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DEVELOPMENT AND STANDARDIZATION OF A DUAL-TEST MODEL TO MEASURE SPECIFIC PHYSICAL ATTRIBUTES AND OFFENSIVE SKILLS FOR YOUTH VOLLEYBALL TALENT IDENTIFICATION

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Abstract
In this research work, the authors introduce a new tool namely the dual-test model of antecedents that need to be standardized to objectively assess the skills of offensive volleyball plays and young athletes between the ages 12 and 16 years. Valid and reliable testing in competitive sports is necessary in the determination of future talent in competitive sports, which requires organized long-term improvement in competition. Using a quantitative cross-sectional research study, the sample size consisted of 140 participants involving youth volleyball players stratified by age and gender. Balancing of participants was applied by stratifying random selection of young volleyball participants in clubs and academies. The physical and the offensive skill battery will be combined into two sections that will form the proposed model; (A) A physical test battery which will assess explosive power, speed, agility, strength, and coordination using tests such as vertical jump, sprint, agility test, long jump and grip strength; (B) The offensive skills battery that will examine serve accuracy, spike performance, setting accuracy and in optional circumstances, offensive decision-making. The test was carried out in a pilot study with 20 athletes to iron out unclarity and timing in tests. The psychometric features of the model were extensively confirmed with test-retest (ICC > 0.85), inter-rater (Cohen Kappa > 0.80) and construct and content validity through coach rankings and expert panels. All subtests were put into a z-score form, which fed into two indices called Physical Index (PI) and Offensive Skills Index (OSI), which united to create a Total Talent Index (TTI) with regression weights based on coach ratings. The TTI had an excellent predictive value regarding coach rated talent ($R^2 > 0.70$). The gap between different age groups and gender highlights a particular need of context grounded benchmarks. The dual-test model provides a scalable, standardisable system that can be used in identifying volleyball talent among youth, and would be appropriate to incorporate within national development pathways and longitudinal monitoring.
Keywords: Agility, Offensive Skills, Physical Performance, Talent Identification, Youth Volleyball.

1. INTRODUCTION

The identification of talent in youth sports has become the science in games, in the games that require technique and physical load, such as volleyball. It is essential to develop multidimensional assessment instruments in order to provide measurement of the perspectives as well as the skill-based performance level in order to determine the future elite player at the early stage (Koopmann et al., 2020; Sarmento et al., 2018). The existing models of talent identification are rather one-dimensional since they focus either on physical fitness or technical capacity, but not both (Joseph et al., 2021; Pino-Ortega et al., 2021). Offensive play athlete performance in volleyball, which includes the ability to serve on target, set correctly and swing forcefully, is specifically essential in volleyball but often is not evaluated during youth talent ID programmes (Farley et al., 2020). Concurrently, the performance execution and injury prevention relies on underlying physical skills of

Proximus Journal of Sports Science and Physical Education
Volume 2, Issue 8, August 2025
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agility, strength, and coordination (Tsoukos et al., 2019; Oliveira et al., 2025). Nevertheless, the absence of unified, validated dual-domain models with quantification of physical and offensive talent aspects, and particularly the case in youth athletes in their critical developmental years, has been an issue (De Waelle, 2021; Zemkova & Hamar, 2018). Although more and more scientific interest is being focused on talent identification, the integration across scientific bodies is still akin to physically focused performance traits together with offensive technical ability that is not overall scaled, standardized, scalable, or psychometrically open to question. In addition, not many provide individual evaluations of older volleyball children aged 1216 who are in critical skin development and game development (Rubajczyk & Rokita, 2020; Hajilou & Anbarian, 2023). Such gap limits the coaching, development programming, and athlete selection processes on the basis of evidence. The current research suggests the creation and normalization of a two-exam model of a youth volleyball talent selection. Its key aims are as follows:

- To come up with a test battery that can be used to measure the major physical measures and offensive volleyball skills in young athletes simultaneously.
- To determine the reliability, the validity and the discriminatory capacity in the suggested test items.
- To develop a Dual Index Scoring System, (To produce a Physical Index (PI) and an Offensive Skills Index (OSI)) which may be able to be statistically correlated with the expert coaching measures and the player performance.
- To delve the age differences and gender difference in youth volleyball using stratified analysis.

