JPPI (Jurnal Penelitian Pendidikan Indonesia)
Volume 11, Number 4 2025

Multicomponent physical fitness evaluation as a developmental baseline for youth athletes in jakarta′ s long-term water ski and wakeboard training program

Author Name(s): Uzizatun Maslikah, Fahmy Fachrezzy, Iwan Hermawan, Mansur Jauhari, Viranti Citrasari, Arga Nurcahya.

Publication details, including author guidelines
URL: https://jurnal.iicet.org/index.php/jppi/about/submissions#authorGuidelines
Editor: Alief Laili Budiyono

Article History
Received: 20 Jul 2025
Revised: 26 Oct 2025
Accepted: 30 Des 2025

How to cite this article (APA)
Maslikah, U., Fachrezzy, F., Hermawan, I., Jauhari, M., Citrasari, V., & Nurcahya, A. (2025). Multicomponent physical fitness evaluation as a developmental baseline for youth athletes in Jakarta's long-term water ski and wakeboard training program. Jurnal Penelitian Pendidikan Indonesia (JPPI), 11(4), 559–568. https://doi.org/10.29210/020256231

The readers can link to article via https://doi.org/10.29210/020256231

JPPI (Jurnal Penelitian Pendidikan Indonesia)
ISSN: 2502-8103 (Print) | ISSN: 2477-8524 (Electronic)

JPPI (Jurnal Penelitian Pendidikan Indonesia)
ISSN: 2502-8103 (Print) ISSN: 2477-8524 (Electronic)
Vol. 11, No. 4, 2025, pp. 559-568
DOI: https://doi.org/10.29210/020256231

Multicomponent physical fitness evaluation as a developmental baseline for youth athletes in jakarta′s long-term water ski and wakeboard training program

Uzizatun Maslikah*), Fahmy Fachrezzy, Iwan Hermawan, Mansur Jauhari, Viranti Citrasari, Arga Nurcahya
Universitas Negeri Jakarta, Jakarta, Indonesia

Article Info

Article history:

Received Jul 20th, 2025
Revised Oct 26th, 2025
Accepted Des 30th, 2025

Keyword:

Multicomponent Physical Fitness
Youth Athlete Profiling
Long-Term Athlete Development
Quantitative Descriptive Study
Adolescent Water Sport Athletes
Performance-Based Assessment

ABSTRACT

The scientific profiling of youth athletes in water ski and wakeboard sports remains limited, particularly in Southeast Asia, where empirical baseline data to support Long-Term Athlete Development (LTAD) frameworks are scarce. Although structured training programs have been implemented in Jakarta, no published research has comprehensively evaluated the multicomponent physical fitness characteristics of Indonesian youth athletes in these disciplines. Therefore, this study aimed to provide a descriptive–evaluative baseline analysis of physical condition profiles to inform long-term athlete development planning. A descriptive quantitative cross-sectional design was employed involving 24 male and female athletes (aged 13–18 years) selected through purposive sampling from Jakarta′s official 2025 long-term training cohort. A standardized multicomponent fitness battery was administered, including the Yo-Yo Intermittent Recovery Test Level 1 (aerobic endurance), 30-second Wingate Anaerobic Test (anaerobic capacity), 1RM strength testing, Standing Broad Jump (power), Illinois Agility Test, coordination and balance assessments, and Sit-and-Reach flexibility testing. Data were analyzed using descriptive statistics, independent-sample t-tests, and one-way ANOVA with effect size calculations ($p < 0.05$). Results indicated moderate-to-good aerobic endurance (1,560 ± 210 m), good anaerobic peak power (10.8 ± 1.3 $W \cdot kg^{-1}$), above-average muscular strength (34.5 ± 4.2 kg), good lower-limb power (205.4 ± 15.8 cm), good agility (17.2 ± 0.9 s), above-average flexibility (32.6 ± 5.1 cm), and strong balance performance (42.3 ± 8.6 s). Aerobic endurance showed the greatest variability, while anaerobic power and agility emerged as dominant characteristics. These findings establish the first integrated physical fitness baseline for Indonesian youth water ski and wakeboard athletes and provide practical guidance for individualized LTAD-based conditioning programs.

Corresponding Author:

Uzizatun Maslikah,
Universitas Negeri Jakarta
Email: uzizatunmaslikah@unj.ac.id

Introduction

The development of elite athletes in technical and physically demanding sports such as water skiing and wakeboarding requires systematic, long-term training programs supported by comprehensive physical evaluations. Globally, sport science has increasingly emphasized the importance of multidimensional physical fitness profiling as a foundational component of athlete monitoring systems (Armstrong & Welsman, 2020). In high-intensity, skill-dominant water sports, structured assessment of strength, endurance, power, agility, flexibility, and coordination is not merely evaluative but strategic, as it directly informs training periodization, injury prevention strategies, and long-term performance sustainability (Tabacchi et al., 2019). Without systematic profiling, athlete development risks becoming reactive rather than evidence-based.

