

# Longitudinal analysis of physical abilities and fundamental skills among the Real Madrid Foundation UNY football players

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

## Abstract

**Background and Study Aim** Football requires physical ability and fundamental skills. Observations regarding this aspect are still mostly carried out in the short term so the results found cannot be said to be comprehensive. The research aims to determine the development of physical abilities and fundamental skills simultaneously within a period of one year.

**Material and Methods** The research is quantitative and descriptive with a longitudinal approach. Participants consisted of 31 male soccer players aged 13-15 years, with weights ranging from 47 to 60 kg and heights ranging from 146 to 164 cm. Sit and reach instruments, 30-meter sprint, vertical jump, MFT, arrowhead, ball throwing, dribbling, passing, receiving, and shooting instruments. Wilcoxon, Kruskal Wallis, and Posh Hoc test data analysis techniques assisted by SPSS 23.

**Results** The Post Hoc analysis yielded comprehensive results, with overall Adj.Sig values ranging from 0.000-0.023 < 0.05 for variables of physical abilities and fundamental skills. Wilcoxon test results for physical abilities, flexibility, coordination, speed, power, agility, endurance sig 0.000 - 0.024 < 0.05. Fundamental skills shooting, dribbling, receiving, passing sig 0.000 < 0.05. The results of the Kruskal Wallis test for physical ability and fundamental skills have a sig value of 0.000 < 0.05.

**Conclusions** Based on the results obtained, it can be concluded that observations for one year illustrate that the physical abilities and fundamental skills of soccer players in the second semester are better than in the first semester. Apart from that, there is simultaneous development of the physical abilities and fundamental skills of soccer players within a period of one year.

**Keywords:** longitudinal study, physical abilities, fundamental skills, football players, young age

## Introduction

Physical abilities and fundamental skills are crucial aspects often considered in the professional development of football players [1]. These respectively include flexibility, endurance, coordination, speed, and power [2], as well as dribbling, shooting, receiving, and passing, which play significant roles in determining the results of a match [3]. Seamless coordination, agility, and speed are required when running, dribbling, passing opponents, and shooting football. Additionally, adequate endurance is needed to maintain performance during a twice 45-minute match [4]. A study reported that elite players commonly execute 150-250 intense and brief actions in a single match [5], signifying the importance of cultivating physical abilities and fundamental skills among the young age group.

In response to the challenges, the Real Madrid Foundation at Yogyakarta State University (UNY) implements football coaching focused on long-term

athlete development (LTAD). This approach includes planned, systematic, and sustainable coaching aimed at achieving early victories alongside the development of life skills, such as cooperation, tolerance, leadership, respect, and a sense of ownership [6]. Additionally, age groups of football players are adjusted based on chronological or actual age, years of training, as well as physiological, psychological, and pedagogical principles [7]. Despite these efforts, optimal implementation of the LTAD concept in football coaching has not been attained.

Previously, Fischeeti & Greco applied a multilateral training approach to enhance physical, technical, and motor skills [8]. Several other studies implemented resistance training based on LTAD [9], explored the opinions of coaches on LTAD effectiveness [10], and assessed the sociological perspective of LTAD adaptation and application [11]. Some sources conducted a narrative model study on the development and coaching of young athletes [12], physiological monitoring [13], and application of game experience learning in football adapting the LTAD concept [14]. Further examinations extended

to the development of LTAD-based training models in various stages of sports such as judo [15] and pencak silat (17), testing of LTAD concept impact on physical development and academic performance [16], as well as performance augmentation based on physical education [17]. Recently, LTAD-based programming was implemented to enhance physical abilities and fundamental skills in basketball [18].

Most of the studies are confined to short-term coaching, LTAD-based model development, and cross-sectional experimental designs, lacking correspondence with LTAD terminology, particularly in terms of long-term monitoring through longitudinal studies. Additionally, the LTAD concept has been criticized for solely being a theoretical process without practical verification [19]. More scientific evidence and evidence-based analyses are suggested for the validation of LTAD effectiveness. This observation is reinforced by the report of various limitations arising from model-based assumptions and less comprehensive study techniques [13], hence scientists need to revise, question, and thoroughly test the LTAD concept [13].