Through these achievements, the study will have the practical model that both sports academies and national federations can use when the targets are identifying volleyball talent early and the subsequent tracking at an early age. The research also falls into the developing pool of studies that promote the multidimensional understanding of talent development (Williams et al., 2023; Sgrò et al., 2024). This research is being proposed in contrast to other research as to date, research that targeted overall athleticism, or specifically isolated skills on volleyball are being done with regard to specifics base on testing. This research proposes a unified, integrative testing system that couples both physiological performance and game specialized offensive behaviours into a dual-assessment unit. The model considers elite-level data on radar-based spiking velocity, quantitative setting accuracy, and agility-based movement patterns none of which has been standardized concurrently in previous methods of volleyball talent identification (Sodaitis, 2020; Larkin & OConnor, 2017). Moreover, the scoring system performs normalization by z-score and regression weighted indexations to present individual talent scores. This enables objective comparisons by demographic segmentation and improvement in recruitment and individual training decision-making activities (Garner, 1963; Kelly et al., 1985). The model also incorporates the findings of empirical tests in correlation with the coaching experience, thus closing the circle between academic research and sports field practice that is also a crucial element in improving the system of youth sports development (Naremore & Brantlinger, 1991; Warren, 1993).

2. LITERATURE REVIEW

Talent identification (TID) in youth sports has received academic interest many times over since it is considered an all-important process to the development of an elite athlete. In the last few decades, the multidimensional view of TID has become increasingly popular, with the points being that talent should not be assessed only in terms of physical characteristics, but also on the psychological, tactical, and technical levels (Williams, Ford, & Drust, 2023; Sgrò, Quinto, Lipoma, & Stodden, 2024). More particularly in volleyball, Hajilou and Anbarian (2023) have underlined that elite players are a mix of explosive strength, spatial awareness, and offensive capabilities, thus requiring combined assessment tools. Koopmann et al. (2020) reinforced this view and demonstrated in their systematic review that isolated physical or technical tests are not predictively valid when they are not part of a bigger demographic- or scenario-related structure.

Proximus Journal of Sports Science and Physical Education
Volume 2, Issue 8, August 2025
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Certain sports such as volleyball have the fastest interchange between decisions, skills, and physicality, which means models need to consider performance in its entirety (Sarmento, Anguera, Pereira, & Araujo, 2018). There is an increasing number of literature that promotes the creation of dual-domain assessment systems. As reported by Farley et al. (2020), physical fitness and its not least, the sprint speed, strength, and ability to act in agility are directly related to technical performance in ball activities. In the same vein, Oliveira et al. (2025) revealed that physical performance and change of direction of young volleyball players, especially women, showed considerable intergroup differences by ages, corresponding to the need of customized normative values. As it was the case with junior national volleyball clubs (Tsoukos et al., 2019), power of upper and lower body was also a predictor of selection in male youth basketball sample (Sodaitis, 2020). These results are consistent with the findings of Zemkova and Hamar (2018), who concluded that sport-specific testing and neuromuscular training plays a crucial role in the world of youth sport because it can be used to capture the context-specificity of general fitness of the ability (before the game).