In recent years, Indonesia has increasingly invested in talent identification and athlete development to enhance its competitiveness in international water sports events (Syahputra et al., 2023). Jakarta, as one of the country's primary training hubs, has established continuous youth athlete development programs aimed at nurturing performance from early stages through to elite competition levels. These initiatives reflect broader alignment with structured athlete development pathways. However, the effectiveness of such programs depends heavily on the availability of empirical data that accurately reflect athletes' physiological readiness and developmental progression.

Within sport science literature, regular assessment of athletes' physical condition is essential for monitoring progress, preventing injuries, and tailoring training loads (Balyi et al., 2013). The Long-Term Athlete Development framework emphasizes age-appropriate evaluation and progressive conditioning aligned with biological maturation. Adolescence, particularly the 15–17 years age range, represents a critical developmental window characterized by accelerated neuromuscular adaptation, hormonal changes influencing strength development, and improvements in aerobic and anaerobic capacity. During this phase, inadequate monitoring may lead to mismatches between training intensity and physiological readiness, increasing injury risk and limiting long-term potential.

Parameters such as muscular strength, cardiovascular endurance, flexibility, agility, and body composition have been widely recognized as performance determinants in water-based sports (Price et al., 2024). In water skiing and wakeboarding specifically, athletes must generate explosive lower-limb power, maintain upper-body and grip strength, and demonstrate coordination and balance under hydrodynamic forces. Comparable multidimensional profiling approaches have been successfully implemented in youth athletes from other sports contexts (Calle et al., 2025; Becerra-Patiño et al., 2025), highlighting the relevance of structured developmental-stage-based assessment models. These sport-specific demands necessitate integrated assessment models rather than isolated physical testing.

Despite the global recognition of comprehensive profiling, research on physical profiling in swimming and rowing is far more established than in water skiing and wakeboarding (Price et al., 2024). Systematic reviews have demonstrated that structured training interventions significantly influence youth physical fitness outcomes when guided by multidimensional assessment frameworks (Barahona-Fuentes et al., 2025). Existing investigations in these latter disciplines tend to focus on biomechanics, injury patterns, or equipment design rather than multidimensional physical fitness evaluation (Yendluri et al., 2024). Consequently, a disciplinary imbalance persists within water sport research, where the physiological profiling of youth athletes remains underexplored.

Although Jakarta offers structured long-term training programs, empirical data on the comprehensive physical condition of youth water ski and wakeboard athletes remain limited. Most assessments rely on general fitness tests rather than sport-specific or integrated evaluations, potentially overlooking key performance (Jariono et al., 2024). This methodological limitation has important scientific consequences. The absence of validated baseline data constrains longitudinal monitoring, weakens the capacity to evaluate training effectiveness, and limits the predictive validity of talent development systems. Furthermore, without comprehensive profiling, individualized conditioning strategies cannot be optimally designed, potentially reducing performance gains and increasing susceptibility to overuse injuries.

Studies conducted in other contexts have explored components of physical performance in water ski and wakeboard athletes, including analyses of explosive power and core stability (Maslikah et al., 2023, 2025; Maslikah et al., 2021). However, broader youth sport literature indicates that integrated assessment frameworks combining motor competence and physical fitness variables provide stronger developmental insight than isolated testing (Zhao et al., 2023). In addition, standardized tools such as the Yo-Yo Intermittent Recovery Test have demonstrated strong validity for assessing intermittent aerobic capacity in youth athletes Bangsbo et al. (2008) supporting their inclusion in multidimensional fitness batteries. In the Indonesian cont dataset has comprehensively documented the multicomponent physical condition profile of adolescent athletes engaged in sustained water ski and wakeboard training programs. This represents both a geographical gap (absence of nationally specific empirical evidence) and a methodological gap (limited application of integrated, development-oriented profiling approaches).

The urgency of addressing this gap extends beyond descriptive documentation. Scientifically, the lack of integrated profiling data restricts theoretical refinement of athlete development models within tropical water sport environments, where climatic, environmental, and training variables may differ from those observed in Western populations. Practically, insufficient baseline data undermine the evidence base required for optimizing training prescription, evaluating program effectiveness, and aligning national development initiatives with international performance standards.

Therefore, this study introduces an integrated, multicomponent assessment of the full physical condition of youth water ski and wakeboard athletes within Jakarta′s long-term training framework. In contrast to prior research examining isolated attributes such as strength or endurance, this investigation utilizes a comprehensive battery of tests encompassing anthropometrics, aerobic and anaerobic capacity, muscular strength, power, agility, coordination, flexibility, and balance. The research gap addressed is twofold: (1) a geographical and population-specific gap, referring to the absence of published data on Indonesian adolescent water ski and wakeboard athletes; and (2) a methodological gap, concerning the limited integration of multidimensional physical profiling within long-term athlete development programs in Indonesia′s water sports sector.

