems that male managers are more frequently described as adopting autocratic approaches that prioritize authority and task completion (Burton et al., 2009). This pattern is not, however, universal, but is shaped by organizational culture and contextual expectations. Considering neuroticism and intellect/imagination, the differences are almost non-existent based on ESM' gender. A good emotional self-control (low neuroticism) not only supports effective decision-making, but also contributes to the sustainability of a successful career in sports management (Allen & Laborde, 2014), regardless of gender. Interestingly, investigating sports managers from Transylvania (Romania), Zamora and Lupu (2010) found that female sport managers manifest a higher level of somatic and psychic anxiety, and a lower level of monotony avoidance (compared to men).

Also, a significant difference in the level of conscientiousness was found between ESM over 40 years of age, and ESM between 25 and 40 years (in favor of older sports managers). Specialized literature (Roberts et al., 2006; Soto et al., 2011) discussed about the changes in personality characteristics across the life course (distinct age trends in each broad Big Five domain), older people being more rule-oriented and having a greater maturity, self-discipline and adjustment, which in the sport management field support, for example, operations, governance, and budgeting. Regarding conscientiousness, "people in leadership careers traditionally display [...] higher conscientiousness" (Farstad & Arnulf, 2024), this trait being a robust predictor of job performance (Barrick & Mount, 1991).

Data analysis revealed no significant differences between married and unmarried ESM and, also, between experienced sports managers who have children and those without children, in terms of the Big Five personality traits. However, some interesting findings are still worth discussing: ESM who have children tend to exhibit slightly higher levels of conscientiousness and agreeableness (compared to ESM without children), while married experienced managers registered, also, the same tendencies (slightly higher scores for conscientiousness and agreeableness). These small differences may reflect the personal stability and social support associated with long-term relationships, and the subtle influence of parental responsibilities on personal and professional functioning.

Limitation of the study

The limitations of the research mainly concern the relatively small number of experienced managers investigated. Further studies are needed to supplement the present data, on larger groups and in different contexts – including other countries, being known that "cultures with an earlier onset of adult-role responsibilities are marked by earlier personality maturation" (Bleidorn et al., 2013). Also, the reliance on a self-reported tool may affect the accuracy of the responses, the limits of explicit/declarative measures being known (Predoiu et al., 2022). In this context, future studies using the implicit (nonconscious/automatic) self-concept of personality can be, also, used (see Schmukle et al., 2008).

Not least, the necessity for sports organizations to consider a comprehensive psychological profile (beyond the Big Five) when selecting and developing managers,

suppose including traits like those within the Dark Triad which may, also, exert considerable influence on leadership outcomes.

Conclusions

Subtle differences in term of Big-Five personality traits were emphasized between experienced and future sports managers (not statistically significant). FMSO registered slightly higher values on the intellect/imagination and conscientiousness sub-scales, indicating a predisposition towards openness to new ideas, creative thinking and self-discipline, while ESM obtained slightly higher results for extraversion and agreeableness. Considering neuroticism, the differences are almost non-existent. Therefore, we can state that Romanian future sports managers have the appropriate characteristics for a successful career in sport management – at least in terms of Big Five personality characteristics.

Based on gender, experienced sports managers (men) reported a stronger tendency towards self-discipline and goal orientation, compared to experienced women sports managers, while in terms of neuroticism and intellect/imagination the differences are almost non-existent. Also, significantly higher results for conscientiousness were observed in older sports managers (between 40–60 years old), regardless of gender, while insignificant Big-Five personality traits-related differences were found according to managers' marital status (married or unmarried) and family situation (with or without children).

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Conflict of interest. *Authors declare no conflict of interest.*

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LASE Journal of Sport Science • 2025/2 • Pages **33**–45
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ORIGINAL RESEARCH PAPERS

The Relationship Between Preventive Sports Physical Activity and Academic Compatibility Among Secondary School Students in Algeria

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Abstract

Academic compatibility and physical fitness are crucial for students' holistic development. While previous research indicates positive effects of sports on achievement and strength, limited evidence exists in Algerian secondary schools. This study explored the impact of preventive sports activity on academic adjustment and muscular strength among pupils in Guelma. Methods: Sixty students (30 males, 30 females) were randomly selected and divided into practitioners (n = 15) and non-practitioners (n = 15) per gender. Data were collected using the Academic Compatibility Scale (34 items) and the 2 kg Medicine Ball Throw Test. Analysis was performed with SPSS v25, applying descriptive statistics and independent samples t-tests at $\alpha = 0.05$. Results: Significant differences favored practitioners in both variables. Male practitioners scored higher in academic compatibility (M = 24.93 vs. 13.86) and muscular strength (M = 11.76 vs. 8.24). Female practitioners also outperformed their counterparts in academic compatibility (M = 26.40 vs. 15.13) and muscular strength (M = 7.96 vs. 5.36), with all results statistically significant ($p < 0.05$). Discussion: Findings confirm that preventive sports activity improves academic and physical outcomes. Practitioners demonstrated better adjustment and strength, supporting the role of sports in enhancing cognitive, social, and physical development. The study emphasizes integrating regular school-based sports programs to promote students' academic and physical growth.

Keywords: School sports, Fitness and Health, Academic achievement, Muscle strength, Participation in sports

Introduction

Compatibility is a crucial factor in shaping an individual's personality, as it represents a significant and continuous developmental process through which a person acquires effective behaviors that guide life changes and support personal growth. Within this context, compatibility in its various forms – personal, emotional, social, and academic – is widely recognized as a primary indicator of mental health. Each stage of human development requires a set of conditions that must be fulfilled in order for the individual to progress to the next stage. Continued positive compatibility therefore becomes essential for achieving a higher quality of life (Abuhmaidan et al., 2020). Academic compatibility, in particular, plays a critical role in shaping the key components of the educational process and is considered one of the most important contemporary constructs. Educational leaders, especially teachers who maintain direct and daily interaction with students, increasingly emphasize the necessity of enhancing students' academic adjustment. As a fundamental prerequisite for success, academic compatibility is regarded as a form of social adjustment, enabling students to establish balance between themselves and their academic environment – including peers, instructors, and curricular demands – while supporting their cognitive and emotional development (AL-Momani et al., 2023).

Athletic participation occupies an important place among high school extracurricular activities. According to the National Federation of State High School Associations, more than 7.6 million students – representing 55.5% of all high school students – participated in sports during the 2010–2011 academic year. This marked the 22nd consecutive year of increased sports participation (Hwang et al., 2016). Sports and physical education have also been highlighted as strategic tools for promoting sustainable development. As emphasized during the 2002 UN World Summit in Johannesburg, transforming existing educational systems is essential to achieve sustainability. Sports-based education for sustainable development provides students with the knowledge, skills, values, and behaviors necessary to contribute to environmental preservation, social justice, and economic responsibility. Through sports, learners develop essential human qualities such as empathy, teamwork, discipline, inclusiveness, hospitality, and respect for others and for rules (Alade et al., 2021).

Physical exercise has, therefore, become an increasingly significant component of public health and education policy. Physical activity refers to any bodily movement produced by skeletal muscles that results in energy expenditure. Current guidelines recommend at least 150 minutes per week of moderate-intensity aerobic activity, or no less than 75 minutes of vigorous-intensity exercise, or an equivalent combination of both (Ijaz & Shaha, 2023). Sports participation is widely recognized as an effective means to promote healthy behaviors and support the holistic development of children and adolescents. In addition, growing research has examined the relationship between sports involvement and academic achievement. Several studies indicate positive associations, suggesting that the adolescents who participate in sports tend to demonstrate stronger academic performance. Both cross-sectional and longitudinal findings provide converging evidence that sports participation substantially contributes to enhanced academic outcomes (Chen et al., 2021).

Interest in understanding the effects of regular exercise on academic achievement has increased over the past 15 years. Despite this growing attention, it remains premature to conclude definitively that physical activity directly improves academic performance. In practice, many students perceive a conflict between athletic and academic demands. A U.S. survey found that 36 % of girls and 26 % of boys reported discontinuing sports in order to concentrate on schoolwork. This reflects the common belief that academic success requires reducing engagement in extracurricular activities. However, emerging evidence contradicts this assumption, indicating that sports involvement is positively related to academic achievement rather than detrimental to it (Kuroda et al., 2023).

In light of these considerations, it is important to explore the relationship between high school students' athletic participation and their academic outcomes in order to clarify the nature of this association and identify potential moderating factors such as gender, sport type, and level of participation. This includes examining how educational expectations, academic support, athletic support from significant individuals, and students' own aspirations interact with participation in sports to influence academic compatibility and performance. Such an approach provides a more comprehensive understanding of how athletic engagement contributes to – or interacts with – the broader educational experience of adolescents.

Materials and Methods

Participants in the study

Sixty (60) secondary school students from the province of Guelma, Algeria, voluntarily participated in the study. The sample consisted of 30 male and 30 female students. Within each gender group, 15 students regularly engaged in organized sports activities, while the remaining 15 did not participate in any structured physical activity. The selection process followed a simple random sampling procedure from the student lists provided by the participating schools.

The participants were enrolled in the second and third years of secondary education, with ages ranging from 16 to 18 years. Inclusion criteria required that students be physically healthy, enrolled full-time in school, and willing to participate in both academic and physical assessments. Students with injuries, medical restrictions, or special educational needs were excluded. Parental or guardian consent, along with student assent, was obtained, as required for research involving minors.

Comparisons were conducted separately for males (practicing vs. non-practicing) and females (practicing vs. non-practicing) across the same set of academic and physical tests.

Research design

The study employed a cross-sectional comparative design aimed at identifying differences between physically active and inactive students with regard to academic compatibility and muscular strength. Two standardized assessments were administered during the data collection period, which took place between March and April 2023.

- Academic Compatibility Assessment: conducted between March 25 and April 1, 2023.
- Muscular Strength Assessment: conducted between April 3 and April 8, 2023.

All tests were administered during school hours in a controlled and standardized environment by trained physical education teachers following unified instructions and procedures.

Assessments

Among the field tests used in the study are the following ones:

- **Academic Compatibility Scale**

The study used the Academic Compatibility Scale originally developed by Youngman (Sihem, 2022). The scale consists of 34 items, including both positively and negatively worded statements designed to assess students' academic adjustment and integration within their school environment.

Participants responded to each item using a dichotomous format ("Yes" indicating agreement and "No" indicating disagreement). Each item was scored either 1 or 0 according to the scoring key, resulting in a total score ranging from 0 (lowest level of academic compatibility) to 34 (highest level).

Higher scores reflected stronger academic compatibility, including better adjustment to teachers, peers, school expectations, and academic tasks.

Because the scale was used in an Algerian/Arabic-speaking context, it underwent translation and cultural adaptation procedures. Content validation was performed by a panel of three experts in educational psychology. Internal consistency reliability (Cronbach's alpha) was calculated for the study sample to ensure acceptable psychometric properties (Sihem, 2022).

- **2 kg medicine ball throw test**

This field test was used to assess upper-body muscular strength.

Purpose – to measure explosive strength of the arms and shoulder girdle. Equipment – a 2-kg medicine ball, measuring tape, marked throwing area. Procedure – Participants stood behind a designated throwing line while holding the ball with both hands at chest height. After receiving standardized instructions and completing a brief warm-up, participants performed three maximal forward throws using an overhead or chest-push technique without crossing the line. The farthest distance (measured to the nearest 5 cm) among the three attempts was recorded as the final score (Johnson & Nelson, 2015).

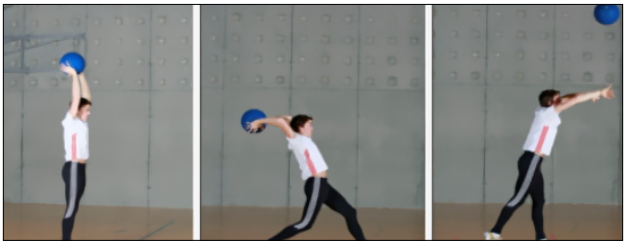

Figure 1 **The 2 kg medicine ball throw test**
(mobilesport.ch, 2012)

Analysis of statistics

Data analysis was performed using SPSS version 25. Descriptive statistics (mean and standard deviation) were used to summarize participant characteristics and assessment scores. Independent samples t-tests were applied to compare practicing and non-practicing students within each gender group.

