Comprehensive Physical, Physiological, and Psychological Profiling of Johor Youth Athletes across Different Sports and Age Categories

Azlan Alfian Rosli., Norhafizah Hamzah., Mohd Syrinaz Azli., and Siti Azilah Atan*

Defence Fitness Academy, Universiti Pertahanan Nasional Malaysia, Kem Perdana Sungai Besi, 57000 Kuala Lumpur, Malaysia

***Corresponding Author**

DOI: https://doi.org/10.47772/IJRISS.2026.101000096

Received: 12 October 2026; Accepted: 17 October 2026; Published: 30 October 2026

ABSTRACT

Youth athlete development is influenced by physical growth, physiological maturation, sport-specific demands, training experience, and psychological skills. However, comprehensive profiles of youth athletes in Johor remain limited. Therefore, this study aimed to examine the physical, physiological, and psychological characteristics of Johor youth athletes across different sport and age categories, as well as the relationships between maturity status, training age, gender, achievement level, and athletic performance. A quantitative, cross-sectional, descriptive-comparative research design was employed. Participants comprised 194 state-level youth athletes aged 12–21 years from 11 sports, including 123 males and 71 females. Athletes were classified into physical-dominant and precision-dominant sport categories and U15 and 16+ age groups. Data were collected using anthropometric and body-composition measurements, physiological field tests, the Mental Skills Questionnaire, and Tanner-stage self-assessment. Data were analysed using descriptive statistics, two-way MANOVA and ANOVA, Spearman correlation, and multiple linear regression. The findings revealed significant age-category differences in height, sitting height, arm span, body mass, skeletal muscle mass, fat-free mass, countermovement-jump height, sprint performance, Yo-Yo distance, and predicted VO_2max. Sport-category differences were identified in selected body-composition and psychological measures. Significant differences between sport categories were observed in imagery ability, mental preparation, and concentration ability, while anxiety and worry management differed by age category. A significant sport-by-age interaction was found only for sit-and-reach performance. Although Tanner stage, training age, gender, and achievement level were positively associated with predicted VO_2max in the correlation analysis, only training age and gender remained significant predictors in the regression model. Overall, these findings provide useful baseline information for sport-specific profiling, athlete monitoring, developmentally appropriate training, and talent identification among youth athletes in Johor.

Keywords: Youth Athletes, Physical Profile, Physiological Characteristics, Mental Skills, Talent Identification

INTRODUCTION

Youth athletic development represents a dynamic, complex, and multi-factorial process governed by the continuous interaction of physical growth, physiological maturation, motor skill acquisition, and psychological development (Lloyd et al., 2016; Till & Baker, 2020). Historically, talent identification frameworks and athletic performance evaluations in youth sports operated under unidimensional paradigms that evaluated adolescent prospects almost exclusively on isolated physical traits, such as linear sprint speed or standing vertical jump height, alongside basic anthropometric measures like standing stature (Johnston et al., 2018). However, contemporary exercise science and sports pedagogy increasingly emphasize that evaluating an adolescent athlete's competitive potential through single-domain metrics yields an incomplete and frequently misleading assessment of their long-term developmental trajectory (Baker et al., 2020; Sieghartsleitner et al., 2019).

Contemporary athletic profiling instead advocates for a holistic, multidimensional framework that concurrently integrates physical fitness outcomes, physiological capacities including body composition and cardiorespiratory

endurance, and psychological traits such as motivation, self-confidence, imagery, and emotional regulation (Dohme et al., 2019; Khayyat et al., 2020). A comprehensive multidimensional approach recognizes that elite athletic performance rarely originates from a single physiological advantage, but rather stems from a synergistic network where superior psychological resilience can offset temporary physical limitations during developmental stages, or where well-developed aerobic power supports sustained motor skill execution under high physiological fatigue (Sieghartsleitner et al., 2019; Till & Baker, 2020). Establishing robust multidimensional profile baselines enables sports scientists, conditioning coaches, and administrative bodies to monitor developmental readiness, individualize periodized training loads, and mitigate risks associated with non-functional overreaching, burnout, and premature sports dropout among young athletes (Lloyd et al., 2016; Towlson et al., 2021).