Physical abilities and fundamental skills testing in football should not be viewed solely as a short-term improvement measure because it is unfit to serve as a final benchmark in LTAD implementation. However, training consistency and natural selection provide real evidence of football player performance. In the holistic development of young athletes, internal factors as well as environmental aspects, including parental support, discipline, and adequate coaching resources, need to be examined [16].

Considering the existing gaps in previous investigations, this study aimed to conduct a longitudinal analysis of physical abilities and fundamental skills in young football players at the Real Madrid Foundation Academy in UNY.

## Material and Methods

### *Participants*

This study comprised 31 male football players aged 13-15 years, with weights of  $\pm 47-60$  kg and heights ranging from 146-164 cm. Furthermore, the participants were affiliated with the Real Madrid Foundation Academy in UNY, Indonesia.

Informed consent was acquired from parents, and the study received approval from the Yogyakarta State University ethics committee because the procedures were in accordance with the standards set forth in the Declaration of Helsinki.

### *Study Design*

This quantitative descriptive study applied a longitudinal approach that obtained facts through continuous and time-focused observational analysis [20]. The study used a longitudinal panel study design, concentrating on time, with variables examined from the same sample at different times

[21]. Data were collected through observational and field tests, aiming to explore the state of physical abilities, including flexibility, speed, vertical jump, aerobic endurance, agility, and coordination, as well as fundamental skills comprising dribbling, passing, receiving, and shooting. Instruments used to measure physical abilities included sit and reach, 30-meter sprint, vertical jump, multistage fitness test, arrowhead, as well as ball catching and throwing [22]. Meanwhile, fundamental skills were assessed with dribbling, passing, receiving, and shooting [23] according to the following testing order.

### *Preparation Phase*

Current individual status, including physical abilities and fundamental skills, was assessed through observation of the Real Madrid Foundation UNY football players aged 13-15 years old. Due to insufficient data resulting from previous studies based on cross-sectional designs, the need for longitudinal observations was identified. Subsequently, instruments for conducting field tests on characteristics such as physical abilities and fundamental skills, were prepared.

### *Study Phase*

From January to June 2023, observations and field tests were conducted to obtain supporting data and rationalization materials. In June 2023, the first-semester assessment of physical abilities and fundamental skills was performed. Generated data were collected, evaluated, and interpreted, then the total results of first-semester tests were analyzed. In December 2023, the second-semester assessment was performed. The second-semester data were collected, evaluated, and interpreted, then the general results were analyzed.

### *Final Phase*

From first and second-semester tests, numerical and language data were interpreted to observe the development of physical abilities and fundamental skills. The percentage results of each observed variable were analyzed, comparing first-semester and second-semester tests, and examining the simultaneous influence of second-semester tests on physical abilities and fundamental skills.

### *Statistical Analysis*

Quantitative data analysis was conducted to derive minimum, maximum, mean, and standard deviation values [24]. Subsequently, the nonparametric Wilcoxon test was used to compare first and second-semester results for each component [14]. To observe a simultaneous difference in second-semester results, the Kruskal-Wallis test, an alternative to the Manova test, was used [25], and the entire analysis processes were performed with SPSS version 23.

**Results**

Descriptive analysis results, including values from first and second-semester tests, are presented in Table 1.

Second-semester tests yielded mean values greater than those of first-semester tests in every component of physical abilities and fundamental skills. Specifically, in both semesters, the mean values of flexibility, power, agility, endurance, coordination, and speed had differences of 3.8, 3.94, 0.88, 0.7, 3.97, and 0.42, while passing, dribbling, shooting, and receiving had differences of 5, 2.76, 36, and 6, respectively. These showed that second-semester tests identified better development among the football players compared to first-semester tests conducted. Moreover, the results of the Wilcoxon test comparing the first and second-semester tests, are presented in Table 2.

