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Standardized Magnitude of Training Adaptation in Under-16 Male Cricketers: A Secondary Analysis of a 12-Week Structured Conditioning Trial

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ABSTRACT: Youth cricket requires a combination of speed, intermittent endurance, muscular strength, agility, and mobility, yet empirical work on age-specific conditioning remains comparatively limited. This secondary analysis quantified the magnitude and relative pattern of adaptation produced by a 12-week structured physical conditioning program in under-16 male cricketers, emphasizing standardized effects rather than significance testing alone. The source dataset contained 100 district-level male cricketers from Sirsa, Fatehabad, Hisar, and Rohtak, Haryana, randomly allocated to an experimental group ($n = 50$) or conventional-training control group ($n = 50$). The experimental group completed three 60-min sessions per week for 12 weeks. Speed, endurance, muscular strength, agility, and flexibility were assessed before and after the intervention. Change scores, percentage change, Welch independent-samples tests, Hedges' g , bootstrap confidence intervals, and baseline-adjusted ANCOVA were computed. Relative to baseline, the experimental group improved by 5.93% in 50-m sprint performance, 23.55% in endurance, 34.82% in push-up performance, 6.28% in shuttle-run performance, and 25.16% in sit-and-reach performance. The adjusted group effects were significant for every outcome (all $p < .001$; partial $\eta^2 = .815-.906$). Standardized between-group effects based on beneficial change were very large: endurance, $g = 6.09$; agility, $g = 5.24$; flexibility, $g = 4.94$; speed, $g = 4.42$; and strength, $g = 4.11$. The intervention generated a broad and highly pronounced physical adaptation profile. Reporting effect magnitude and the relative hierarchy of responses provides additional information beyond binary significance testing and offers a practical basis for prioritizing conditioning content in adolescent cricket.

1. INTRODUCTION

Cricket is an intermittent sport in which prolonged periods of activity are interspersed with repeated high-intensity actions. The physical profile required for effective participation therefore extends beyond a single fitness domain and includes endurance capacity, acceleration and sprint ability, muscular force, change-of-direction ability, coordination, and sufficient range of motion (Noakes & Durandt, 2000; Wagh et al., 2022). In adolescent players, these qualities develop concurrently with growth and neuromuscular maturation, making training design particularly important.

Contemporary youth strength-and-conditioning literature supports structured, supervised training as an effective strategy for improving motor performance and physical fitness when exercise selection, progression, recovery, and athlete readiness are appropriately managed (França et al., 2023; Long et al., 2024; Moreno-Torres et al., 2025). The Long-Term Athletic Development framework similarly emphasizes developmentally appropriate progression rather than treating young athletes as smaller versions of adults (Lloyd et al., 2016). Resistance and neuromuscular training can improve physical capacities in youth, and recent meta-analytic evidence indicates meaningful benefits for speed, agility, and power when such interventions are delivered systematically (Müller et al., 2023).

Cricket-specific conditioning research also indicates that physical attributes are relevant to performance and that coaches use integrated strength-and-conditioning methods to address the demands of bowling, batting, wicketkeeping, and fielding (Weldon et al., 2021; Wagh et al., 2022). However, the evidence base for under-16 cricket remains less developed than the literature on senior or elite players. This is important because adolescence is a period when training responses may differ across fitness domains depending on the nature of the stimulus and the athlete's developmental status.

A further issue concerns how training outcomes are interpreted. Intervention studies frequently report statistical significance but provide less emphasis on the comparative magnitude of change across physical qualities. Knowing that a program significantly improves five variables does not show which qualities respond most strongly, whether gains are balanced across domains, or how substantial those changes are in standardized terms. Effect sizes, confidence intervals, and change-score analyses provide a more informative description of practical magnitude than p-values alone.

The present manuscript therefore constitutes a secondary analysis of the 12-week controlled conditioning trial described in the supplied study materials. The purpose is intentionally different from a conventional efficacy report: rather than asking only whether the program worked, the analysis quantifies how strongly each fitness domain responded and identifies the relative adaptation hierarchy. This framing provides a distinct interpretation of the existing experimental dataset and should be disclosed transparently to the target journal to avoid redundant publication.

2. OBJECTIVES

1. To quantify pre-to-post changes in speed, endurance, muscular strength, agility, and flexibility following the 12-week structured conditioning program.
2. To compare the magnitude of beneficial change between the experimental and control groups using standardized effect sizes.
3. To determine the relative hierarchy of adaptation across the five physical fitness domains.
4. To estimate baseline-adjusted group effects using ANCOVA and report effect-size metrics alongside statistical significance.

