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The Role of Concentration and Flexibility in Enhancing Topspin Stroke Accuracy among Table Tennis Players

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Abstract

Topspin stroke accuracy is a critical determinant of performance in table tennis, as it enables players to control ball placement and gain tactical advantages during competition. Although previous studies have identified the importance of cognitive and physical factors in sport performance, limited research has simultaneously examined the contributions of concentration and flexibility to topspin stroke accuracy. Therefore, this study aimed to investigate the relationships between concentration, flexibility, and topspin stroke accuracy among table tennis players. A cross-sectional correlational design was employed involving 62 table tennis players aged 20–23 years. Concentration was assessed using the Concentration Grid Test, flexibility using the Sit-and-Reach Test, and topspin accuracy using a standardized topspin accuracy test. Data were analyzed using Pearson correlation. The results revealed significant positive correlations between topspin accuracy and concentration ($r=0.774$, $p<0.001$) as well as flexibility ($r=0.604$, $p<0.001$). In conclusion, concentration and flexibility were significantly associated with topspin stroke accuracy, with concentration showing the strongest relationship. These findings suggest that both psychological and physical factors should be considered in training programs aimed at improving topspin performance in table tennis players.

Keywords: accuracy; concentration; flexibility; table tennis; topspin stroke; motor skills; psychophysical factors

1. Introduction

Table tennis has long been considered one of the fastest and technically demanding racket sports. In this sport, athletes need to combine exceptional speed, accuracy and tactical awareness for competition. In contrast to many other sports, the nature of table tennis revolves around the quick exchange. Table tennis rallies often unfold within fractions of a second, requiring players to respond to high-speed balls with varying and unpredictable spin characteristic (Noor et al., 2025). These properties create an environment where players not only respond quickly to the direction of the ball, but also predict, jump and rotate speed before crossing the network. Consequently, the ability to anticipate ball trajectory and opponent actions becomes essential, as even minimal delays in response may result in missed opportunities and unforced errors. As a result, athletes need to refine a complex set of skills that integrate physical speed, technical accuracy and cognitive sharpness, allowing them to achieve accurate and effective returns under the most challenging conditions (Na, 2025). Among the various technical skills in table tennis, stroke accuracy represents a critical determinant of successful

performance because it directly influences ball placement, tactical control, and point-winning opportunities. In contemporary competitive play, the topspin stroke has become one of the most frequently utilized offensive techniques due to its ability to generate both speed and spin while maintaining control over ball trajectory.

Basic techniques such as shots, services, and returns are often considered the basis for table success, as the correct execution of these elements directly determines the possible outcomes of the game flow and match. Each rally unfolds with the possibility of changing dynamics. In other words, mastering the most basic skills can create a critical competitive advantage. However, technical implementation alone cannot guarantee success (Chen et al., 2025). Game speed requires players to expand their focus beyond the mechanics and involve strategic thinking at a higher level. This includes reading your opponent's position, expectation of tactical intent, and planning appropriate pre-counter structures. In this context, concentration becomes a non-negotiable attribute that acts as a mental anchor that allows players to maintain the ball's trajectory and its wider game plane (Haryanto et al., 2025). The ability to maintain sharp focus allowed athletes to photograph accessible areas of the table, forcing the enemy in defensive positions, increasing the odds of scores (Behaein et al., 2025).

Topspin strokes are widely utilized by professional table tennis players in modern competition because they generate high ball speed and spin, making it more difficult for opponents to anticipate and control the ball effectively (Barchukova et al., 2025). The successful execution of a topspin stroke is influenced not only by concentration and timing but also by an athlete's flexibility. Flexibility enables a greater range of motion in the trunk, shoulder, and wrist joints, allowing players to perform topspin movements with better biomechanical alignment and movement control. A greater range of motion facilitates smoother body rotation and more efficient transfer of force throughout the kinetic chain, which contributes to a more stable and coordinated stroke execution (Lin et al., 2025). In addition, enhanced flexibility may improve an athlete's ability to consistently position the racket at the optimal angle and contact point during ball impact. As a result, athletes with better flexibility are more likely to achieve precise ball placement and maintain the accuracy of their topspin strokes during competitive play (Zhan & Cui, 2023).