Adolescence represents a critical developmental period marked by substantial anatomical, endocrine, and neuromuscular transformations that alter physical performance capabilities independently of an athlete's cumulative sports practice. Chronological age alone serves as an unreliable metric for evaluating athletic performance because youth of identical chronological age can vary by up to three to four years in biological maturity status (Cumming et al., 2017; Towlson et al., 2021). Dividing adolescent athlete populations into distinct, mutually exclusive developmental stages—specifically early adolescence (under 15 years old) and late adolescence (15 years old and above)—provides a vital empirical framework for isolating biological maturation from training adaptations (Emmonds et al., 2020; Lloyd et al., 2016). Early adolescence is typically characterized by the onset of peak height velocity, somatic growth spurts, fluctuating pubertal development, and rapid long-bone elongation that often temporarily disrupts neuromuscular coordination and movement economy, a phenomenon known as adolescent awkwardness (Cumming et al., 2017; Lloyd et al., 2016). In contrast, late adolescence represents post-pubertal stabilization, featuring significant androgenic hormonal surges, marked hypertrophy in skeletal muscle mass and fat-free mass, and near-adult motor unit recruitment capabilities that foster enhanced rate of force development, explosive power, and superior absolute aerobic capacity (Cumming et al., 2017; Lloyd et al., 2016).

Beyond biological maturation, the operational profile of a youth athlete is heavily conditioned by the specific functional, energetic, and bio-behavioral demands imposed by their selected sports discipline (Khayyat et al., 2020; Opstoel et al., 2015). Sport disciplines can be classified based on metabolic energy system reliance and movement skill taxonomy into physical-dominant sports versus precision-dominant sports (Opstoel et al., 2015; Pion et al., 2015). Physical-dominant sports impose substantial metabolic and physical demands that necessitate high absolute and relative cardiorespiratory endurance, anaerobic capacity, and explosive muscular strength (Khayyat et al., 2020). Conversely, precision-dominant sports depend primarily on perceptual-motor acuity, static and dynamic postural control, fine motor coordination, and psychological regulation (Koopmann et al., 2020; Pion et al., 2015).

While youth participation in competitive sports is on the rise in Johor, there remains a lack of a comprehensive profile that integrates the physical, physiological, and psychological attributes of young athletes. The lack of locally generated, multifaceted profiles impairs Johor sport programs in accurately identifying talent, designing developmentally suitable training, and tracking progress over time. Therefore, the general objective of this study is to profile the physical, physiological, and psychological characteristics of Johor youth athletes across different sport and age categories, and to examine the influence of maturity status, training age, gender, and level of achievement on athletic performance.

METHODOLOGY

Research Design

The study utilized a quantitative, cross-sectional, descriptive-comparative research design to evaluate and compare the multidimensional characteristics of athletes at a single point in time across different sport categories and age groups.

Participants and Sampling

A total of 194 state-level youth athletes (123 males, 71 females) aged 12 to 21 years from 11 sports participated via purposive sampling. Participants were categorized into two sport categories: physical-dominant sports (silat, wushu, boxing, canoeing, squash, sailing; n = 101) and precision-dominant sports (archery, shooting, petanque, tenpin bowling, lawn bowls; n = 93). They were further divided into two age categories: U15 (15 years and under; n = 146) and16+ (16 years and older; n = 48). To be included in the study, participants were required to hold active state-level competition status in Johor, maintain a continuous sports training history of at least 12 months, and obtain medical clearance for maximal exertion testing. Athletes were excluded if they presented with an acute musculoskeletal injury in the preceding 3 to 6 months, had underlying chronic cardiorespiratory conditions, or failed to complete all required testing sessions. Ethical approval was obtained prior to data collection, with written informed consent secured from parents or legal guardians for all minor participants, alongside written assent provided by participants under 18 years of age.