3. METHODS

3.1 Study design and participants

A secondary quantitative analysis was performed on the raw dataset supplied with the doctoral synopsis and the previously prepared article. The underlying study used an experimental pre-test/post-test control-group design. One hundred male district-level cricketers younger than 16 years were selected from four Haryana districts: Sirsa, Fatehabad, Hisar, and Rohtak, with 25 players from each district. The source methodology states that participants were randomly divided into an experimental group ($n = 50$) and a control group ($n = 50$) and were medically fit at study entry.

The study materials do not provide the exact randomization sequence, allocation-concealment procedure, participant flow, biological maturation status, or detailed inclusion/exclusion criteria. These elements should be included in the final submission if they were documented in the original study.

3.2 Intervention

The experimental group completed a 12-week structured conditioning program, with three sessions per week on alternate days, each lasting 60 minutes. Sessions comprised a 10-minute warm-up, a 45-minute main workout, and a 5-minute cool-down. The intervention progressed through three four-week phases: a foundation phase emphasizing sprint technique, body-weight strength, and basic power; a development phase integrating plyometrics, interval running, and coordination; and a

peak phase emphasizing maximum speed, explosive power, and sport-specific reactive agility. The control group continued conventional cricket training.

3.3 Outcome measures

Five performance domains were represented in the raw dataset. Speed was measured with a 50-m sprint (seconds), endurance with a Yo-Yo test (meters), muscular strength with a push-up test (repetitions), agility with a 10 × 4-m shuttle run (seconds), and flexibility with the sit-and-reach test (centimeters). The synopsis also mentions a standing broad jump as a strength measure; however, that variable is not present in the supplied raw dataset. Accordingly, the present analysis operationalizes strength exclusively through push-up performance and does not infer or reconstruct standing-broad-jump scores.

3.4 Data preparation and statistical analysis

All analyses were conducted directly from the 100-row raw dataset. For each outcome, individual change scores were calculated as post-test minus pre-test. Because lower times indicate better performance in speed and agility, the direction of the beneficial change was reversed for those outcomes so that a positive value consistently represented improvement. Percentage change was calculated from the individual pre-test value. Group differences in change scores were assessed with Welch's independent-samples t test because the change-score variances were unequal for all five outcomes according to Levene's test. Where appropriate, distributional robustness was assessed using Mann–Whitney U tests; the direction and statistical conclusion were unchanged.

Between-group magnitude was expressed as Hedges' g based on beneficial change scores, with 95% bootstrap confidence intervals (5,000 resamples). Within-group paired standardized effects were summarized with Cohen's d_z . To adjust for baseline differences, separate ANCOVAs were fitted for each post-test outcome with group as the fixed factor and the corresponding pre-test score as a covariate. Partial eta squared (η^2_p) quantified the adjusted group effect. The Holm adjustment was applied to the five ANCOVA p-values to control the family-wise error rate. Statistical significance was set at $\alpha = .05$.

3.5 Ethical and reporting considerations

The supplied synopsis states that participants were medically fit and that testing was administered by the researcher with assistance from trained personnel. It does not provide the name of an ethics committee, an approval number, a parental consent procedure, or an assent procedure. Those details should be inserted from the original study records before journal submission. Because the present manuscript uses an existing dataset, the authors should also disclose the relationship of this secondary analysis to any prior publication from the same cohort.

4. RESULTS

The raw dataset contained 50 experimental and 50 control observations, with no missing values in the variables analyzed. Descriptive results showed small baseline differences between groups, followed by substantially larger changes in the experimental group across every domain.

Table 1. Descriptive statistics and beneficial percentage change

Outcome	Group	Pre, M (SD)	Post, M (SD)	Change, M (SD)	Beneficial change (%)
50-m sprint	Experimental	7.47 (0.37)	7.02 (0.37)	-0.44	5.93
	Control	7.39 (0.35)	7.36 (0.37)	-0.03	0.44
Yo-Yo test	Experimental	1081.92 (150.93)	1332.16 (160.40)	250.24	23.55
	Control	1078.12 (165.68)	1087.54 (168.15)	9.42	0.89
Push-up test	Experimental	22.26 (5.42)	29.54 (5.57)	7.28	34.82
	Control	21.94 (4.56)	22.20 (4.71)	0.26	1.27
10 × 4-m shuttle run	Experimental	10.94 (0.37)	10.26 (0.43)	-0.69	6.28

	Control	10.86 (0.36)	10.83 (0.35)	-0.03	0.23
Sit-and-reach	Experimental	18.12 (2.70)	22.59 (2.93)	4.47	25.16
	Control	18.47 (3.12)	18.65 (3.15)	0.19	1.05

Note. Positive beneficial-change percentages indicate improvement after directionally coding the 50-m sprint and shuttle-run outcomes, with lower times indicating better performance. Raw change values retain the original direction of measurement.

