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Fitness Foundations of Success: A Study on the Physical Fitness of Purulia District U-17 Champion Footballers

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Abstract- Competitive youth football rewards players who can sprint, change direction, jump, and keep working as fatigue sets in. Yet fitness profiles of district level champion sides in eastern India remain thinly documented, which leaves selectors and coaches leaning on intuition rather than measured evidence. This study profiled the physical fitness of 22 male Under 17 footballers who won the Purulia District championship, and it tested how the separate fitness qualities hang together. Motor fitness was captured through the 50 m dash (speed), the standing broad jump (explosive leg power), and a zig zag run (agility). Body composition was indexed by Body Mass Index derived from height and weight, then sorted into World Health Organization categories. Cardiovascular efficiency was measured with the long form Harvard Step Test, from which the Physical Efficiency Index (PEI) was calculated using three post exercise recovery pulse counts. Descriptive statistics and Pearson product moment correlations were computed. On average the squad recorded a 50 m dash of 7.49 s, a broad jump of 1.88 m, a zig zag time of 24.83 s, a BMI of 18.62 kg/m2, and a PEI of 120.26. Every player scored in the "Excellent" PEI band, while BMI split between the normal (59.1%) and underweight (40.9%) ranges. Speed correlated with power and agility ($p < .01$), and agility tracked cardiovascular recovery ($p < .01$). The findings appear to indicate a fit but lean cohort whose fitness qualities are meaningfully interlinked, with practical value for talent screening and conditioning design.

Keywords: Motor Fitness, Youth Football, Harvard Step Test, Body Mass Index, Agility, Talent Identification, Physical Efficiency Index

I. INTRODUCTION

Football at the youth level asks a lot of the body in a short window of time. A single passage of play may demand a flat out sprint, an abrupt cut past a defender, a leap for a header, and then a rapid return to a defensive shape, all inside ten seconds. Because the sport blends these qualities, the physical profile of a successful young player is rarely built on one standout attribute. It rests, instead, on a working balance of speed, power, agility, body composition, and the capacity to recover between efforts (Stolen et al., 2005; Reilly et al., 2000).

District championships in India serve as an early filter in the talent pipeline. Winning sides are, in a loose sense, the survivors of that filter. What is less clear is why they survive it. Coaches at this level often select on the eye test, match performance, and reputation, with fitness testing treated as an afterthought when it happens at all. That gap matters. Without baseline measurement, a talented but under conditioned player can be mistaken for a limited one, and a physically mature early developer can be over rated relative to peers who simply grew later (Malina et al., 2004).

The research base on elite and academy football is deep, but it skews heavily toward European academies and national teams. Studies of district level champion cohorts in eastern India, and in Purulia specifically, are scarce. This leaves local practitioners applying norms drawn from populations that differ in genetics, nutrition, training exposure, and playing culture. Practically speaking, a BMI benchmark or sprint standard imported from a Scandinavian academy may not describe a Purulia teenager well at all.

This study addresses that shortfall by profiling a championship winning U-17 squad on three fitness domains and by examining how those domains relate to one another. The work carries both applied and conceptual weight: applied, because coaches gain a reference profile for their own athletes; conceptual, because the correlation structure speaks to whether these fitness qualities behave as one general athleticism or as separable traits.

Research questions

1. What is the motor fitness status of the players across speed, explosive leg power, and agility?
2. How is the squad distributed across standard BMI categories?
3. What level of cardiovascular efficiency, indexed by the Harvard Step Test PEI, do the players display?
4. How do motor fitness components, BMI, and cardiovascular fitness inter-relate?

II. LITERATURE REVIEW

2.1 The physical demands of football

Match analysis work has repeatedly shown that football is intermittent by nature: long stretches of low intensity movement punctuated by short, decisive high intensity actions (Bangsbo et al., 2006). Those decisive actions sprints, tackles, jumps, turns often decide goals. Bloomfield et al. (2007) quantified how frequently Premier League players change activity and direction, underlining that repeated agility, rather than steady state running, characterises the modern game. For a developing player, being able to repeat these bursts without a steep drop in quality is a genuine performance asset.

