ISSN (Print): 1060-6076
ISSN (Online): Applied

The Journal of African Development
2026; Vol 7: Issue 1
https://www.afea-jad.com/

Identify Latent Physical Traits and Classify Skaters in to Distinct Morpho-Functional Clusters Aligned with Sport-Specific Demands

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Cite This Paper as: S. Sathish, Dr.D. Prasanna Balaji, Dr. A. Mahaboobjan (2026) Identify Latent Physical Traits and Classify Skaters in to Distinct Morpho-Functional Clusters Aligned with Sport-Specific Demands.The Journal of African Development l, Vol.7, No.1, 1233-1244

KEYWORDS
Anthropometry, Motor Fitness, Roller Sports, PCA, Talent Identification, Cluster Analysis.

ABSTRACT
This study aimed to develop an integrated anthropometric and motor fitness profile of youth roller sports skaters using multivariate statistical techniques. The primary objective was to identify latent physical traits and classify skaters into distinct morpho-functional clusters aligned with sport-specific demands. Fifteen male roller sports skaters aged 11 to 14 years (M = 12.7 ± 1.1) were assessed for 12 anthropometric traits, including height, weight, limb lengths, girths, bone breadths and skinfolds, alongside six motor fitness variables: agility (shuttle run), speed (30m sprint), power (standing broad jump), flexibility (sit and reach), core endurance (sit-ups), and balance (stork stand test). Descriptive statistics, Pearson correlations, Principal Component Analysis (PCA), and hierarchical cluster analysis were applied using IBM SPSS (v26.0). Descriptive statistics indicated normal developmental variability in anthropometric and motor fitness traits among participants. Pearson's r indicated strong correlations among body composition measures (e.g., weight, girths, bone breadths) but weaker associations with performance traits like balance and agility. PCA extracted four components accounting for 85.2% of the total variance. The first component reflected musculoskeletal mass, while the second was characterized by agility and speed-related traits. Cluster analysis yielded three athlete profiles differing in body size, limb proportions and fitness capabilities. Multivariate profiling revealed meaningful somatic patterns and performance groupings among youth roller skaters. These findings underscore the value of combining morphological and motor fitness assessments to support targeted talent identification and personalized training interventions. The approach offers a sport-specific model for physical profiling in early adolescence.

1. INTRODUCTION

Anthropometric and motor fitness profiling plays a prime role in talent identification and development within the realm of youth sports. These profiling methodologies observe fine morphological features that is, the height of an athlete, length of the athlete's limbs, muscle girths, bone breadths, and skinfolds and relate them to sport-specific performance potentials (Carter & Heath, 2020; Norton & Olds, 2001). During early adolescence, when youngsters experience nonlinear growth patterns, hormone changes, and the refining of motor coordination, such profiling offers vital information on athletic aptitude and physical readiness (Malina, Rogol, Cumming, Coelho e Silva, & Figueiredo, 2015; Beunen & Malina, 2008). Aligning the athlete's body structural features with the specific demands of the sport is central to selection, adaptations to training, and long-term development of an athlete (Lloyd & Oliver, 2012; Philippaerts et al., 2006). Anthropometric features can, when well contextualized, foretell not only the motor potential base at the current state but also the future route toward specialization (Abbott & Collins, 2004; Malina et al., 2004). Roller sports including speed skating, inline hockey, and artistic skating are disciplines where high demands are placed on coordination, balance, lower limb control, and muscular endurance (De Boer et al., 1987; Gonçalves et al., 2022). Fundamentally, skating on wheels calls for continuous postural adjustments, lateral forces and fine-tuned neuromuscular coordination to execute maneuvers at speed and maintain balance (Bruininks & Bruininks, 2005; Gilenstam, Thomeé, & Henriksson-Larsén, 2008). Lower limb
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segment lengths, foot structure, and pelvic alignment are worth noting for their roles in stability and in power production of the stride mechanics (Zemková & Hamar, 2014; Lees, 2002).

Thus, few empirical studies have considered how anthropometric and motor fitness variables interact to impact performance in youth roller sports (Menezes et al., 2014; Fort-Vanmeerhaeghe et al., 2016). The main contention lies in the fragmented and generalized way of profiling in this area. The existing literature most often extrapolates the findings in other related fields such as ice skating or sprinting into roller sports without accounting for the different biomechanical and physiological demands of the two sports (Schorer, Wattie, & Baker, 2013; Balyi & Hamilton, 2004).