Table tennis accuracy issues are especially important. This is because even the strongest or fastest strokes may not achieve competitive advantage without the ability to place the ball accurately. Athletes who were instructed to concentrate on both destination and ball showed a significant improvement in stroke accuracy than those concentrated solely on grip. This finding highlights the central role of attentional focus in refinement of stroke accuracy, suggesting that psychological strategies can complement physical training in wise ways (Łuba-Arnista et al., 2025). Similarly, empirical evidence from training studies strengthened the relationship between physical state and accuracy. For example, experiments using elastic bands in training showed significant improvements in topspin accuracy in athletes containing exercise based on routine resistance (Nikolakakis et al., 2020). This improvement is attributed to improved muscle coordination and physical control, demonstrating how targeted training methods directly affect technical outcomes.

Previous studies have shown that both cognitive factors, such as concentration, and physical factors, such as flexibility, contribute to sports performance. However, existing research has largely examined these factors separately, and limited evidence is available regarding their combined relationship with topspin stroke accuracy in table tennis. Therefore, this study aims to investigate the relationship between concentration, flexibility, and topspin stroke accuracy among table tennis players. By integrating psychological and physical factors within a single framework, this study seeks to provide a more comprehensive understanding of the determinants of topspin accuracy. The findings are expected to contribute to both theory and practice by offering insights that may assist coaches in designing more effective training programs to improve topspin performance.

2. Method

It is a cross sectional study involving 62 participants that were recruited using purposive sampling from university table tennis courses. Inclusion criteria were: (a) aged 20–23 years, (b) actively participating in table tennis training for at least six months, and (c) possessing basic proficiency in topspin stroke execution. Participants with recent musculoskeletal injuries or medical conditions affecting physical performance were excluded from the study. Their ability to perform topspin techniques can be categorized in the medium category and still cannot do like professional athletes. All participants were informed in advance about the data collection plan to be carried out, the purpose of the research, and its theoretical and practical benefits, they had also expressed their willingness to become participants in this study. The researcher provides an overview of the steps of data collection that will be carried out and provides examples and opportunities for each participant to reach first before the actual data collection is carried out. They were also asked to warm up before the test was carried out.

Topspin stroke accuracy was assessed using a standardized instrument that has demonstrated acceptable validity and reliability in previous research (Haryanto et al., 2023). Participants performed ten topspin strokes directed toward a predefined target area located on the opposite side of the table. A trained feeder delivered standardized balls from the center position at 3-second intervals to ensure consistency across participants. Each successful stroke was evaluated according to the scoring criteria established by Haryanto et al. (2023), with scores ranging from 0 to 3 points based on the accuracy of ball placement. A score of 0 was assigned when the ball failed to land on the table surface. The total score obtained from the ten trials was used as the indicator of topspin accuracy.

Concentration was assessed using the Concentration Grid Test developed by Harris and Harris (1984), which is designed to evaluate an individual's ability to sustain attention and process visual information efficiently under time constraints. The test consisted of a 10 × 10 grid containing randomly arranged two-digit numbers from 00 to 99. Participants were instructed to identify and mark the numbers sequentially in ascending order within a specified time limit. The total number of correctly identified numbers was recorded as the concentration score, with higher scores indicating better concentration ability.

Flexibility was assessed using the Sit-and-Reach Test, a widely used measure of hamstring and lower-back flexibility in physical fitness research (Ashok, 2008). Although topspin performance primarily involves trunk and upper-body movement, the sit-and-reach test was selected as a general indicator of flexibility because it reflects the functional range of motion required for coordinated body movement during stroke execution. During the assessment, participants sat barefoot on the floor with their legs fully extended and their feet placed flat against a standardized sit-and-reach box. Testers ensured that both knees remained fully extended throughout the procedure. Participants slowly reached forward with both hands overlapping and palms facing downward, extending as far as possible along the measurement scale. Following three familiarization attempts, one recorded trial was performed and held for at least 2 seconds. Scores were recorded according to standard procedures, where a score of zero indicated that the fingertips reached the toes, negative values indicated that the fingertips did not reach the toes, and positive values indicated that the fingertips extended beyond the toes.