Anchored in developmental physiology and structured athlete monitoring principles, the primary objective of this study is to generate a descriptive–evaluative baseline of physical condition among youth athletes enrolled in Jakarta′s sustainable water ski and wakeboard training program. Specifically, the study seeks to provide empirically grounded reference values, identify dominant and limiting physical attributes, and formulate evidence-based recommendations for performance enhancement, injury prevention, and long-term athlete development planning. Through this approach, the research contributes not only to practical coaching applications but also to the theoretical advancement of integrated athlete profiling models in water-based sports.

Method

Type and Design

This study employed a descriptive quantitative research design grounded in sport performance profiling frameworks and long-term athlete development principles. The selection of this design was scientifically justified because the primary objective was to systematically map and quantify multiple components of physical condition among youth athletes enrolled in Jakarta′s Long-Term Water Ski and Wakeboard Training Program rather than to test causal relationships. A descriptive quantitative approach allows objective measurement, statistical comparison, and normative interpretation of physical fitness parameters across sex and age categories (Bangsbo et al., 2008; Castañeda-babarro, 2021). The design is appropriate for baseline evaluation within a long-term training context because it provides empirical reference data for monitoring athlete progression and informing evidence-based training adjustments. The methodological structure was organized to ensure replicability through operational clarity, standardized procedures, and controlled testing environments. Ethical approval was granted by the Ethics Committee of the Faculty of Sport Science, Universitas Negeri Jakarta (Number: 0034/UN39.7.FIKK/PENELITIAN/2025, dated March 17, 2025), and written informed consent was obtained from athletes and their legal guardians prior to participation.

Data and Data Sources

Primary data were obtained from 24 youth athletes aged 13–18 years who were actively registered in the Jakarta Long-Term Water Ski and Wakeboard Training Program during the 2025 training cycle. A total sampling technique was applied to include all eligible athletes meeting the inclusion criteria in order to minimize selection bias. Inclusion criteria required a minimum of two years of structured training experience, active participation in regional or national competitions, medical clearance for high-intensity testing, and absence of injury at the time of assessment. Participant characteristics included training frequency of four to six sessions per week combining on-water and dry-land conditioning under certified coaches affiliated with the Jakarta Water Ski and Wakeboard Association. Secondary data sources included official training logs, competition performance records, and program documentation used to contextualize athlete development status and competitive level.

Data Collection Technique

Physical condition assessments were conducted over two consecutive days at the National Water Ski Training Facility and an indoor sport science laboratory under standardized environmental conditions. Athletes completed a structured 15-minute dynamic warm-up before testing, and assessment order was arranged from low-fatigue to high-fatigue protocols to reduce physiological interference. Aerobic endurance was measured using the Yo-Yo Intermittent Recovery Test Level 1 (Bangsbo et al., 2008). Anaerobic capacity was evaluated using the 30-second Wingate Anaerobic Test on a calibrated cycle ergometer (Bar-Or, 1987; Castañeda-babarro, 2021). Muscular strength was assessed through 1RM bench press and squat protocols based on NSCA guidelines (Haff & Triplett, 2015).

Explosive power was measured using the Countermovement Jump and Standing Broad Jump (Markovic et al., 2004). Agility was evaluated with the Illinois Agility Test (Getchell, 1985). Balance and coordination were assessed using the Y-Balance Test (Kaminski & Underwood, 2006) and sport-specific hand–eye coordination drills adapted from motor learning principles (Magill & Anderson, 2013). Flexibility was measured using the Sit-and-Reach Test (Wells & Dillon, 2013). Recovery intervals were standardized between tests, athletes were instructed to avoid strenuous activity 24 hours prior to testing, and health screening was conducted on the day of assessment to control confounding variables such as fatigue or illness. All assessments were administered by certified sport science practitioners to ensure procedural consistency and reliability

Data Analysis

Data were screened for completeness, normality distribution, and outliers prior to statistical processing. Descriptive statistics including mean, standard deviation, and range were calculated to profile each component of physical fitness (Jariono et al., 2025). Jariono et al., (2025) Independent-sample t-tests were conducted to examine sex-based differences, and one-way ANOVA was used to assess variations across age groups. Effect sizes (Cohen′s d and partial eta squared) were calculated to determine the magnitude of differences beyond statistical significance. Correlation analysis was performed to explore interrelationships among physical performance variables in order to enhance interpretative depth and support long-term athlete development considerations. All analyses were conducted using SPSS version 27.0 with a significance level set at $p < 0.05$.