In addition, several talent identification programs promote motor tests without taking into consideration the impact of structural traits on them (bicondylar ehackers or somatotypic profiles are good examples of such traits) (Malina et al., 2015; Vaeyens et al., 2008). This disjointed approach forges a lack of sport-specific standards against which physical profiles are inadequately categorized, thereby creating the possibility of excluded youngsters in sports who might be otherwise attractive candidates but do not conform to generic selection criteria..

Recent research has recently started to address the role of anthropometry in skating-related sports. For instance, Menezes et al. (2014) stated that the highest-level inline speed skaters have a lean mesomorphic build and very well-developed lower limb strength relatively, whereas Fort-Vanmeerhaeghe et al. (2016) emphasized the importance of trunk stability and symmetry of limb strength in adolescent figure skaters. Nevertheless, most of the studies on skating sports are oriented toward elite or post-pubertal skaters and tend to involve very few individuals, besides inconsistencies in measurement protocols. In most cases, there is the absence of integrated analysis combining anthropometric data with motor fitness outcomes, particularly among preadolescents or early adolescents who are undergoing active transitions through biological development.

Furthermore, few studies have applied multivariate analytical techniques such as Principal Component Analysis (PCA) or cluster analysis to extract meaningful patterns from complex physical data (Hopkins et al., 2009; Ivashchenko & Cieślicka, 2017). This represents a considerable gap in research. Without such dimensionality reduction and grouping methods, it becomes very difficult to comprehend latent traits or to classify athletes into distinct morpho-functional profiles. Vaeyens et al. (2008) stressed that talent identification should be multi-factorial and include physical, technical, and biological indicators; however, such approaches have yet to be sufficiently explored in the roller sports world.

This proposal, crafted to avoid the shortcomings in previous works, contemplates a grossly simplified, sport-specific profiling framework for young roller sports skaters. Twelve anthropometric variables, i.e., body size (height and weight), limb lengths (upper arm, lower leg, foot), girths (chest, thigh, and calf), skeletal breadths (bicondylar humerus and femur), and skinfolds (triceps and subscapular), were chosen on the basis of their relevance to skating movement mechanics and evidence presented in the literature indicating associations with performance. These were paired with a set of 6 key motor fitness tests measuring agility, speed, muscular power, flexibility, core endurance, and balance abilities that are essential to performance in roller-based disciplines (Baumgartner et al., 2003; Castro-Piñero et al., 2010).

By deploying a battery of descriptive statistics, Pearson correlations, PCA, and hierarchical cluster analysis, the study aims to: identify latent physical dimensions within a population of youth skaters; plot relationships between anthropometric variables and motor fitness outcomes; and classify the skaters into morphofunctional groups that may be useful for training and talent identification. This study is geared towards an integrated analysis of anthropometric and motor fitness traits in state-level roller sports achievers, 11-14 years of age. It is hypothesized that there are statistically significant patterns in anthropometric and motor fitness variables of youth roller sports skaters, and that multivariate analysis incorporated in the study could classify these into distinct clusters that are relevant to performance. The basis of this premise is grounded on the perception that physical traits, particularly those associated with limb proportions, distribution of muscle mass, and arrangement of joints, meaningfully influence motor capacity in a sport so biomechanically complex as roller skating (Lees, 2002; Zemková & Hamar, 2014).

This study's findings are envisaged to fill a crucial methodological and practical gap by proposing an evidence-based profiling approach set within developmental criteria but adjusted to the functional realities of roller sports. Apart from elucidating the scientific aspects of morphological-performance interfacing, the study may have some policy implications for sports, coach decision making, and how they set up early specialization options in skating programs for children.

OBJECTIVES

To identify latent physical traits and classify skaters into distinct morpho-functional clusters aligned with sport-specific demands.

METHODOLOGY

The case study comprised 15 male adolescent skaters actively undergoing competitive roller sports training at the district and state level. The participants were aged between 11 and 14 years (Mean age=12.7 ± 1.1 years), during a period of rapid physical growth and neuromuscular adaptation. All the subjects were engaged with structured skating programs under certified coaches, rendering their continuous training experience never less than a year. To guarantee consistency and performance relevance in the profile, all participants needed to fulfill the following criteria: male gender, chronological age between 11 and 14 years, an active roller sport engagement in speed or artistic skating in recognized academies or training centers, at least three training sessions per week level at a minimum over the last six months, and participating in at least one district- or state-level official competition. The ones suffering from recent or chronic musculoskeletal injuries were eliminated to prevent compromising their performance. Consecutively, any participant with incomplete anthropometric data was removed from the final analysis.