The Wilcoxon test results showed that both physical abilities and fundamental skills had overall Asymp.sig. (2-tailed) values <0.05, presenting significant differences between the first and second-semester tests. Specifically, flexibility, power, agility, endurance, coordination, and speed had values of 0.002<0.05, 0.000<0.05, 0.000<0.05, 0.000<0.05, 0.024<0.05, and 0.000<0.05, while passing dribbling, shooting, and receiving had 0.000<0.05, 0.000<0.05, 0.000<0.05, and 0.000<0.05, respectively. Moreover,

Table 3 presents the results of the Kruskal-Wallis test for the simultaneous development of physical abilities and fundamental skills assessed in second semester.

The Kruskal-Wallis test results showed that variables of physical abilities and fundamental skills yielded Asymp.sig. (2-tailed) values of 0.000 < 0.05, signifying the existence of a simultaneous difference between both. To further observe simultaneous differences between several variables, Post Hoc analysis was conducted, generating the following results presented in Table 4.

The Post Hoc analysis yielded comprehensive results, with overall Adj.Sig values ranging from 0.000-0.023 < 0.05 for variables of physical abilities and fundamental skills. This suggested significant and simultaneous development of several variables subjected to second-semester tests among the football players. Figure 1 provides a clearer representation of the results through yellow lines connecting the related variables.

**Discussion**

The purpose of this study is to determine the development of the physical and fundamental skills of young soccer players. Based on the results obtained from observations during the first year, the results of the second semester test are better

**Table 1.** Descriptive analysis results of first and second-semester tests

Physical Abilities	Min	Max	Mean	Std. Dev
Flexibility 1	19	39	31.81	5.833
Flexibility 2	2	46	35.61	5.619
Power 1	29	57	44.58	6.536
Power 2	39	62	48.52	5.638
Agility 1	17	22	18.91	1.082
Agility 2	16	21	18.03	1.137
Endurance 1	47	54	50.79	1.820
Endurance _2	47	55	51.49	1.831
Coordination 1	40	73	52.16	7.819
Coordination 2	28	73	56.13	10.069
Speed 1	4.11	5.22	4.72	0.30232
Speed 2	4.00	5.00	4.30	0.29137
Fundamental Skills	Min	Max	Mean	Std. Dev
Passing 1	2	12	8	2.484
Passing 2	10	20	13	2.767
Dribbling 1	22	32	24.74	3.215
Dribbling 2	20	28	21.98	1.855
Shooting 1	17	55	34	9.983
Shooting 2	32	90	70	15.883
Receiving 1	7	14	11	1.911
Receiving 2	9	22	17	3.749

**Table 2.** Wilcoxon test results for the first and second-semester tests

Aspect	Variable	Mean	Difference	Asymp.sig. (2-tailed)
Physical Abilities	Flexibility 1	31.81	3.8	0.002
	Flexibility 2	35.61		
	Power 1	44.58	3.94	0.000
	Power 2	48.52		
	Agility 1	18.91	0.88	0.000
	Agility 2	18.03		
	Endurance 1	50.79	0.7	0.000
	Endurance 2	51.49		
	Coordination 1	52.16	3.97	0.024
	Coordination 2	56.13		
	Speed 1	4.72	0.42	0.000
	Speed 2	4.30		
Fundamental Skills	Passing 1	8	5	0.000
	Passing 2	13		
	Dribbling 1	24.74	2.76	0.000
	Dribbling 2	21.98		
	Shooting 1	34	36	0.000
	Shooting 2	70		
	Receiving 1	11	6	0.000
	Receiving 2	17		

**Table 3.** The Kruskal-Wallis test results for physical abilities and fundamental skills

Variable	Asymp.sig. (2-tailed)
Physical abilities (flexibility, power, agility, endurance, coordination, and speed) * fundamental skills (passing, dribbling, shooting, and receiving)	0.000

than the results of the first semester test in aspects of physical and fundamental skills, and there is a simultaneous increase. Based on these findings, the author can state that monitoring the increase in physical and fundamental skills in football needs to be carried out comprehensively. In this case, exercise programming is carried out in a planned, systematic, and sustainable manner. Optimizing the development of physical and fundamental skills in soccer players is one of the basic ways to achieve achievements driven by the day.