2.2 Motor fitness: speed, power, and agility

Sprint speed and explosive leg power tend to travel together, since both draw on fast twitch muscle recruitment and rate of force development. Chelly et al. (2010) reported that leg power predicts 5 m sprint performance in junior players, and Markovic et al. (2004) validated jump tests as reliable proxies for lower body power. Agility, once treated as a simple by product of speed, is now understood as a partly independent quality that folds in deceleration, reactive balance, and change of direction technique (Sheppard & Young, 2006). This distinction matters for testing: a fast player in a straight line is not automatically an agile one.

2.3 Body composition in young athletes

BMI is a blunt instrument. It cannot separate lean mass from fat mass, and it can mislabel muscular athletes as overweight (Cole et al., 2000; WHO, 2000). Even so, at population and squad level it remains a low cost screening tool, and in lean adolescent footballers it typically sits in the normal to low range (Gil et al., 2007; Nikolaidis, 2012). Wong et al. (2009) cautioned that anthropometric measures in youth cohorts are heavily confounded by biological maturation, so a low BMI in a 15 year old may reflect late maturation rather than poor conditioning.

2.4 Cardiovascular efficiency and the Harvard Step Test

Brouha's (1943) step test endures because it is cheap, portable, and needs no laboratory. The Physical Efficiency Index it yields reflects how quickly heart rate recovers after standardised work, and faster recovery is generally read as better cardiovascular fitness (Fox et al., 1993). The tool has known limits it is sensitive to step cadence, motivation, and pulse counting error and its classification bands were derived decades ago on different populations. Those caveats deserve attention when interpreting uniformly high scores.

2.5 Talent identification and the multi domain view

Contemporary talent identification models argue against single trait selection. The Ghent Youth Soccer Project (Vaeyens et al., 2006) and Reilly et al.'s (2000) multidisciplinary framework both treat physical fitness as one strand within a wider profile that also covers technical, tactical, and psychological factors. Mujika et al. (2009) found that fitness determinants of success differ by sex and level, which warns against transplanting one squad's norms onto another.

2.6 Gaps in current knowledge

Three gaps stand out. First, most fitness profiling evidence comes from academy or national team settings, not district champion cohorts. Second, Indian regional data, and Purulia data in particular, are underrepresented. Third, few studies pair a full motor fitness battery with both body composition and a field based cardiovascular test in the same sample

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while also reporting the correlation structure among them. This study speaks to all three.

III. METHODOLOGY

3.1 Research design

The study used a quantitative, descriptive correlational design. No intervention was applied; players were measured once, in their trained state, shortly after the championship. The aim was to describe status and to map relationships, not to establish cause.

3.2 Participants

Twenty two male footballers (N = 22) from the Under-17 team that won the Purulia District championship formed the sample. Selection was purposive: the champion squad was chosen precisely because it represents a successful competitive standard at district level. All players were active members of the winning team and were free of injury at the time of testing.

3.3 Variables and instruments

Domain	Component	Test	Unit
Motor fitness	Speed	50 m dash	seconds
Motor fitness	Explosive leg power	Standing broad jump	metres
Motor fitness	Agility	Zig-zag run	seconds
Body composition	Body mass	Stadiometer / weighing scale	cm / kg
Body composition	BMI	Weight / Height2	kg/m2
Physiological fitness	Cardiovascular efficiency	Harvard Step Test (PEI)	index

3.4 Testing procedures

i. 50 m dash. Players sprinted 50 m from a standing start on a flat surface; time to the nearest fraction of a second was recorded, with the faster of standard attempts retained.

ii. Standing broad jump. From a two foot take off behind a line, players jumped forward for maximum distance; the horizontal distance to the nearest heel strike was measured.

iii. Zig-zag run. Players negotiated a marked change of direction course as quickly as possible; total time indexed agility.

iv. Anthropometry. Standing height (cm) and body weight (kg) were recorded with standard equipment; BMI was computed as weight (kg) divided by height squared (m2) and classified using WHO cut offs (underweight < 18.5; normal 18.5-24.9; overweight 25-29.9; obese >= 30).

v. Harvard Step Test. Players stepped up and down a standard bench at a set cadence for the full test duration (300 s). After stopping, pulse was counted over three recovery windows (1-1.5, 2-2.5, and 3-3.5 min). The long form Physical Efficiency Index was calculated as PEI = (100 x duration in seconds) / (2 x (P1 + P2 + P3)).

