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Talent identification for soccer: Physiological Aspects

By

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Abstract

Objectives: Soccer coaches are always looking to discover the next star player, without investing the necessary resources, time, and effort into a player's development. In the modern era, talent identification in soccer seems to be a comparative process rather than a developmental process. This article will look at the physiological profiles of soccer players in the modern era and how testing and talent identification processes should coincide with this data.

Design: An extensive literature search identifying the physiological attributes of soccer players that are required to compete at an elite level was conducted. An examination of the methods to test these attributes was also conducted.

Methods: Studies were assigned into three areas to understand the physiological aspect of soccer: physiological testing methods, benchmark values, and correlations between different tests.

Results: A testing battery was established to test the key physiological attributes of prospective youth soccer players. Benchmark levels were also identified to allow coaches to understand areas of improvement.

Conclusion: Using a physiological testing battery will allow teams to track their players' progress throughout their developmental years. This allows coaches to consistently identify a player's strengths and weaknesses, as well as allow players who may experience late maturation to still be identified.

Key words: youth; physical; testing; anthropometrics; elite

Introduction

The physiological demands of soccer in the modern era have changed dramatically from previous decades, with soccer players covering greater distances, undertaking more explosive movements, and competing at higher intensities than ever before^{4, 10}. Sports science has played an integral role in this advancement with match analysis data serving as the foundation from which the current physiological demands are derived. The acknowledgement that high intensity actions play an integral part to decisive moments in the game (i.e. goals being scored or stopped, and duels being won¹⁹) has become the keystone to which conditioning programs are based upon.

Soccer clubs are becoming increasingly aware of the importance of identifying talented youth soccer players at early ages (11 to 16 years old) and incorporating them into academies or youth teams. Soccer clubs are like businesses, with the facilities and players being the main assets. The promotion and relegation structure is prevalent in soccer leagues throughout the world, making the industry the most pressurized out of all sports. Astronomical player transfer fees and wages are being witnessed more often in soccer to achieve success. While clubs with large financial backers can afford these costs, smaller clubs often cannot and, by attempting to compete with the larger clubs, risk being financially crippled. Therefore, talent identification and selection is especially important for smaller clubs as it allows the clubs to develop these players into elite soccer players. By identifying players early, players can be brought into the soccer clubs' playing system, with the concept of these players developing into top class soccer players.

Entry into talent identification programs is usually based on a selection criterion that fails to consider the potential or developmental processes of young players. Young players mature physically at differing rates which plays a large part in talent identification programs. Maturation is dependent

upon the timing and the tempo of its process and has been shown to determine player selection into talent identification pathways due to the anthropometrical, aerobic, and anaerobic power advantages accompanying more mature players²².

To understand the physiological attributes required to play elite soccer, the match demands on a player need to be outlined. In professional soccer, the total distance covered during a game by outfield players was ~ 10-12 km, at an average work intensity of 80-90% of HR_{max} ³⁴. Approximately 1-11% of this total distance involved sprinting, with an average sprint of 2-4 s every 90 s. There are 1000-1400 acyclical short activities changing every 4-6 s incorporating high intensity running every 70 s; approximately 15 tackles, 10 headers, 50 involvements with the ball, 30 passes, and dueling activities³⁴. Higher blood lactate concentrations infer that there are more explosive and high intensity actions being performed at the elite level than non-elite level, with first half averages of ~ 7.0 vs. 2.7 mmol/L and second half averages of ~ 4.5 vs. 1.0 mmol/L respectively³⁴. Soccer in the modern era is largely dependent upon the ability to repeatedly perform high intensity actions, which increase the number of decisive moments in a game, subsequently increasing the chance of winning.