Prior to conducting the t-tests, statistical assumptions were examined, including normality (using the Shapiro–Wilk test) and homogeneity of variance (using Levene's test). The significance level was set at $p < .05$, corresponding to a 95% confidence interval. Effect sizes (Cohen's d) were also calculated to evaluate the magnitude of differences between groups.

Ethical Considerations

The study followed ethical standards consistent with the Declaration of Helsinki. Approval was obtained from the institutional review board of the University of Guelma. Written consent was obtained from parents or guardians, and assent was obtained from all participating students.

Regarding the illustrative figure of the medicine ball test, permission to use the image was secured, and the image does not include identifiable personal information.

Results

Table 1 displays the results of the academic compatibility test for males. The mean score of practitioners ($M = 24.93$, $SD = 4.33$) was substantially higher than that of non-practitioners ($M = 13.86$, $SD = 2.47$). The independent samples t-test indicated a statistically significant difference between the two groups. We observe from the table that the value of (t) computed at a degree of freedom of (28) is equal to (8.589). This is because the degree of significant probability (sig=0.00) is less than the level of significant significance ($p < .05$). These findings suggest that the male students who engage in regular physical activity exhibit markedly higher levels of academic compatibility compared with their non-active peers.

Table 1

Statistical analysis of the results for the academic compatibility test for males

Test grade	Practice variable	
	Practitioners	Non-practitioners
N	15	15
Mean	24.93	13.86
Std. deviation	4.33	2.47
T test	8.589	
df	28	
Significance level	$p < .05$	
Sig	0.00	
Statistical estimate	Significant	

Source: Present research

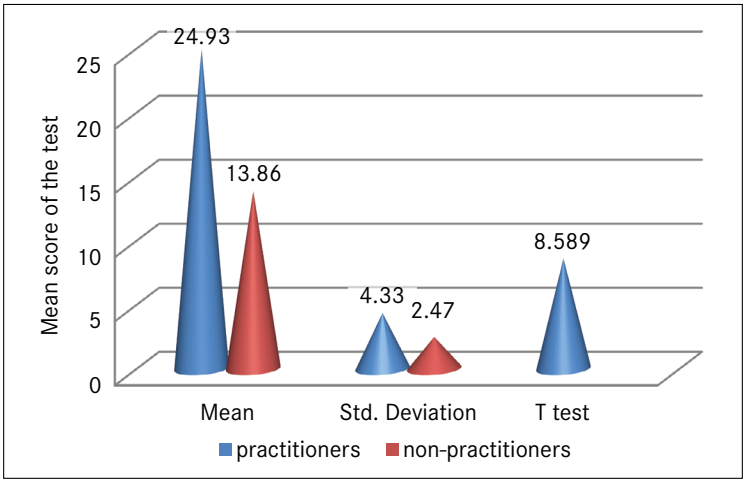

Figure 2 **Graph of the Mean and std Deviation of the academic compatibility test for males**

Table 2

Statistical analysis of the results for the academic compatibility test for females

Test grade	Practice variable	
	Practitioners	Non-practitioners
N	15	15
Mean	26.40	15.13
Std. deviation	4.57	1.92
T test	8.786	
df	28	
Significance level	$p < .05$	
Sig	0.00	
Statistical estimate	Significant	

Source: Present research

As shown in Table 2, female practitioners also demonstrated higher academic compatibility scores ($M = 26.40$, $SD = 4.57$) than non-practitioners ($M = 15.13$, $SD = 1.92$). The t-test confirmed that this difference was statistically significant, $t(28) = 8.786$, ($p < .05$). Similar to the results for males, these findings indicate that engagement in physical activity is associated with improved academic compatibility among female students.

The decision to analyze male and female students separately was based on documented gender-related differences in both academic and physical development during adolescence, which may influence both compatibility and muscular performance. Therefore, separate analyses provide a clearer and more meaningful interpretation of group-specific trends.

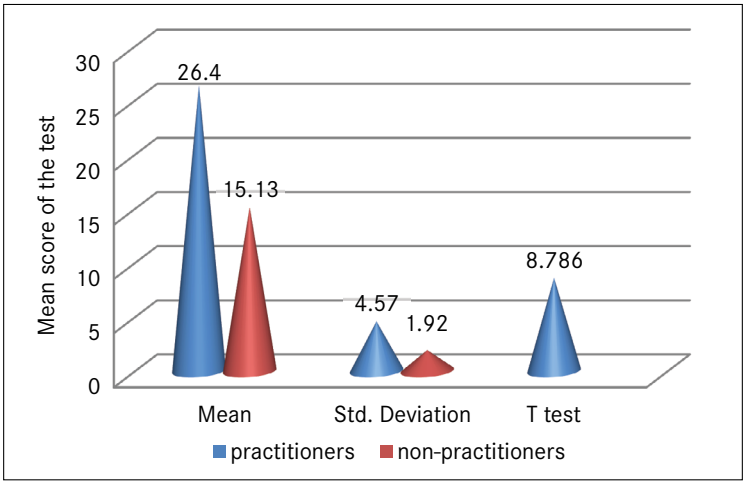

Figure 3 **Graph of the Mean and std Deviation of the academic compatibility for females**

Table 3

Statistical analysis of the results for the muscle strength test for males

Test grade	Practice variable	
	Practitioners	Non-practitioners
N	15	15
Mean	11.76	8.24
Std. deviation	1.28	1.51
T test	6.858	
df	28	
Significance level	$p < .05$	
Sig	0.00	
Statistical estimate	Significant	

Source: Present research

Table 3 presents the muscular strength test results for male students. Practitioners achieved a higher mean distance in the 2 kg medicine-ball throw ($M = 11.76$, $SD = 1.28$) compared to non-practitioners ($M = 8.24$, $SD = 1.51$). The difference was statistically significant, $t(28) = 6.858$, ($p < .05$). These results highlight the positive impact of regular physical activity on upper-body muscular strength among male adolescents.

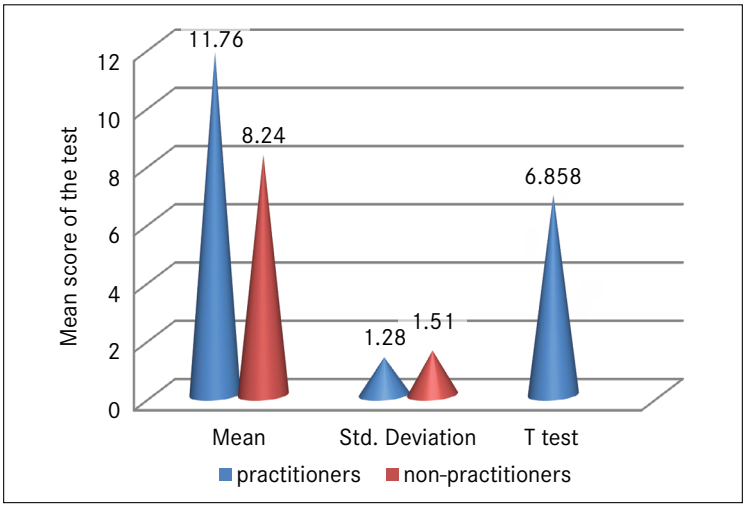

Figure 4 **Graph of the mean and standard deviation of the muscle strength test for males**

Table 4

Statistical analysis of the results for the Muscle strength test for females

Test grade	Practice variable	
	Practitioners	Non-practitioners
N	15	15
Mean	7.96	5.36
Std. deviation	1.12	1.31
T test	5.812	
df	28	
Significance level	p<.05	
Sig	0.00	
Statistical estimate	Significant	

Source: Present research

Table 4 shows that female practitioners also outperformed non-practitioners in the muscular strength test, with mean scores of (M = 7.96, SD = 1.12) and (M = 5.36, SD = 1.31) respectively. The independent samples t-test indicated a statistically significant difference, t (28) = 5.812, (p < .05). These findings further support the conclusion that participation in sports is associated with enhanced muscular strength among female students.

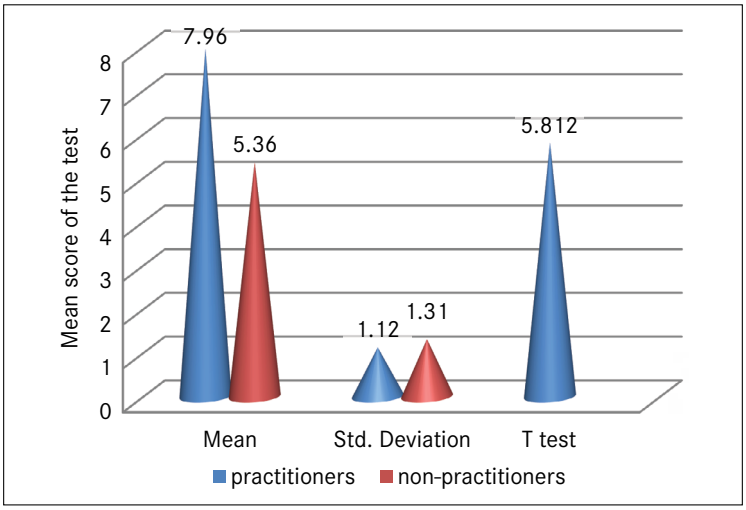

Figure 5 **Graph of the mean and standard deviation of the muscle strength test for females**

Across all analyses, the students who participated in physical activity demonstrated significantly higher academic compatibility and muscular strength than those who did not. These results underscore the potential role of regular sports engagement in promoting both academic and physical development during adolescence. Future studies should examine effect sizes, confidence intervals, and test assumptions of normality and homogeneity more explicitly as well as considering additional contextual variables that may influence these outcomes.

Discussion

The analysis of the data presented in the tables, based on both the physical fitness tests and the academic compatibility test administered to the study sample, indicates that the differences in academic adjustment and muscular strength among high school students. Although the results show that students who engage in weekly sports activities tend to report better fitness and muscle strength levels, these findings should be interpreted as associations rather than causal effects. The observed disparities between practicing and non-practicing students appear to align with the general pattern that regular physical activity – whether during physical education classes or in leisure time – is positively associated with indicators of fitness and academic compatibility. Numerous studies in the literature support this general trend, offering important context for interpreting the present findings.

Several previous studies have reported positive correlations between sports participation and academic outcomes. For example, Kuroda et al. (2023) found a favorable association between athletic success and academic performance among high school males.

Similarly, Ijaz and Shaha (2023) reported a significant positive relationship between academic achievement and engagement in sports, suggesting that physical activity may contribute to attention, cognitive functioning, and personal development. Chen et al. (2021) also observed a dose-dependent pattern in which greater sports participation was associated with higher self-reported grades among students of different genders and grade levels.

Other research further supports the association between sports involvement and academic indicators. Alade et al. (2021) highlighted that sports participation is positively correlated with academic achievement and school engagement. Lombarte et al. (2020) found that increased time spent in sports was associated with improved academic results and fewer failed subjects. Likewise, Garcia and Subia (2019) reported that academic performance and involvement in school athletics tend to be positively correlated. Hwang et al. (2016) showed that participation in athletics may reinforce academic identity without negatively influencing educational aspirations. Additional studies emphasize psychological mechanisms — such as enhanced self-esteem and positive school climate — that may mediate this association (Abisha & Vincent, 2015).

Historical evidence also suggests that high school athletics are linked to improved academic outcomes such as graduation rates and standardized test performance (Bowen & Greene, 2012). However, Gadžić (2009) noted that athletes' superior academic results might be partly explained by external factors rather than sports participation alone, underscoring the relevance of potential confounders.