3.5 Statistical analysis

Descriptive statistics (mean, standard deviation, standard error, range, coefficient of variation, skewness) summarised each variable. Pearson product moment correlations quantified the associations among the 50 m dash, standing broad jump, zig-zag run, BMI, and PEI. Statistical significance was judged at alpha = .05 (two-tailed, df = 20), with p < .01 and p < .10 also flagged.

3.6 Scope and limitations

The sample is small and single site, so the profile describes one champion squad rather than U-17 footballers broadly. Cross sectional timing rules out any causal reading. BMI cannot distinguish lean from fat mass, and biological maturity was not assessed, which limits interpretation of body composition figures. The Harvard PEI is field based and sensitive to pulse counting accuracy and pacing. Playing position, training history, and diet were not controlled. These constraints shape how far the results should travel.

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IV. ANALYSIS & RESULTS

4.1 Descriptive profile

The squad presented as light, lean, and quick. Table 1 reports the central tendency and spread for every measured variable.

Table 1. Descriptive statistics of the U-17 champion squad (N = 22)

Variable	Mean	SD	SE	Min	Max	Range	CV (%)
50 m dash (s)	7.49	0.52	0.11	6.50	8.50	2.00	7.0
Standing broad jump (m)	1.88	0.22	0.05	1.17	2.28	1.11	11.6
Zig-zag run (s)	24.83	0.75	0.16	22.94	26.00	3.06	3.0
Height (cm)	161.73	6.45	1.37	151.00	172.00	21.00	4.0
Weight (kg)	48.84	6.06	1.29	34.00	62.00	28.00	12.4
BMI (kg/m2)	18.62	1.48	0.32	13.97	20.96	6.99	8.0
PEI	120.26	17.65	3.76	98.68	161.29	62.61	14.7

A few patterns stand out. Agility times were remarkably consistent (CV = 3.0%), which hints at a shared movement competence across the squad the players simply move alike when changing direction. Speed was similarly tight (CV = 7.0%). Explosive power, by contrast, varied more (CV = 11.6%), and its negative skew traces largely to one athlete who recorded a 1.17 m jump, well below the group. That single low value is a useful reminder that even within a winning side, one physical quality can lag while others compensate.

4.2 Motor fitness (Objective 1)

Averaging 7.49 s over 50 m and 1.88 m in the broad jump, the group sits in a respectable band for the age and level. The spread in jump distance is the story here. Strip out the 1.17 m outlier and the cohort clusters tightly between roughly 1.67 m and 2.28 m, which suggests that explosive power, while trainable, was the least uniform quality on display. Notably, the fastest sprinter (6.50 s) also produced one of the longest jumps (2.28 m) a pairing the correlation analysis later confirms is not coincidental.

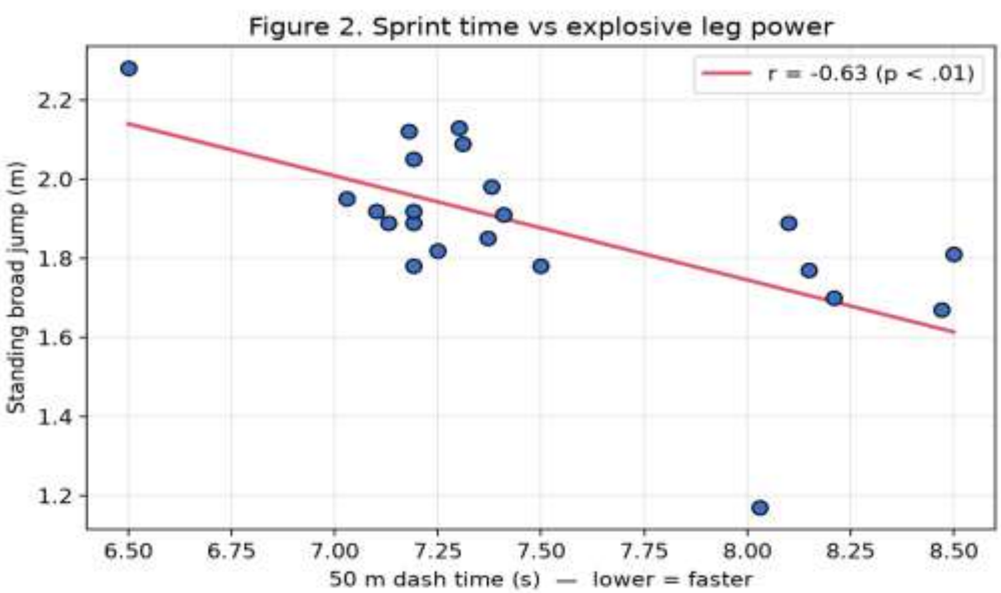

Figure 2. Sprint time versus explosive leg power.

