

Supervised vs. Unsupervised Training: A Comparative Analysis of Push-up, Sit-up, and Squat Improvements

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ABSTRACT. Introduction: Supervised physical training enhances adherence, technique, and muscular adaptation, whereas many university students rely on unguided routines that may limit progress in basic bodyweight exercises. Prior research shows that structured programs (especially those using progressive overload, circuit training, and high-intensity formats) produce superior gains in muscular endurance. **Objective:** This study aimed to compare the effects of an eight-week supervised program with unguided training on push-up, sit-up, and squat performance in non-sport major university students. **Material and methods:** Fifty-three students were randomly allocated to a supervised training group (n = 25) or a control group (n = 28), with comparable gender distributions. All participants completed standardized pre/post assessments, and the intervention group performed structured sessions integrating progressive overload, circuit training, and AMRAP, while controls trained independently. **Results:** The supervised group showed markedly greater improvements, gaining +5.52 push-ups, +9.68 sit-ups, and +15 squats, compared to the control group's +2.46, +3.11, and +6.39. Percentage increases were 2–3 times higher in the supervised group, and regression models identified supervised participation as the strongest predictor of improvement, independent of sex, BMI, anthropometrics, or baseline fitness. **Conclusion:** An eight-week supervised program built on progressive overload, circuit structures, and AMRAP leads to substantially greater muscular endurance gains than unguided training in university students. The findings underscore the value of structured, instructor-led approaches for enhancing basic bodyweight performance.

Keywords: supervised training; AMRAP; university students; intervention study

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INTRODUCTION

The importance of structured physical training for enhancing fundamental fitness capacities is well established among young adults with diverse baseline activity levels (Fennell et al., 2016). Evidence consistently shows that supervised programs lead to superior adherence, technique execution, and muscular adaptations compared with unsupervised formats in older adults, recreational lifters, and university cohorts (Lacroix et al., 2017; McNeil et al., 2015). Unsupervised routines, although useful for accessibility, often yield weaker strength outcomes, particularly in technically demanding tasks such as push-ups or sit-ups (Mahjur & Norasteh, 2021; Emerenziani et al., 2014). Structured training programs, supported by systematic instruction and targeted feedback, have been shown to produce superior improvements in motor performance and physical capacities compared to unstructured or self-directed practice, particularly in educational and youth sport contexts (Gherman et al., 2025). Growing interest in high-intensity functional or multimodal exercise further highlights the need for structured prescription, as inconsistent progression can reduce effectiveness in self-guided training (Sobrero et al., 2016; Sharp et al., 2024). School- and university-based studies show that circuit, resistance, or combined endurance–strength interventions substantially improve muscular endurance and body composition when systematically supervised (Stojanović et al., 2023; Pérez-Ramírez et al., 2024). Remote HIIT programs can still produce endurance benefits, though autonomic and strength adaptations remain more variable without direct oversight (García-Suárez et al., 2022). Recent educational research emphasizes that well-designed instructional strategies and supervised practice environments facilitate more efficient skill acquisition and performance improvements than unsupervised training, even when exercise content remains relatively simple (Gherman et al., 2025). Across youth and adult populations, whole-body HIIT and multimodal circuit formats demonstrate balanced improvements in endurance and strength (Bossmann et al., 2022; Falk Neto & Kennedy, 2019). At the same time, methodological analyses emphasize that standardized reporting of volume, intensity, and adherence is crucial for valid comparisons between training conditions (Liu et al., 2020). Training response is also shaped by baseline fitness, BMI, and sex-related physiological differences, with lower-fit individuals often showing greater proportional progress (Pihlainen et al., 2020; Mwebaze et al., 2025). Empirical evidence from applied sports science highlights that structured interventions allow for better control of training variables, improved adherence, and more reliable performance outcomes compared to freely chosen training routines (Gherman et al., 2018). In collegiate settings, daily activity patterns further predict performance in basic muscular endurance tests such as push-ups, sit-ups, and squats (Heinrich et al., 2022; Edman et al., 2013). Considering these factors, this study examines whether an

eight-week supervised program using progressive overload, circuit training, and AMRAP produces greater improvements in push-up, sit-up, and squat performance than unguided training among non-sport major university students. General physical education lessons should be structured to generate diverse problem-solving situations, thereby fostering the development of memory, balance, spatial orientation, and movement coordination through the effective and purposeful use of physical activities (Prodea & Karacsony, 2022).