The largest relative improvement in the experimental group was observed for push-up performance (+34.82%), followed by flexibility (+25.16%) and endurance (+23.55%). Speed and agility improved by 5.93% and 6.28%, respectively, when expressed as beneficial percentage change. The control group showed only small average changes across the outcomes. For example, endurance improved by less than 1%, strength by 1.27%, and flexibility by about 1.05%.

Table 2. Between-group change effects and baseline-adjusted ANCOVA

Outcome	Change difference*	95% CI	Hedges' g (95% CI)	F(1,97)	p	η^2p
Yo-Yo test	240.82	[225.16, 256.48]	6.09 [5.30, 7.35]	931.87	< .001	0.906
10 × 4-m shuttle run	0.66	[0.61, 0.71]	5.24 [4.58, 6.24]	682.49	< .001	0.876
Sit-and-reach	4.28	[3.94, 4.62]	4.94 [4.33, 5.86]	609.86	< .001	0.863
50-m sprint	0.41	[0.37, 0.45]	4.42 [3.73, 5.41]	488.40	< .001	0.834
Push-up test	7.02	[6.34, 7.70]	4.11 [3.55, 4.92]	427.59	< .001	0.815

Note. *Between-group difference in beneficial change (experimental – control). Hedges' g is calculated from beneficial change scores. Negative signs in speed/agility are removed by directional coding before standardization; therefore all reported g values in this table represent benefit magnitude. All ANCOVA p values remained < .001 after Holm correction.

4.1 Standardized adaptation hierarchy

The effect-size analysis demonstrated a clear adaptation hierarchy. Endurance showed the largest standardized effect (Hedges' g = 6.09), followed by agility (g = 5.24), flexibility (g = 4.94), speed (g = 4.42), and muscular strength (g = 4.11). The corresponding bootstrap intervals remained far from zero, indicating that the ordering was not driven solely by sampling noise within the present dataset.

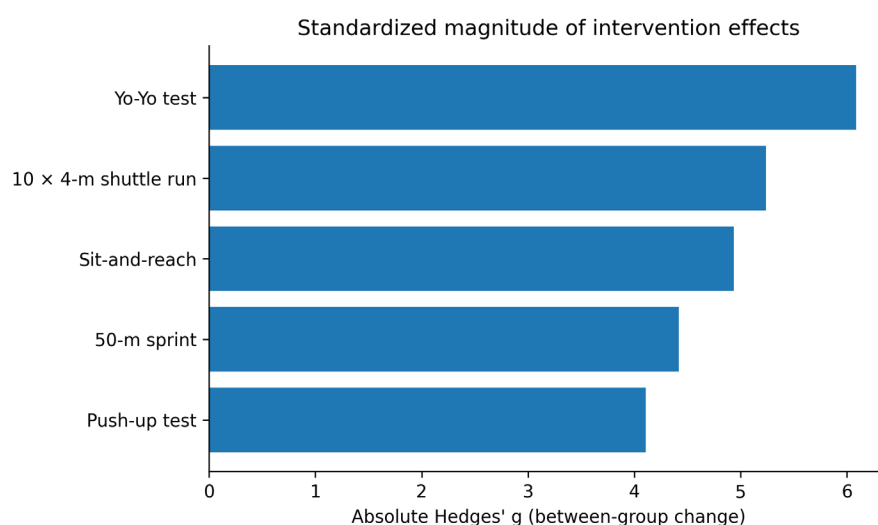


Figure 1. Absolute Hedges' g for the between-group difference in beneficial change.

4.2 Within-group adaptation and statistical robustness

Paired analyses showed significant pre-to-post improvements in the experimental group for all five outcomes (all $p < .001$). Control-group changes were much smaller: speed showed a small statistically detectable change, endurance and flexibility showed modest changes, while strength and agility did not show comparable evidence of improvement. Because the change-score variances were heterogeneous between groups, Welch's tests were used for the primary between-group change comparisons. Nonparametric sensitivity analyses yielded the same inference for every outcome (all two-sided $p < .001$).

4.3 Baseline-adjusted effects

The baseline-adjusted ANCOVA results reproduced the strong intervention effects while using the pre-test value as a covariate. Group effects were $F(1,97) = 488.40$ for speed, 931.87 for endurance, 427.59 for strength, 682.49 for agility, and 609.86 for flexibility; all corresponding p -values were $< .001$. Partial eta squared ranged from .815 to .906, indicating that group membership accounted for a large proportion of adjusted outcome variance in this dataset.

5. DISCUSSION

The principal finding of this secondary analysis is that the 12-week structured conditioning program was associated with a broad adaptation profile across all five measured physical fitness domains, with very large standardized between-group effects. The analysis builds on the earlier efficacy-focused interpretation by quantifying the relative magnitude of adaptation and showing that responses were not uniform across domains.