In terms of muscular strength, numerous intervention studies support the general observation that physical activity contributes to improvements in strength-related measures among adolescents. Research has shown that physical education programs can effectively increase muscular strength through structured training involving jumps, isometric exercises, and resistance work (García-Baños et al., 2020). High-intensity interval training (Abarzúa et al., 2019) and strength programs incorporating push-ups, medicine ball throws, and horizontal jumps (Cardoso et al., 2020) have also been found effective. Both free weight and elastic resistance training can lead to significant strength gains in adolescents (Lubans et al., 2010), while kettlebell-based programs appear to improve strength, posture, and overall training motivation (Kirsanova, 2020).

Specific resistance modalities such as ballistic strength training (Granacher et al., 2011), CrossFit-inspired programs (Mokhtar et al., 2022), and mixed bodyweight-resistance band protocols (Zhao et al., 2022) have also demonstrated measurable improvements in strength, endurance, and mobility. Functional Strength Training programs (Liao et al., 2022) and school-based resistance training (Kennedy et al., 2022) further highlight the importance of training specificity in determining strength outcomes. Earlier evidence confirms that even lighter resistance exercises performed with proper technique and frequency can be effective for adolescents (Marin et al., 2013; Ten Hoor et al., 2018; Wolbers, 1956).

Although these studies provide valuable theoretical and empirical support for interpreting the current findings, it is important to acknowledge that the discussion in this research should avoid suggesting that sports participation improves academic compatibility in a causal manner. Given the cross-sectional nature of the present study, the results can

indicate associations between physical activity and both academic and physical measures, but causal relationships cannot be established.

Furthermore, several potential confounding variables may influence the relationship between sports participation and academic compatibility. Factors such as prior academic performance, personal motivation, socioeconomic background, parental involvement, and general lifestyle habits could contribute to both higher engagement in sports and better academic outcomes. Recognizing these variables adds nuance to the interpretation of the findings and prevents overgeneralization.

Conclusion

The findings of this study indicate that participation in regular sports and physical activity – whether during physical education classes or leisure time – is associated with better academic adjustment and improved physical health among secondary school students. Practicing students consistently demonstrated higher performance in indicators related to academic compatibility and physical fitness compared to their non-practicing peers, suggesting that engagement in healthy sports activities may contribute positively to both cognitive and physical development.

The study relied on a limited sample size and cross-sectional design, which restricts the ability to generalize the findings or infer causal relationships between sports participation and academic outcomes. Additionally, the measurement tools used were basic and may not fully capture the complexity of academic or physical performance variables.

Ethically, the study was conducted with the approval of the relevant educational institution and in accordance with required procedures for research involving minors, including obtaining informed parental consent and ensuring confidentiality of student data.

Overall, the findings underscore the potential value of promoting structured physical activity within school environments as part of efforts to support students' academic well-being and physical health. Educators and policymakers may consider integrating more effective and enjoyable physical activity programs to encourage regular participation among students.

Future research should aim to employ larger and more diverse samples, adopt longitudinal research designs, and utilize validated and standardized measurement instruments to obtain more robust evidence. Investigating the differential effects of specific types of sports or training programs may also provide deeper insights into the mechanisms linking physical activity to academic and developmental outcomes.

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Conflict of interest. *The author declares no competing interests.*

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Structural Upgrading Measurement and Optimization Path of Sports Industry: An Examination of China's Solution

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Abstract

It is of great significance to explore the level of structural upgrading and optimization path of the sports industry to promote the transformation and development of the sports industry. Taking the structure of China's sports industry as the research object, a quantitative analysis method is adopted to construct a model for measuring the structural upgrading of China's sports industry, measuring the external structure of China's sports industry from 2006 to 2023 by the index of the proportion of the sports industry in the economic structure, and the direction and rate of the internal structural upgrading of China's sports industry from 2006 to 2023 by the coefficient of the overstepping forward of the industrial structure, the value of the change of Moore's structure and the value of the average change of the industrial structure. The direction and rate of upgrading the internal structure of China's sports industry from 2006 to 2023 are measured by the coefficient of industrial structure overrun, the value of Moore's structural change, and the average change value of industrial structure. The results show that: (1) the external structure of China's sports industry is continuously optimized, and its role in China's economic development is constantly emerging, but the contribution rate to economic growth is still relatively low; (2) the over-advanced development of the sports service industry, and the lagging development trend of the sports construction industry and the sporting goods manufacturing industry conform to the law of upgrading of the industrial structure; (3) from the internal viewpoint of the sports service industry, the sports management activities, the sports fitness and leisure activities, and the sports competition and performance activities are lagging. Sports management activities, sports fitness and leisure activities, and sports competition and performance activities are lagging, which has become one of the critical obstacles restricting the transformation and upgrading of China's sports industry. (4) From the perspective of the upgrading rate, there is ample space for structural changes in China's sports industry, and the upgrading rate is in an upward trend, especially in the emerging industries.

Keywords: transformation development, sports industry structure, upgrading measurement, optimization path

Introduction

The global transition to a knowledge-driven economy is forcing various industries to undergo structural adjustments, and the sports industry, as a strategic area that integrates economic vitality, technological innovation, and social well-being, has attracted much attention in terms of its upgrading path. Against the backdrop of countries responding to the need for recovery and sustainable growth in the post-epidemic era, optimizing the industrial structure has become a key focus point for enhancing productivity, fostering innovation ecosystems, and aligning with the United Nations Sustainable Development Goals (SDGs). In this context, China's practice of promoting the modernization of the sports industry provides a valuable case study for examining the structural upgrading mechanism of transition economies. From the viewpoint of industrial structure theory, upgrading industrial structure promotes resource allocation, coordinates industrial division of labor, and drives economic development (Wang, 2018). The process of sports industry development is also the process of industrial structure adjustment and continuous improvement of innovation ability, shifting from resource-intensive and labor-intensive low-value-added industries to high-value-added high-tech industries and strategic emerging industries. The idea of claiming the speed and efficiency of economic development from the evolution of industrial structure is the core and essence of industrial development policy (Liu, 2000.) After years of development, China's sports industry has entered a rapid development stage, with rapid growth in the scale and added value of the sports industry and continuous optimization of the industrial structure. Still, it faces structural problems, such as weak innovation ability, small total scale, unreasonable structure, and unbalanced regional development.

Some scholars have already determined through empirical research that economic structure conversion helps to promote the rapid development of the economy and believe that the measurement and judgment of the level of industrial structure adjustment will directly affect the decision-making and implementation process of the economic growth; therefore, the assessment of the effect of industrial upgrading and the promotion of structural conversion has become an essential path for the rapid development of the economy (Liu & Ling, 2020). Through the collection and collation of relevant literature on economic structure optimization and industrial structure upgrading, the research on industrial structure upgrading by scholars at home and abroad mainly focuses on the evaluation of the optimization effect (Cheng, Sun, & Bao, 2020), influencing factors (Yu & Shen, 2020; Lei & Cai, 2019), and the relationship with related systems (Zhu & Liu, 2020; Liu & Ling, 2020), and mainly focuses on quantitative research. There are three basic methods for industrial structure analysis: industrial structure correlation analysis method (e.g., structural similarity coefficient, Hoffman's ratio), industrial structure benefit analysis method (e.g., comparing labor productivity, rate of technological progress), and industrial structure change analysis method.

In terms of the analysis method of industrial structure change, some scholars have used the dynamic deviation-share method to study the industrial structure change; Fabricant (2009) used this method for the first time and utilized the decomposition formula to analyze the industrial structure effect; Paci et al. (1997) and Fagerberg et al. (1999) used this

method to investigate the adjustment effect of industrial structure under the economic growth environment. Meanwhile, scholars at home and abroad have widely utilized Moore's structural change value, Lilien's index, and the average change value of industrial structure to determine the rate of industrial structure upgrading and the coefficient of overshoot to determine the direction of industrial structure upgrading. John H. Moore (1978) proposed Moore's structural change value to measure industrial structure change in 1978, and Robson (2006) used the Lilien index to analyze the change in industrial structure in each region of Britain. These several methods of industrial change analysis at home and abroad are more mature in their application system, with lower data requirements, simple operation, and strong interpretation, which are not only widely used in the analysis of the structural change of three industries (Liu & Ling, 2020), but also applicable to the research of transformation and upgrading of subdivided industries (Xu, Zhuang & Chu, 2019; Zhao, Yin & Ma, 2015; however, the use of these methods of industrial structure change analysis to measure the degree of structural change of the sports industry is still to be carried out in the field of sports.

Specifically for the emerging sports industry, the number of research on industrial structure is rising. There are two main perspectives in the quantitative analysis of sports industry structure optimization. Hu Hongcheng (2012) and Yang Qian et al. (2011) earlier used grey correlation analysis to quantitatively analyze the optimization of China's industrial structure, and on this basis, An Junying et al. (2017) applied grey system theory to establish a GM (1, 1) prediction model to predict and analyze the structural changes in China's sports industry from 2016 to 2020, which provided the quantitative scientific basis for the dynamic evolution of the structure of the sports industry – Huang Haiyan (2011), Zhao Fuxue (2017), Yang Qian, etc. (2011) use location entropy, industrial structure diversification index, deviation-share analysis, comparative labor productivity, and other indicators to quantitatively analyze the basic situation of China's sports industry structure, through which the dynamic optimization process of China's sports industry structure can be observed. Secondly, it studies the relationship between the optimization of sports industry structure and related systems. Dai Tenghui et al. (2019) took the contribution rate and pulling rate of economic growth of the sports industry as the indexes and used quantitative analysis to explore the macroeconomic effect in the development of China's sports industry from the perspectives of total quantity and structure. In general, the perspectives of measuring the structure of the sports industry include industry structure, investment structure, etc. There are internal and external structures from the analysis direction, and the quantitative analysis methods are also varied. In this study, we will start from the industry structure, take the statistical data of each industry of China's sports industry from 2006 to 2023 as the support, and use the indexes such as the proportion of the added value of the sports industry to GDP to study the external structure of China's sports industry and draw on the three methods of analysis of changes in industry structure, namely, the coefficient of industrial structure overshooting, the value of changes in Moore's structure, and the value of average changes in the structure of the industry, which are used in the study of optimization of the economic structure.

The purpose is to propose an optimization path based on clarifying the structural level of China's sports industry.

Therefore, for the sports industry in its initial stage, how can we study the upgrading and optimization of the sports industry structure? How do we measure and evaluate the effectiveness of upgrading the previous sports industry structure? What problems exist in the structure of the Chinese sports industry? These are the questions to be analysed. The innovation of this study is to scientifically observe the upgrading of the sports industry structure through 18 years of statistical data to provide a reference for other countries to examine the upgrading and transformation of their own sports industry.

Methods

External structure optimization index

The optimization of the structure of China's sports industry is reflected in the increasing proportion of the sports industry in the economic structure. This paper will use the proportion of the added value of the sports industry in GDP and the proportion of the added value of the sports service industry in the added value of the tertiary sector to measure the external structure of China's sports industry from 2006 to 2023.

Internal structural upgrading model

Coefficient of industrial structure overshooting

Industrial structure upgrading is evolving from lower to higher form, and its direction has a certain regularity. The coefficient of industrial structure advancement can reflect the trend of industrial structure evolution and the degree of advancement and is calculated as follows.

$$Ei = ai + (ai - 1) / Rt$$

In this formula, the sports industry can be divided into *n* parts according to different criteria. *Ei* denotes the coefficient of structural overrun for industry *i*. *ai* represents the ratio of the share of industry *i* in the reporting period to the share in the base period. *Rt* denotes the average growth rate of the sports industry over the same period, calculated as $R_t = \ln(GDP_{reporting}) - \ln(GDP_{base}) / m$, *m* is the number of years, and GDP uses current prices. The base period *Ei* is 1; if *Ei* > 1, it indicates that the proportion of industry *i* tends to rise, and industrial development is ahead of schedule, the larger *Ei* is, the more significant the magnitude of ahead of schedule is; if *Ei* < 1, it indicates that the proportion of industry *i* tends to decrease, and industrial development is lagging, the smaller *Ei* is, the smaller the magnitude of lagging is.