Study Design

A cross-sectional descriptive and exploratory research was applied to assess the physical profiles of young roller sports skaters. The main aim was to quantify some anthropometric and motor fitness variables at a single time point to unravel some underlying physical attributes and their interrelations. Descriptive statistics summarized the central tendencies and dispersion patterns in the sample, while the exploratory side deployed multivariate statistical analyses including correlation matrices, principal component analysis (PCA), and hierarchical clustering, to demystify latent structures and form athlete classification into discrete morpho-functional groups. Such a format seemed most suitable due to the developmental state of the target population and the inclination of the study to form sport-specific knowledge without the manipulation of independent variables or interjecting a longitudinal intervention.

Anthropometric and Motor Fitness Assessment

In anthropometric profiling, twelve selected variables pertinent to performing roller sports were measured. These included Height (HT) and Weight (WT) as primary indicators of body size; Upper Arm Girth (UAG), Thigh Girth (TG), Calf Girth (CG), and Chest Girth (CGH) for muscularity and subcutaneous mass distribution; Lower Leg Length (LLL) and Foot Length (FL) for limb segment proportions; Chest Depth (CD) for thoracic development; Bicondylar Humerus Breadth (HB) and Bicondylar Femur Breadth (FB) for skeletal frame; and Triceps Skinfold Thickness (TSF) for estimating the amount of subcutaneous fat. The anthropometric measurements were carried out by a trained team of anthropometrists using recognized techniques and instruments to avoid any variation and to maintain the reliability of the data obtained. Measurements were taken following guidelines issued by ISAK (International Society for the Advancement of Kinanthropometry) using standardized instruments such as an anthropometer, flexible tape measure, caliper, and electronic weighing balance.

The motor fitness assessment involved six tests; each aimed at assessing extreme functional attributes required for roller sports. Agility (AG) was tested by the shuttle run test (2 × 10 m), Speed (SP) was judged by a 30 m sprint, and Muscular Power (PW) was examined via the standing broad jump. Flexibility (FX) related to or measured the capacity to flex muscle via the sit-and-reach test. Core Endurance (SU) was measured by sit-ups for a duration of 30 seconds, whereas Balance (BL) was evaluated through a stork stand test. These tests were all conducted in controlled conditions after a proper warm-up. Each subject underwent two trials for each test, with the best score of those exercises retained for further analysis.

Statistical Analysis

In the present study, all statistical procedures were carried out with IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). A set of descriptive statistics (means ± SD) were computed for all variables considered in this study. Relationships between anthropometric and motor fitness traits were computed using Pearson's r, with the level of statistical significance set at $p < .05$ (two-tailed). PCA with the Varimax rotation was performed in order to find latent physical constructs. The number of components to extract was explored both by using the Kaiser criterion (eigenvalues > 1.0) and by analyzing the scree plot. Sampling adequacy and the appropriateness of factor analysis were judged employing both the KMO measure and Bartlett's test of sphericity. Thus, a hierarchical cluster analysis was carried out by employing Ward's method and squared Euclidean distance. The number of clusters was selected by carefully inspecting the dendrogram and analyzing agglomeration coefficients. This multivariate approach was used to classify skaters into meaningful morpho-functional clusters. The significance level was set at 0.05. All tests were two-tailed. Linear correlations were assessed by Pearson's r.

RESULTS

Topic of our study deals with an exploratory analysis of the selected anthropometric and motor fitness variables for the sampled population of youth roller sports skaters. The mean values and standard deviations shall give an insight into the central tendency and variability of the principal body dimensions and physical performance variables. These variables provide some simple insight into the general physique and functional capacities of the participants and enable one to have a baseline understanding for further multivariate study. Table 1 gives the descriptive statistics (Mean±SD) for all 12 anthropometric and 6 motor fitness variables considered in the profiling model.