Descriptive statistics have been calculated and specified as the mean with standard deviation. The normal distribution of key variables was validated using a Z-score of skewness and Kurtosis <. 3.29 (Mishra et al., 2019). The association between topspin accuracy and concentration and flexibility was first examined by Pearson's correlation analysis. Correlation coefficients between 0.3 and 0.5 were considered by moderate strength, whereas correlation coefficients above 0.5 were considered strong (Cohen, 2013). Subsequently, linear regression was used to examine the combined association of

concentration, and flexibility with topspin accuracy. All statistical analyses were conducted with SPSS 29.0 (IBM, Armonk, NY, USA) for the total sample and separately for male and female participants with a statistical significance at $p < 0.05$.

3. Result

This study involved 62 participants, with 64.5% being male and 36.5% female. There was no significant difference between the ages of male and female participants. However, male participants were taller than female participants ($p < 0.05$), and male participants were heavier than female participants ($p < 0.01$).

BMI analysis of the female players showed that they were within the normal range, but three male participants were found to be obese. Despite these variations in body composition, performance outcomes showed little divergence between sexes, as concentration, flexibility, and topspin accuracy yielded comparable results across groups.

Table 1. Descriptive characteristics for the total sample and separately for male and female participants

	Total Sample	Male	Female
Age (years)	21.3 ± 1.1	21.4 ± 1.2	21.0 ± 0.8
Height (cm)*	159.4 ± 5.8	160.7 ± 5.9	157.0 ± 4.8
Weight (kg)**	55.1 ± 6.0	57.1 ± 6.2	51.4 ± 3.4
BMI (kg/m²)**	21.6 ± 1.4	22.1 ± 1.6	20.8 ± 0.6
Concentration (score)	14.6 ± 4.8	14.2 ± 5.2	15.2 ± 4.0
Flexibility (cm)	6.4 ± 3.5	6.4 ± 3.7	6.5 ± 3.2
Topspin accuracy (points)	18.6 ± 3.3	18.6 ± 3.4	18.6 ± 3.1

Data is presented in mean ± SD
*sex difference at $p < 0.05$; ** sex difference at $p < 0.01$

From several variables analyzed, it was found that the accuracy of topspin shots had a strong correlation with concentration and a fairly strong correlation with player flexibility. Both were statistically significant ($p < 0.01$). In addition, statistical analysis based on gender showed that their levels of concentration and flexibility had a strong correlation with topspin accuracy ($p < 0.01$). In addition, concentration itself showed a robust link with flexibility ($p < 0.01$). In contrast, the pattern was less pronounced among females: concentration emerged as the only factor strongly related to topspin accuracy ($p < 0.01$), whereas its associations with flexibility were not statistically significant.

Table 2. Association between topspin accuracy, concentration, and flexibility

	Concentration	Flexibility
Topspin Accuracy	0.774 **	0.604 **
Male only	0.827 **	0.771 **
Female only	0.656 **	0.211
Concentration		0.593 **
Male only		0.766 **
Female only		0.118

** $p < 0.01$

Although the correlates of topspin accuracy were significantly related to one another, the regression analysis revealed no issues of multicollinearity, as indicated by VIF values below 3 and tolerance levels exceeding 0.35. When all three predictors were entered into the initial model, they jointly accounted

for 63.8% of the variance in topspin accuracy. Within the full sample, concentration and flexibility emerged as the most influential variables, together explaining 63.2% of the observed variability. Both factors showed a clear positive association with topspin accuracy, and as such, all predictors were retained in the model. In contrast, the sex-specific analysis yielded a different pattern. For female participants, the initial model accounted for only 47.2% of the variance, and among the tested predictors, concentration was the sole factor that significantly contributed to topspin accuracy.