The total distance covered and the amount of high intensity actions performed within a game differs somewhat between playing positions. Central defenders (CD) have been shown to partake in the least distance covered and number of high intensity actions within a game compared to wingers (WM), fullbacks (FB), central midfielders (CM), and forwards (FW)^{3,4,6,9,11,27,34}. These variances in distances covered and number of high intensity actions can be related to role specific objectives and tactics¹⁰. The spatial aspects of the WM and FB role encompass sprinting over longer distances⁹, with the main purpose to provide crosses, attacks, or defense from wide positions. The CM position involves a high incidence of dueling and shorter sprinting distances³³ with a major involvement in both attack and defense. The FW role can be either as a “target man” helping to link the attack or as an “out-an-out” striker where the attack is provided behind the opposition’s defensive line. Nonetheless these roles still require the FW to engage in goal scoring and defensive opportunities, with the total distance covered being slightly less than the WM total distance^{3,4,6,9,11,27,34}. The role of the CD is to provide solidarity and structure to the defensive line with the retention of the formational shape being of utmost importance. This explains the low total distances covered and the number of high intensity actions as the CD is only

required to leave their position and engage in action when a potential goal scoring or ball-winning opportunity presents itself or as means of starting an attack from a deeper field position.

Physiological data indicates that teams who perform more high intensity actions and who cover more distance (which has been related to maximal oxygen uptake capacity (VO_{2max})^{16,29,33}), obtain higher league rankings than teams with lower VO_{2max} values, lesser total distance covered and lesser high intensity actions^{10,18,23,27,38}. However, the ability to outperform the opposition in these areas does not guarantee success. Soccer is decided by the team that scores more goals than their opponent, therefore being clinical in goal scoring opportunities and ruthless in preventing them, is the underlying determinants of success or failure in soccer matches. Being able to get into goal scoring or preventing opportunities, is mostly a result of the ability to perform anaerobic actions associated with decisive moments within the game¹⁹.

Talent identification programs in soccer typically focus on the tactical and technical aspects. However, omitting aspects such as physical, physiological, psychological, and sociological data risks players to slip through the identification process, especially those who experience late maturation. The purpose of this article is to focus on physiological profiles of elite soccer players to ascertain what attributes are pertinent to elite soccer. A testing battery targeting these attributes will then be devised. Talent identification trends and practical applications will be discussed with recommendations made for utilizing the testing battery.

Methods

This review examined four areas of research concerning the physiological aspects of soccer. Firstly, as identified in the introduction, the physiological characteristics of elite soccer players were recognised to provide benchmarks in talent identification. Once these characteristics were recognised, methods of testing physiological characteristics with normative data were identified and described for coaching instruction. Finally, this review also compiled correlations between these different physiological test results. After establishing physiological characteristics and testing methods relevant to soccer, a testing battery incorporating these tests was proposed to provide a thorough but efficient testing protocol for

assessing physiological capacity. In most cases, the suggested tests are designed to allow practically to cater for the various resources available to clubs.

Results

Within soccer players there were physiological and anthropometric characteristics that separate elite from non-elite players. For an extensive review, see Table 1. Elite players display higher VO_{2max} levels^{13,34,38}, faster sprint times^{13,17,34,38}, greater high intensity running distances³, greater repeated sprint ability (RSA)^{3,8,25,26,28}, larger one-repetition maximum (1RM) back squat values^{18,34,38}, higher jumping distances^{13,18,34}, and lower body fat percentages (BF%)^{13,14,18} compared to non-elite players. VO_{2max} and RSA are interrelated, as higher VO_{2max} values will improve performance by increasing the total distance covered, work intensity, number of sprints, and number of involvements with the ball during a match¹⁶. Higher VO_{2max} values may also result in lower blood lactate concentrations³⁴ due to an “enhanced recovery from high intensity intermittent exercise through: increased aerobic response; improved lactate removal; and enhanced phosphocreatine regeneration”³⁵. Higher glycogen levels have been reported with higher VO_{2max} levels due to a glycogen sparing effect². Increasing RSA has also been shown to improve VO_{2max} and the respiratory compensation point¹². Both physiological aspects are extremely important in elite soccer, as VO_{2max} and RSA levels will determine a player’s capacity to perform repeated sprints and work at higher intensities during a soccer match. It can be assumed that increasing both aspects should allow a player to undertake more repeated sprints and obtain higher intensities throughout the match.