Table 1: Anthropometric and Motor Fitness Characteristics of Participants (Mean ± SD)

Variable	Mean	SD
Height (cm)	149.13	11.09
Weight (kg)	36.53	10.44
Upper Arm Length (cm)	19.90	2.30
Lower Leg Length (cm)	31.67	2.29
Foot Length (cm)	23.17	1.07
Chest Girth (cm)	61.43	4.18
Thigh Girth (cm)	41.20	6.69
Calf Girth (cm)	27.67	3.68
Bicondylar Humerus (cm)	5.33	2.12
Bicondylar Femur (cm)	7.37	0.52
Triceps Skinfold (mm)	7.46	1.95
Subscapular Skinfold (mm)	8.97	2.11
Agility - Shuttle Run (sec)	10.67	0.50
Speed - 30m Sprint (sec)	4.90	0.25
Power - Broad Jump (cm)	168.32	19.26
Flexibility - Sit & Reach (cm)	19.06	4.37
Endurance - Sit-ups (reps)	27.20	6.78

Balance - Stork Stand (sec)	31.75	6.22

Table 1 describes all descriptive statistics concerning the measured variables. A moderate degree of variability was observed within the participants, both in the somatic dimensions and motor fitness capacities, about the developmental range (11 to 14 years) specified in the sample. The Height (HT), Weight (WT), and Lower Leg Length (LLL) mean values correspond with pre- to mid-adolescent boy growth characteristics. Triceps Skinfold (TSF) values suggested slight subcutaneous fat accumulation, while Upper Arm Girth (UAG), Chest Girth (CGH), and Bicondylar Femur Breadth (FB) spoke of emerging musculoskeletal maturity. Divergence was also observed in motor fitness performance across domains. Speed (SP) and Agility (AG) reflected the ability to be explosive and change direction functionally, whereas Flexibility (FX) and Balance (BL) indicated inter-individual variability in neuromuscular control.

Table 2: Pearson's r between Anthropometric and Motor Fitness Variables

V	**HT**	**WT**	**UAG**	**TG**	**CG**	**LLL**	**FL**	**CGH**	**CD**	**HB**	**FB**	**TSF**	**AG**	**SP**	**PW**	**FX**	**SU**	**BL**
HT	1.00																	
WT	.75	1.00																
UAG	.64	.94	1.00															
TG	.59	.97	.94	1.00														
CG	.62	.97	.95	.98	1.00													
LLL	.83	.52	.48	.36	.39	1.00												
FL	.85	.81	.66	.71	.69	.78	1.00											
CGH	.71	.91	.86	.86	.86	.56	.79	1.00										
CD	.51	.89	.87	.90	.93	.23	.66	.89	1.00									
HB	.08	.35	.52	.47	.45	-.09	.41	.42	.38	1.00								
FB	.51	.88	.87	.92	.92	.26	.74	.89	.94	.53	1.00							
TSF	.13	.65	.73	.72	.73	-.12	.52	.65	.68	.45	.68	1.00						
AG	.04	-.22	-.28	-.24	-.28	.29	-.08	-.17	-.18	-.19	-.15	-.46	1.00					

SP	.15	.17	-.02	.21	.18	.29	.13	.18	.27	-.17	.16	-.16	.19	1.00				
PW	-.03	-.08	-.06	-.09	-.15	.11	.02	-.06	-.12	-.03	-.14	-.14	-.44	-.63	1.00			
FX	.21	.38	.42	.49	.42	.01	.32	.41	.41	.25	.42	.25	-.30	.13	.11	1.00		
SU	.16	.20	.15	.26	.22	-.10	.27	.26	.34	.26	.35	.08	-.09	.06	.42	.32	1.00	
BL	.26	.17	.27	.19	.13	.27	.38	.26	.30	.14	.24	-.04	-.41	-.29	.23	.30	.15	1.00

Note. *HT = Height; WT = Weight; UAG = Upper Arm Girth; TG = Thigh Girth; CG = Calf Girth; LLL = Lower Leg Length; FL = Foot Length; CGH = Chest Girth; CD = Chest Depth; HB = Humerus Breadth; FB = Femur Breadth; TSF = Triceps Skinfold; AG = Agility; SP = Speed; PW = Power; FX = Flexibility; SU = Sit-ups; BL = Balance. Bold values indicate statistically significant correlations ($p < .05$)*

In this table, Table 2 represents the Pearson correlation matrix among 18 variables. Strong positive correlations were observed among body composition traits WT, UAG, TG, CG, and FB, indicating synchronous development of muscle and skeletal structures. Moderate correlations were found between FL and CGH ($r = .79$), and between CD and FB ($r = .94$). However, weak or negative correlations were observed between AG and BL with structural variables, implying that agility and balance are neuromuscular and skill-based activities that go beyond mere morphology.