4. Discussion

The present study demonstrated that concentration and flexibility were significantly associated with topspin stroke accuracy among table tennis players. Consistent with our expectations, concentration showed the strongest relationship with topspin accuracy ($r = 0.774$), suggesting that cognitive factors may play a critical role in successful stroke execution. Furthermore, concentration and flexibility jointly explained a substantial proportion of the variance in topspin accuracy indicating that both psychological and physical attributes contribute to technical performance in table tennis. Interestingly, these relationships were more pronounced among male players than female players, particularly for flexibility, which showed a strong association with topspin accuracy in males but not in females.

The strong relationship between concentration and topspin accuracy supports previous findings highlighting the importance of attentional control in racket sports. Table tennis is characterized by rapid ball exchanges that require players to continuously process visual information, anticipate ball trajectories, and make immediate decisions regarding stroke selection (Tian et al., 2025). Under such conditions, athletes with higher levels of concentration are likely to allocate attentional resources more effectively toward task-relevant cues, resulting in improved stroke precision. This finding is consistent with previous studies reporting that concentration is a key determinant of technical performance and shot accuracy in table tennis (Haryanto & Amra, 2020; Yachsie et al., 2023). Moreover, research has shown that directing attention toward the intended target rather than solely focusing on body movements can enhance movement accuracy and motor performance (Spancken et al., 2021). Therefore, concentration appears to facilitate not only decision-making processes but also the accurate execution of topspin strokes.

Flexibility was also positively associated with topspin accuracy, although its contribution was lower than that of concentration. This finding suggests that flexibility may support accurate topspin performance through improved movement efficiency and biomechanical control (Gusdernawati et al., 2021; He et al., 2022). A greater range of motion allows players to execute smoother trunk rotation and coordinate body segments more effectively during stroke production, thereby contributing to more consistent racket positioning and ball placement. Previous studies have similarly reported that flexibility is associated with improved movement quality and technical execution in racket sports (Al-Selmi et al., 2024). The present findings further support the notion that flexibility should be considered an important physical component in table tennis training programmes.

An interesting finding of this study was the apparent sex-related difference in the observed relationships. While concentration and flexibility were both strongly associated with topspin accuracy among male participants, flexibility was not significantly related to topspin accuracy among female participants. Although the present study was not designed to explain these differences, several factors may contribute, including variations in movement strategies, playing experience, physical conditioning, and sample size distribution between groups. Future studies should investigate these potential mechanisms to better understand whether the determinants of topspin accuracy differ according to sex.

From a practical perspective, these findings suggest that coaches should adopt a multidimensional training approach that combines technical practice with concentration-enhancing and flexibility-

development exercises. Mental training strategies aimed at improving attentional focus may enhance stroke accuracy, while flexibility training may contribute to more efficient movement patterns and technical consistency. Such an integrated approach may be particularly beneficial for improving topspin performance in competitive table tennis.

Several limitations should be acknowledged. First, the relatively small sample size and the predominance of recreational or intermediate-level players may limit the generalizability of the findings to elite athletes. Second, the cross-sectional design prevents causal conclusions regarding the influence of concentration and flexibility on topspin accuracy. Third, flexibility was assessed using the sit-and-reach test, which primarily reflects lower-back and hamstring flexibility and may not fully capture the trunk and upper-limb mobility involved in topspin execution. Future research should include larger and more diverse samples, utilize sport-specific flexibility assessments, and employ longitudinal or experimental designs to further clarify the mechanisms underlying topspin accuracy in table tennis players.