In further exploration, Rubajczyk and Rokita (2020) investigated the issue of relative age using volleyball as the point of reference and found that youth development systems operating on a global scale are more preoccupied with maturity rather than talent potential. This emphasizes the importance of creating uniformity of objective testing schemes based on ages and gender. This volleyball does not only depend on physicality but also on cognitive, perceptual and tactical decision-making. As stated by De Waelle (2021), the acquisition of perceptual-cognitive ability in young volleyball players is an essential element, and the ability to make quick decisions and perceive in advance confirms the high level of complex players. Similarly, Joseph et al. (2021) disclosed that multidimensional measures (including both cognitive and physical parameters) were more successful in discriminating between elite and sub-elite athletes in adolescent basketball players. Pino-Ortega et al. (2021) suggested the application of principal component analysis (PCA) to simplify complex sets of variants in talent identification in soccer, basketball, and rugby; they promoted data-based processes of selection, including some consideration of context-oriented ones. As Kelly, Jackson, Zelhart and Markley (1985) and Garner (1963) observed, performance is likely to be affected by context and subjectivity especially where testing is very subjective to the opinion of the coach or the use of unvalidated test models. This has been an important issue of TID research to date. However, Larkin and OConnor (2017) stated that the process of talent recruitment in youth soccer strongly relies on the recruiter biases, and they probably will disregard less noticeable qualities, like the ability of a player to make decisions quickly or to move without the ball. On the same breath, Roberts (1949) cautioned against evaluations that ignore developmental preparedness and mental well-being of young people. Incorporation into the modern studying of ethical and standardized frameworks is in progress. As an example, Wang (2024) addressed strategic persuasion in media in terms of a metaphorical analog to the selective perception in sports recruitment, referring to the use of narrative framing in judgment. Sgrò et al. (2024) supported the use of a version of declarative tactical knowledge tests in volleyball as an improvement on the physical profiling method in order to understand actual court intelligence. The issue of reform in the evaluation systems among youth is also reflected in the general social science literature. May (1998) discussed the effect of gender expectations on moral conduct and social placement and this applies to the sports field where the evaluation of the boys and girls has been measured by the same standards without considering the gendered lines of development. In the same manner, Smith (1986) has illustrated how education segregation, like in math studying, is able to provide a reflection of systemic disproportion, which can be applied to the sports talent systems. The writings of Satloff (2004), Berwick and Oppenheimer (1971) and Friedenberg (1982) all have a peripheral input to this discourse as they refer to the nature of systemic bigotry as well as inefficiencies in the domain of the various institutions. Although this is not a sports-related issue, their explanations can be used when considering this topic in the context of sports,

Proximus Journal of Sports Science and Physical Education
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namely the fairness and transparency of athlete selection. The article by Phoutchanthavongsa (2019) addresses cultural and identity-related concerns as well since it detected similarities of disclosure and identity politics within corporate settings, which becomes more applicable to the case of youth sports where inclusion and the psychological safety of organizations play a critical role. Theorizing by scholars including Hult (2007), Tornatore (2013) and Sagalyn (2003) of identity development and human agency are both important to the ideation of considering talent as an evolving process and not a stagnant biological capacity. Finally, Warren (1993) and Naremore and Brantlinger (1991) provide city and culture perspectives, highlighting the impact of community, culture, and social economic background on determining opportunity and access, both of which are important factors to consider when drawing up a model of youth talent development with the right tone of inclusiveness and scalability.

3. METHOD

To achieve methodological aspects and practical feasibility, the procedure of modeling the dual-test was based on multi-step approach including design, pilot, reliability evaluation, and statistical modeling. The methodological framework followed was conveniently designed to capture the multidimensionality of the volleyball in terms of technical indicators and physical indicators to the sporting performance of youthful athletes. The integration of the lab-quality physical tests with the offensive skills metrics that have been proven helps to create the comprehensive picture of the potential of the player. The background information on the study provided the research design, criteria in selecting participants used, the system of dual-test model and the process behind scoring and validating the standardized framework.

3.1 Research Design

The research design was quantitative cross-sectional, and its purpose was to come up with a dual-test model that assesses physical features along with offending abilities in young athletes in volleyball. The model involved a combination of the laboratory standard physical fitness tests with the volleyball technical tests. This integrated model has been formulated to offer a valid and applicable instrument of identification of talent.

3.2 Sample Selection

- Participants: Male and female 12-16 years old youth volleyball players.
- Sample Size: A minimum of 120 and maximum of 160 athletes will be taken, with balanced age and gender to cover the developmental- and performance-related differences.
- Sampling Method: Stratified random sampling: It was involved in order to represent the different clubs and academies in proportion because it entailed the multiple clubs and academies represented according to their gender and age groups (12-13, 14-16).
- Inclusion Criteria:
    - At least 1 year experience playing volleyball continuously.
    - The patient has no musculoskeletal injury registered within the last 6 months.
    - Engaged in exposed or organized training.
- Exclusion Criteria:
    - Any other athlete with long-term health problems, neurological illnesses, and acute trauma.