Anthropometrics can be measured using electronic scales for weight, a stadiometer for height, and calipers for skinfold measurement³⁶, with an average of 3 tests on a 7-site skinfolds being the final body fat %. Anaerobic power can be measured by vertical jump with hands on hips and from a self-selected height, utilizing a force plate in the laboratory if possible, if not, the Myotest-T (Myotest, SA) using flight time as the calculation is a valid alternative⁷, with the best of 3 jumps, 1-2 min rest between jumps, being recorded as the result. Change of direction speed (CODS) can be measured using the sprint 9-3-6-3-9 m with backward and forward running (SBF)³² with stopwatch or timing gates, with the best of 3 attempts recorded utilizing 3-5 min rest between attempts. Linear speed can be measured using

timing gates placed at 10 m intervals over a 40 m distance, with the best of 3 sprints measured and a sufficient rest of 3-5 min between attempts⁵. Repeated sprint ability (RSA) can be measured using the running repeated sprint ability test (rRSA) with 6 x 20 m sprints with a 20 s active recovery using timing gates to record the speed¹. Maximal aerobic power can be measured using the Yo-Yo intermittent endurance test level 2 (YYIE2)². Maximal lower body strength can be measured using a one-repetition maximum (1RM) back squat with free weights and Olympic bar²¹ by building up to the maximal squat in 4-5 lifts with sufficient rest of 3-5 min between lifts. If an athlete has not developed physically, a predictive 1RM can be used.

Table 2 illustrates the correlations between different physiological tests. Maturation processes have been shown to determine elite from non-elite players with body mass being correlated with ball shooting speed and 30 m sprint time³⁹. Height has been correlated with vertical jump ability, 10 m and 30 m sprint times, Yo-Yo intermittent endurance run (YYIER) distance, and running time during VO_{2max} ³⁹. Body mass index (BMI) has been correlated with ball shooting speed, 30 m sprint times, Hoff test dribble distance, YYIER distance, sub-maximal running cost, and VO_{2max} running time³⁹. Anthropometric aspects such as height, weight, BF%, and physical and physiological aspects, such as speed and VO_{2max} in younger athletes up until the early years of puberty, have been shown to be predominant factors found in elite teams^{13,22,39}. From puberty onwards, agility becomes more important in performance^{13,30}. Positional differences have also been associated with anthropometrical values. Goalkeepers and defenders were the heaviest and tallest players, and forwards were the lightest, shortest, and had the lowest BMI³⁹. However, whether these aspects were specifically targeted and selection processes based upon these values is unclear from the literature.

Soccer players born in the first semester of the year (January to June), dominate team selection²². This is attributed to an advanced neuromuscular system caused by a greater volume and intensity of training¹⁵, and advanced maturation processes^{13,22,39}, compared to soccer players born in the second semester of the year (July to December). This aspect has been manipulated by changing the selection year, from a calendar year to a financial year (July to June), and regardless of the selection year structure, players born in the first semester of either structure continued to dominate team selection²². Due to the physical and physiological advances that players born in the first semester have

over their second semester counterparts, it is salient to predict a talent identification pattern leaning towards more mature players.

Players born in the second semester have been shown to have higher dropout rates in soccer due to a lack of interest and motivation^{13,22}. These factors are all attributable to the selection processes of talent identification programs being dominated by players born in the first semester of the year. If players born in the second semester of the year, and who have not been identified or selected into a talent program, can remain within the talent program, then they are likely to become more successful compared to their older counterparts²². This has been attributed to overcompensating in other aspects of the game such as motivation and perseverance to overcome this setback²². Once players reach the age of 16-17 years old, all maturation advantages level out as the less mature players “catch-up” with their physical development¹⁴.

When designing physiological talent identification criteria or strength and conditioning programs for soccer teams, it is imperative that programs and testing batteries draw upon the latest data containing attributes specific for elite players. This allows conditioning coaches to formulate strength and conditioning programs that best develop the physiological, physical, and anthropometrical values, thereby increasing a soccer team’s likelihood of success. Testing batteries should, therefore, include the following aspects pertinent to elite soccer:

- Anthropometrical
- Linear speed
- Change of direction speed
- Maximal Anaerobic power
- Repeated sprint ability
- Maximal aerobic power
- Maximal lower body strength

A testing battery (Table 3) has been formulated using the latest physiological data from soccer players and provides the basis from which these attributes can be targeted and developed. This is not a stringent testing battery as there are numerous reliable and valid alternative tests for these physical and physiological attributes.

Discussion

By utilizing talent identification processes in selecting players for academies, it is recommended that a core group of initial players and ones on the periphery of this group are constantly monitored for physiological development using a testing battery. Talent identification programs and academies should continue to develop these players with a final selection process occurring around the age of 16 to 17 years old, where it has been shown that physical aspects level off, allowing for a more “level playing field”.