5. Conclusion and Recommendation

This study demonstrated that both concentration and flexibility were significantly associated with topspin stroke accuracy among table tennis players. Concentration emerged as the strongest predictor, while flexibility also showed a meaningful contribution to performance. These findings suggest that topspin accuracy is influenced by both psychological and physical factors, highlighting the multidimensional nature of technical performance in table tennis. Therefore, training programs should not focus solely on technical skills but should also incorporate strategies to enhance concentration and flexibility in order to improve stroke accuracy and overall performance.

Future studies should include larger and more diverse samples, particularly athletes from different competitive levels, to improve the generalizability of the findings. Further research is also needed to examine additional psychological factors, such as attentional control, decision-making, and stress regulation, as well as to investigate the long-term effects of concentration and flexibility training on table tennis performance using longitudinal or intervention-based designs.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

References

Abdullahi, Y., Toriola, A. L., Goon, D. T., Paul, Y., Igbokwe, N. U., & Suarau, M. A. (2017). Anthropometric and motor performance characteristics of Nigerian badminton players. *Asian Journal of Scientific Research*, *10*(3), 244–251. https://doi.org/10.3923/ajsr.2017.244.251

Al-Selmi, A. D. H., Abdul-Hameed, S. H., Hasib, N. R., & Abdul-Salam, Z. (2024). How Precision, Strength and Flexibility Affect Badminton Skills. *International Journal of Disabilities Sports and Health Sciences*, *7*, 184–191. https://doi.org/10.33438/ijdshs.1418997

Ashok. (2008). Test your physical fitness. In *Kalpaz Publication*. Kalpaz Publication.

Barchukova, G. V, Vagin, A. Y., & Daoming, Q. (2025). Variability of kinematic characteristics when executing a forehand top spin in table tennis for highly qualified athletes. *Teoriya i Praktika Fizicheskoy Kultury*, *2025*(1), 97–99.

Behaein, N., Farsi, A., Franz, E., & Lipowski, M. (2025). Effects of Biofeedback and Mindfulness on the Psychological Skills and Forehand Flick Accuracy in Adolescent Table Tennis Players. *Journal of Rational - Emotive and Cognitive - Behavior Therapy*, *43*(1). https://doi.org/10.1007/s10942-025-00581-6

Chen, Z., Zhao, T., Shen, Y., Ren, S., & Sun, L. (2025). The effects of muscle fatigue on shoulder proprioception and forehand stroke accuracy in Chinese elite table tennis athletes. *BMC Sports Science, Medicine and Rehabilitation*, *17*(1). https://doi.org/10.1186/s13102-025-01204-4

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. Taylor & Francis.

Gusdernawati, A., Widiyanto, W., & Nasrulloh, A. (2021). Biomechanical analysis of topspin techniques in table tennis games. *MEDIKORA*, *20*(2), 125–133. https://doi.org/10.21831/medikora.v20i2.40891

Harris, D. V, & Harris, B. L. (1984). *The Athlete's Guide to Sports Psychology: Mental Skills for Physical People*.

Haryanto, J., & Amra, F. (2020). The relationship of concentration and eye-hand coordination with accuracy of backhand backspin serve in table tennis. *International Journal of Technology, Innovation and Humanities*, *1*(1), 51–56. https://doi.org/10.29210/881701

Haryanto, J., Edmizal, E., Meyfitri, F., Becerra-Patiño, B., Hajji, J., & Drenowatz, C. (2023). Validity and reliability of topspin accuracy tests in table tennis. *Journal of Physical Education and Sport*, *23*(12), 3371–3377. https://doi.org/10.7752/jpes.2023.12386

Haryanto, J., Edmizal, E., Ndayisenga, J., Geantă, V. A., Orhan, B. E., & Asnaldi, A. (2025). Concentration and Precision: Analyzing the Relationship between Mental Focus and Forehand Push Accuracy in Table Tennis. *Annals of Applied Sport Science*, *13*(Special-Issue), 147–150. https://doi.org/10.61186/aassjournal.1485

He, Y., Fekete, G., Sun, D., Baker, J. S., Shao, S., & Gu, Y. (2022). Lower Limb Biomechanics during the Topspin Forehand in Table Tennis: A Systemic Review. *Bioengineering*, *9*(8), 336. https://doi.org/10.3390/bioengineering9080336