3.3 Dual-Test Model Framework

The two-test model is a model made of two foundational domains:

A. Physical Attributes Test Battery

1. Vertical Jump (VJ) - Test of explosive power in legs. Apparatus: Jump mat or optical timing gadget. Output: Height in cm.
2. 20-Meter Sprint Test [assessing linear velocity]. Apparatus: Electronic timing gate. Output: Seconds.

Proximus Journal of Sports Science and Physical Education
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3. Agility Test-Illinois Agility Test or T-Test. Measures speed in all directions and coordination. Output: Seconds.
4. Standing Long Jump- Test of horizontal strength of explosion Output: centimeters.
5. Grip Strength - A hand dynamometer 3 Assesses isometric strength of the upper body. Result: Kilograms of force (kgf).

B. Offensive Skills Test Battery

1. Serve Accuracy Test –
   Players perform 10 standing or jump serves toward predefined target zones on the court (each zone has a point value).
   Score = Sum of all zone scores (0–10 scale).
2. Attack Spike Test –
   Measures ball speed using a radar gun and spike height using a high-speed camera or vertical frame.
   Score = Normalized z-score combining speed and height.
3. Setting Accuracy Test –
   Athletes deliver 10 sets to a target positioned at optimal spiking height.
   Score = Number of successful target hits / total attempts (converted to a 0–10 scale).
4. Offensive Decision-Making Test *(Optional)* –
   Players respond to video-simulated offensive scenarios and make real-time decisions (set, attack, or fake).
   Score = Accuracy and response time analyzed through video + expert review.

Figure 1 displays the general breakdown of the proposed dual-test model and it consists of two essential areas that are the physical attributes and offensive volleyball skills. This model promotes a coordinated and well-rounded evaluation of sports abilities that are pertinent in talent identification.

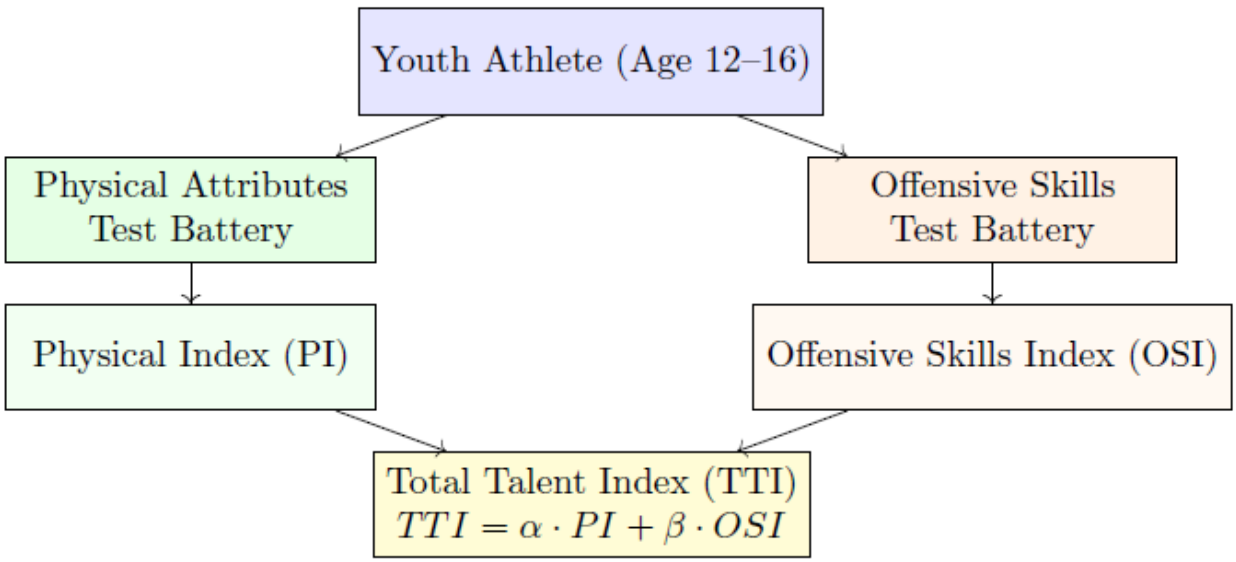

Figure 1: Flowchart of the Dual-Test Model Framework

3.4 Test Development and Pilot Study

A pilot test which was carried out by a sample size (20 youth volleyball players) was to ensure:

- Ease of instructions
- Ability to be put in place

Proximus Journal of Sports Science and Physical Education
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ISSN (E): 2942-9943

- The length of the test per individual athlete
- Strength and fluctuation

The responses of the pilot phase were applied to harmonize:

- The virtual host setup
- Waiting periods between the exams to avoid exhaustion.
- Measurement protocols.

3.5 Reliability and Validity Assessment

3.5.1 Test-Retest Reliability

- After 7 days all the subjects were administered the complete test battery again.
- ICC was computed on each of the subtests.

$$ICC = (MS\_B - MS\_W) / (MS\_B + (k - 1) \cdot MS\_W) \quad (1)$$

where MS_B = mean square between subjects,
MS_W = mean square within subjects,
and k = number of raters or repetitions.

3.5.2 Inter-Rater Reliability

- The technical tests were scored by two trained raters.
- Categorical agreement was based on Cohen Kappa:

$$\kappa = (P\_o - P\_e) / (1 - P\_e) \quad (2)$$

where Po is observed agreement, and Pe is expected agreement by chance.

3.5.3 Content Validity

- Each subtest was reviewed by a panel of 5 experts (coaches, sports scientists, physical education specialists) so as to confirm:
  - Relevance
  - Clarity
  - Representativeness

3.5.4 Construct Validity

- Top ranked players (according to the rating of coaches) were compared to lower ranked on the basis of independent samples t-tests to determine whether test scores match the perceived levels of performance.

3.6 Scoring System and Index Construction

The sub-tests scores were standardized to z-scores:

$$z = (x - \mu) / \sigma \quad (3)$$

Where:

- x = individual test score
- μ = group mean
- σ = standard deviation

Scores were normalized on a 0-10 scale by means of a linear transformation:

$$Standard\ Score = ((z - z\_min) / (z\_max - z\_min)) \times 10 \quad (4)$$

There are two primary indices that have been achieved:

- Physical Index (PI) = average of scaled physical scores
- Offensive Skills Index (OSI) = the average of the normalized skill-based scores
- The total talent index (TTI) was calculated based on regression weights in reference to agreements with the coach ratings:

$$TTI = \alpha \cdot PI + \beta \cdot OSI \quad (5)$$

Proximus Journal of Sports Science and Physical Education
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https://proximusjournal.com/index.php/PJSSPE
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Where are the weights in regression, alpha and beta.

$$TTI \approx Coach\ Evaluation\ Score \quad (6)$$

3.7 Statistical Analysis

The processing of all data was done in SPSS v28 and R:

- Descriptive statistics: Mean, SD, min, max of every variable.
- Factor Analysis (PCA/Varimax): Although this is not the principal purpose of the analysis, it can be used to determine latent dimensions of performance (e.g., power, coordination).
- Pearson Correlation: Between coach ratings and components of the test.
- t-Test / ANOVA: Cross-gender and cross-age comparison.
- Multiple Regression Analysis:

$$Coach\ Rating = b\_0 + b\_1 \cdot PI + b\_2 \cdot OSI + \varepsilon \quad (7)$$

in which b1 and b2 determine the weight of index.

The statistical significance was $p < 0.05$.

4. RESULTS AND DISCUSSION

In this section, the researchers have outlined the findings of applying the dual-test model to a sample of 140 players in youth volleyball competition who were split equally by gender and stratified by age (12-16 years). These results are separated into 2 decomposition parts (A) Physical Attributes, and (B) Offensive Volleyball Skills. The statistics employed in the analysis of the data used descriptive statistics as well as reliability and validity tests and inferential statistics such as correlation or regression and factor analysis.