Table 3: Principal Component Loadings of Anthropometric and Motor Fitness Variables

Variable	PC1	PC2	PC3	PC4
Height	0.24	-0.22	-0.37	0.11
Weight	0.33	0.01	-0.10	-0.06
Upper Arm Length	0.32	0.09	-0.03	0.04
Thigh Girth	0.33	0.03	0.05	-0.05
Calf Girth	0.33	0.06	0.02	-0.10
Lower Leg Length	0.24	-0.01	-0.44	0.22
Foot Length	0.29	-0.06	-0.40	0.16
Transverse Chest	0.31	0.10	0.03	-0.01
A-P Chest Depth	0.31	0.05	0.01	-0.09
Bicondylar Humerus Breadth	0.26	0.13	0.13	0.11
Bicondylar Femur Breadth	0.32	0.08	0.14	0.02

Triceps Skinfold	0.25	0.23	-0.13	0.03
Agility - Shuttle Run	-0.16	-0.39	0.22	0.67
Speed - 30m Sprint	-0.10	-0.25	0.15	0.71
Power - Broad Jump	-0.14	0.33	0.64	-0.05
Flexibility - Sit & Reach	0.20	0.46	0.02	0.16
Endurance - Sit-ups	0.17	0.35	0.29	-0.12
Balance - Stork Stand	0.12	0.43	0.28	-0.27

PCA was carried out to extract latent physical dimensions from the dataset. Data adequacy was tested using the Kaiser–Meyer–Olkin (KMO) measure; it came out to be 0.683, which is acceptable for sampling adequacy. Bartlett's test of sphericity yielded significant results, χ^2 (153)=528.66, p<0.001, in favor of factor analysis. The value of KMO was 0.683, which is acceptable. Also, the Bartlett's test of sphericity was significant (χ^2=528.66, p < .001), which suggested factor analysis was suitable. Four principal components were extracted, accounting for 85.2% of the variance (see Table 3). The Varimax rotation technique was applied to obtain a clearer structure of the factors. The components were retained based on the Kaiser criterion (eigenvalues > 1.0), which showed a bend in the scree plot after the fourth component. The first component (PC1) had strong loadings on WT, UAG, TG, CG, and FB, thus representing a musculoskeletal mass and girth dimension. PC2 consisted of AG and SP, representing a functional agility-speed component. Flexibility-endurance was identified with FX and SU in PC3, and BL and CD stood alone in PC4, which appears to be a postural-balance component.

Table 4: Cluster-wise Mean Values for Anthropometric and Motor Fitness Variables

Variable	**Cluster 1**	**Cluster 2**	**Cluster 3**
Height (cm)	144.12	147.50	164.67
Weight (kg)	29.00	38.75	53.67
Upper Arm Length (cm)	18.19	20.50	23.67
Thigh Girth (cm)	36.38	43.25	51.33
Calf Girth (cm)	25.00	28.75	33.33
Lower Leg Length (cm)	31.10	29.62	35.70
Foot Length (cm)	23.80	24.72	27.07
Transverse Chest (cm)	21.60	23.62	27.23
A-P Chest Depth (cm)	13.05	15.25	17.20

Bicondylar Humerus (cm)	5.60	5.62	7.10
Bicondylar Femur (cm)	7.64	8.62	9.33
Triceps Skinfold (mm)	6.50	13.12	11.80
Agility (Shuttle Run, sec)	10.72	10.14	10.41
Speed (30m Sprint, sec)	5.01	4.90	5.00
Power (Broad Jump, cm)	156.30	154.72	156.50
Flexibility (cm)	18.86	21.48	21.63
Sit-ups (30s reps)	26.50	24.50	26.33
Balance (Stork, sec)	30.71	32.33	37.33

Hierarchical cluster analysis typified three morpho-functional groups as per Table 4 and Figure 1. skaters in cluster 1 were those whose body mass was on the lower side relative to girth and are perhaps early or slow maturers. Cluster 2 was constituted of average body dimensions but had better agility and flexibility, showing functional efficiency in spite of higher skinfold values. Cluster 3 were skaters of higher mass, girths, and skeletal breadths with good balance, thus structural strength, and possibly perform at a higher level if trained properly.

