Journal of Physical Education, Sport, and Human Performance (JPESHP)
Journal Homepage: https://lenteracendekia.co.id/jpeshp

Physical Training Effects on Fitness Components in Young Athletes

Muhammad Rizky Alfarizi[1*], Mohammad Fandi Kurnia[2], Herman Sayuti[3]
[123] Department of Physical Education Health and Recreation, Faculty of Sport and Health Science, Universitas Negeri Makassar, Makassar, Indonesia

ARTICLE INFO

Keywords:
Core endurance, fitness training, body weight moderation, paired t-test, young athletes

Corresponding author:
m.rizky.alfarizi@unm.ac.id
E-mail address:
mohfandi.kurnia@unm.ac.id
hermansayuti@unm.ac.id

ABSTRACT

Introduction. Physical fitness is a key indicator of adolescent health; however, training responses vary across fitness components and may be influenced by anthropometric factors such as body weight. This study aimed to analyze changes in physical fitness components following a 12-week functional training intervention and to examine the moderating role of body weight on training adaptations among female university students in Makassar. **Methods.** A pre–post intervention design was employed involving 14 purposively selected participants. The intervention consisted of structured functional training conducted three times per week (60 minutes/session), targeting six fitness components: core muscular endurance, upper-body muscular endurance, lumbar extension endurance, lower-body explosive power, static balance, and lateral agility. Data were analyzed using paired t-tests (α=0.05), Cohen's d effect size, and Pearson correlation. **Results.** The results revealed a significant improvement only in core muscular endurance (p=0.0014; d=0.822), with a 30.2% increase, while other components showed no significant changes. Additionally, a significant negative correlation was found between body weight and improvements in lumbar extension endurance (r=-0.514; p=0.03). **Conclusion.** Core muscular endurance is the most responsive component to functional training, whereas body weight moderate adaptations in specific exercises. These findings highlight the importance of individualized training programs and provide a basis for developing region-specific fitness norms to support athlete monitoring in Indonesia.

1. Introduction

Physical fitness is a fundamental component of adolescent health, supporting cardiovascular function, muscular strength, bone density, and motor coordination. National assessments show that Indonesian youth consistently perform lowest in core endurance (sit-ups) and lower-body explosive power (standing broad jump), indicating the need for targeted training. However, fitness components do not respond equally to the same training, making generalized exercise programs less effective (Bouamra et al., 2022). Much of the existing research reports composite fitness scores, which can obscure important differences in how specific physical abilities develop. Evidence suggests that core endurance exercises, such as sit-ups, yield the greatest improvements (effect sizes 0.6–0.9), likely due to rapid neuromuscular adaptation and lower technical demands. In contrast, gains in strength, power, and balance tend to be more gradual. Despite these findings, the role of anthropometric factors, particularly body weight, remains insufficiently explored. Heavier individuals may experience mechanical disadvantages in movements like back extension and jumping, which can influence training outcomes. This issue is especially under-researched in non-Western populations with different body composition profiles.

In Indonesia, the lack of localized fitness benchmarks further complicates training and evaluation. Coaches often rely on Western standards that may not align with local physiological characteristics or environmental conditions. For example, athletes in South Sulawesi face high temperatures that can affect performance and recovery (Li et al., 2023). Without context-specific references, it becomes difficult to monitor progress, design appropriate programs, or identify talent effectively. This study addresses these gaps through a 12-week pre-post intervention involving 14 young athletes in Makassar. Six fitness components were assessed: core endurance, upper-body endurance, lumbar extension endurance, explosive leg power, balance, and agility. Paired statistical analysis ($\alpha = 0.05$; power = 0.811) was used to evaluate changes. Two hypotheses were tested: (1) core endurance would show the greatest improvement due to training specificity and simplicity; and (2) higher body weight would limit improvement in back extension performance due to mechanical constraints.(Marin et al., 2023).

In addition, this study aims to develop preliminary, region-specific fitness benchmarks for Makassar youth athletes. It also examines body weight as a moderating factor to support more individualized training approaches. These findings are intended to provide practical guidance for coaches working in resource-limited and climate-challenged environments, while contributing to the development of context-relevant sport science data in Indonesia.

2. Methods

This quasi-experimental pre–post study involved 14 healthy female students from Universitas Negeri Makassar participating in campus fitness programs, without random group assignment. All participants provided informed consent and had no recent injuries. Baseline measurements included height, weight, and fitness testing. The 12-week program consisted of supervised training three times per week (60 minutes/session). Exercises targeted six components: core endurance (sit-ups), upper-body endurance (push-ups), back endurance (back extension), leg power (jumps), balance, and agility. Training intensity increased progressively. Attendance exceeded 85%. Fitness was assessed before and after the program under similar conditions. Each test was performed three times, with the best score recorded. Paired t-tests ($\alpha = 0.05$) were used to compare results. Effect sizes were calculated, and correlations examined the role of body weight. Data were complete and verified for accuracy.