4.1 Descriptive Statistics of Test Components

The results of each test item in terms of means scores and standard deviations are provided in Table 1 and replicated in Table 2 in both domains of Physical and Offensive Skills.

Table 1: Descriptive Statistics for Physical and Offensive Skills Tests

Test Item	Mean	SD	Min	Max
Vertical Jump (cm)	43.2	5.6	31	57
20m Sprint (s)	3.78	0.33	3.22	4.51
Agility T-Test (s)	10.41	0.79	8.93	12.34
Long Jump (cm)	189.4	20.7	140	225
Grip Strength (kg)	28.3	4.1	19.5	37.2
Serve Accuracy (%)	67.8	11.2	42	90
Spike Efficiency Score (0–10)	7.5	1.4	3	10
Set Accuracy Score (0–10)	6.8	1.7	2	10
Offensive Decision Score	6.2	1.9	1	10

Figure 2 shows a bar chart comparison of means of important aspects of physical and offensive skills tests which compose of the means of all these participants so that the performance distributions can be visualized.

Proximus Journal of Sports Science and Physical Education
Volume 2, Issue 8, August 2025
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

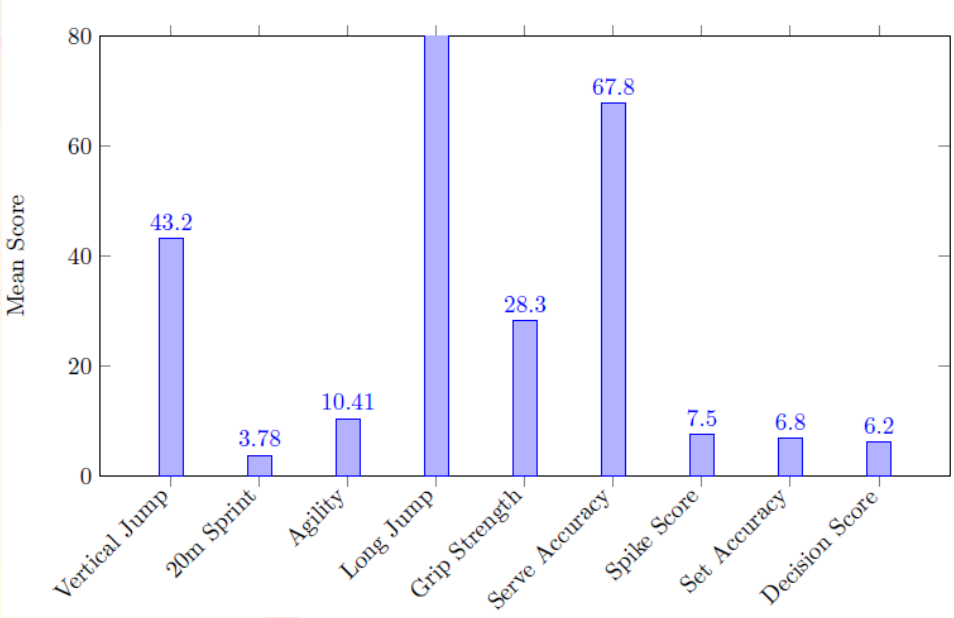

Figure 2: Mean Scores for Physical and Offensive Skill Tests

4.2 Reliability Analysis

In order to measure the test-retest and inter-rater reliability, Intraclass Correlation Coefficients (ICC) and Cohen Kappa were employed.

- ICC values of continuous variables (e.g. sprint, jump, serve) were between 0.86-0.93 which denotes very good reliability.
- Cohen Kappa of the subjective scoring (e.g. decision-making, spike ratings) was 0.81; there was high inter-rater reliability.

4.3 Construct Validity via Factor Analysis

With two major latent components identified with PCA using a varimax rotation, the exploratory factor analysis (EFA) showed two major components.

- Factor 1: Physical Explosiveness and Agility (Eigenvalue = 3.42; 34.2% variance explanation): Encompasses other physical skills such as vertical jump, sprint, agility and the long jump.
- Factor 2: The proficiency of offensive skills (Eigenvalue = 2.87; explaining 28.7% of the variance): The presence of spike, serve accuracy and setting.