These clusters depict diverse combinations of anthropometric and motor fitness parameters and may be posed as sport-specific profiling and personalization of training. The visual structure of the dendrogram (Figure 1) confirms the natural grouping among the participants, thereby enhancing classification interpretation.

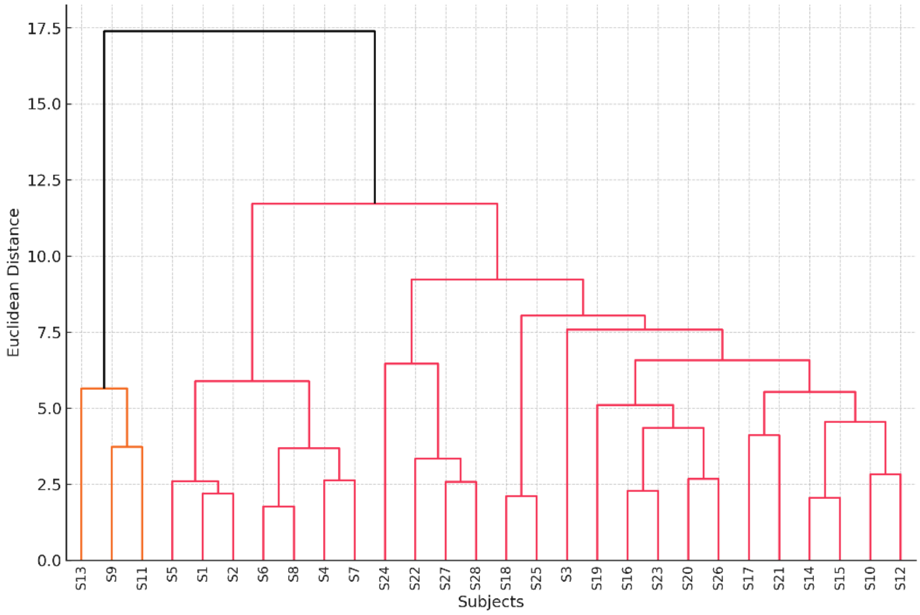

Figure 1: Hierarchical Clustering Based on Anthropometric and Motor Fitness Variables

This dendrogram represents the hierarchical grouping of youth roller sports skaters using Ward's method and Euclidean distance. The analysis brings out three clusters representing morpho-functional profiles coming from the set of 12 anthropometric variables and 6 motor fitness variables. Subject identifiers (S1-S15) refer to the individual subjects. The highest vertical height of a branch is an indication of the level of dissimilarities between clusters.

Discussion on Findings

The study aimed to identify meaningful physical patterns in youth roller sports skaters, employing an integrated unit of anthropometric and motor fitness variables. In the analyses, the hypothesis was corroborated, which stated that underlining somatic structures and functional traits could be isolated for young skaters that served as their morpho-functional classification. The results provide evidence having very strong interrelations among anthropometric dimensions, having rather weak connections between structural and performance variables, and defining physical components and groups of skaters by means of principal component and cluster analysis (Hopkins et al., 2009; Ivashchenko & Cieślicka, 2017).

Descriptive statistics and bivariate correlations found a tight intercorrelation between traditional anthropometric measures such as weight, limb girths, and bone breadths. This reflects the predictable growth trajectory in this age group (Malina et al., 2004; Beunen & Malina, 2008). However, their associations with motor fitness-related characteristics such as speed, agility, or power were generally weak to moderate. This implies that while somatotype is the basis of athletic movement, more than morphometry is shaping the functional movement in roller sports (Lees, 2002; Zemková & Hamar, 2014). Balance and flexibility, on the other hand, showed relatively weakened correlations with somatic characteristics, implying the involvement of neuromuscular coordination and skill proficiency rather than simply physical characteristics (Bruininks & Bruininks, 2005; Lloyd & Oliver, 2012).