MATERIALS AND METHODS

Participants

The study included 53 university students from non-sport faculties, assigned to either a control group or a supervised training group. Participants differed in gender, height, weight, and baseline fitness, forming a heterogeneous yet representative student sample. All completed standardized push-up, sit-up, and squat tests before and after the eight-week intervention. The supervised group followed a structured program, whereas the control group trained independently or minimally, enabling a clear comparison of performance improvements.

Training methods used in the intervention

For non-sport major students, these three methods balance safety, simplicity, and measurable progression without requiring advanced motor skills. Progressive overload creates steady improvements with minimal physiological stress, while circuit training offers variety and improved general conditioning. AMRAP provides a reliable performance metric that is easy to track across testing sessions. In contrast, HIIT, Tabata, EMOM, and failure-based methods demand higher technical proficiency, impose greater metabolic strain, and can discourage low-fitness participants. Therefore, the chosen methods maximize adherence and performance gains while minimizing risk, making them ideal for this type of sample.

Research design

The research used a quasi-experimental pre-post design with two groups: a supervised training group and a control group. Participants were randomly assigned to reduce selection bias, and both groups completed identical baseline and post-intervention tests. The control group trained independently in any manner they chose and was kept separate from the supervised group to avoid cross-influence. The intervention group followed a structured program using progressive overload, circuit training, and AMRAP, enabling a clear comparison between guided and self-directed training.

Regression framework and control variables

This section expands explanation by incorporating all control variables included in the regression models, specifically MALE, HEIGHT_CM, WEIGHT_KG, and BMI, which also play an important role in producing unbiased estimates of training effects. Regression analysis offers substantial advantages over simple mean-difference comparisons because it allows the model to statistically control for participant-level characteristics that may influence performance independently of the training intervention. Differences in body composition, anthropometrics, and gender-based physiological capacity can create systematic variation in performance outcomes. By including these variables, regression isolates the causal contribution of the supervised training program more accurately. The general regression equation, applicable to all six models (three absolute gains and three percentage gains), is specified as:

$$Y_i = \beta_0 + \beta_1 \cdot \text{TRAINING}_i + \beta_2 \cdot \text{MALE}_i + \beta_3 \cdot \text{HEIGHT_CM}_i + \beta_4 \cdot \text{WEIGHT_KG}_i + \beta_5 \cdot \text{BMI}_i + \beta_6 \cdot \text{PUSHUPS_PRE}_i + \beta_7 \cdot \text{SITUPS_PRE}_i + \beta_8 \cdot \text{SQTS_PRE}_i + \varepsilon_i$$

In this formulation, Y_i refers to one of the dependent variables: PUSH_GAIN, PUSH_%, SIT_GAIN, SIT_%, SQT_GAIN, or SQT_%. TRAINING_{*i*} is the intervention indicator, while MALE_{*i*} controls for sex-related physiological differences that may influence strength, endurance, or adaptation rates. The variables HEIGHT_CM_{*i*} and WEIGHT_KG_{*i*} capture anthropometric differences that affect leverage, limb length, or body mass loading during exercise execution. BMI_{*i*} integrates height and weight into a standardized measure of body composition that influences mechanical effort and aerobic efficiency. The variables PUSHUPS_PRE, SITUPS_PRE, and SQTS_PRE capture baseline performance levels. Including these variables ensures that the regression estimates training effects net of initial ability. This is essential because individuals with higher initial scores may have less potential for improvement, while those with low baselines may exhibit larger proportional gains independent of training quality. Together, these variables form a comprehensive statistical framework that controls for demographic, anthropometric, and baseline fitness differences. This allows the regression models to quantify the true contribution of the supervised training program with greater accuracy and methodological rigor.

RESULTS

Descriptive statistics and summary of participant data

This report presents descriptive statistics, numerical summaries, and visualizations based on a dataset of 53 participants, divided into a Control group (N = 28) and a Training group (N = 25). Variables include demographic data

(height, weight, BMI) and performance measures for push-ups (PUSHUPS_PRE, PUSHUPS_POST), sit-ups (SITUPS_PRE, SITUPS_POST), and squats (SQTS_PRE, SQTS_POST), with individual percentage improvements and group/sex comparisons provided descriptively. Table 1 shows moderate baseline fitness levels: mean PUSHUPS_PRE = 14.13 (SD = 4.37), increasing to 18.04 (SD = 5.79) after eight weeks. SITUPS_PRE averaged 24.4 (SD = 4.66) and rose to 30.6 (SD = 7.05), while SQTS_PRE increased from 37.91 (SD = 7.11) to 48.36 (SD = 11.31), the largest absolute gain, consistent with strong lower-body responsiveness. Anthropometric values averaged 170.85 cm (SD = 8.84) for height and 70.24 kg (SD = 11.16) for weight, with a mean BMI of 24.09 (SD = 3.65), typical for university-aged adults. Improvements across all exercises indicate broad physical gains, while higher post-test SDs reflect expected variability in mixed-sex, non-athlete samples. Overall, the descriptive results confirm meaningful increases in muscular endurance and strength over the intervention period.