The ability to perform quicker sprints and higher jumps than an opponent is crucial in determining the results of duels within a match. A good 1RM back squat (or predicted 1RM for underdeveloped athletes) has been shown to have a positive effect on sprinting times^{20,21,37,40} and jumping ability^{20,40}. Anthropometric values such as low BF% are related to quicker sprinting, acceleration, and change of direction times³¹. This is based on the premise that BF% determines the amount of non-functional inertia that a soccer player must overcome when accelerating and changing direction. This would also seem appropriate for jumping performance. Therefore, it is appropriate to suggest that a lower BF% is desirable within elite soccer players.

It seems salient to propose that teams with higher anaerobic capabilities (sprinting, jumping, change of direction, and lower body strength), higher aerobic processes (VO_{2max}), greater RSA, and desirable anthropometric values (BF%, height, and weight), are optimizing their chances of success. There is an abundance of physiological, physical, and anthropometrical data of youth and elite soccer players in the literature. While it is extremely naïve to consider that physiological aspects alone can determine success in soccer, there is an overriding trend in the literature stating that soccer players who possess better VO_{2max} values, sprint times, RSA, VJ, agility, 1RM back squat values, lower BF%, born in the first semester of the year, and taller and heavier players at the youth level, have a greater chance of making it as a professional soccer player. Soccer clubs and talent identification programs get caught up or are often unaware that when these athletes are born, barring height, these attributes are all trainable²⁴, and merely base their selection into their programs on player's current physiological, physical, and anthropometric status.

Throughout youth soccer players' careers, there are numerous times when they will be selected or not selected for high performance teams (i.e. national team). Consistent testing processes for team selection purposes allow coaches to ensure that they are selecting players who, at the current time, are the most physically and physiologically ready to compete at the elite level. This is only one aspect of the testing process (i.e. match performance, tactical, technical, psychological etc.) and when all testing results are compiled, the players with the highest ratings across all tests should be considered highest for selection. Continual development of the non-selected players in their areas of weakness is a necessity to ensure that all players are given an equal opportunity to develop optimally.

Conclusions

Based upon the physiological data in the literature, there appears to be attributes pertinent to elite soccer players. The designed testing battery allows for these attributes to be targeted for team selection purposes or for identification of strengths and weaknesses for development. While the literature identifies key attributes in elite versus non-elite soccer players, especially those found within talent identification programs, there is a need to utilize this predominant data in developmental ways in youth soccer players to allow for optimal development. Allowing less mature players, who are on the cusp of these programs to remain or be incorporated into elite programs, increases the chance that these players will attain a professional status. This subsequently allows for a widening of the talent pool in which selection can be derived from. Talent identification programs should incorporate a testing battery, like the one in Table 3, based on the physical and physiological attributes of elite soccer players, to monitor the maturation and progress of the talent pool. It also provides a means in which strength and conditioning programs can be designed to magnify strengths and improve weaknesses.

Practical Applications

- Basing talent identification programs solely on physiological aspects and not incorporating skill, technical, psychological, and sociological aspects risks allow players, especially those who experience late maturation, to slip through the identification process

- A testing battery has been designed in accordance with current physiological data from matches and elite soccer players
- The testing battery can be utilized throughout the course of a soccer players' career to gauge their current physiological levels and to continually improve their weaknesses, resulting in the potential development of a well-rounded player.

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Table 1. Attributes pertinent to elite soccer