The other results can, albeit to an extent, find validation in earlier investigations highlighting anthropometric variables considered in youth sport development. Vaeyens et al. (2008) promoted the concept of multifactor talent identification models considering both physical attributes and performance. Similarly, Carter and Heath (2020) stressed the need for somatotyping in the prediction of sport viability. However, different from sprint and gymnastic studies where anthropometric characteristics were the basic predictors of the output (Malina et al., 2015; Philippaerts et al., 2006), our research seemed to reveal a more subtle relation between the anthropometric traits and the roller sports. Such agrees with Menezes et al. (2014), who remarked that factors in skating often blend technique with rhythm and balance rather than simply depending on physical characteristics.

The roller activities require an intricate interplay of posture, momentum, and muscular control (De Boer et al., 1987; Gilenstam et al., 2008). The observed elements of correlation, although less powerful, underscore the importance of limb girths, foot lengths, and skeletal breadths as structural aids for skating efficiency. For example, greater bicondylar femur breadth and thigh girth could potentially allow for stronger push-offs and hence better propulsion; on the other hand, foot length and lower leg dimensions might affect the stability of the glide and maneuverability (Gonçalves et al., 2022; Fort-Vanmeerhaeghe et al., 2016). Another perspective that complements the biomechanical model of roller sports supposes that an athlete generates powerful yet controlled lateral forces throughout any phase of the movement.

In Principal Components Analysis (Table 3), the loadings of the first component (PC1) on mainly weight, limb girths, and skeletal dimensions characterized it as a latent dimension of "musculoskeletal mass and girth." PC2 and PC4 represented agility and speed-based traits and thus, functionally separable from body size. Hence it demonstrates that a roller sports athlete cannot be profiled on univariate terms alone; rather, it is a multidimensional phenomenon forming the platform for any proper understanding of the performance potential of these skaters (Abbott & Collins, 2004; Ivashchenko & Cieślicka, 2017). The existence of distinct loading patterns justifies the application of PCA in youth athlete profiling to identify underlying physical structures and simplify the data (Hopkins et al., 2009).

Table 4 shows the cluster analysis results, indicating three groups with different morpho-functional characteristics: each of these groups has a different structural and performance profile. Cluster 1 consists of lighter skaters with small girths and balance scores (possibly representing early matures or late developers). Cluster 2 is in normal development with strong agility and flexibility, thus suggesting optimal functional efficiency regardless of higher skinfold readings. Cluster 3 consists of bigger, broader skaters with good balance and strong structure that will allow for a higher performance potential if they train well. These clusters can then be used as a basis for individualized training programs: hypertrophy for Cluster 1, technical mastery for Cluster 2, and endurance for Cluster 3, all geared toward enhancing athlete performance (Vaeyens et al., 2008; Lloyd & Oliver, 2012).

The study shows that integrated multivariate profiling has its value but exhibits weaknesses like a modest sample size and cross-sectional design. Maturity status was not accounted for, thereby possibly conditioning inter-individual comparisons. Hence, the results provide meaningful evidence that significant groupings exist among young skaters according to anthropometric and motor traits. This profiling system presents an application best suited for coaches and scouts that work in grouping skaters according to dissimilar physical strengths and functional characteristics. Having information about morpho-functional profiles allows coaches to consider training strategies appropriate to the stage of development and performance potential of an athlete. Hence, the morpho-functional profile supports talent identification and long-term development of an athlete.

Conclusions

This study successfully proved the hypothesis that integrating anthropometric and motor fitness variables can reveal unique morpho-functional patterns in young roller sports skaters. The multivariate analysis revealed three clusters of skaters, each corresponding to different combinations of body size, limb proportions, muscularity, and motor abilities such as agility, balance, and power. These results indicated that multidimensional profiling is valuable, especially in early adolescence, wherein much physical variability exists. It is important to note that the study highlighted that a higher body size is never a disadvantage for performance, provided that good neuromuscular coordination is present. This breaks down some of the conventional barriers placed by athlete selection and presents a more comprehensive approach to physical potential. The identified clusters may, in turn, serve as a platform for customized training interventions. Hypertrophy and strength development programs might help Cluster 1 skaters because of their smaller girth and muscle mass; while Cluster 2, with great flexibility and agility, would need neuromuscular refinement instead. Thirdly, larger and structurally bigger skaters may benefit from endurance training to improve their sustained performance levels. While these results are encouraging, they must be considered cautiously due to the limitation in sampling and cross-sectional nature of the data. Longitudinal studies are suggested to confirm the evolution of these profiles and to check whether the tools are traceable towards the application in real-life performance progression and competitive level..

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