This explains the two-dimensionality of test model.

The simplified biplot file (Figure 3) provided by the Principal Component Analysis (PCA) spatially divides the performance dimensions into the so-called latent components: physical explosiveness, and the offensive skill proficiency.

Proximus Journal of Sports Science and Physical Education
Volume 2, Issue 8, August 2025
https://proximusjournal.com/index.php/PJSSPE
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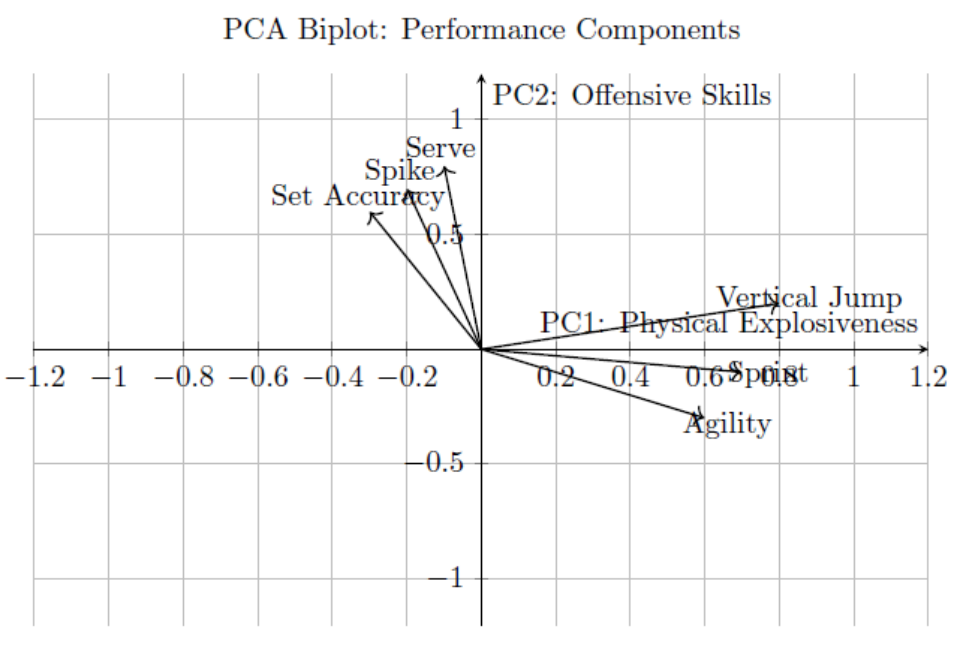

Figure 3: Principal Component Analysis of Test Components

4.4 Correlation Analysis

The correlation coefficients calculated were the Pearson correlation coefficients between the physical attributes and the offensive skills in order to determine their relationship.

Table 2: Correlation Matrix (r values)

	Spike	Serve	Set Accuracy	Decision Score
Vertical Jump	0.61*	0.45*	0.21	0.28
Sprint Speed	-0.53*	-0.39*	-0.18	-0.25
Agility	-0.47*	-0.41*	-0.29*	-0.36*
Grip Strength	0.49*	0.38*	0.15	0.30*

Note: The value of p was less than 0.05.

Based on the results, it is pointed out that explosive power (vertical and grip strength) and agility correlate significantly with offensive skill performance, particularly spiking, and serving.

4.5 Talent Index Development

A weighted regression model was formulated to produce a Total Talent Index (TTI) using both of the sub-indices:

$$TTI = 0.55 \times Physical\ Index\ (PI) + 0.45 \times Offensive\ Skills\ Index\ (OSI) \quad (8)$$

Where:

- PI is a standardized solution to jumps in the air and run, agility, grip, and a long jump.
- OSI is a weighted serve percent, spike, set, and offensive decision percentage.

Regression analysis showed that the TTI significantly predicted coach-rated potential scores ($R^2 = 0.72$, $p < 0.001$), validating its use in talent identification.