Moore structural change values

Moore's structure change value determination model is based on the vector space angle. The sports industry is divided into n parts, and a set of n-dimensional vectors is constructed there. The angle between the two sets of vectors in 2 periods can be used as an indicator of the change industry's structure, i.e., the Moore value. The formula is as follows.

$$M = \cos \alpha = \sum_{i=1}^{n} (W_{i0} \times W_{it}) / (\sum_{i=1}^{n} W_{i0}^2 \times \sum_{i=1}^{n} W_{it}^2)^{1/2}$$

In the formula, *M* denotes the value of Moore's structural change, which is the cosine of the angle between the two vectors; W_{i0} denotes the share of industry *i* in the base period; W_{it} denotes the share of industry *i* in the reporting period. Therefore, the angle α between the two sets of vectors in the 2 time periods is $\alpha = arccosM$, the larger the value of α, the faster the change of industrial structure; the smaller α, the slower the change of industrial structure.

Average value of change in industry structure

The value of the average change in the industrial structure represents the absolute value of the change over a certain period of time and is calculated as follows.

$$k = \sum_{i=1}^{n} (|q_{it} - q_{i0}|) / n$$

In the formula, *k* is the average change in industrial structure; q_{it} is the proportion of the reporting period; q_{i0} is the proportion of the base period; *n* is the number of industrial categories; *t* is the number of years between the base period and the reporting period; the larger the value of *k*, the faster the change in industrial structure; the smaller the value of *k*, the slower the change in industrial structure.

Statistics

The data sources are the National Sports Industry Total Scale and Value Added Data Bulletin jointly issued by the General Administration of Sport of China and the National Bureau of Statistics of China, the International Sports Industry Development Report, and the China Statistical Yearbook, with a period of 2006–2023. It is worth noting that the current Chinese sports industry has adopted three classifications: the Classification of Sports and Related Industries (Trial) (2008), the National Statistical Classification of Sports Industry (2015), and the Statistical Classification of Sports Industry (2019). Compared with the classification system of 2008, the classification system of 2015 has changed a lot, not only stripping, adjusting, and adding two significant categories (sports competition and performance activities, sports media and information services) from the original classification system but also adjusting and changing the medium and small categories. Compared with the classification system of 2015, the classification system of 2019 has made adjustments to the relevant categories, descriptions, and corresponding industry codes to keep the original classification's basic structure unchanged, and the changes are relatively small. The statistical data of the sports industry in 2006–2014 are based on the classification system of 2008. The sports industry is divided into nine categories, which can correspond to the classification system of 2015, and the correspondence of these nine categories is shown in Table 1. The correspondence is shown in Table 1.

Table 1

Correspondence of Statistical Classification of Sports Industries

Category	Sports and Related Industries Classification (Trial) (2008)	National Sports Industry Statistical Classification (2015)	Sports Industry Statistical Classification (2019)
Sports Service Industry	Sports Organization and Management Activities	Sports Management Activities	Sports Management Activities
		Sports Competition and Performance Activities	*Sports Competition and Performance Activities*
	Sports Fitness and Leisure Activities	Sports Fitness and Leisure Activities	Sports Fitness and Leisure Activities
	Sports Venue Management Activities	Sports Venue Services	Management of Sports Facilities and Facilities
	Sports Intermediary Activities	Sports Intermediary Services	Sports Agency and Representation, Advertising and Exhibition, Performance and Design Services
	Sports Training Activities	Sports Training and Education	Sports Education and Training
	Other Sports Activities	*Sports Media and Information Services*	*Sports Media and Information Services*
		Other Sports-Related Services	Other Sports Services
	Sales of Sports Goods, Clothing, Footwear, and Headwear	Sales of Sports Goods and Related Products, Trade Agency and Rental	Sales of Sports Goods and Related Products, Rental and Trade Agency
Sports Goods Manufacturing Industry	Manufacture of Sports Goods, Clothing, Footwear, and Headwear	Manufacture of Sports Goods and Related Products	Manufacture of Sports Goods and Related Products
Sports Construction Industry	Construction of Sports Venues and Facilities	Construction of Sports Venues and Facilities	Construction of Sports Venues and Facilities

To ensure the continuity of analysis and consistency of presentation, this paper categorizes sports competition and performance activities and sports media and information services into sports management activities and other sports services, respectively, in 2015–2023, focusing on nine types of subsectors such as sports management activities, sports fitness and leisure activities, and sports venues and facilities and management, etc., and analyzes 2015–2023 separately. The two subsectors of sports competition and performance activities and sports media and information services are examined individually.

They are based on the presentation of the subsectors in the Statistical Classification of the Sports Industry (2019).

Results

External Structure Optimization Measurement

Based on the statistical data of China's sports industry from 2006 to 2023, the proportion of the added value of China's sports industry to GDP and the proportion of the added value of the sports service industry to the added value of the tertiary industry was calculated, and the results of the calculation are shown in Table 2.

Table 2

The Share of China's Sports Industry in the Structure of the Economy, 2006–2023

Share of sports industry in economic structure (year)	Share of added value of sports service industry in tertiary industry (%)
2006	0.30
2007	0.33
2008	0.35
2009	0.37
2010	0.38
2011	0.44
2012	0.46
2013	0.46
2014	0.44
2015	0.79
2016	0.93
2017	1.33
2018	1.39
2019	1.43
2020	1.33
2021	1.40
2022	1.44
2023	1.58

The data show that from 2006 to 2023, the added value of China's sports industry has increased from 98.289 billion yuan to 149.15 billion yuan, with an average annual growth rate of 17.70%, and the proportion of the sports industry in GDP grows from 0.47% to 1.18%. Meanwhile, the added value of China's sports service industry grows from 24.46 billion yuan in 2006 to

1084.6 billion yuan in 2023, with an average annual growth rate of 26.53%, and the added value of the sports industry service industry accounts for the proportion of tertiary industry added value grows from 0.30% to 1.58%. Over the past 18 years, the external structure of China's sports industry has been continuously optimized, and its role in China's economic development has constantly been revealed.

To grasp the external structure of the sports industry more clearly, this paper chooses the tourism and culture industries as references. It makes a horizontal comparison of the external structure of the three industries, and the comparison results are shown in Figure 1.

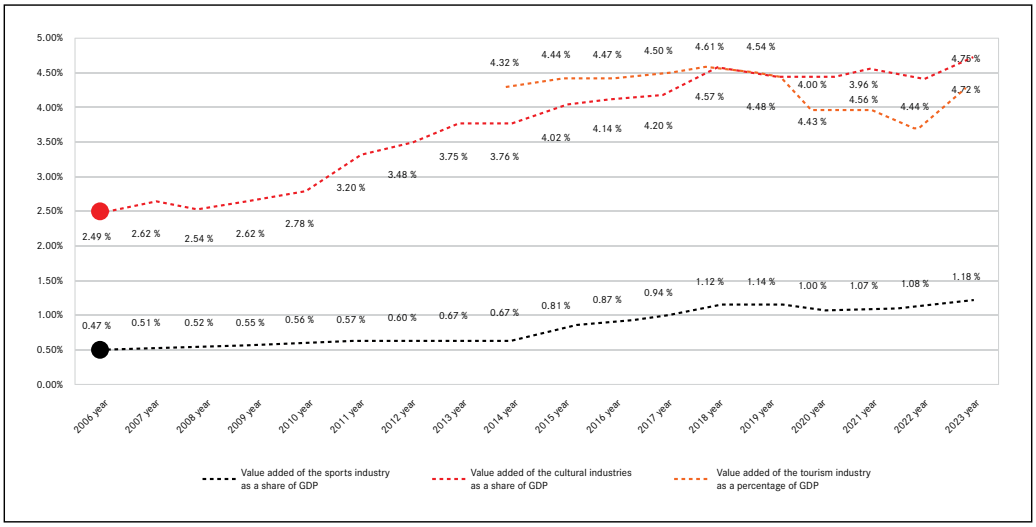

Figure 1 **Comparison of the external structure of the sports industry with the tourism industry and the cultural industry**

Note: Tourism industry 2006–2013 statistics are missing.

Internationally, the industries that have a pivotal position in the development of the national economy account for more than 4% of the national economy in terms of added value, contribute significantly to the growth of the national economy, conform to the direction of the evolution of the industrial structure, are conducive to the optimization of the industrial structure, have a strong correlation, and can drive the development of many related industries are called the pillar industries (Liu, 2019. As shown in Figure 1, the tourism and culture industries became the pillar industries of the national economy around 2014 and 2015, while the value added by the sports industry accounted for only 0.63% of the GDP in 2014. The value added by the sports industry accounted for a significant increase in the proportion of GDP after 2014, and it will be 1.18% by 2023. Relevant information shows that the proportion of added value of sports industry to GDP in Germany was 3.9% in 2012, the proportion of added value of sports industry to GDP in the United States was 3% in 2015, and the proportion of added value of sports industry to GDP in South Korea reached 4.3% in 2017 (Huang, 2020). After the above comparative analysis, it can be found

that China's sports industry is still in the early stage of development, the external structure is not very reasonable, and the proportion of sports industry in the national economy and the contribution rate of the sports industry to economic growth is still relatively low.

Internal Structure Upgrading Measurement

Direction of industrial structure upgrading of the three major industries

Based on the statistical data of China's sports industry from 2006 to 2023, combined with formula (1), we calculate the change value of the proportion of the three major industries in China's sports industry as well as the coefficient of overshooting to reflect the direction of structural upgrading of the sports industry. To compare the changes in the structure of the sports industry in different periods, taking the introduction time of the National Statistical Classification of the Sports Industry (2015) as the node, the development cycle of China's sports industry is divided into two time periods, T1 = 2006–2014 and T2 = 2015–2023, and the overrun coefficients of the two time periods are calculated respectively. The results of the calculations are shown in Table 3. Industries are 47.80, −46.04, and −1.77, respectively, and the overrun coefficients are 15.64, 4.61, and 3.95.

Table 3

Changes in the proportion of the three major industries in China's sports industry and the coefficient of overshooting

Time period	Value of change in the share of three major industries			Three industry override factors		
	Sports Service Industry	Sports Goods Manufacturing Industry	Sports Construction Industry	Sports Service Industry	Sports Goods Manufacturing Industry	Sports Construction Industry
T_1 = 2006–2014year	8.70	−8.71	0.01	3.57	0.11	1.02
T_2 = 2015–2023year	23.50	−24.50	1.00	5.78	−3.89	17.69
T = 2006–2023year	47.80	−46.04	−1.77	15.64	4.61	3.95

The overall proportion of the sports service industry as a whole is on the rise, and the industry is overrunning; the proportion of the sporting goods manufacturing industry and the sports construction industry as a whole is on the decline, and the overrun coefficients are < 1, and the industry is lagging. From 2006 to 2014, the sports service and construction industries were overdeveloped, with overdevelopment coefficients of 3.57 and 1.02, respectively, and the sporting goods manufacturing industry lagged, with an overdevelopment coefficient of < 1, at 0.11. From 2015 to 2023, the overdevelopment coefficient of the sports service industry is 5.78, the overdevelopment coefficient of the sports construction industry rises to 17.69, and the overdevelopment coefficient of

the sporting goods manufacturing industry In general, the coexistence of sports service industry's over-advanced development, sports construction industry and sporting goods manufacturing industry's lagging development is in line with the law of industrial structure upgrading. However, China still needs to focus on the transformation and development of the sporting goods manufacturing industry and the sports construction industry, utilize technological innovation to explore the growth point of the sporting goods manufacturing industry and the sports construction industry, and, at the same time, ensure the efficient, reasonable and rapid development of the sports service industry.