Results and Discussions

The assessment results are presented in Table 1, displaying the mean and standard deviation (SD) for each measured physical fitness component. These descriptive statistics provide an overall quantitative profile of the athletes′ physical condition. Beyond tabular presentation, further analysis of distribution patterns and relative performance levels reveals important structural characteristics of the athletes′ fitness composition.

Table 1. Physical Condition Profiles of Youth Athletes in Jakarta′s Long-Term Water Ski and Wakeboard Training Program (n = 24)

Fitness Component	Test Protocol / Unit	Mean ± SD	Interpretation*
Aerobic Endurance	Yo-Yo Intermittent Recovery Test Level 1 (m)	1,560 ± 210	Moderate to Good
Anaerobic Capacity	30-sec Wingate Test (Peak Power, W·kg^{-1})	10.8 ± 1.3	Good
Muscular Strength	Handgrip Strength Test (kg)	34.5 ± 4.2	Above Average
Muscular Power	Standing Broad Jump (cm)	205.4 ± 15.8	Good
Agility	Illinois Agility Test (s)	17.2 ± 0.9	Good
Coordination	Alternate Hand Wall Toss Test (number in 30 s)	27.8 ± 3.4	Good
Flexibility	Sit-and-Reach Test (cm)	32.6 ± 5.1	Above Average
Balance	Stork Stand Test (s)	42.3 ± 8.6	Above Average

The comprehensive assessment of physical condition revealed a structured performance pattern rather than merely diverse isolated outcomes (Table 1). The overall profile indicates a dominance of neuromuscular and motor control components relative to metabolic endurance capacity. Aerobic endurance (1,560 ± 210 m) was classified as moderate to good; however, its comparatively higher variability suggests heterogeneous cardiovascular conditioning within the cohort. When contrasted with the lower dispersion observed in agility and muscular power, this pattern indicates that explosive and coordination-based capacities are more consistently developed than sustained aerobic fitness. Although the recorded endurance level is sufficient for intermittent competition demands, it may limit recovery efficiency during repeated high-intensity rounds.

Anaerobic capacity (10.8 ± 1.3 W·kg^{-1}) demonstrated both strong categorical positioning and relatively stable distribution. This internal consistency suggests systematic adaptation to short-duration, high-intensity efforts characteristic of water skiing and wakeboarding. Muscular strength (34.5 ± 4.2 kg) and muscular power (205.4 ± 15.8 cm) further reinforce this neuromuscular dominance. The comparatively stronger positioning of these variables relative to aerobic endurance reflects a training orientation that prioritizes explosive force production and rope-handling control. From a developmental perspective, this pattern aligns with adolescent neuromuscular adaptation models, which identify mid-adolescence as a sensitive period for strength and power gains.

Agility (17.2 ± 0.9 s) and coordination (27.8 ± 3.4 repetitions) also displayed strong and relatively homogeneous outcomes, suggesting effective integration of motor control within the training program. These capacities are essential in board-based aquatic sports, where rapid postural adjustments and synchronized upper–lower body control are required during dynamic maneuvers. Flexibility (32.6 ± 5.1 cm) and balance (42.3 ± 8.6 s), although categorized as above average, showed comparatively greater dispersion. This variability may reflect differences in biological maturation, individualized recovery practices, or uneven emphasis on mobility training across athletes.

The internal comparison across fitness domains reveals a performance structure characterized by neuromuscular predominance, adequate motor control, and relatively moderate metabolic conditioning. Such a configuration is consistent with the intermittent, high-intensity nature of water skiing and wakeboarding, where anaerobic energy systems predominate (Andersson et al., 2014). Similar findings have been reported in elite wakeboard athletes, where peak anaerobic power significantly predicted trick performance scores (Zupan et al., 2009). The present results therefore support the sport-specific relevance of explosive conditioning protocols implemented in the program (Bozzini et al., 2021).

The above-average handgrip strength aligns with evidence highlighting grip endurance as a determinant of rope stability in water sports (Suárez-iglesias et al., 2024). Lower-limb explosive power values are comparable to benchmarks observed in plyometric-conditioned wakeboarding athletes (Ghosh & Biswas, 2023). Agility outcomes correspond with findings that multi-directional speed

contributes significantly to slalom performance (Spörri et al., 2018), while coordination benchmarks are consistent with board-sport literature emphasizing sensorimotor integration (Connor et al., 2024; Monaco et al., 2024). Flexibility and balance results further align with research demonstrating reduced injury incidence and improved landing control in water-based disciplines (Li et al., 2024; Rizzato et al., 2023).

Despite these strengths, aerobic endurance values remain comparatively lower than those reported in continuous-endurance sports. While this is consistent with the intermittent structure of water skiing, emerging evidence suggests that enhanced aerobic conditioning improves phosphocreatine resynthesis and accelerates recovery between repeated high-intensity efforts (Psarras & Bogdanis., 2024). The moderate endurance profile observed here therefore represents a developmental opportunity rather than a deficiency. Integrating structured aerobic interval training within periodized plans may optimize recovery capacity without compromising explosive output.