Lin, Y., Zhang, R., Zhang, Y., Xu, Y., Gao, Q., & Luo, Q. (2025). Comparing the Efficacy of Solely Scapular Stability Training versus Combined Thoracic Flexibility Training in Elite Table Tennis Players with Scapular Dyskinesis. *Journal of Human Kinetics*, *98*, 93–106. https://doi.org/10.5114/jhk/196512

Liu, D. (2023). Elbow joint training in table tennis teaching. *Revista Brasileira de Medicina Do Esporte*, *29*. https://doi.org/10.1590/1517-8692202329012022_0512

Łuba-Arnista, W., Arnista, P., Niźnikowski, T., Sadowski, J., Mastalerz, A., Ratkowski, W., Niźnikowska, E., Różański, P., & Starzak, M. (2025). Is holistic focus of attention equally effective to external focus in performing accuracy of table tennis forehand stroke in low-skilled players? *BMC Sports Science, Medicine and Rehabilitation*, *17*(1). https://doi.org/10.1186/s13102-025-01133-2

Mishra, P., Pandey, C. M., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. *Annals of Cardiac Anaesthesia*, *22*(1), 67–72. https://doi.org/10.4103/aca.ACA_157_18

Na, Z. (2025). A Study on Table Tennis Trajectory Prediction Methods Based on the Informer Model. *Proceedings - 2025 Asia-Europe Conference on Cybersecurity, Internet of Things and Soft Computing, CITSC 2025*, 198–204. https://doi.org/10.1109/CITSC64390.2025.00043

Nikolakakis, A., Mavridis, G., Gourgoulis, V., Pilianidis, T., & Rokka, S. (2020). Effect of an intervention program that uses elastic bands on the improvement of the forehand topspin stroke in young table tennis athletes. *Journal of Physical Education and Sport*, *20*, 2189–2195. https://doi.org/10.7752/jpes.2020.s3294

Noor, A., Chin, S.-Y., Tsai, P.-J., Lin, R.-Y., Cheng, K.-S., & Shaw, F.-Z. (2025). Generality and Specificity of Attention Dimensions in Elite Table Tennis Players. *Montenegrin Journal of Sports Science and Medicine*, *14*(2), 61–67. https://doi.org/10.26773/mjssm.250907

Pradas, F., de la Torre, A., Castellar, C., & Toro-Román, V. (2021). Physiological profile, metabolic response, and temporal structure in elite individual table tennis: Differences according to gender. *International Journal of Environmental Research and Public Health*, *18*(22). https://doi.org/10.3390/ijerph182211898

Spancken, S., Steingrebe, H., & Stein, T. (2021). Factors that influence performance in Olympic air-rifle and small-bore shooting: A systematic review. *PloS One*, *16*(3), e0247353. https://doi.org/10.1371/journal.pone.0247353

Tian, J., Liu, Y., & Xiao, Y. (2025). The correlation between table tennis players' reaction agility and stroke effect. *Scientific Reports*, *16*, 1673. https://doi.org/10.1038/s41598-025-31222-8

Yachsie, B. T. P. W. B., Graha, A. S., & Hartanto, A. (2023). Circuit game development: Implications on balance, concentration, muscle endurance, and arrow accuracy. *Physical Education Theory and Methodology*, *23*(1), 92–97. https://doi.org/10.17309/tmfv.2023.1.13

Zhan, C., & Cui, P. (2023). Impacts of weight training on physical fitness in table tennis. *Revista Brasileira de Medicina Do Esporte*, *29*. https://doi.org/10.1590/1517-8692202329012023_0036

Zhuang, Y., Li, Y., & Zhuang, X. (2024). Table tennis stroke technique and fitness improvement based on strength training. *Applied Mathematics and Nonlinear Sciences*, *9*(1), 1–14. https://doi.org/10.2478/amns-2024-2322