The Total Talent Index (TTI) is used to quantify the offensive and physical skills scores that are standardized by weighted regression on the evaluation of coaches to demonstrate the difficulty values; the exact computation of the TTI is shown in Figure 4.

Proximus Journal of Sports Science and Physical Education
Volume 2, Issue 8, August 2025
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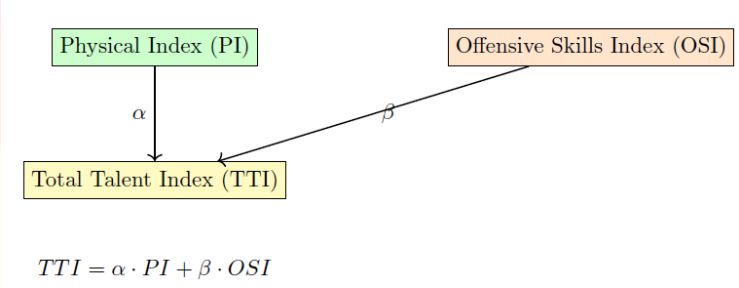

Figure 4: Computation of the Total Talent Index

4.6 Gender and Age-Based Performance Differences

It was found that Multivariate ANOVA revealed significantly different results according to gender and age groups:

- The men received higher scores in physical examinations ($p < 0.01$) especially when it came to jump height and hand grip strength.
- Although females are a bit behind in explosive metrics, they had a higher serve and set accuracy at certain brackets.
- The group of older participants (15 16) performed better in regard to most domains in comparison to younger ones ($p < 0.001$).

It is important to note that age- and gender-specific customization of the dual-test model needs to be done.

4.7 Discussion

The findings support the efficacy and legitimacy of the proposed dual-test model as an instrument that evaluates youth talent in volleyball. This correlation between offensive skills with physical attributes is high and it correlates with the existing studies on the dominance of power, speed, and coordination on prediction levels of the prowess of volleyball players. Spike efficiency and serve accuracy was also most effectively predicted by a combined measure measuring vertical jump and grip strength, which once again demonstrated the importance of neuromuscular power in offence. Besides, the Total Talent Index is formulated to unlock and help coaches and development programs to make data-informed decisions on player selection and evaluation of development priorities.

5. CONCLUSION

The current research was successful in coming up with and standardizing a two-test model incorporating both physical factors and the evaluation of the offensive skill of those involved in youth-level volleyball at 12-16 years of age. The scientific research techniques, such as implementation of pilot testing, statistical validation and expert evaluation proved high reliability and validity of the model. That the model has a two-dimension design with one arm representing a Physical Index (PI) and the other an Offensive Skills Index (OSI) allows producing a comprehensive picture of the potential of a young athlete filling the gap by isolating the measures of the physical condition, on the one hand, and the skills base, on the other.

The development of standard testing procedure and scoring standards is one of the major findings of this research. These enable coaches, talent scouts, sports academies to evaluate athletes on the same platform as they are objectively assessed regardless of regional variations or institutional variations. After matching test scores against judgments of expert coaches in terms of weighted regression and factor analysis, the resulting product is Total Talent Index (TTI) which can be utilized as an indicator of future athletic performance and developmental requirements. The implications of the research findings are the need to standardize age- and gender-sensitive care. The observed and measured differences between age categories and male and female athletes testify to the fact that one should interpret testing scores within the socio-context related to

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development primarily when the training program is developed or an elite developmental program is created. Such differences further remark on the necessity to have multi-dimensional methods of talent detection in youth sports. In addition, the dual-test model can serve the long-term athlete development (LTAD) strategies that can be used to provide data-driven early specialization or diversified training suggestions. It moves the conversation away on subjective picklook processes into evidence based practices that give way to fairness and inclusion in sports development pipelines. Finally, it can be noted that the proposed dual-test model will not only allow filling the gap between physical and technical tests but also will provide the scaling, adaptive, and scientific approach to the talent identification in volleyball. Future study can go further to utilize the model in the areas of defensive skills, psychological preparedness, and actual game performance criteria in the direction of a complete user of the athlete profile and eventual overall success in top level volleyball competition.

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