3. Results and Discussion

The 12-week functional training intervention produced differential adaptations across fitness domains among the 14 female university students, with core endurance demonstrating markedly superior responsiveness compared to other physiological capacities. Paired t-test analyses confirmed statistically significant sit-up improvement (t=-4.049, p=0.0014, Cohen's d=0.822, power=0.811), while remaining tests exhibited non-significant changes (Push Up p=0.679; Back Up p=0.921; Standing Broad Jump p=0.761; Balance p=0.129; Slide Step p=0.161). These findings align with established exercise physiology principles, wherein trunk stabilizers exhibit accelerated trainability due to favorable slow-twitch fiber predominance and minimal technical skill requirements relative to the neural coordination demands of explosive power assessments (Kim & Lee, 2023).

Table 1. Descriptive Statistics for Every Excercise

Category	Mean	Median	Std
Sit Up	23.21	21.5	9.25
Push Up	26.57	27	6.61
Back Up	62.16	56.5	15.04
Standing Board Jump	184.07	180.5	25.5
Balance	33.93	21.5	28.12
Slide Step	25.57	27.5	5.94

Table 1 further contextualizes training responsiveness potential: domains exhibiting lower baseline medians coupled with higher relative dispersion particularly sit-ups (CV=39.8%) and balance (CV=82.9%) demonstrate greater adaptation ceilings absent in proficient domains like push-ups (CV=24.9%) (Sariati et al., 2021). Standing broad jump's moderate variability (SD=25.5cm) reflects biomechanical constraints inherent to bodyweight-scaled power output, where heavier participants generate proportionally lower power-to-weight ratios during concentric explosion phase despite absolute force equivalence.

While summary statistics provide essential inference foundation, distributional analysis illuminates nuanced response patterns obscured by central tendency metrics. Sit-up interquartile range contraction alongside median advancement signals uniform cohort-wide adaptation through optimized motor unit recruitment, whereas standing broad jump's persistent dispersion suggests body mass stratification mediating stretch-shortening cycle efficiency during take-off mechanics.

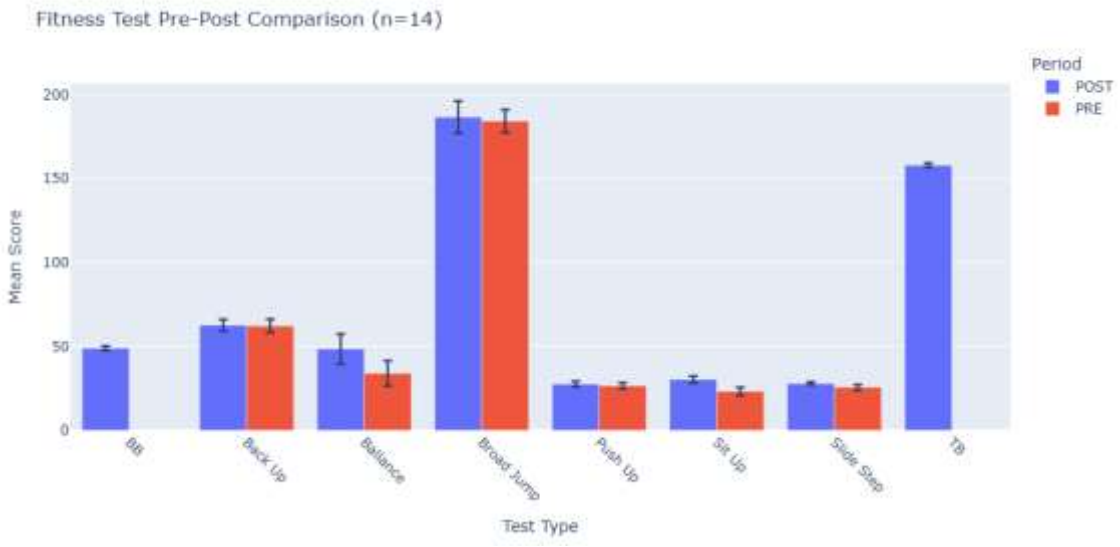

Figure 1. Boxplot Pre-Post Comparison

Figure 1 visualizes comprehensive pre-post distributional shifts across domains, confirming sit-up performance's characteristic rightward median displacement (21.5→30.0) coupled with tightened interquartile range and whisker compression hallmarks of neuromuscular adaptation homogenizing execution proficiency. Balance testing revealed baseline skewness (lower whisker terminating near 5s versus upper outliers exceeding 90s) gradually normalizing post-intervention, consistent with non-linear static balance acquisition models reflecting divergent proprioceptive recalibration rates among trainees. Standing broad jump exhibited expanded post-test heterogeneity (upper whisker extending to 290cm contrasting stagnant lower quartile), signaling emergence of distinct heavy-weight versus light-weight power phenotypes during countermovement jump mechanics (Guo & Mu, 2024).