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4.3 Body composition (Objective 2)

BMI averaged 18.62 kg/m2, sitting near the boundary between underweight and normal. The distribution, shown in Figure 1, tells a sharper story than the mean alone: no player fell in the overweight or obese range, 59.1% registered as normal, and a sizeable 40.9% fell below the 18.5 threshold into the underweight band.

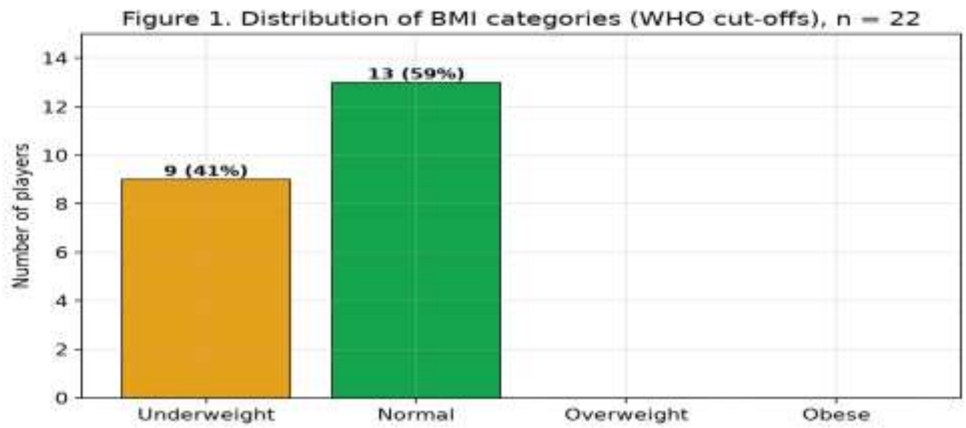

Figure 1. Distribution of BMI categories (WHO cut-offs), n = 22.

Table 2. BMI category distribution (WHO cut-offs)

BMI category	Range (kg/m2)	n	%
Underweight	< 18.5	9	40.9
Normal	18.5 - 24.9	13	59.1
Overweight	25.0 - 29.9	0	0.0
Obese	>= 30.0	0	0.0

The underweight proportion should be read with care. In a lean adolescent athlete, a sub 18.5 BMI can reflect late maturation or naturally low fat mass rather than under nourishment (Wong et al., 2009).

Even so, four in ten players falling below the threshold is worth a coach's attention, since it may flag scope for supervised strength and nutritional support.

4.4 Physiological fitness (Objective 3)

Cardiovascular efficiency was high across the board. Mean PEI reached 120.26, and, when scored against Brouha's classification, all 22 players landed in the "Excellent" band (PEI > 90), as Figure 4 shows.