Table 1. Descriptive Statistics

Variable	Mean	SD	Min	Max
HEIGHT_CM	170.85	8.84	151.0	199.0
WEIGHT_KG	70.24	11.16	45.2	109.8
BMI	24.09	3.65	18.0	33.8
PUSHUPS_PRE	14.13	4.37	3	27
PUSHUPS_POST	18.04	5.79	5	34
SITUPS_PRE	24.40	4.66	10	40
SITUPS_POST	30.60	7.05	13	49
SQTS_PRE	37.91	7.11	20	58
SQTS_POST	48.36	11.31	24	78

Sex-based comparison of performance gains

Table 2 shows that female participants achieved slightly higher percentage improvements than males in push-ups (PUSH_INC: 29.55% vs 26.3%), sit-ups (27.71% vs 23.51%), and nearly identical gains in squats (27.39% vs 27.15%). A likely explanation is that females typically begin with lower baseline values—especially in upper-body tasks—which allows larger relative gains even when absolute increases are similar (e.g., +3 reps from 10→13 equals +30%, while 20→23 equals +15%). The greater sit-up improvements for women (27.71% vs 23.51%) may also reflect stronger adherence or comfort with core-based exercises, which can enhance training quality. The near-equal squat gains (27.39% vs 27.15%) indicate robust lower-body adaptation in both sexes, as multi-joint lower-limb exercises elicit strong responses regardless of gender. Physiologically, men’s higher muscle mass and strength can produce smaller relative percentage gains under identical training loads due to a “ceiling effect,” whereas women may show larger proportional improvements when progressing from low to moderate levels over an eight-week period.

Table 2. Percentage improvements by gender

Gender	PUSH_INC	SIT_INC	SQT_INC
Female	29.55	27.71	27.39
Male	26.3	23.51	27.15

Descriptive visualization of training-related changes

The combined boxplot (Figure 3) provides clear visual and numerical evidence of improvement across all exercises from pre- to post-testing. For push-ups, the median rises from about 13–14 reps to around 18, with the upper whisker increasing from roughly 23 to 27–31 reps, indicating strong performers also progressed. Sit-ups show a pre-test median of 24–25 reps increasing to about 30, while the upper whisker grows from 35–36 to approximately 46–49 reps, reflecting higher central values and greater variability. Squats, which begin with the highest baseline scores, show the largest absolute change: the median climbs from roughly 38–39 reps to around 48, and the upper whisker extends dramatically to 70–78 reps, suggesting strong lower-body adaptation in some individuals. Across all exercises, slightly wider post-test IQRs indicate broader individual progress due to variation in adherence and baseline fitness. Overall, the boxplot trends match the descriptive statistics, showing upward median shifts, higher maxima, and modest variability increases over the 8-week period.