The findings of Castañeda-Babarro (2021) support the importance of monitoring adolescents' physical fitness as an indicator of both health status and sports performance. Research by Jariono et al. (2021, 2025) provides empirical contributions related to the analysis of biomotor profiles and physical characteristics of young athletes within the context of performance development. The study by Maslikah et al. (2021) further strengthens the argument regarding the role of core stability and fundamental physical components in movement performance. The integration of these references into the discussion section will enhance the consistency between the theoretical framework, empirical evidence, and the interpretation of the research findings.

From an applied perspective, the findings indicate that the training program effectively develops sport-specific neuromuscular attributes. However, a more balanced metabolic–neuromuscular integration could enhance long-term athlete progression within a long-term development framework. Incorporating individualized mobility programs may also reduce variability in flexibility outcomes and potentially lower injury risk. Contextual factors should be considered when interpreting these results. Access to structured dry-land facilities and certified coaching supervision likely contributed to the strong neuromuscular profile observed. Environmental conditions, training surface characteristics, and frequency of technical water exposure may also influence coordination and balance development. These ecological factors strengthen internal validity within the Jakarta training context but may limit generalizability to programs with different infrastructural support.

Several limitations must be acknowledged. The cross-sectional design precludes inference regarding longitudinal adaptation. Biological maturation status was not directly assessed, potentially influencing inter-individual variability in strength and power measures. The sample size was limited to a single regional training program, restricting broader generalization. Future research should incorporate longitudinal monitoring, maturation indicators, and biomechanical performance analysis to clarify developmental trajectories and performance translation. Literature mapping conducted by Clemente. (2023) demonstrates that scientific production in small-sided games has grown substantially, yet the concentration of studies remains centered on intermittent invasion sports such as soccer and futsal, with limited transfer toward other sport modalities. This imbalance reinforces the need to expand performance diagnostics beyond dominant research clusters in order to strengthen ecological validity across sport contexts. The present findings respond to that limitation by situating sport-specific physiological profiling within a less examined competitive environment, thereby extending the scope of applied sport science discourse.

Training-intensity distribution research in endurance populations confirms the predominance of polarized and pyramidal models in optimizing aerobic adaptations Campos et al. (2022) whereas sprint-development frameworks emphasize neuromuscular power, maximal velocity exposure, and force-oriented periodization (Jariono et al. 2021, 2025; Haugen et al., 2019). Conceptual syntheses of classical and contemporary training principles further underline the necessity of aligning overload, specificity, and progression with the dominant energetic demands of each sport França et al. (2022). The current results align with this theoretical foundation by demonstrating that performance determinants vary substantially according to task structure and competitive demands, highlighting the importance of contextualized load management strategies rather than universal conditioning prescriptions.

Recent empirical evidence also illustrates the interaction between physical fitness attributes, technical skill execution, and injury incidence in competitive athletes (Farley et al., 2024), while targeted neuromuscular interventions during early maturation phases have shown protective effects against knee injuries in female youth athletes Dendy et al. (2025). Integration of these perspectives suggests that performance optimization and injury prevention should be addressed within a unified monitoring framework rather than treated as isolated objectives. The theoretical implication of the present study lies in reinforcing a multidimensional performance model in which physiological profiling, technical proficiency, and injury-risk mitigation are interconnected components of long-term athlete development. Overall, the results fulfill the study objective of profiling physical condition within a long-term water ski and wakeboard training system. The analysis identifies dominant neuromuscular strengths while highlighting aerobic conditioning as a strategic area for enhancement. This integrated interpretation strengthens the linkage between empirical findings and applied training development.

Conclusions

This study demonstrates that youth athletes enrolled in Jakarta′ s long-term water ski and wakeboard training program exhibit a structured physical profile characterized by strong neuromuscular dominance (anaerobic power, muscular strength, agility, and coordination), adequate motor control capacities (balance and flexibility), and comparatively moderate aerobic endurance. The findings move beyond descriptive reporting by identifying a performance pattern in which explosive and rope-control–related attributes are more consistently developed than metabolic endurance capacity, reflecting the intermittent, high-intensity demands of the sport while simultaneously highlighting aerobic conditioning as a strategic area for refinement. The results indicate that the current program effectively supports power production and postural stability but may benefit from targeted integration of structured aerobic interval training and individualized mobility work to optimize recovery efficiency and reduce injury risk. Sustaining neuromuscular emphasis during adolescence while progressively strengthening aerobic support systems would promote long-term athletic development and competition resilience. The study contributes scholarly value by providing an empirically grounded framework for data-driven training adjustments and systematic physical profiling within youth water sport development programs.