Author	Subjects	Anthropometrics					Strength	Sprint (s)	Repeated Sprint Ability (RSA)	VO _{2max} (ml•kg ⁻¹ •min ⁻¹)	Vertical Jump (cm)	Change of Direction Speed (CODS)
		Age (yrs)	Height (cm)	Weight (kg)	Body (%)	Fat						
Aziz al. ¹	et 39 Singapore Youth National Players	15.4-17.5	169.4-172.5	60.1-60.5					rRSA test (6 x 20 m): FS time: 3.03 ± 0.09 s TS time: 18.48 ± .53 s	Estimated: 51.2 ± 3.5		
Gil al. ¹³	et Players from Arenas Club de Getxo							30 m sprint:			Squat jump (90° knee angle, hands on hips)	
	U14	14.7 ± 0.2	172.1 ± 1.1	60.4 ± 1.1	11 ± 0.4			3.95 ± 0.05		56 ± 2	35.8 ± 0.7	
	U15	15.5 ± 0.3	174.2 ± 1.1	67.6 ± 1.1	11.5 ± 0.3			3.73 ± 0.03		58 ± 2	39.6 ± 1.0	
	U16	16.8 ± 1.0	177.2 ± 1.2	72.5 ± 1.2	12.1 ± 0.5			3.68 ± 0.04		53 ± 3	40.9 ± 1.2	
	U17	17.8 ± 0.9	177.8 ± 1.5	74 ± 1.5	11.6 ± 0.2			3.60 ± 0.04		62 ± 2	42.6 ± 1.1	
Kalapothen arakos al. ¹⁸	et 19 National Greek League Players ^b	26 ± 4	180 ± 5	78 ± 4.5	9 ± 1.8		RKE (Nm): 276 ± 33 LKE (Nm): 269 ± 27				CMJ (90° knee angle) 47.2 ± 4.3	

Table 1 Continued

Author	Subjects		Anthropometrics					Strength	Sprint	Repeated Sprint Ability (RSA)	VO _{2max} (ml•kg ⁻¹ •min ⁻¹)	Vertical Jump (cm)	Change of Direction Speed (CODS)
			Age (yrs)	Height (cm)	Weight (kg)	Body Fat (%)							
Lopez-Segovia et al. ²⁰	14	U21 Amateur Players	20.1 ± 0.4	179 ± 10	75.5 ± 7.7				10 m: 1.92 ± 0.06 20 m: 3.22 ± 0.09 30 m: 4.43 ± 0.14			CMJ (90 ⁰ knee angle, hands on hips) 38.3 ± 4.5	
Rampinini et al. ²⁸	12	Professional 3rd Division Italy ^c	25 ± 4	180 ± 3	73.9 ± 4.5					6 x 40 m (20 + 20 m): FS: 6.86 ± 0.13 s AS: 7.17 ± 0.09 s	58.5 ± 4.0		
Sporis al. ³²	150	Elite First Junior League Team, Croatia	19.1 ± 0.6	177.1 ± 6.3	71.2 ± 5.7	8.7 ± 2.1					60.9 ± 2.1		SBF (sprint 9-3-6-3-9 m with backward and forward running) 7.81 ± 0.44 s
Sporis al. ³³	270	Croatian 1st division players	28.3 ± 5.9	181.4 ± 2.5	78.4 ± 3.1	11.9 ± 3.1			5 m: 1.44 ± 0.5 s 10 m: 2.27 ± 0.4 s 20 m: 3.38 ± 0.7 s		60.1 ± 2.3	Squat jump (90 ⁰ knee angle, hands on hips): 44.1 ± 1.3	

Table 1 Continued.

Author	Subjects	Anthropometrics					Strength	Sprint	Repeated Sprint Ability (RSA)	VO _{2max} (ml·kg ⁻¹ ·min ⁻¹)	Vertical Jump (cm)	Change of Direction Speed (CODS)
		Age (yrs)	Height (cm)	Weight (kg)	Body (%)	Fat (%)						
Wong et al. ⁴⁰	20 Hong Kong Premier League Footballers ^d	24.6 ± 1.5	176 ± 2.0	71.1 ± 1.8			1RM Back Squat (90° knee angle): 148 ± 1.9 kg	10 m: 1.78 ± 0.02 30 m: 4.29 ± 0.03			Vertical Jump (90° knee angle, hands on hips): 66.0 ± 1.4	
Wong et al. ³⁹	60 U14 Hong Kong Footballers ^d										Vertical Jump (90° knee angle, hands on hips)	
	Defenders	13.3 ± 0.8	167 ± 7.0	56.2 ± 6.2				10 m: 2.09 ± 0.23 30 m: 4.81 ± 0.36		53.2 ± 6.8	54.3 ± 7.7	
	Midfielders	13.4 ± 0.6	165 ± 8.0	52.2 ± 9.6				10 m: 2.05 ± 0.14 30 m: 4.82 ± 0.31		57.9 ± 5.1	53.2 ± 12.9	
	Forwards	13.0 ± 0.8	156 ± 11	43.9 ± 9.5				10 m: 2.07 ± 0.15 30 m: 4.96 ± 0.40		56.5 ± 4.9	53.9 ± 6.1	
Wisloff et al. ³⁷	17 Elite Footballers Rosenberg FC, Norway	25.8 ± 2.9	177.3 ± 4.1	76.5 ± 7.6			1RM Back Squat (90° knee angle): 171.7 ± 21.2 kg, 2.2 ± 0.3 x m _b , 9.4 ± 1.5 kg/m _b ^{0.67}	10 m: 1.82 ± 0.3 20 m: 3.0 ± 0.3 30 m: 4.0 ± 0.2		65.7 ± 4.3	56.4 ± 4.0	