The direction of upgrading the industrial structure of the sports service industry

As we all know, the development of the sports service industry plays an irreplaceable role in the structural upgrading and high-quality development of the sports industry. Therefore, this paper utilizes the 2006–2023 sports industry statistics to calculate the industry structure overrun coefficients of seven sectors of China's sports industry service industry from 2006 to 2023 and utilizes the 2015–2023 statistics to estimate the overrun coefficients of the two subsectors, namely, sports competition and performance activities, and sports media and information services. The results of the calculations are shown in Tables 4 and 5, respectively.

The data in Tables 4 and 5 reflect that the overrun coefficient of sports management activities and stadium services is less than 1 in 2006–2014, which is a lagging development. At the same time, sports education and training, sports brokerage and agency, advertising and exhibition, and performance and design services were overdeveloped. Overall, the internal structure of China's sports service industry from 2006 to 2014 was unreasonable, and the core principal industry of the sports industry was in a state of lagging development. From 2015 to 2023, the sports media and information service industry has overdeveloped since its separation from other sports services in 2015, with an overdevelopment coefficient of 29.84, and the sports competition and performance activities industry has overdeveloped, with an overdevelopment coefficient of 8.48. Sporting goods and related products sales, trade agency, and rental are lagging, with an overrun coefficient of −0.90. Sports brokerage and agency, advertising and exhibition, performance and design services, sports education and training, sports fitness and leisure activities, and other sports services are overrunning, with overrun coefficients of 33.40, 26.21, 22.19, and 17.36, respectively. This indicates that the National Statistical Classification of the Sports Industry (2015), the structure of the sports industry has been optimized to a certain extent since then, and the higher value-added sports management activities, sports fitness, and leisure activities have turned from lagging development to overdevelopment from 2006–2014.

Table 4

Coefficient of overshooting of industrial structure within China's sports service industry

Sports Service Industry 1	T_1 = 2006–2014year		T_2 = 2015–2023year		T = 2006–2023year	
	Specific gravity change value	Overrun factor	Specific gravity change value	Overrun factor	Specific gravity change value	Overrun factor
Sports Management Activities	−0.82	−0.09	3.50	9.44	−1.01	0.24
Sports Fitness and Leisure Activities	1.12	3.38	6.80	22.19	−4.42	6.31
Management of Sports Facilities and Facilities	−0.14	0.25	0.30	1.27	6.74	21.88
Sports Agency and Representation, Advertising and Exhibition, Performance and Design Services	0.51	26.37	1.30	33.40	1.39	39.99
Sports Education and Training	3.09	67.53	11.80	26.21	14.83	181.50
Other Sports Services	1.31	7.09	7.00	17.36	8.02	22.09
Sales of Sports Goods and Related Products, Rental and Trade Agency	3.63	5.74	-7.20	-0.90	13.42	10.92

Table 5

Structural Overrun Coefficient of Sports Competition and Performance Activities, Sports Media and Information Services Industries

Industry	Specific gravity change value	Overrun factor
Sports Competition and Performance Activities	1	8.48
Sports Media and Information Services	2.70	29.84

Enlarging the period of observing the structure of China's sports industry from 2006 to 2023, the development trend of various subsectors of China's sports service industry shows different development trends. Although the sports service industry, in general, is ahead of its time, its internal structure is inadequate. Sports management activities, fitness and recreational activities, and sports competitions and performances, which are of good benefits and high added values, should have been ahead of their time. Still, they have shown obvious lagging development compared with other sports service industries, which is unreasonable. However, compared with other sports service industries, they are lagging. The coefficients of sports management activities and sports fitness and leisure activities are 0.24 and 6.31, respectively, lagging behind the development of other industries. In sharp contrast, the sports education and training industry, with a forward coefficient of 181.50, is developing ahead of schedule by a considerable margin, which indicates that the sports education and training industry is growing faster in optimizing and upgrading the structure of China's sports industry. In addition, the coefficients of sports brokerage and agency, advertising and exhibition, performance and design services, stadium services, other sports services, and the sales, trade agency, and rental of sporting goods and related products are 39.99, 21.88, 22.09, and 10.92 respectively, indicating that these industries are also ahead of their time.

Structural upgrading rate of China's sports industry

This paper examines the rate of structural change in China's sports industry. It determines the rate of transformation of the sports industry through the value of Moore's structural change, the average change of industrial structure, i.e., the value, and the value. Using the statistical data of China's sports industry from 2006 to 2023, combined with the two mathematical formulas of (2)(3), the Moore structural change value, the vector pinch angle, the average annual change value of the vector pinch angle, and the average annual change value of the industrial structure for the upgrading of the three major industries of China's sports industry, the subsectors, and the emerging industries in 2006–2014, 2015–2023, and 2006–2023, respectively, are computed values, to more accurately reflect the rate of structural upgrading of China's sports industry. The calculation results are shown in Table 6.

From 2006 to 2023, the overall development trend of China's sports industry's three major industries, subsectors, and emerging industries is accelerating. (1) The three major industries. In 2006–2023, the average annual change value of the industrial structure of China's three major industries is 0.32%, the vector pinch angle is 51.39°, and the average yearly change value of the vector pinch angle reaches 3.02°. The structure of the sports industry as a whole is at a high level. Among them, the change in the structure of the sports industry in 2015–2023 is significantly faster than that in 2006–2014, and the average annual change value of the vector clamp angle and the average annual change value of the industry structure reached 2.52 and 2.67 times of the average change value in 2006–2014. (2)

Table 6

Speed of Industrial Transformation and Upgrading of China's Sports Industry by Category, 2006–2018

Classification		T_1 = 2006–2014year	T_2 = 2015–2023year	T = 2006–2023year
Three main industries	Moore Numeric	0.16	0.83	0.90
	Vector angle in degrees	8.91	47.56	51.39
	Average annual change in vector angle (degrees)	1.11	2.80	3.02
	Average annual change value of industrial structure (%)	0.06	0.16	0.32
Niche industry	Moore Numeric	0.96	0.84	0.79
	Vector angle in degrees	16.79	32.53	37.73
	Average annual change in vector angle (degrees)	2.10	1.91	2.22
	Average annual change value of industrial structure (%)	0.02	0.05	0.07
Emerging industry	Moore Numeric	1.00	0.84	0.91
	Vector angle in degrees	4.48	32.53	24.01
	Average annual change in vector angle (degrees)	0.56	1.91	1.41
	Average annual change value of industrial structure (%)	0.01	0.02	0.03

Segmented industries. In 2006–2023, the average annual change value of the industry structure of segmented industries in China is 0.07%, the vector pinch angle is 37.73°, and the average yearly change value of the vector pinch angle reaches 2.22°. The change in the structure of the sports industry is slower than that of the three major industries. Similarly, the structural change of the sports industry in 2015–2023 is less pronounced compared

with 2006–2014. (3) Emerging industries. From 2006 to 2023, the average annual change value of the industrial structure of China's emerging industries is 0.03%, the average yearly change value of the vector pinch angle is 24.01°, and the average annual change value of the vector pinch angle is 1.41°, and the structural change of the sports industry is significantly slower than that of the three major industries and subsectors. However, similarly, the structure of the sports industry changes slightly faster than in 2006–2014 and 2015–2023. It can be seen that the industrial structure change of emerging industries is more significant, which indicates that the space for upgrading the industrial structure of emerging industries is expanding. In general, 2014 was a watershed in the structural change of China's sports industry, and the change in industrial structure accelerated after 2014, which also gradually tends to be reasonable. This is closely related to the State Council's issuance of Several Opinions on Accelerating the Development of the Sports Industry and Promoting Sports Consumption in 2014, which is also known as the "first year" of the development of the sports industry by relevant experts. This year, the development of China's sports industry also entered the fast lane. After this year, the national statistical classification of the sports industry was updated and adjusted in 2015. Some fast-developing emerging industries, such as the sports competition and performance industry, sports media, and information services, were included, which is one of the reasons for the significant structural change of the sports industry from 2015 to 2023. It can be seen that the structure of China's sports industry has ample space for change, and the rate of upgrading is in an upward trend. Although the structure of China's sports industry is not reasonable, it is still in the process of accelerated optimization and adjustment.

Discussion

The external structure of China's sports industry is not reasonable enough, which is mainly reflected in the proportion of the sports industry in the national economy and the low contribution rate of the sports industry to economic growth. From the data, the proportion of the added value of the sports industry to GDP and the proportion of the sports service industry to the tertiary industry from 2006 to 2023 has shown remarkable and rapid growth. However, horizontally, there is still a big gap between it and the external structure of the tourism industry, culture industry, and sports industry in developed countries, and the rapid development of tourism and culture has boosted consumption growth and promoted the upgrading of consumption. The economic benefits of the sports industry have not been given full play to send out; that is to say, the current scale of China's sports industry is still relatively low; the main reasons are: first, the core of the sports body industry development is backward. Currently, the added value of the competition and performance industry and the fitness and leisure industry only accounts for 11.20% of the added value of the sports industry, which is below its core status. Secondly, the adequate supply is insufficient. The sports industry is underdeveloped, and the supply of exceptional venues and guidance services for popular sports such as soccer, basketball, and tennis is inadequate to meet the diversified sports needs of various sports fans. Third, the effective demand is not strong

(Li et al., 2019). It is manifested in the insufficient demand for ornamental and participatory sports consumption, while the demand for physical sports consumption accounts for a high proportion of the demand (Ren & Huang, 2020); secondly, the consumption consciousness is weak, and sports and healthy lifestyles have not yet become an integral part of lifestyle consumption, and the residents' sports consumption consciousness is not strong.

The overall trend of structural upgrading in China's sports industry is in line with the law of industrial structural upgrading, and the speed of change has accelerated. Still, the level of internal structural upgrading is not high. First of all, the proportion of the sporting goods manufacturing industry in the structure of China's sports industry has been persistently high for a long time, and the proportion of the sports service industry is relatively low. The proportion of the sports service industry exceeded the sporting goods manufacturing industry for the first time in 2015, reaching 55.51%, but it was only 33.59% in 2013; the proportion of the sports service industry has improved to a certain extent, but the long-term structural problems have not been substantially improved (Chen, 2019). Secondly, the sports service industry is generally overdeveloped, but the internal structure of the sports service industry is weak; it is still in a relatively low-end state, and the level of development of the sports service industry is not sufficient. Specifically, it is manifested in the following: sports management activities with good benefits and high added value, sports fitness and leisure activities, and sports competitions and performances show obvious lagging development, and the supply of medium and high-end sports services is insufficient. Finally, the sporting goods manufacturing industry is under more significant pressure for transformation and upgrading. After years of development, China's sporting goods manufacturing industry has developed more maturely. Still, due to the long-term reliance on production factor drive, there are problems with more low-end and medium-end products, low product quality, a high degree of homogenization, and fewer brand-oriented enterprises. In general, the speed of internal structural upgrading of China's sports industry is accelerating, and the direction is constantly being adjusted, but the level of upgrading is not high.

Conclusion

The kernel of the high-quality development of the sports industry is the optimization and upgrading of the structure of the sports industry. Through the model measurement, the following conclusions are drawn: the external structure of China's sports industry is continuously optimized, and its role in China's economic development is constantly emerging, but the contribution rate to economic growth is still relatively low; the overdevelopment of the sports service industry, the lagging development of the sports construction industry and the sporting goods manufacturing industry are basically in line with the law of upgrading of the industrial structure; from the internal point of view of the sports service industry, sports education and training, sports media and information services, sports brokerage and agency, advertising and exhibition, performance and design services, stadium services, other sports services, sporting goods and related products. From within the sports service industry, sports education and training, sports media and information services, sports brokerage

and agency, advertising and exhibition, performance and design services, stadium services, other sports services, sales, trade agency, and rental of sports goods and related products are developing ahead of time. Still, sports management activities, sports fitness and leisure activities, and sports competition and performance activities are lagging, which is one of the critical obstacles restricting the transformation and upgrading of the sports industry. Regarding the upgrading rate, China's sports industry has ample space for structural change, and the upgrading rate is on an upward trend, especially in emerging industries.