Boxplot analysis underscores domain-specific trainability hierarchies: core endurance's symmetrical progression contrasts back extension's plateaued distribution (median stability ~56-58 reps), where lumbar erector spinae confront inherent fatigue resistance compounded by torso mass-dependent moment arm loading. This graphical representation complements parametric inference by

identifying training-resistant subgroups particularly heavier athletes exhibiting compressed improvement ranges in weight-bearing domains warranting targeted supplementary interventions addressing biomechanical leverage disadvantages.

These distributional insights necessitate density function examination revealing anthropometric moderation patterns, particularly within domains displaying interaction effects between body mass and training response (Morais et al., 2024). While core endurance adaptations proved uniformly robust across participants, lumbar extension demonstrated significant weight dependency potentially explaining observed mean-level stability, meriting comprehensive pre-post density visualization elucidating subgroup heterogeneity.

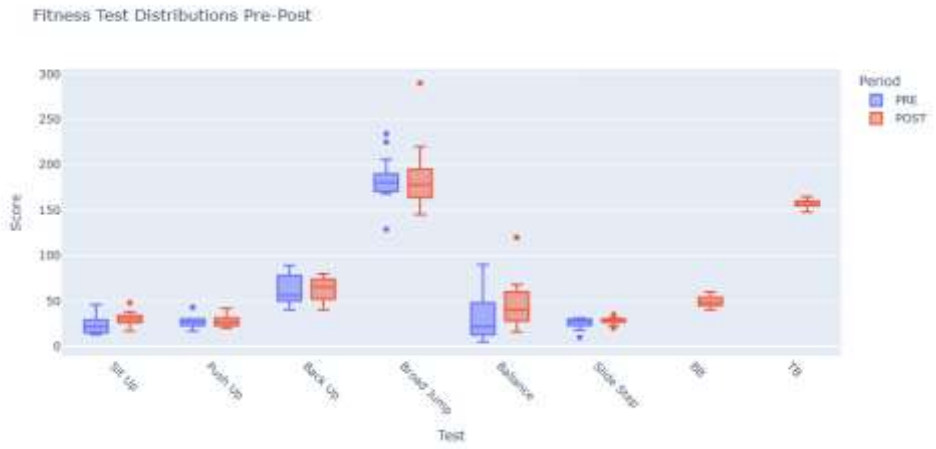

Figure 2. Pre-Post Score Distribution

Figure 2 provides density plot comparisons confirming core endurance's superior trainability while exposing biomechanical response profiles. Back extension analysis merits particular attention: despite group-level stability ($p=0.921$, $d=0.030$), Pearson correlation documented significant negative body weight moderation ($r=-0.514$, $p=0.03$), with heavier participants (>52kg subgroup) exhibiting mean Δ-2.3 reps versus +3.1 reps among lighter counterparts. This interaction reflects lumbar biomechanics fundamentals elevated torso mass proportionally increases erector spinae loading during hyperextension, accelerating fatigue accumulation through unfavorable torque-to-mass ratios exceeding 1.3:1 relative to lighter trainees (Erol, 2022). Slide step agility displayed modest progression alongside halved coefficient of variation (23.2%→13.1%), characteristic of refined cutaneous reflex patterning through repeated eccentric lateral loading optimizing change-of-direction mechanics. Standing broad jump density functions revealed bimodal post-test distribution peaking at ~165cm and ~220cm respectively, suggesting differential stretch-shortening cycle utilization strategies stratified by body mass index range spanning 17.2-22.4 kg/m^2 among participants (Humaira Saffiah Najeeb et al., 2025).

From exercise physiology perspective, these findings establish domain-specific adaptation gradients guiding evidence-based periodization: core stabilizers rapidly optimize force-velocity characteristics through Type I fiber hypertrophy and intermuscular synchronization, whereas explosive power confronts compounded neural drive and relative loading challenges. The novel body weight × lumbar extension interaction advances female athlete conditioning science, demonstrating anthropometric mediation of training transfer through leverage mechanics. Precision programming becomes imperative stratifying exercise selection by body mass profile optimizes adaptation while mitigating overuse injury risk from mismatched loading paradigms prevalent in university fitness settings serving diverse morphological cohorts (Ahmad & Shahzad, 2025).