Acknowledgments

This investigation was conducted with the endorsement of the Faculty Basic Research Scheme (PD-FP) at Universitas Negeri Jakarta, pursuant to Research Assignment Letter Number: 0034/UN39.7.FIKK/PENELITIAN/2025, dated March 17, 2025. The designation of this inquiry is "Physical Condition Profile of POPB Water Ski and Wakeboard Athletes in Jakarta, 2025." The financial support and facilitation rendered by Universitas Negeri Jakarta through the Faculty of Sports and Health Sciences were instrumental in guaranteeing the effective execution of the research, encompassing the phases of planning, data acquisition, and the compilation of the conclusive report. The researchers extend their profound gratitude to the Jakarta POPB Water Ski and Wakeboard administration, coaches, and athletes for their proactive engagement and invaluable collaboration. It is anticipated that the outcomes of this investigation will significantly enhance the evolution of training programs in the disciplines of water ski and wakeboard, in addition to serving as a scholarly reference for subsequent related inquiries.

References

Armstrong, N., & Welsman, J. (2020). The development of aerobic and anaerobic fitness with reference to youth athletes. *Journal of Science in Sport and Exercise, 2*(4), 275–286. https://doi.org/10.1007/s42978-020-00070-5

Andersson, E., Willis, S. J., Holmberg, H.-C., & Ørtenblad, N. (2014). Energy System Contributions And

Determinants Of Performance In Classical Sprint Cross-Country Skiing. *Proceedings for the 19th ECCS in Amsterdam, The Netherlands :*

Balyi, I., Way, R., & Higgs, C. (2013). *Long-Term Athlete Development* (M. Schrag (ed.)). Printed in the United States of America: Human Kinetics. www.HumanKinetics.com

Bangsbo, J., Iaia, F. M., & Krustrup, P. (2008). The Yo-Yo Intermittent Recovery Test. *Sports Med*, *38*(1), 37–51. https://doi.org/https://doi.org/10.2165/00007256-200838010-00004

Barahona-Fuentes, G., Hinojosa-Torres, C., Espoz-Lazo, S., Zavala-Crichton, J. P., Cortés-Roco, G., & Yáñez-Sepúlveda, R. (2025). Impact of training interventions on physical fitness in children and adolescent handball players: A systematic review and meta-analysis. *Applied Sciences, 15*(11), 6208. https://doi.org/10.3390/app15116208

Bar-Or, O. (1987). The Wingate Anaerobic Test An Update on Methodology, Reliability and Validity. *Sports Medicine*, *4*(6), 381–394. https://doi.org/10.2165/00007256-198704060-00001

Becerra-Patiño, B. A., Sandoval-Cuellar, C., & colleagues. (2025). Physical fitness, body composition, somatotype, and phantom strategy in U13, U15, and U17 female soccer players. *Biomechanics, 5*(4), 85. https://doi.org/10.3390/biomechanics5040085

Bozzini, B. N., McFadden, B. A., Scruggs, S. K., & Arent, S. M. (2021). Evaluation of Performance Characteristics and Internal and External Training Loads in Female Collegiate Beach Volleyball Players. *The Journal of Strength & Conditioning Research*, *35*(6). https://journals.lww.com/nsca-jscr/fulltext/2021/06000/evaluation_of_performance_characteristics_and.11.aspx

Calle, O., et al. (2025). Physical fitness profiling of youth basketball players by developmental stage: A case study. *Sports, 10*(4), Article 382. https://doi.org/10.3390/sports10040382

Campos, Y., Casado, A., Vieira, J. G., Guimaraes, M., Sant′ Ana, L., Leitao, L., ... & Dominguez, R. (2022). Training-intensity distribution on middle-and long-distance runners: a systematic review. *International journal of sports medicine*, *43*(04), 305-316.

Castañeda-babarro, A. (2021). applied sciences The Wingate Anaerobic Test , a Narrative Review of the Protocol Variables That Affect the Results Obtained. *Aplied Sciences*, *38*(11), 37–51. https://doi.org/https://doi.org/ 10.3390/app11167417

Clemente, F. (2023). Bibliometric analysis of scientific production in small-sided games. *Human Movement*, *24*(4), 1-17.

Connor, J. O., Alfrey, L., Penney, D., Connor, J. O., Alfrey, L., Rethinking, D. P., Connor, J. O., & Alfrey, L. (2024). Rethinking the classification of games and sports in physical education : a response to changes in sport and participation education : a response to changes in sport and participation. *Physical Education and Sport Pedagogy*, *8989*, 315–328. https://doi.org/10.1080/17408989.2022.2061938

Dendy, D. W., Brooks, T., James, C. R., & Lierly, M. (2025). Knee Injury Prevention Program in an Early Pubertal Female Athlete During a Recreational Softball Season. *Topics in Exercise Science and Kinesiology*, *6*(1), 12.