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LASE Journal of Sport Science • 2025/2 • Pages **63**–78
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ORIGINAL RESEARCH PAPERS

Assessing the Impact of Structured Yoga Interventions on Health-Related Quality of Life in COVID-19 Adult Survivors

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Abstract

Framework: The World Health Organisation defines quality of life (QOL) as "an individual's perception of their position in life, considering the cultural and value systems they are part of, in conjunction with their goals, expectations, standards, and concerns." Standard indicators for quality-of-life include factors such as wealth, employment, environmental conditions, physical and mental health, education, and leisure, with numerous elements that affect quality of life. However, health-related quality of life (HQOL) is closely related to various dimensions of quality of life. Health is considered the fundamental step toward fulfilling life, as good health facilitates achieving other life goals. During the COVID-19 pandemic, there were movement restrictions, people were in quarantine and Yoga (YOG) has gained worldwide recognition as a key health intervention, with substantial evidence supporting its effectiveness in improving quality of life.

Method of research work: Eighty participants of both the genders (34 male & 46 female proportion 0.425 & 0.575) with median and interquartile range of male and female were 26(Q1; Q3, 24 to 28) and 25(Q1; Q3, 23 to 27) subsequently were chosen for this study using a simple random sampling method. Data collection was carried out using the World Health Organisation Quality of Life (WHOQOL-BREF) questionnaire, administered toparticipants both before and after undergoing specific interventions. Participants participated in designated yogic practices for duration of two months. The results of the pre- and post-intervention assessments were compiled, recorded and organised into tables to evaluate the impact of the yoga interventions. The study exclusion threshold was set at 10%.

Outcomes: Following a 60-day yoga intervention involving selected yoga practices, final test data was collected and analysed at a significance level (α) across all WHOQOL dimensions

on day 60. The average score for the physical domain of quality of life was recorded as 99.6 before the intervention and 101.8 afterward (P=<.001). Within the psychological domain, the mean scores were 75.5 initially and 77.7 after the intervention (P=<.001). The social relations domain showed mean scores of 42.20 before and 43.33 after the intervention (P=<.001). The environmental domain was measured with mean scores of 90.5 and 91.8, respectively (P=<.001). Overall, the mean quality of life was calculated at 308 before and 315 after the intervention (P=<.001).

Interpretation: In fact, an increase in the average value indicates an improved quality of life. Statistical evidence shows a significant difference in overall quality due to specific yogic practices. Consequently, such practices can be recommended as an integrative, alternative, or complementary medicine to improve quality of life after CoViD-19 treatment.

Keywords: COVID-19 survivors, Quality of Life, Yoga, Yoga micro exercise, Yoga cleansing technique

Introduction

To begin with, the word YOGA that has promiscuous definitions in numerous Indian manuscripts, the Indian heritage is serving the humanities since beginning with this magnificent system of health and healthy lifestyle, since health is not only required for happiness but also the foundation pillar of productivity and wealth, however, for emancipation health is primus. Quality of life is the measure of overall health, it finds the Physical, psychological, social and environmental domain. Lower the score of any domain considered as vanquishing the health in related segment. Each thought of yoga has its significance to uplift each domain and overall quality of life. Most renowned Hatha Yoga is generally considered for Physical domain enhancement; however, physical aspect of Hatha Yoga is a basic consequence but it's deeper and leads to conquering heaven. Though, good health leads to achieving the goal of life that is transcendental state. It is well known that physical health is associated with mental health that is known psychosomatic condition. Hathayogapradipika, upadesh 1 (Chapter 1) verse-17 very first limbs of Hathayoga are physical postures (Asana) are beneficial for physical and mental health, best known for health retention and prevention from diseases. This only part is favorable for physical and psychological domain of QOL. Moreover, Hathayogic practices are supportive for another domain of QOL. Yet, Yoga sutra of Patanjali or Patanjal yoga darshana (Yoga Philosophy of Patanjali) Samadhipada (Chapter-1) verse-33 recommend the deeds are required to improve and sustain mental health, in addition, Sidhasidhanta Paddti one of the Hatha Yoga manuscript upadesh 1 (Chapter-1) verse-8 sub verses 1–5 conveyed the message to enduring mental health and take one step ahead the psychological domain of QOL for instance, Niranjanata means group of traits or personality traits that destroy the peace and mental which are anger, greed, attachment and hate etc. which are associated with Kundilini serpent energy that help to join with the divine and transform the life, Balancing the aforementioned leads toward better psychological health. For the Psychological domain of QOL Patanjal yoga darshana (Yoga Philosophy of Patanjali) Sadhanapada (Chapter 2) verse-3 there are five types of

traits known as Pancha Klesha (Eliminator of Psychological health) to describe, Avidhaya Unknowingness or ignorance is one the root cause for depression and stress etc. and these weaken the psychological condition. Hathayogapradipika, upadesh 1 (Chapter 1) verse-12 beautifully taught for the social and environmental health of an individual the place to live in and availability of enmities for health social and environmental life. Several Yogic texts may be considered to improve the quality of life. Deeksha P. Shetty et al. (2025) found yoga to enhance Quality of life and suggest as a non-pharmacological approach. Zhengjia Li et al. (2025), concluded effectiveness for improving breast cancer-related fatigue and quality of life in a systematic review and network meta-analysis. M. Salih Tan et al. (2024), randomized control trial on patients with bronchiectasis significantly improved with yoga interventions. Savithri Nilkantham et al. (2025), increase in QOL in patients with hypothyroidism using a scientific yoga module in RCT. There are promiscuous sherds of evidence support yoga as integrative medicine to improve Quality of life as curative approach as well as to sustain health and overcome the ageing related consequences.

Aim of the Research

To evaluate the impact of structured yoga module grounded in Hathayogic texts and yogic micro exercises on the four domains of quality of life (physical, psychological, social, and environmental) to elucidate the psychosomatic mechanisms by which these practices promote holistic health.

Methodology

Independent variables

The study has selected certain SYPs as independent variables, specifically “Jal Neti”, “Kapalbhati”, as elaborated in traditional “Hathayogic” texts, and Dhirendra Brahamchari’s specific Yogic Suksam Vyayam, who was the founder of “Vishwayatan Yoga Ashram”, now referred to as “Morarji Desai National Yoga Institute” in Delhi, India.

Dependent variables

In this research study, quality of life, as defined by the World Health Organisation, was used as a dependent variable. The evaluation of health-related quality of life, encompassing the physical, mental, social, and environmental domains, was conducted using a questionnaire administered to subjects.

Duration of Intervention

Certain yogic exercises were administered to participants for 60 minutes daily for a span of 60 days, excluding weekends and additional days were administered for excluded weekends.

Null hypothesis

Ho1 There will be no significant change in the physical domain of quality of life of adult CoVid-19 survivors.

Ho2 There will be no significant change in the psychological domain of quality of life of adult CoVid-19 survivors.

Ho3 There will be no significant change in the domain of social relationships of quality of life of adult CoVid-19 survivors.

Ho4 There will be no significant change in the environmental domain of quality of life of adult CoVid-19 survivors.

Ho5 There will be no significant change in the quality of life of adult CoVid-19 survivors.

Research Design

In the study, a pre-test-post-test research design was used, which was non-invasive. Baseline data were collected on day 0 of the pre-test, and the SYP intervention began on day one, incorporating "selective cleansing" techniques and "micro-Yogic exercise" ("shuksma vyayam" by Dhirendra Brahmachari Ji). These practices were carried out for more than two months, with sessions lasting 60 minutes each day. On day 60, the post-test data were collected and tabulated. A "paired sample t-test" was used to analyse the data as shapiro-wilk test applied to check the normality of data at both pre and post stages, providing results to determine the effectiveness of the SYP approach.

Procedures

Eighty adults between the ages of 18 and 30 were chosen using the purpose-sampling technique. Informed consent was obtained through Google Forms, and a separate form was used to collect data on common symptoms of previous corona infections, based on the official website of the World Health Organization. On the first day of the intervention, pre-test data on the quality of life of the participants were collected, recorded, and organized for further analysis. Though, this research work is a non-invasive approach and does not take any personal information on the subjects so there was no need for ethical approval. However, information was submitted to institute regarding the research work.

The intervention is planned to last two months plus an additional sixteen days, excluding Saturdays and Sundays and attendance recorded each day before the intervention applied. This timeline will be adhered to during the manipulation of the independent variable, following the intervention schedule outlined for the subjects.

Following the intervention, the post-test sample data were collected, stored and organized into tables. A total of N = 80 participants were included in the analysis. Additionally, the independent variable was manipulated between 1 September and 8 December 2023, within the pre-winter and winter periods, also referred to as Basant and Sharad Ritu in Ayurveda's ritucharaya (seasonal cycle). During the study, the average temperature in northern India ranged from 18 to 19° C. Practices were carried out Monday through Friday, between 9 am and 10 am.

Admissible and elimination criteria

1. The study included adults aged 18 to 30 years from various demographic areas: urban, semi-urban, and rural areas.
2. Smokers and alcoholics were excluded.
3. Participants with diagnosed cardiac disease, hypertension, or those on chronic disease medications were also omitted.
4. Included were individuals who had fever, dry cough, loss of taste or smell, nasal congestion, sore throat, and muscle or joint pain.
5. Participants with symptoms consistent with CoViD-19, as defined by the World Health Organisation, were part of the study.

Table 1

Intervention schedule

Sr. No.	Name of the Independent Variable	Time	Rest time	Total Round	Total Time
1.	Jal Neti	5 min	1 min	1	6 min
2.	Kapalabhati	5 min	1 min	1	6 min
3.	Uccharan shal tatha vishuddhi chakra shudhi kriya	1 min	1 min	3	6 min
4.	Buddhi tatha Dhriti Shakti Vikashak kriya	1 min	1 min	3	6 min
5.	Medha Shakti Vikashak Kriya	1 min	1 min	3	6 min
6.	Griva shakti vikashak kriya –1	1 min	1 min	3	6 min
7.	Skanda tatha bahumool Shakti vikashak kriya	1 min	1 min	3	6 min
8.	Bhujaballi Shakti Vikashak Kriya	1 min	1 min	3	6 min
9.	Vaksha sthal shakti vikashak kriya part 1	1 min	1 min	3	6 min
10.	Vaksha sthal shakti vikashak kriya part 2	1 min	1 min	3	6 min
				Total time	60 min

Table 2

Results

Sr. No.	N	M	SD	r	df	t- value	Significance level (α)
QOL Physical domain	80	Pre-99.6 Post-101.8	15.2 14.5	.998	79	17.1	0.001
QOL Psychological domain	80	Pre-75.5 Post-77.7	16.4 15.8	.995	79	17.5	0.001
QOL Social relation domain	80	Pre-42.2 Post-43.3	8.3 7.9	.993	79	15.6	0.001
QOL Environmental Domain	80	Pre-90.5 Post-91.8	20.1 19.8	.999	79	17.8	0.001
Overall, QOL	80	Pre-308 Post-315	47.8 46.1	.998	79	26.2	0.001