Instrumentation and Data Collection Procedures

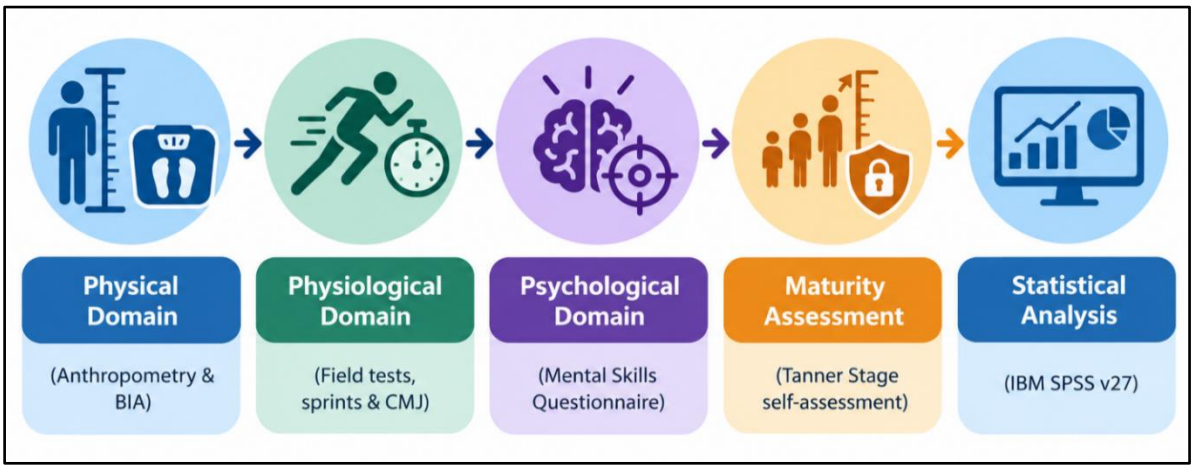


Figure 1: Data Collection Flow

Data collection was structured across four distinct battery testing procedures:

1. *Physical Domain:* Anthropometric measurements (standing height, sitting height, arm span) were recorded using a stadiometer and measuring tape. Body composition variables (body mass, BMI, body fat percentage, skeletal muscle mass, fat-free mass, waist-hip ratio, visceral fat level) were assessed via a multi-frequency Bioelectrical Impedance Analyser (BIA).

2. *Physiological Domain:* Field-based tests included the Sit and Reach test (flexibility), Countermovement Jump (CMJ, lower body power), 20 m and 30 m linear sprint tests (speed), 505 test (change of direction speed), and the Yo-Yo Intermittent Endurance Test (distance and predicted VO_2max). Electronic timing gates and jump mats were utilized for precise time and height recording.

3. *Psychological Domain:* The Mental Skills Questionnaire (MSQ; Bull et al., 1996) assessed seven mental skill subscales (imagery ability, mental preparation, self-confidence, anxiety and worry management, concentration ability, relaxation ability, and motivation) using a 6-point Likert scale converted to percentage scores.

4. *Maturity Assessment:* Maturity status was self-assessed using gender-specific Tanner stage illustrations (Stages 1 to 5) under confidential supervision.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 27. Descriptive statistics were computed for all metrics. Two-way multivariate analysis of variance (MANOVA) and follow-up univariate two-way ANOVAs were executed to examine main and interaction effects of sport category and age category. Spearman rank correlation

and multiple linear regression analyses evaluated the influence of Tanner stage, training age, achievement level, and gender on predicted VO_2max. Statistical significance was set at $p < .05$.

RESULTS AND FINDINGS

Physical Characteristics

Statistically significant main effects of age category were found across physical anthropometrics: height ($F = 10.36$, $p = .0015$, partial $\eta^2 = .052$), sitting height ($F = 24.21$, $p < .001$, partial $\eta^2 = .113$), arm span ($F = 10.92$, $p = .0011$, partial $\eta^2 = .054$), body mass ($F = 8.23$, $p = .0046$, partial $\eta^2 = .042$), skeletal muscle mass ($F = 16.26$, $p = .0001$, partial $\eta^2 = .081$), and fat-free mass ($F = 15.82$, $p = .0001$, partial $\eta^2 = .079$). Significant sport-category main effects were revealed for arm span ($F = 4.66$, $p = .0322$, partial $\eta^2 = .024$), body mass ($F = 10.77$, $p = .0012$, partial $\eta^2 = .055$), BMI ($F = 9.75$, $p = .0021$, partial $\eta^2 = .050$), percent body fat ($F = 7.73$, $p = .0060$, partial $\eta^2 = .040$), fat-free mass ($F = 4.15$, $p = .0429$, partial $\eta^2 = .022$), waist-hip ratio ($F = 8.40$, $p = .0042$, partial $\eta^2 = .044$), and visceral fat level ($F = 12.52$, $p = .0005$, partial $\eta^2 = .064$). Precision-dominant athletes possessed higher body fat and visceral fat levels than physical-dominant athletes, while older athletes displayed superior muscle mass.