Physical abilities and fundamental skills share a positive relationship in football performance, hence this study explains the components of physical abilities sequentially. The explanation starts with flexibility, defined as the ability to move joints and muscles to the maximum extent [26]. Additionally, dynamic flexibility is the ability to move the body repeatedly, while extent flexibility is the capability to stretch the trunk and back muscles to the maximum limit.

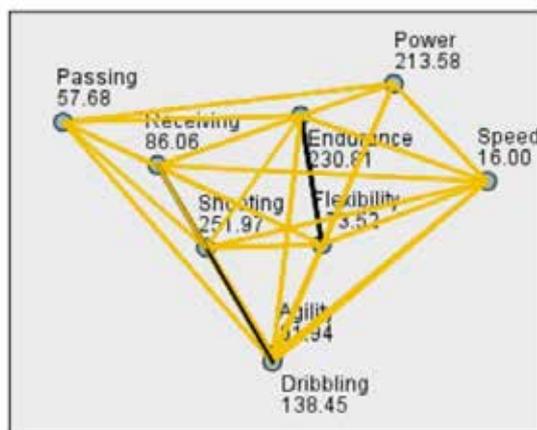
An innovative study in basketball for 11-12-year-olds applied the Raise, Activation Mobility, and Potentiation (RAMP) principles to develop flexibility

[18]. Raise includes characteristic movements such as lifting the front, back, and side thighs, which increases blood flow, core and muscle temperature, elasticity, and nerve conduction activation [18][26]. The Activation and Mobility phases feature active and passive stretching activities [18], while the Potentiation phase incorporates a series of specific movements as preparation for core exercises [26].

Despite the importance of the RAMP principles, many coaches occasionally neglect stretching, considering it an additional exercise not specifically programmed. At the age of 14 years, football players enter the peak high-velocity (PHV) phase, leading to motor disturbances because soft tissues adapt more slowly to rapid bone growth [27]. This slower adaptation results in joint range of motion challenges, abnormal movement pattern development, as well as decreased muscle and tendon flexibility, increasing the risk of extremity injuries [27]. Although this study shows increased flexibility, continuous development is essential as players age chronologically and gain experience, considering the integral role of flexibility in enhancing speed, power, agility, and coordination.

**Table 4.** Post Hoc analysis results for physical abilities and fundamental skills

Variable	Total statistics	Std.error	Std.test statistics	Sig	Adj.Sig
Speed-Receiving	-70.065	20.492	-3.419	0.001	0.023
Speed-Agility	-75.935	20.492	-3.707	0.000	0.008
Speed-Dribbling	-122.452	20.492	-5.976	0.000	0.000
Speed-Flexibility	157.516	20.492	7.687	0.000	0.000
Speed-Power	197.581	20.492	9.642	0.000	0.000
Speed-Endurance	-214.906	20.492	9.642	0.000	0.000
Speed-Shooting	-235.968	20.492	-11.515	0.000	0.000
Passing-Dribbling	-80.774	20.492	-3.942	0.000	0.003
Passing-Flexibility	115.839	20.492	5.653	0.000	0.000
Passing-Power	155.903	20.492	7.608	0.000	0.000
Passing-Endurance	173.129	20.492	8.449	0.000	0.000
Passing-Shooting	-194.290	20.492	-9.481	0.000	0.000
Receiving-Flexibility	87.452	20.492	4.268	0.000	0.001
Receiving-Power	127.516	20.492	6.223	0.000	0.000
Receiving-Endurance	144.742	20.492	7.063	0.000	0.000
Receiving-Shooting	165.903	20.492	8.096	0.000	0.000
Agility-Flexibility	81.581	20.492	3.981	0.000	0.002
Agility-Power	121.645	20.492	5.936	0.000	0.000
Agility-Endurance	-138.871	20.492	-6.777	0.000	0.000
Agility-Shooting	-160.032	20.492	-7.810	0.000	0.000
Dribbling-Power	75.129	20.492	3.666	0.000	0.009
Dribbling-Shooting	-113.516	20.492	-5.540	0.000	0.000
Flexibility-Shooting	-78.452	20.492	-3.828	0.000	0.005