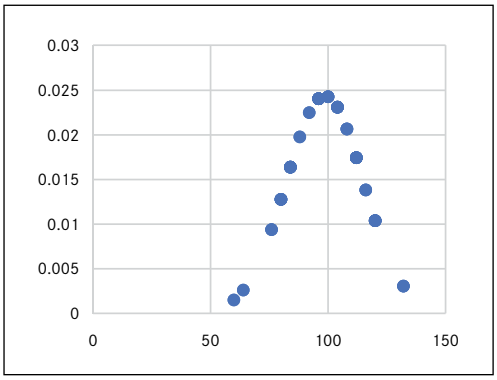

Figure 1 Pre-test Data Distribution of QOL Physical Domain

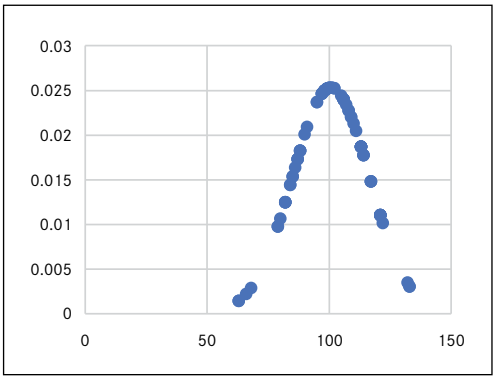

Figure 2 Post-test Data Distribution of QOL Physical Domain

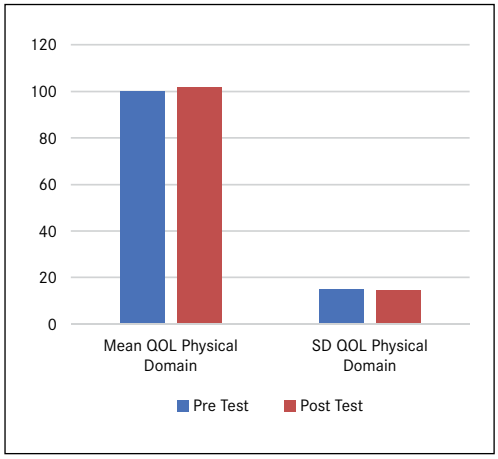

Figure 3 **QOL Physical Domain Mean and SD**

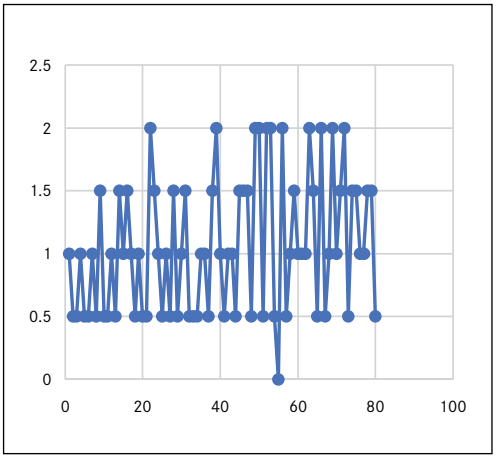

Figure 4 **Standard Error Pre- and Post- Test Data of QOL Physical Domain**

For 60 days, the subjects underwent a specific yoga practice and on the 60th day the data was collected and analysed. Mean (SD) QOL physical domain before yoga intervention 99.6 (15.2) was lower than after the implementation 101.8 (14.5), with statistically significant difference 2.16, 95% TI [1.91–2.41], $t(79) = 17.1$, $p < .001$, $d = 1.91$. The calculated t overcomes the p value which support to reject the null hypothesis.

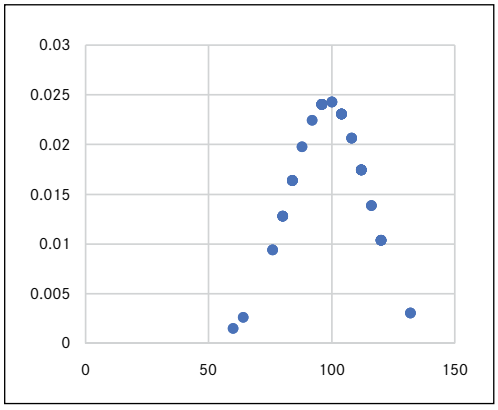

Figure 5 **Pre-test Data Distribution of QOL Psychological Domain**

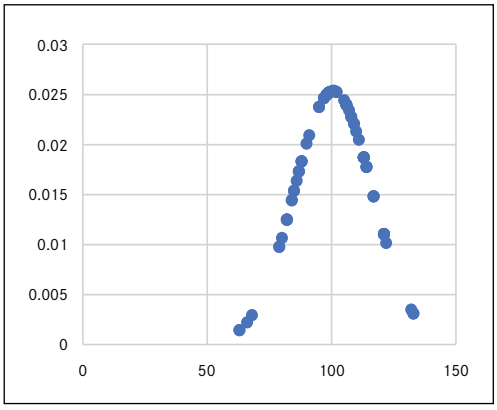

Figure 6 **Post-test Data Distribution of QOL Psychological Domain**

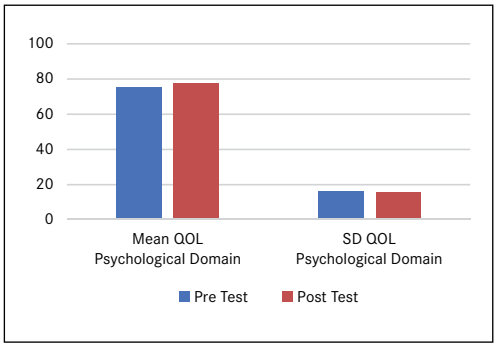

Figure 7 **QOL Psychological Domain Mean and SD**

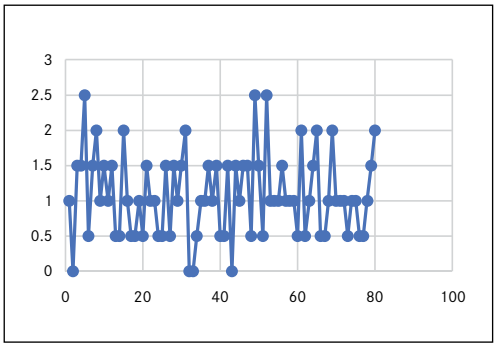

Figure 8 **Standard Error Pre- and Post- Test Data of QOL Psychological Domain**

A specific yogic practice was applied to participants for duration of 60 days, with data collected and analysed on day 60 for a post-test evaluation. Mean (SD) QOL psychological domain before yoga intervention 75.5 (16.4) was lower as compare to after the yogic application 77.7 (15.8), with statistically significant difference 2.17, 95% TI [1.58–2.33], $t(79) = 17.5$, $p < .001$, $d = 1.96$.

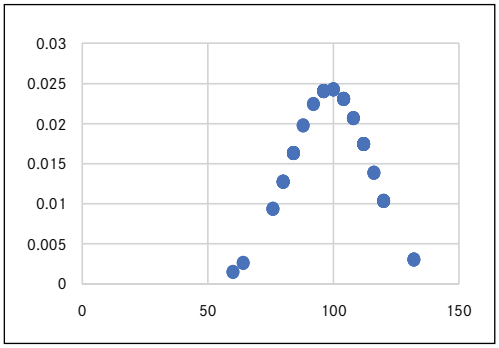

Figure 9 **Pre-Test Data Distribution of QOL Social Relation Domain**

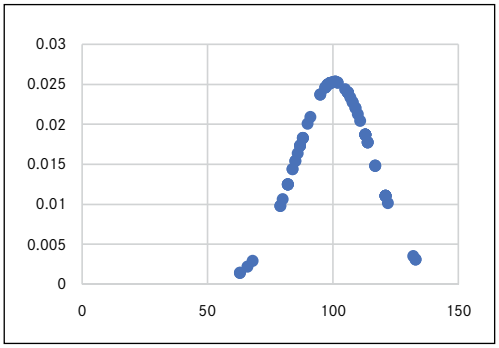

Figure 10 **Post-test Data Distribution of QOL Social Relation Domain**

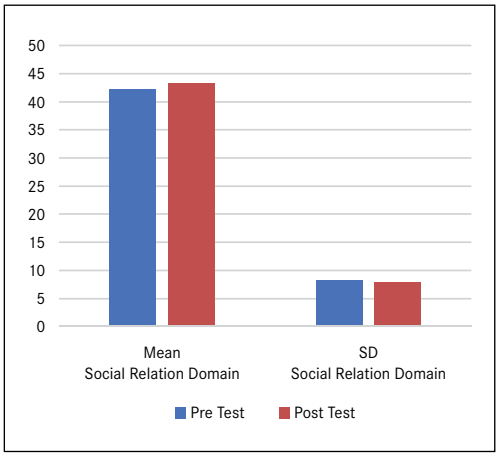

Figure 11 **Mean and SD of QOL Social Relation Domain**

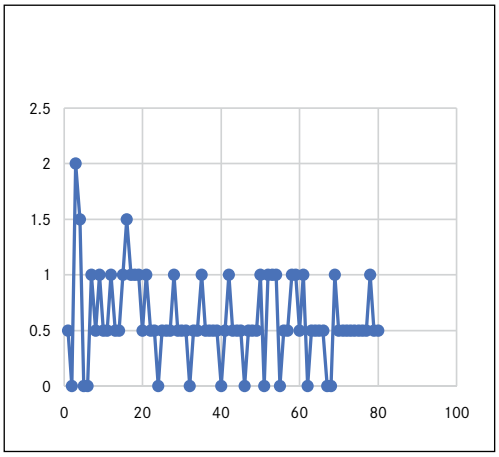

Figure 12 **Standard Error Pre- and Post- Test Data of QOL Social Relation Domain**

For a duration of 60 days, the subjects underwent a specific yogic practice, with evaluations conducted on the 60th day. Initially, Mean (SD) QOL social relation domain before yoga intervention 42.2 (8.30) was lower as compare to after the yogic application 43.3 (7.92), with statistically significant difference 1.13, 95% TI [1.40–2.09], $t(79) = 15.6$, $p < .001$, $d = 1.75$. Based on the result the null hypothesis is rejected.

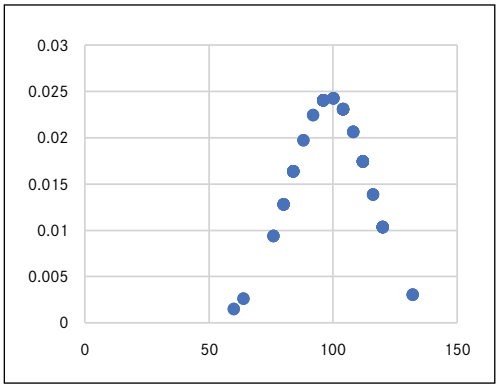

Figure 13 **Pre-test Data Distribution of QOL Environmental Domain**

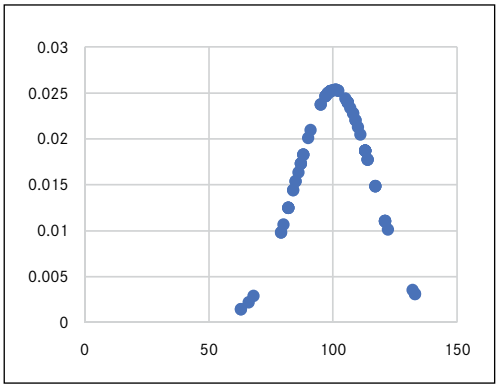

Figure 14 **Post-test Data Distribution of QOL Environmental Domain**

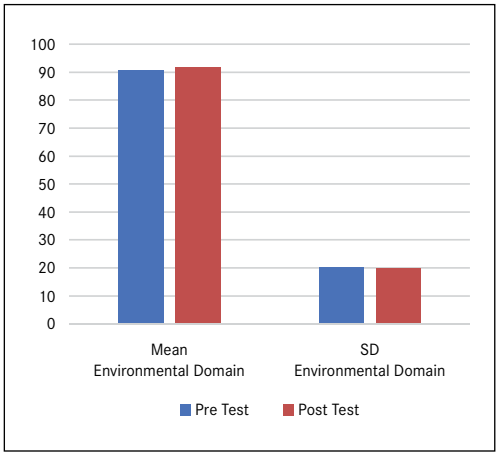

Figure 15 **Mean and SD of QOL Environmental Domain**

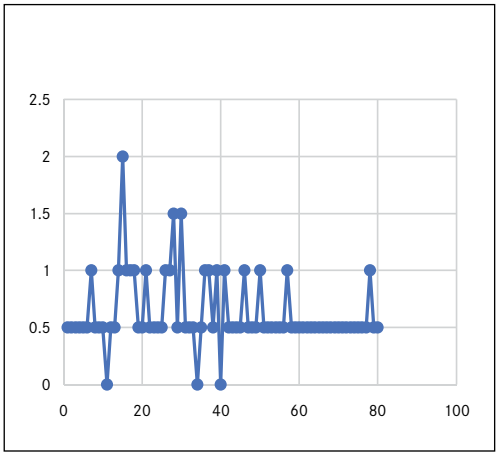

Figure 16 S**tandart Error Pre- and Post- Test Data of QOL Environmental Domain**

For duration of 60 days, the subjects underwent a specific yogic practice and on the last day the collected data were evaluated. Mean (SD) QOL environmental domain prior yoga intervention 90.5 (20.1) was lower as compare to after the yogic application 91.8 (19.8), with statistically significant difference 1.24, 95% TI [1.61–2.37], $t(79) = 17.8$, $p < .001$, $d = 1.99$. The null hypothesis is therefore rejected.