Note: CMJ = counter-movement jump; BF% = body fat percentage; FS = fastest sprint time; TS = total sprint time; AS = Average sprint time; RKE = right knee extension; LKE = left knee extension; Nm = Newtons per meter; 1RM = one repetition maximum; m_b = body mass;
a = Information for players selected only, omitted non-selected players information
b = The best team information only, omitted medium and worst team information
c = 3rd division players information only, omitted 6th division amateur team information
d = Outfield players information only, omitted goalkeepers information

Table #2: Correlation Table of Attributes Related to Elite Soccer

Table #3: Testing Battery

Table 2. Correlation table of attributes related to elite soccer

	m_b	Height	BMI	1RM	10 m	30 m	VJ	RSA	CODS	VO_{2max}
m_b	1									
Height		1								
BMI			1							
1RM				1						
10 m		-0.32 ^{39**}		0.94 ^{37***}	1					
30 m	-0.54 ^{39***}	-0.64 ^{39***}	-0.24 ^{39*}	0.71 ^{37**}	0.62 ^{19***}	1				
VJ		0.36 ^{39**}		0.78 ^{37*}	0.72 ^{37***}	0.60 ^{37**}	1			
RSA								1		
CODS				0.68 ^{37*}	0.35 ^{19***}	0.46 ^{19***}			1	
VO_{2max}			-0.42 ^{39***}					-0.45 ^{28*}		1

Note: m_b = body mass; BF% = body fat percentage; 1RM = one repetition maximum back squat; 10 m = ten meter sprint time; 30 m = thirty metre sprint time; VJ = vertical jump; RSA = repeated sprint ability; CODS = change of direction speed; VO_{2max} = maximal oxygen uptake. * Denotes significance at $p \leq 0.05$; ** Denotes significance at $p \leq 0.01$; *** Denotes significance at $p \leq 0.001$

Table 3. Testing Battery

Test	Recommended Tests	Normative Data
Anthropometric - Skinfolds - Height - Weight	Skinfolds: Cost efficient field-test and suitable for footballers due to their average lean bodies ³⁶ Height: Stadiometer Weight: Electronic Scales	~ 8-12 % body fat ^{18,29,33} Recommended 8-10 % body fat
Anaerobic Power	Vertical Jump: Myotest-T (Myotest, SA) using flight time calculations ⁷	Hands on hips (concentric jump), self-selected knee angle ~ 50-70 cm ^{37,39,40}
Change of Direction Speed (CODS)	SBF: Sprint 9-3-6-3-9 m, with backward and forward running (SBF) ³²	~ 7.81 s ³²
Linear Speed	Timing Gates: Dual-beam electronic timing gates set at every 10 m interval over a 40 m distance (Swift Performance Equipment, Lismore, Australia) ⁵	10 m ~ 1.83 s 20 m ~ 3.05 s 30 m ~ 4.25 s 40 m ~ 5.50 s ³⁴
Repeated Sprint Ability (RSA)	Running Repeated Sprint Ability (rRSA) Test: 6 x 20 m with 20 s active recovery ¹	Total sprint time ~ 18.5 s Fastest sprint time ~ 3.03 s ¹
Maximal Aerobic Power	Yo-Yo Intermittent Endurance Test Level 2 (YYIE2) ³	~ 2400 m ³
Maximal Lower Body Strength	1 Repetition Maximum Back Squat ²¹	Recommended: ≥ 2.10 x body weight ²¹ , or ≥ 9.0 kg/m ^{-0.67 34}

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