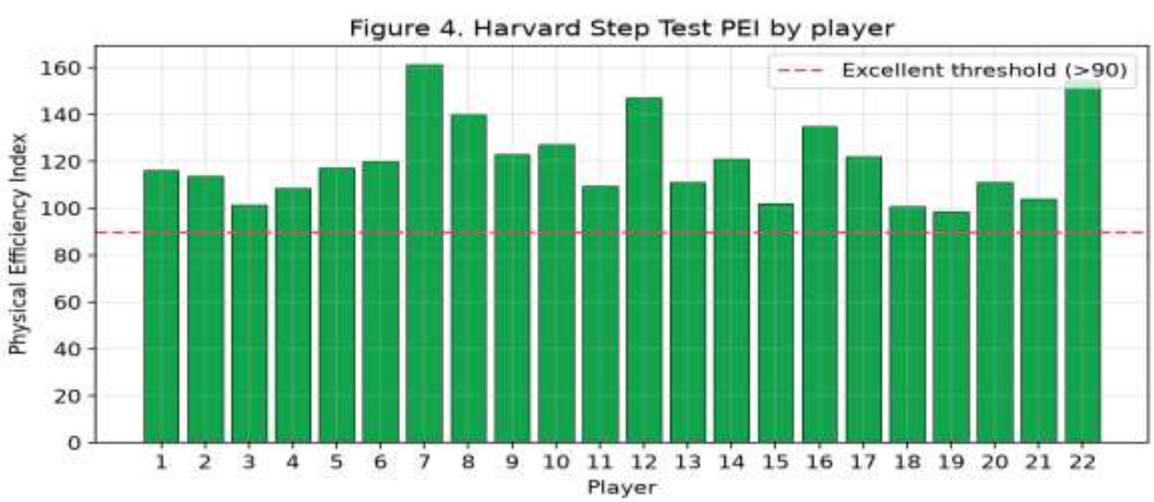

Figure 4. Harvard Step Test PEI by player.

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This uniformity cuts two ways. On one hand, it fits a trained champion squad whose players recover briskly between efforts. On the other, a ceiling where every athlete earns the top grade suggests the classification bands developed long ago on adult populations may lack the resolution to separate fit adolescent footballers from one another. The raw PEI spread (98.68 to 161.29) is far more informative than the single label, and it is the spread, not the band, that the correlation analysis draws on.

4.5 Inter relationships (Objective 4)

Pearson correlations exposed a coherent structure among the fitness qualities. Figure 3 maps the full matrix; Table 3 lists the coefficients with significance.

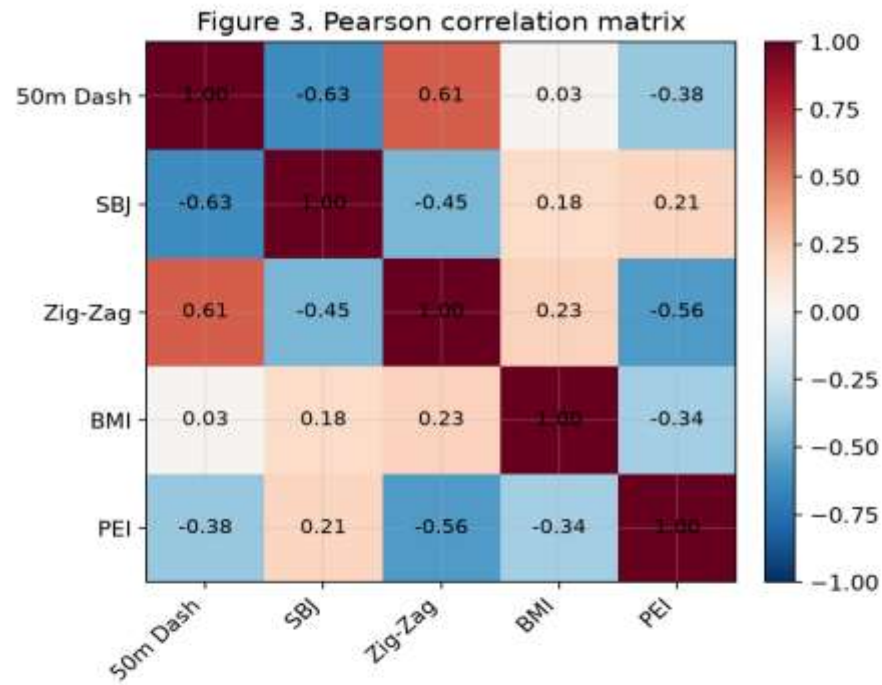

Figure 3. Pearson correlation matrix.

Table 3. Pearson correlations among fitness variables (N = 22, df = 20)

Variable pair	r	Interpretation	Significance
50 m dash x Broad jump	-0.63	Faster sprinters jump farther	p < .01
50 m dash x Zig-zag	+0.61	Faster sprinters are more agile	p < .01
Zig-zag x PEI	-0.56	More agile players recover better	p < .01
Broad jump x Zig-zag	-0.45	More powerful players are more agile	p < .05
50 m dash x PEI	-0.38	Faster players tend to recover better	p < .10 (trend)
BMI x PEI	-0.34	Higher BMI, slightly weaker recovery	ns
Zig-zag x BMI	+0.23	Weak positive	ns
Broad jump x PEI	+0.21	Weak positive	ns
Broad jump x BMI	+0.18	Weak positive	ns
50 m dash x BMI	+0.03	Essentially unrelated	ns

The strongest links sit within the motor-fitness cluster. Speed, power, and agility move together: quicker sprinters jumped farther and turned faster, and the signs run in the expected directions (recall that lower dash and zig-zag times mean better performance).