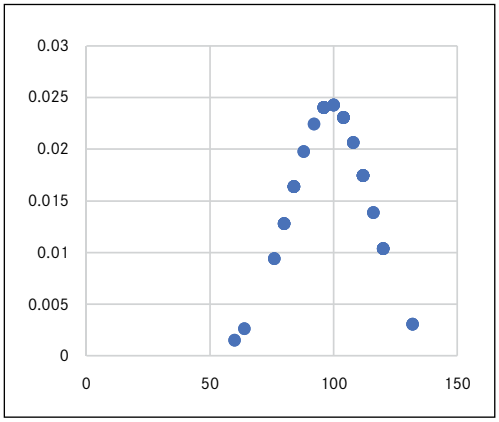

Figure 17 **Pre-test Data Distribution of Quality of Life**

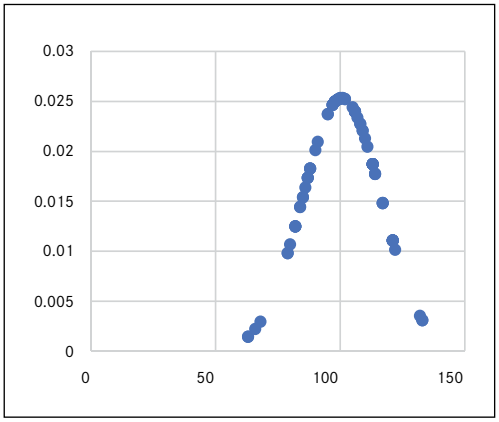

Figure 18 **Post-test Data Distribution of Quality of Life**

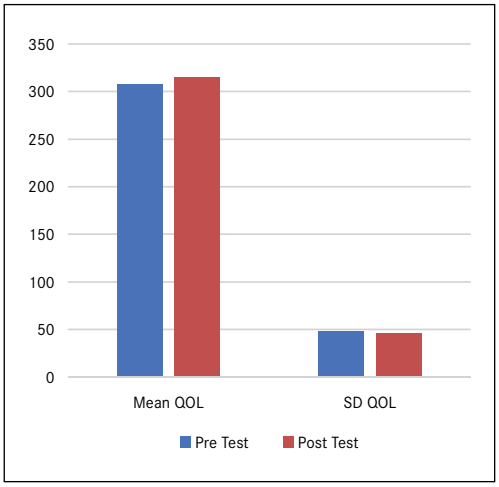

Figure 19 **Mean and SD of Quality of Life**

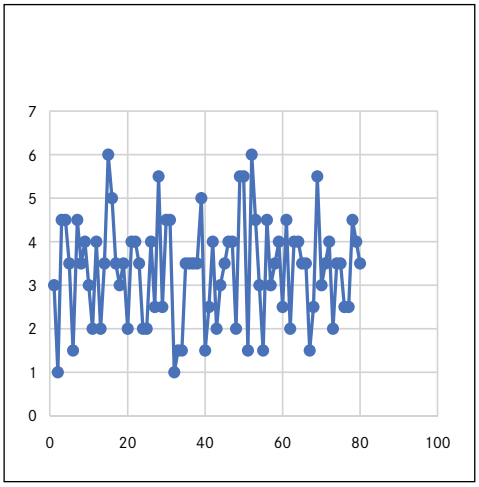

Figure 20 **Standart Error Per- and Post- Test Data of Quality of Life**

Subjects underwent a 60-day yogic intervention involving selected practices, with data collected and statistical analysis performed on day 60. The initial and follow-up Mean (SD) QOL 308 (47.8) and 315(46.1) respectively, with statistically significant difference 6.70, 95% TI [6.19–7.21], $t(79) = 26.2$, $p < .001$, $d = 2.91$.

Data Analysis

To evaluate data before and after the test, paired samples t- test was conducted using Jamovi version 2.6.44, and then the results were analysed.

Discussion and review of the literature

Sridevi Prabhu et al. (2023) from India conducted a systematic review and meta-analysis of randomized controlled trials to evaluate the efficacy of yoga therapy for caregivers of individuals with dementia. Their findings suggested that yoga significantly helps alleviate caregiver stress and improve psychological well-being (95% CI 0.64–0.89, $p < 0.05$). The reduction in stress among these caregivers was significant. Although various yoga traditions have their distinct importance, Patanjali's Yoga Sutras and Hathayoga are the most esteemed texts within the vast array of yogic literature. Patanjali's yoga philosophy is divided into four sections, each offering knowledge relevant to the practitioner's aptitude and interest, with the eight limbs being particularly prominent. Specifically, postures (Asana), breathing exercises (Pranayama), and meditation (Dhyana) are central practices. Postures contribute to stability and address musculoskeletal structures, yet every yogic discipline embraces a holistic approach, indirectly or directly influencing various bodily systems. Breathing exercises involve expanding, regulating, and controlling breath, which methodically enhances the expansion of the chest cavity and other pulmonary functions.

it regulates the autonomic cardiac function. Additionally, breathing practices have potential to manage the hypertension among mild hypertensive subjects, Efficacious meditation manages stress by balancing the hypothalamic-pituitary-adrenal axis and the combination of postures, breathing practices, and meditation that are crucially significant for health and lifestyle-related problems. Mindfulness-Based Stress Reduction (MBSR) is a well-established psychoeducational and skill-oriented treatment that integrates hatha yoga with mindfulness meditation. The Mindfulness component is designed for individuals facing chronic conditions such as depression, anxiety, skin and immune disorders, chronic pain, cancer, diabetes mellitus, and hypertension, as well as those looking to enhance their coping skills and decrease stress. The practice of yoga enhances well-being by reducing stress and enhancing mental health, and it can also serve as a distraction for caregivers of individuals with serious mental illnesses. Yoga provides significant stress relief for caregivers of individuals with schizophrenia, as demonstrated by notable enhancements in their overall quality of life and substantial reductions in total psychological distress mental health component score.vivii M.J. Sangeethalaxmi Alex Hankey (2023) Yoga breathing and relaxation were impacted as an additional therapy on quality of life, anxiety, depression, and lung function in young adults with bronchial asthma , the yoga module included rhythmic abdominal breathing, Vakshasthala Shaktivikasaka kriya, Kapalabhati, Bhastrika, and guided relaxation . Srinivas M et al. (2023) the efficacy of yoga was found to be significant in quality of life in patients with pulmonary tuberculosis in a randomised control trial. Resti Yudhawati and Mariani Rasjid Hs (2019) validate the effect of yoga consisting of postures and breathing practices twice a week for 60 minutes added, Ujjayi, Kaphalabati and Sitkari breathing. In addition, a spiritual focus was introduced to increase the feeling of comfort during meditation. Savasana was chosen as a meditative movement exercise. However, yoga administered twice a week still affected the quality of life of COPD patients. Yoga should be part of life and performed on a regular basis, which may be more effective. J. Amy et al. (2012) demonstrated the effects of ten weeks of yoga training on improving the quality of life of women suffering from asthma. The yoga regimen involved one hour sessions twice a week and included 40 minutes of home practice each day. It integrated breathing techniques, yoga poses, relaxation, and meditation. The study results indicated a notable improvement in the quality of life of the participating women. Gülyeter Erdoan Yüce and Sultan Taşc (2019) reported that pranayama improved asthma management and asthma- related quality of life in individuals with asthma, although no significant change was observed in the pulmonary function test. The exercise of breathing for twenty minutes daily for a month revealed its effectiveness, suggesting that consistent pranayama practice could maintain respiratory health in the long term. The essential elements of Yogic breathing involve controlled and deep breaths and are recommended to promote a healthy lifestyle. Swami Dayananda Saraswati, a sage and founder of Arya Samaj, recommended the daily practice of at least three rounds of nadi shodhana (deep inhalation, holding breath, and managed exhalation) to maintain cardiovascular health. Kandula UR and Wake AD (2021) used the Google Scholar database to assess the quality of life of yoga professionals, acknowledging them as front-line defenders against the CoViD virus. Their findings indicated that quality of life deteriorated

during the pandemic. Yoga and Ayurveda were crucial in addressing stress, anxiety, and other mental health issues arising from the virus outbreak. The meta-analysis conducted by Kuan-Yin Lin et al. (2011) on an online database indicated promising advantages of yoga for cancer patients in enhancing psychological well-being. Ancient yogic texts document the effects on both physiological and psychological health, leading to liberation. In contemporary settings, yoga is believed to foster harmony, increase happiness, and increase productivity in both personal and professional aspects. Tantsura Y et al. (2020) described in their brief communication the impact of the COVID-19 pandemic on the quality of life of families in Ukraine with children with epilepsy. They found that financial instability was a common issue among these families during the pandemic. Additionally, they noted that yoga serves as a cost-effective approach to enhance psychological well-being. The study by Désirée Lötzke et al. (2016) in Germany evaluated the impact of Iyengar-Yoga on women with stage I-III breast cancer as part of adjuvant treatments (Neo), focussing on aspects such as quality of life related to health, mindfulness, spirituality, life satisfaction, and fatigue associated with cancer. The findings indicated that the Yoga Intervention (YI) improves quality of life. YI combines yoga poses with breathing exercises, and Iyengar Yoga is known to use props such as belts, blocks, and ropes to aid practitioners in maintaining the correct alignment of postures.

Conclusions

Quality of life is largely determined by variety of factors, including social, political, economic, and environmentalaspects that are often interrelated; however, these can be managed effectively by individuals in good health. Yoga has shown a therapeutic impact on improving quality of life among adult COVID-19 survivors. SYP is broadly effective in elevating the quality of life for survivors, as yoga benefits health in a comprehensive way, serving as a countermeasure against the viral impact that disrupts quality of life. This yoga module may be recommended as a complementary and alternative medicine to enhance quality of life. Although, More RCT to be conducted to for deep validation of the said selective intervention.

Consent and ethical clearance

Consents were obtained from participants via Google forms; additionally, as this is a non-invasive study, ethical clearance is not required.

Limitation

Diet, lifestyle, and social, cultural, financial, and political contexts all impact the quality of life of the individuals, which could serve as a limitation of this study. Additionally, random variations can affect the findings, since the research was conducted in humans who are subject to genetic and environmental influences. The eating habits and lifestyles of the participants were not regulated, which could have positively impacted the results. In particular, this research was confined to a single city in the central northern part

of central India, although the participants came from a variety of demographic backgrounds. It is important to note that the study population consisted solely of adults and that the sample size was limited to 80 individuals.

Suggestions

Human subjects may vary in age, demographic locations, and socioeconomic conditions, influencing the effectiveness of a specific yogic package in various settings. In addition, factors such as diet or weather might affect the results of the SYP.

Submission statement. *The researcher states that the content detailed within this work has not been previously published (with the exception of abstract form or inclusion in a published lecture or academic thesis). Furthermore, it is not submitted for publication elsewhere, and should it be accepted, it will not be published in any other format, including eletronically, in any language such as Hindi, without the copyright holder's written permission.*

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Conflict of interest. *There are no conflicts of interest.*

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