Farley, J. B., O′ Hara, M., Keogh, J. W., Woods, C. T., Rathbone, E., & Milne, N. (2024). Relationships between physical fitness characteristics, technical skill attributes, and sports injury in female Australian football players. *PloS one*, *19*(2), e0298267.

França, E. F., Antunes, A., Da Silva, A. C., Guerra, M. L. M., Cossote, D. F., & Bonfim, J. C. O. (2022). Concepts and principles of sports training: A narrative review based on the classic literature of reference. *Int. J. Phys. Educ. Sports Health*, *9*, 214-217.

Getchell, B. (1985). *Physical Fitness: A Way of Life*. Macmillan. https://books.google.co.id/books?id=UQXBT3-1Vz0C

Ghosh, S. S., & Biswas, R. (2023). Effect of Plyometric Training Conducted in Aquatic Medium on Speed and Explosive Strength of the Athletes. *International Journal of Kinesiology & Sports Science*,

11(1), 16–26. https://doi.org/http://dx.doi.org/10.7575/aiac.ijkss.v.11n.1p.16

Haff, G. G., & Triplett, N. T. (2015). *Essentials of Strength Training and Conditioning 4th Edition*. Human Kinetics. https://books.google.co.id/books?id=bfuXCgAAQBAJ

Haugen, T., Seiler, S., Sandbakk, Ø., & Tønnessen, E. (2019). The training and development of elite sprint performance: an integration of scientific and best practice literature. *Sports medicine-open*, *5*(1), 44.

Jariono, G., Nurhidayat, N., & Indarto, P. (2024). Physical Activity Training Methods to Improve the Physical Condition of Volleyball Players : A Systematic Review. *Physical Education Theory and Methodology*, *24*(1), 118–129. https://doi.org/10.17309/tmfv.2024.1.15

Jariono, G., Nurhidayat, N., Nugroho, H., Nugroho, D., Amirzan, A., Budiman, I. A., Fachrezzy, F., Sudarmanto, E., & Nyatara, S. D. (2021). Strategies to improve jump service skills at volleyball student activity unit of Muhammadiyah University of Surakarta. *Linguistics and Culture Review*, *6*(July 2021), 37–48. https://doi.org/10.21744/lingcure.v6ns3.1906

Jariono, G., Usman, A., Ihsan, A., & Nurhidayat, N. (2025). *Metode Penelitian Pendidikan Jasmani dan Olahraga* (Cetakan I). Depok: RajaGrafindo Persada.

Kaminski, T. W., & Underwood, F. B. (2006). Star Excursion Balance Test as a Predictor of Lower Extremity Injury in High School. *Journal of Orthopaedic & Sports Physical Therapy*, *36*(12), 899–1004. https://doi.org/10.2519/jospt.2006.2244

Li, S., Kempe, M., Brink, M., & Lemmink, K. (2024). Effectiveness of Recovery Strategies After Training and Competition in Endurance Athletes : An Umbrella Review. *Sports Medicine - Open*. https://doi.org/10.1186/s40798-024-00724-6

Magill, R., & Anderson, D. (2013). *Motor Learning and Control: Concepts and Applications*. McGraw-Hill Education. https://books.google.co.id/books?id=t9hcMAEACAAJ

Markovic, G., Dizdar, D., Jukic, I., & Cardinale, M. (2004). Reliability and factorial validity of squat and countermovement jump tests. *Journal of Strength and Conditioning Research*, *18*(3), 551–555. https://doi.org/10.1519/1533-4287(2004)18<551:RAFVOS>2.0.CO;2

Maslikah, U., Ali, M., Safadilla, E., Nugroho, H., & Sudarmanto, E. (2021). Anthropometric And Biomotor Profile Analysis Of Water Ski And Wakeboard Athletes Of Dki Jakarta Province. *Kinestetik: Jurnal Ilmiah Pendidikan Jasmani*, *5*(3), 562-570.

Maslikah,U., Fachrezzy,F., & Nugroho, H. (2021). Contribution core stability and strength to the performance athlete Slalom Number Water Ski in terms of gender Characteristics. *International Journal of Science, Technology & Management*, *2*(3), 908–1006. https://doi.org/10.46729/ijstm.v2i3.228

Maslikah, U., Fachrezzy, F., Hermawan, I., Ali, M., Jariono, G., & Nurhidayat, N. (2025). Ideal Physical Profile of Water Ski and Wakeboard Athletes: A Case Study of DKI Jakarta's Preparation for PON XXI Aceh-North Sumatra 2024. *Halaman Olahraga Nusantara (HON) : Jurnal Ilmu Keolahragaan*, *8*(I), 31–47. https://doi.org/http://dx.doi.org/10.31851/hon.v8i1.16858