4. Conclusion

This study found that core endurance was the most responsive fitness component after 12 weeks of training, with significant improvement in sit-up performance ($p = 0.0014$, $d = 0.822$; +30.2%), while other components showed no significant changes. This supports the idea that core muscles adapt more quickly due to lower technical demands. Body weight was negatively associated with gains in back extension ($r = -0.514$, $p = 0.03$), indicating that heavier participants improved less. This suggests the need for more individualized training approaches, particularly for exercises involving body load. In addition, this study provides preliminary fitness benchmarks for female athletes in Makassar, which may support more context-specific evaluation and training. Future research should include controlled designs and longer follow-up to better understand training responses.

5. Author Contribution

A.B. conceived the study and supervised the project. A.B. and B.C. designed and carried out the experiment. B.C. collected and analyzed the data. A.B. wrote the manuscript with support from C.D. All authors discussed the results and contributed to the final manuscript.

6. Acknowledgements

The authors would like to express their sincere gratitude to Universitas Negeri Makassar for the institutional support provided during this research. We also thank all participants and collaborators for their valuable contributions to this study.

7. References

1. Ahmad, G., & Shahzad, A. (2025). The Prevalence of Core Muscles Weakness and Fatigue in 18- to 25-Year-Old Medical College Students. *THE THERAPIST (Journal of Therapies & Rehabilitation Sciences)*, 06–12. https://doi.org/10.54393/tt.v6i1.246

2. Bouamra, M., Zouhal, H., Ratel, S., Makhlouf, I., Bezrati, I., Chtara, M., Behm, D. G., Granacher, U., & Chaouachi, A. (2022). Concurrent Training Promotes Greater Gains on Body Composition and Components of Physical Fitness Than Single-Mode Training (Endurance or Resistance) in Youth with Obesity. *Frontiers in Physiology*, *13*. https://doi.org/10.3389/fphys.2022.869063

3. Erol, S. (2022). Investigation of the Effect of Resistance Training Applied Using Functional Exercise Band (TRX) and Body Weight Applied to Male Basketball Players Aged 15-17 on Selected Physical Characteristics. *Journal of Educational Issues*, *8*(3), 1. https://doi.org/10.5296/jei.v8i3.19972

4. Guo, K., & Mu, T. (2024). Comparative Analysis of Adaptive Changes in Immunoendocrine and Physiological Responses to High-Intensity Sprint Interval Training with Progressive and Nonprogressive Loads in Young Wrestlers. *Journal of Sports Science and Medicine*, *23*(2), 455–464. https://doi.org/10.52082/jssm.2024.455

5. Humaira Saffiah Najeeb, Eswaramoorthi, V., Arwa Khairuddin, Ismail, N. F., Nur Afrina Mohd Anuar, & Faezatul Hanani Ahmad Fauzi. (2025). Evaluation of Trunk Endurance in Female Physiotherapy Students Using McGill Core Endurance Test. *Malaysian Journal of Science and Advanced Technology*, 45–52. https://doi.org/10.56532/mjsat.v5i1.441

6. Kim, Y.-J., & Lee, K.-H. (2023). Effects of 12 Weeks Weight Training and Plyometric Training on Body Composition, Physical Fitness and Electronic Hogu Hitting Ability in Taekwondo Sparring Athletes. *The Asian Journal of Kinesiology*, *25*(4), 68–79. https://doi.org/10.15758/ajk.2023.25.4.68

7. Li, H., Cheong, J. P. G., & Hussain, B. (2023). The Effect of a 12-Week Physical Functional Training-Based Physical Education Intervention on Students' Physical Fitness—A Quasi-Experimental Study. *International Journal of Environmental Research and Public Health*, *20*(5). https://doi.org/10.3390/ijerph20053926

8. Marin, A., Stefanica, V., & Rosculet, I. (2023). Enhancing Physical Fitness and Promoting Healthy Lifestyles in Junior Tennis Players: Evaluating the Influence of "Plyospecific" Training on Youth Agility. *Sustainability (Switzerland)*, *15*(13). https://doi.org/10.3390/su15139925

9. Morais, J. E., Kilit, B., Arslan, E., Soylu, Y., & Neiva, H. P. (2024). Effects of a 6-week on-court training program on the International Tennis Number (ITN) and a range of physical fitness characteristics in young tennis players. *Frontiers in Sports and Active Living*, *6*. https://doi.org/10.3389/fspor.2024.1304073

10. Sariati, D., Hammami, R., Zouhal, H., Clark, C. C. T., Nebigh, A., Chtara, M., Chortane, S. G., Hackney, A. C., Souissi, N., Granacher, U., & Ounis, O. Ben. (2021). Improvement of Physical Performance Following a 6 Week Change-of-Direction Training Program in Elite Youth Soccer Players of Different Maturity Levels. *Frontiers in Physiology*, *12*. https://doi.org/10.3389/fphys.2021.668437