Physiological Characteristics

Significant age-category main effects were established for CMJ height ($F = 9.48$, $p = .0024$, partial $\eta^2 = .051$), 20 m sprint ($F = 8.52$, $p = .0040$, partial $\eta^2 = .047$), 30 m sprint ($F = 9.58$, $p = .0023$, partial $\eta^2 = .059$), Yo-Yo distance ($F = 16.11$, $p = .0001$, partial $\eta^2 = .084$), and predicted VO_2max ($F = 19.88$, $p < .001$, partial $\eta^2 = .102$). Older athletes consistently outperformed U15 athletes across explosive power, linear speed, and aerobic capacity measures. For flexibility (sit and reach), significant main effects were found for sport category ($F = 4.06$, $p = .0453$, partial $\eta^2 = .021$) and age category ($F = 10.48$, $p = .0014$, partial $\eta^2 = .054$), along with a significant sport-by-age interaction ($F = 3.95$, $p = .0485$, partial $\eta^2 = .021$). Physical-dominant athletes scored higher in U15 (34.7 cm vs. 31.9 cm), but precision-dominant athletes surpassed physical-dominant athletes in the 16+ group (38.0 cm vs. 36.5 cm).

Psychological Characteristics

Significant sport-category effects were detected for imagery ability ($F = 12.63$, $p = .0005$, partial $\eta^2 = .065$), mental preparation ($F = 4.82$, $p = .0293$, partial $\eta^2 = .026$), and concentration ability ($F = 4.14$, $p = .0433$, partial $\eta^2 = .022$). Precision-dominant athletes demonstrated higher scores in imagery ability (82.1% vs. 74.9%) and mental preparation (83.6% vs. 78.4%), whereas physical-dominant athletes exhibited greater concentration scores (72.9% vs. 66.0%). Anxiety and worry management showed a significant age-category effect ($F = 4.19$, $p = .0421$, partial $\eta^2 = .022$).

Influencing Factors and Regression

In bivariate correlation analysis, Tanner stage, training age, gender, and achievement level were positively correlated with predicted VO_2max. However, in the multiple linear regression model, only training age and gender remained significant independent predictors of predicted VO_2max.

Table 1: Physical, physiological, and psychological profiling of johor youth athletes

Domain / Variable	Physical 16+ (Mean ± SD)	Physical U15 (Mean ± SD)	Precision 16+ (Mean ± SD)	Precision U15 (Mean ± SD)
Standing Height (cm)	162.44 ± 7.23	158.86 ± 8.67	165.76 ± 4.89	160.18 ± 8.09
Body Fat Percentage (%)	21.85 ± 11.42	22.30 ± 8.94	25.20 ± 11.04	26.99 ± 11.57
CMJ Height (cm)	35.18 ± 7.93	31.13 ± 7.49	34.20 ± 8.99	29.88 ± 7.32

20 m Sprint Time (s)	3.56 ± 0.41	3.73 ± 0.37	3.57 ± 0.36	3.89 ± 0.50
Predicted VO_2max (ml/kg/min)	31.79 ± 5.01	28.53 ± 4.90	31.53 ± 5.06	26.88 ± 4.40
Self-Confidence MSQ (%)	67.75 ± 13.01	68.84 ± 11.37	67.67 ± 7.83	68.90 ± 11.62
Motivation MSQ (%)	75.75 ± 25.97	78.60 ± 18.95	81.80 ± 15.31	80.49 ± 17.31

DISCUSSION

The findings confirm that physical and physiological differences between age categories are primarily driven by biological growth and maturation processes, aligning with the Long-Term Athlete Development (LTAD) model (Balyi & Hamilton, 2004) and the Youth Physical Development (YPD) model (Lloyd & Oliver, 2012). This supported by few studies conducted in Asian region to support this notion. Kung et al., (2025) showed that increases in biological maturity accounted for moderate-to-large enhancements in skeletal body dimensions and significant gains in physical capacity (sprint speed and explosive power output), proving that biological maturation status drives the physical separation observed across youth age divisions. Furthermore, findings revealed that peak gains in aerobic power and mechanical movement force coincided directly with peak ossification rates and maturational spurts during pubertal stages (~13.5 to 15.3 years), confirming that physiological differences between younger and older age brackets are predominantly maturational rather than just chronological (Lolli et al., 2021).