A second, subtler finding is the tie between agility and cardiovascular recovery ($r = -0.56$, $p < .01$). Players who turned faster also recovered faster after the step test. This suggests that the repeat effort quality prized in match play may share a common base with change of direction economy, though a single cross-sectional sample cannot pin down the mechanism.

BMI, by contrast, sat almost apart from performance. Its near zero link with sprint speed ($r = 0.03$) and only modest, non-significant ties elsewhere imply that, within this lean band, body size added little to explaining who performed well. Practically speaking, a lighter player was neither advantaged nor penalised on the track technique and power mattered more than mass.

V. DISCUSSION

5.1 A fit, lean, and internally consistent squad

Read together, the numbers describe a squad that is quick, agile, aerobically efficient, and carrying little excess mass. That profile aligns with what the literature expects of successful youth footballers, who tend to be lean and to score well on speed and agility relative to less selected peers (Gil et al., 2007; Le Gall et al., 2010). The uniform "Excellent" PEI band, in particular, is consistent with a trained cohort, even if the band itself is too coarse to grade them finely.

5.2 The correlation structure and what it implies

The clustering of speed, power, and agility supports the view that these motor qualities share underlying neuromuscular machinery rate of force development, fast twitch recruitment, and coordinated movement (Chelly et al., 2010; Markovic et al., 2004). Yet agility did not collapse fully into speed; its correlation with the dash ($r = 0.61$), while strong, still leaves room for the independent change of direction skill that Sheppard and Young (2006) describe. This suggests that coaches should keep training and testing agility on its own terms rather than assuming a fast player is automatically an agile one.

The agility recovery association is the more unexpected result. One reading is that both reflect a shared conditioning base built through the repeated high intensity turns of match play. A cautious interpretation is warranted, though: the link could equally be driven by an unmeasured third factor such as overall training volume, and the field based PEI carries its own noise.

5.3 Body composition in context

The large underweight fraction sits in tension with the strong performance scores, and that tension is instructive. If four in ten players are below the BMI threshold yet the squad still wins and tests well, then BMI is plainly a poor stand in for football readiness in this group. This echoes long standing warnings that BMI conflates mass with fatness and ignores maturation (Cole et al., 2000; Wong et al., 2009). The near zero BMI-performance correlations reinforce the point on the ground: in a lean cohort, more mass did not buy more speed.

5.4 Practical implications

Several applied takeaways follow. First, selectors working with similar cohorts should resist single trait thinking; the interlinked profile argues for a small battery rather than one signature test. Second, the underweight signal, even if partly maturational, points to a case for supervised resistance training and nutritional guidance, which could lift explosive power the least uniform quality here without compromising the leanness that serves these players well. Third, because agility was both consistent and tied to recovery, drills that combine change of direction work with repeated efforts may offer good training economy. Consider a hypothetical mid table side hoping to close the gap on this champion squad: the data suggest their quickest wins would come from power development and repeat sprint conditioning, not from chasing raw straight-line speed alone.

5.5 Comparison with prior work

The broad direction of these results matches the European academy literature lean, fast, agile players with strong recovery but the absolute BMI figures run lighter, which is consistent with regional and maturational differences flagged by Mujika et al. (2009) and Malina et al. (2004). This supports the argument that imported norms should be localised before they are used to judge Indian district level athletes.

VI. CONCLUSION & FUTURE SCOPE

6.1 Summary of contributions

This study delivered a measured fitness profile of a district champion U-17 football squad from Purulia a population that existing research has largely passed over. The players were fast, agile, cardiovascularly efficient, and lean, with body mass concentrated in the normal to underweight range. Their fitness qualities were not scattered but interlinked: speed, power, and agility moved together, and agility tracked cardiovascular recovery. BMI, by contrast, told us little about who performed well.

6.2 Limitations

The conclusions rest on a small, single site, cross sectional sample. Maturation, position, training history, and diet were not controlled. BMI's inability to separate lean from fat mass, and the coarse, dated PEI classification bands, both limit how finely the body composition and cardiovascular findings can be read.

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