Endurance displayed the largest standardized effect. The experimental group increased its Yo-Yo performance from a mean of 1,081.92 m to 1,332.16 m, whereas the control group changed only from 1,078.12 m to 1,087.54 m. The intervention combined interval running with broader multicomponent conditioning, providing a plausible stimulus for improvement in repeated-effort capacity. This aligns with contemporary evidence that appropriately structured youth conditioning can improve aerobic and general physical fitness, particularly when sessions are performed two to three times per week for several weeks (Müller et al., 2023; Moreno-Torres et al., 2025).

Agility produced the second-largest standardized effect. Shuttle-run time decreased by approximately 0.69 s in the experimental group compared with only 0.03 s in the control group. The progressive program incorporated agility ladder work, T-drills, zigzag running, and reactive movement tasks. These exercises likely provided repeated exposures to acceleration, deceleration, and change-of-direction demands. Meta-analytic evidence in youth athletes similarly indicates that neuromuscular training can improve speed and agility, although the magnitude of effects varies by training design and population (Müller et al., 2023).

Flexibility also demonstrated a pronounced response. Sit-and-reach performance increased by 4.47 cm in the experimental group compared with 0.19 cm in controls. The intervention included mobility exercises during warm-up, dynamic and static stretching, and dedicated flexibility work. For adolescent athletes, this type of regular mobility exposure is consistent with current youth conditioning recommendations that emphasize an appropriate warm-up and movement preparation within supervised training (Long et al., 2024).

The strength outcome, operationalized in the dataset as push-up performance, improved by 7.28 repetitions on average in the experimental group versus 0.26 repetitions in controls. The intervention used body-weight circuits in the foundation phase and light-to-moderate resistance work in later phases. This pattern is consistent with the established position that properly supervised resistance training can improve muscular fitness in youth and can contribute to long-term athletic development when training is age-appropriate and progressive (Lloyd et al., 2016; Zwolski et al., 2017).

Speed improved by approximately 0.44 s in the experimental group, corresponding to a beneficial change of 5.93%. Although its standardized effect was the fourth-largest in the adaptation hierarchy, the effect remained very large. Sprint technique, short-distance acceleration, flying sprints, and progressive power exercises were incorporated into the program. These elements are consistent with current youth physical development approaches that combine technical sprint exposure with neuromuscular and power training, rather than relying on isolated running volume (França et al., 2023; Long et al., 2024).

The relative ordering of effect sizes is informative for program design. It suggests that the intervention was not merely a generic stimulus that produced an undifferentiated increase across all outcomes; rather, the measured qualities responded with varying magnitudes. In practical terms, endurance and agility may represent particularly sensitive outcomes for this program

structure, while strength and speed still improved substantially. Such ranking can help coaches allocate limited training time and can support future studies that explicitly test whether particular program components are responsible for the largest changes.

At the same time, the extremely large effect sizes require cautious interpretation. In a real-world youth cohort, standardized effects are unlikely to remain this large because samples differ in maturity, baseline skill, adherence, training history, and measurement conditions. The present results should therefore be viewed as evidence of a strong signal within this specific cohort rather than as a universal estimate for all under-16 cricketers. The large effects also highlight the importance of replication with multisite samples and tighter reporting of maturation and training exposure.

The secondary nature of the analysis is important. The manuscript intentionally uses the same underlying trial data as the previously prepared paper but asks a different question and uses a different statistical emphasis: magnitude, ranking, and robustness of change rather than a simple significance-based efficacy summary. The final submission should transparently cite the earlier article and disclose the dataset overlap to the editor. This is particularly important because publisher guidance generally discourages redundant or essentially duplicate publication and encourages clear disclosure of data provenance and prior use.

6. PRACTICAL IMPLICATIONS

- A three-session-per-week structure can simultaneously target endurance, agility, flexibility, speed, and muscular fitness in adolescent cricket settings.
- The effect-size hierarchy suggests that endurance and agility may be especially responsive to a program combining interval running, change-of-direction drills, and progressive neuromuscular work.
- Push-up and sit-and-reach changes indicate that relatively simple field-based tests can detect meaningful adaptation in youth players.
- Coaches should individualize training progression according to maturity, readiness, recovery, and existing cricket workload rather than applying the same load indiscriminately to every adolescent athlete.

7. CONCLUSION

A 12-week structured conditioning program produced large improvements across speed, endurance, muscular strength, agility, and flexibility in the analyzed cohort of under-16 male cricketers. Endurance showed the greatest standardized benefit, followed by agility, flexibility, speed, and strength. The findings demonstrate the value of reporting effect magnitude and adaptation hierarchy alongside conventional significance testing. For youth cricket, the results support a progressive multicomponent conditioning model that integrates running, neuromuscular training, strength development, mobility, and sport-specific movement. Future studies should replicate these findings in larger and more diverse samples while incorporating maturation status, adherence, workload, and sport-skill outcomes.

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