Nevertheless, another study showed that when we interpret results on young athletes, we have to look at other factor such as Peak Height Velocity (PHV) rather than chronological age. A longitudinal study of Japanese local talent identification and development programme showed explosive lower-body power (standing broad jump) and linear sprint speed improvements synchronized precisely with the timing of PHV rather than chronological age. The study highlighted that biological maturation acts as a direct physical performance accelerator in Asian male youth (Hagiwara et al., 2026)

The empirical literature supports the premise that body composition profiles diverge significantly based on the specific physiological, mechanical, and postural demands of the sport category. Precision-dominant sports, which emphasize static positioning and fine motor control, presented higher fat mass and visceral fat levels, whereas physical-dominant sports required higher lean muscle mass to optimize power-to-weight ratios (Ackland et al., 2012; Opstoel et al., 2015). For instance, archers had higher relative body mass and lower center of gravity contributed directly to dampening body sway (micro-oscillations) during the aiming phase. The study confirmed that unlike dynamic sports, where excess mass acts as "dead weight," in precision sports like archery and shooting, higher mass provides biomechanical grounding without hindering execution (Taha et al., 2009). This was futher supported by Rahim et al., (2021) findings comparing adolescent archers to dynamic sports athletes (e.g., badminton), this study found that archers exhibited significantly higher body mass index (BMI = 24.3 kg/m^2) and higher percentage of body fat ($\%BF = 24.3\%$) compared to the high-intensity dynamic group ($\%BF = 16.1\%$). The low caloric expenditure during precision training combined with a lack of high-intensity aerobic flux led to higher fat accumulation, validating that precision sports do not impose the metabolic stimulus required for low adiposity. Evaluating hundreds of youth athletes across diverse disciplines, Opstoel et al., (2015) established that athletes in combat, racquet, and team sports (physical-dominant) maintain significantly higher fat-free mass index (FFMI) and lower fat mass index (FMI) to optimize their power-to-weight ratio. In contrast, target and precision sport athletes presented higher body fat percentages and lower muscularity, reflecting lower metabolic training loads and a lack of selection pressure for explosive muscle mass

On the psychological front, precision athletes demonstrated superior imagery and pre-performance mental preparation routines, which are vital for closed-skill execution under pressure (Koopmann et al., 2020). Cumming and Williams (2013) demonstrated that athletes in closed-skill, precision sports utilize higher frequencies of Cognitive Specific (CS) imagery mentally rehearsing exact technical mechanics, alignment, and release points to reinforce motor programs and fine-tune movement consistency before execution.Conversely,physical-dominant athletes displayed higher tactical concentration, reflecting the dynamic

nature of open-skill, direct contact environments (Khayyat et al., 2020). Memmert (2009) highlighted that open-skill, direct-contact sports place severe demands on dynamic concentration and tactical awareness. Success in these environments is governed by attentional flexibility, the capacity to maintain concentration amid rapid sensory overload, physical fatigue, and unexpected tactical changes introduced by an opponent.

Lastly, The retention of training age and gender as sole significant predictors of cardiorespiratory fitness in regression modeling underscores the key role of structured training volume over time (Ericsson et al., 1993) alongside post-pubertal dimorphic physiological differences (Malina et al., 2004).

CONCLUSION

This study establishes the first comprehensive, multidimensional baseline profile for state-level youth athletes in Johor across physical, physiological, and psychological domains. Chronological age category strongly drives anthropometric growth and physiological capacity, whereas sport classification dictates body composition and specialized mental skill profiles. Integrating multidimensional testing frameworks provides sports bodies with an evidence-based approach to talent identification, mitigating selection bias associated with biological maturation, and enabling periodized, developmentally appropriate conditioning and mental skills training.