**Figure 1.** Pairwise comparisons of physical abilities and fundamental skills.

Coordination is a combined movement of two or more related joints to produce effective fundamental skills [28], often enhanced through the agility, balance, and coordination (ABC) running exercise model [29]. Improved coordination contributes to better accuracy in shooting [30,31], while flexibility and coordination positively impact motion speed in football sport.

Speed training stages are influenced by flexibility and endurance strength, as football athletes with good flexibility and techniques often move effectively and efficiently. A strong player can move quickly, and an enduring type will perform quick movements repeatedly for a long duration. Characteristics such as maximum cyclic speed, agility, and quickness are highly needed in football.

Agility is an integrated speed, which refers to the ability to change direction quickly in a relatively short time with a stimulus [32]. Integration between balance, coordination, flexibility, and reflex speed needs to be achieved before maximizing agility training. Scientific approaches to improve movement quality and increase running step frequency contribute to effective speed training.

The combination of speed and strength yields power, but 14 to 15-year-old players engaging in power training should focus on foundational development [33]. Integration of power training with agility ladder drills and techniques requires careful consideration [34]. A combination of weight training and plyometrics enhances jump height, strength, and running performance at various ages. However, characteristics such as intensity, volume, and type of exercise must correspond to the maturity and initial strength level of players [35]. Training concentrated on speed, strength, and endurance forms the foundation for developing physical abilities.

The movement patterns in football include low, moderate, and maximum intensity. Players run approximately 13 km in a single match, with predominant distances covered being low-intensity long-duration and high-intensity short-duration [36]. An in-depth analysis of elite football players showed 28% high-intensity (2.43 vs 190 km) and 58% sprint (650 vs 410 m) compared to the amateurs [14,36]. Therefore, young football players need good endurance, developed through general training integrated simultaneously with technical training.

Regarding fundamental skills, coaches should innovate and implement varied training techniques, including drills, massed and distributed practices, games experience learning, multilateral development, and part-whole approaches [8,14,29,37–39]. These contribute positively to the development of fundamental skills in football players. Besides, it is essential to reiterate that peak performance is achieved at the senior age. This implies that achieving success at a young age is not necessarily a benchmark for becoming a champion at the senior level. Therefore, understanding of pedagogical principles by coaches plays a key role in helping athletes explore potential and gain broad knowledge for individual, social, and health benefits [40].

## Conclusions

In conclusion, significant differences were observed between first and second-semester test results for physical abilities, including flexibility, coordination, speed, power, and endurance as well as fundamental skills, comprising dribbling, receiving, shooting, and passing. Additionally, this study identified a simultaneous difference between physical abilities and fundamental skills of the young Real Madrid Foundation UNY football players, with second-semester tests producing better results.

## Acknowledgment

The authors are grateful to Yogyakarta State University for permitting the conduction and completion of this study.

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Cite this article as:

Sulistiyono, Sumaryanto, Sumarjo, Ngatman, Primasoni N, Yudhistira D. Longitudinal analysis of physical abilities and fundamental skills among the Real Madrid Foundation UNY football players. *Pedagogy of Physical Culture and Sports*, 2024;28(3):184–191. <https://doi.org/10.15561/26649837.2024.0303>

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Received: 31.01.2024

Accepted: 21.03.2024; Published: 30.06.2024