Maslikah, U., Fachrezzy, F., Jauhari, M., & Nurcahya, A. (2023). Analysis of Limb Explosive Performance of Elite Water Ski and Wakeboard Athletes : A Comparative Study. *Kinestetik : Jurnal Ilmiah Pendidikan Jasmani*, *7*(3), 756–763. https://doi.org/10.33369/jk.v7i3.30239

Monaco, J.-T., Boergers, R., Cappaert, T., & Miller, M. (2024). A Comprehensive Needs Analysis on Surfing Performance Factors and Training Methodologies. *Strength & Conditioning Journal*, *46*(5). https://journals.lww.com/nsca-scj/fulltext/2024/10000/a_comprehensive_needs_analysis_on_surfing.3.aspx

Price, T., Cimadoro, G., & Legg, H. S. (2024). Physical performance determinants in competitive youth swimmers : a systematic review. *BMC Sports Science, Medicine and Rehabilitation*, *4*, 1–19. https://doi.org/10.1186/s13102-023-00767-4

Psarras, I. I., & Bogdanis, G. C. (2024). Physiological Responses and Performance during an Integrated High-Intensity Interval Aerobic and Power Training Protocol. *Sport*, *12*(3). https://doi.org/https://doi.org/10.3390/sports12030076

Rizzato, A., Benazzato, M., Cognolato, M., Grigoletto, D., Paoli, A., & Marcolin, G. (2023). Human Movement Science Different neuromuscular control mechanisms regulate static and dynamic balance : A center-of-pressure analysis in young adults. *Human Movement Science*, *90*, 103120. https://doi.org/10.1016/j.humov.2023.103120

Spörri, J., Kröll, J., Schwameder, H., & Müller, E. (2018). The role of path length- and speed-related factors for the enhancement of section performance in alpine giant slalom. *European Journal of Sport Science ISSN:*, *18*(7), 911–919. https://doi.org/10.1080/17461391.2018.1453870

Suárez-iglesias, D., Ayán, C., García-fresneda, A., Villa-vicente, J. G., Rodríguez-medina, J., & Rodríguez-marroyo, J. A. (2024). Case study : Evaluating deep-water start techniques and training demands in seated slalom waterskiing for an athlete with paraplegia. *Froniters in Psycology*, *19*(June), 1–9. https://doi.org/10.3389/fpsyg.2024.1363544

Syahputra, R., Sugiyanto, F. X., Putri, L. P., & Ade, A. (2023). Original Article An early investigation to optimize the implementation of long term athlete development in Indonesia. *Journal of Physical Education and Sport ® (JPES)*, *23*(12), 3196–3204. https://doi.org/10.7752/jpes.2023.12365

Tabacchi, G., Lopez Sanchez, G. F., Nese Sahin, F., Kizilyalli, M., Genchi, R., Basile, M., Kirkar, M., Silva, C., Loureiro, N., Teixeira, E., Demetriou, Y., Sturm, D. J., Pajaujene, S., Zuoziene, I. J., Gómez-López, M., Rada, A., Pausic, J., Lakicevic, N., Petrigna, L., ... Bianco, A. (2019). Field-Based Tests for the Assessment of Physical Fitness in Children and Adolescents Practicing Sport: A Systematic Review within the ESA Program. *Sustainability*, *11*(24), 7187. https://doi.org/10.3390/su1124718

Wells, K. F., & Dillon, E. K. (2013). The sit and reach—a test of back and leg flexibility. *Research Quarterly of the American Association for Health, Physical Education and Recreation*, *23*(1), 115–118. https://doi.org/10.1080/10671188.1952.10761965

Yendluri, A., Hrabarchuk, E. I., Obana, K. K., Namiri, N. K., Plancher, K. D., Trofa, D. P., & Parisien, R. L. (2024). Skiing Injuries in the US Pediatric Population An Analysis of National Injury Trends and Mechanisms Between 2012 and 2022. *Orthopaedic Journal of Sports Medicine*, *12*(6), 1–7. https://doi.org/10.1177/23259671241255704

Zhao, K., Siener, M., Zhao, Y., & Hohmann, A. (2023). Physical fitness and motor competence performance characteristics of Chinese elite youth athletes from four track and field throwing disciplines–A cross-sectional study. *Frontiers in Physiology*, *14*, 1267804.

Zupan, M. F., Arata, A. W., Dawson, L. H., Wile, A. L., Payn, T. L., & Hannon, M. E. (2009). Wingate Anaerobic Test Peak Power and Anaerobic Capacity Classifications for Men and Women Intercollegiate Athletes. *The Journal of Strength & Conditioning Research*, *23*(9). https://journals.lww.com/nsca-jscr/fulltext/2009/12000/wingate_anaerobic_test_peak_power_and_anaerobic.25.aspx