REFERENCES

1. Ackland, T. R., Lohman, T. G., Sundgot-Borgen, J., Maughan, R. J., Meyer, N. L., Stewart, A. D., & Müller, W. (2012). Current issues in anthropometry of athletes. Sports Medicine, 42(3), 227–249.
2. Baker, J., Schorer, J., & Wattie, N. (2020). Compromising talent: Issues in identifying and developing talent in sport. Sports Medicine, 50(5), 983–999.
3. Balyi, I., & Hamilton, A. (2004). Long-term athlete development: Trainability in childhood and adolescence. Victoria: National Coaching Institute BC.
4. Bull, S. J., Albinson, J. G., & Shambrook, C. J. (1996). The Mental Skills Questionnaire. Chichester: Wiley.
5. Cumming, S. P., Lloyd, R. S., Oliver, J. L., Eisenmann, J. C., & Malina, R. M. (2017). Bio-banding in sport: Applications to competition, talent identification, and strength and conditioning. Strength & Conditioning Journal, 39(2), 34–47.
6. Cumming, J., & Williams, S. E. (2012). the role of imagery in performance. In Advances in Sport and Exercise Psychology (3rd ed.). Human Kinetics.
7. Dohme, I., Backhouse, S., Piggin, J., & Morgan, G. (2019). Categorizing and defining psychological characteristics for developing excellence. The Sport Psychologist, 33(4), 283–293.
8. Emmonds, S., Scantlebury, S., Murray, F., Turner, L., Robuck, R., & Jones, B. (2020). Physical qualities of elite youth female soccer players. Journal of Sports Sciences, 38(11-12), 1228–1239.
9. Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. Psychological Review, 100(3), 363–406.
10. Hagiwara, M., Kinugasa, T., Haramura, M., Nakao, T., Teshima, K., Yamashita, S., & Shirai, K. (2026). Maturity-specific trajectories of physical fitness in talented youth athletes: A longitudinal study of Japanese local talent identification and development programme. Frontiers in Sports and Active Living, 8, 1821744.
11. Johnston, K., Wattie, N., Schorer, J., & Baker, J. (2018). Talent identification in sport: A systematic review. Sports Medicine, 48(10), 2323–2335.
12. Khayyat, Y., Ersoz, G., & Polat, M. (2020). Multidimensional profiling of elite Turkish taekwondo athletes. International Journal of Environmental Research and Public Health, 17(18), 6820.
13. Koopmann, J., Faber, I., Baker, J., & Schorer, J. (2020). Assessing psychological characteristics in precision sports. Frontiers in Psychology, 11, 1582.
14. Kung, J., et al. (2025). Maturation and physical performance in national level youth athletes. Journal of International Sports Coaching / IUSCA Journal, 5(1), 389.
15. Lolli, L., Johnson, A., Di Salvo, V., & Gregson, W. (2021). Skeletal maturation in male elite youth athletes: Biological changes and physical performance trajectories. Journal of Sports Sciences, 39(14), 1610–1619.

16. Lloyd, R. S., & Oliver, J. L. (2012). The youth physical development model: A new approach to long-term athletic development. Strength & Conditioning Journal, 34(3), 61–72.
17. Lloyd, R. S., Cronin, J. B., Faigenbaum, A. D., Haff, G. G., Howard, R., Kraemer, W. J., & Oliver, J. L. (2016). Long-term athletic development-part 1: A pathway to optimal performance. Journal of Strength and Conditioning Research, 30(6), 1491–1504.
18. Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). Growth, maturation, and physical activity (2nd ed.). Champaign, IL: Human Kinetics.
19. Memmert, D. (2009). Pay attention! A review of visual attentional expertise in sport. International Review of Sport and Exercise Psychology, 2(2), 119–138.
20. Opstoel, K., Pion, J., Elferink-Gemser, M., Hartman, E., Willemse, B., Philippaerts, R., & Lenoir, M. (2015). Anthropometric and physiological characteristics of youth athletes across different sports. Journal of Sports Sciences, 33(10), 1025–1035.
21. Pion, J., Segers, V., Fransen, J., Debrot, A., Frencken, W., Deprez, D., ... & Lenoir, M. (2015). Generic motor coordination tests support holistic talent identification in youth sport. Journal of Sports Sciences, 33(10), 1036–1042.
22. Rahim, A. A., Ismail, S. M., & Nor, M. M. (2021). Physiological, metabolic, and body composition profiles across adolescent sport disciplines. Malaysian Journal of Movement, Health & Exercise, 10(2), 45–54.
23. Sieghartsleitner, R., Zuber, C., Zibung, M., & Conzelmann, A. (2019). Science or artists' intuition? Comparing the validity of multidimensional talent identification models. Journal of Sports Science and Medicine, 18(1), 126–137.
24. Taha, H., Abdullah, M. R., & Juahir, H. (2009). The influence of body mass and postural stability on shooting performance in youth archers. Journal of Sports Sciences, 27(11), 1185–1193.
25. Till, K., & Baker, J. (2020). Challenges and [mis]conceptions of talent identification and development (TID) in youth sport. Journal of Sports Sciences, 38(11-12), 1228–1239.
26. Towlson, C., MacMaster, C., Levett, N., & Parkin, G. (2021). The relative age effect in youth soccer: A systematic review. Sports Medicine, 51(6), 1125–1141.