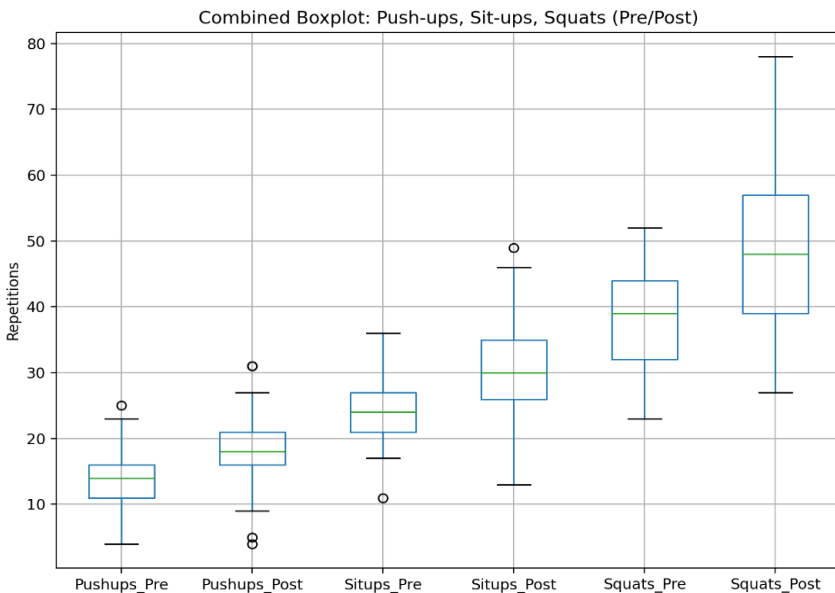


Fig. 3. Combined Boxplot of Pre/Post Performance Across all Exercises

Group differences in performance gains: Welch's t-test analysis

Based on the available data, both absolute and percentage performance gains were analyzed to compare the Training group (three-method program) with the Control group (free training). Welch's t-tests showed large and significant absolute differences: PUSHUPS increased by 5.52 reps in Training vs 2.46 in Control ($t = 5.68, p = 1.36 \times 10^{-6}$); SITUPS rose by 9.68 vs 3.11 ($t = 8.98, p = 5.19 \times 10^{-11}$); and SQUATS improved by 15 vs 6.39 ($t = 6.12, p = 6.98 \times 10^{-7}$). Percentage changes amplified these differences: PUSH_INC reached 40.89% in Training vs 16.40% in Control ($t = 7.99, p = 1.12 \times 10^{-9}$); SIT_INC averaged 38–41% vs 13–15% ($t = 10.58, p < 10^{-11}$); and SQUAT_INC was 36–37% vs 19% ($t = 6.40, p \approx 10^{-6}$). Sex-specific analyses aligned with overall results. Among men, absolute gains were significantly larger in Training ($t \approx 4.5\text{--}6.0, p < .001$), and percentage improvements were two to three times higher than in Control. Among women, relative differences were even stronger: PUSH_INC = +42.4% vs 15.7% ($t = 6.66, p = 1.23 \times 10^{-6}$), SIT_INC = +41.3% vs 13.06% ($t = 6.48, p = 1.83 \times 10^{-6}$), and SQUAT_INC = +35.23% vs 18.95% ($t = 3.59, p = .002$). Overall, both absolute and percentage analyses—whether for the full sample or split by sex—show that the supervised three-method program produced substantially greater improvements than the unstructured training of the Control group.

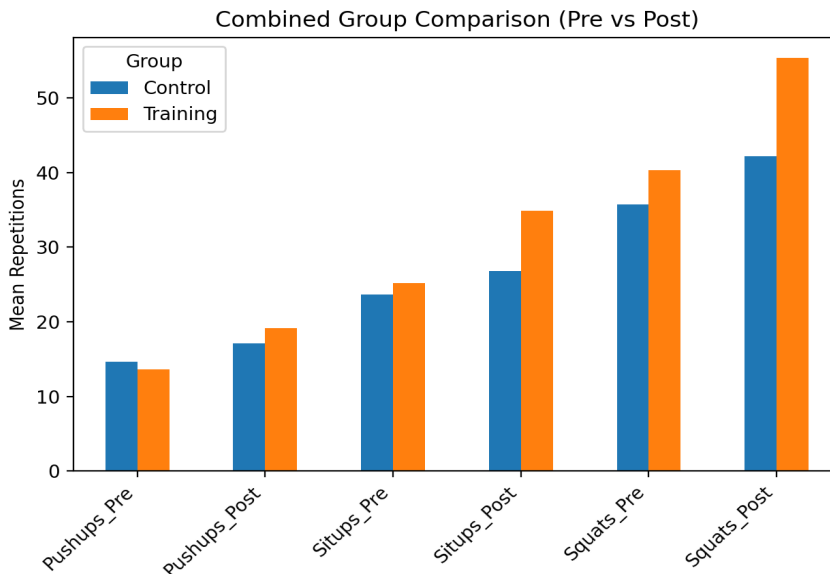


Fig. 4. Mean Performance Comparison Between Training and Control Groups

Interpretation of regression results

The results presented in Table 3 indicate that TRAINING is consistently the strongest and most significant predictor across all six regression models. The coefficients are large and positive—for example, 3.38 for PUSH_GAIN, 24.81 for PUSH_%, 6.11 for SIT_GAIN, and 20.56 for SQT_%, confirming a robust training effect (all $p < .001$). In contrast, MALE is not statistically significant in any model, with small coefficients such as -0.46 for PUSH_GAIN, indicating no meaningful association with performance changes. HEIGHT_CM likewise shows negligible influence, with coefficients near zero (e.g., -0.08 for PUSH_GAIN, -0.22 for SIT_GAIN), suggesting height does not explain improvements in repetitions. WEIGHT_KG also lacks predictive value, with small, nonsignificant coefficients such as 0.15 for PUSH_GAIN and -0.50 for SQT_GAIN. Similarly, BMI exhibits minor nonsignificant effects, -0.47 for PUSH_GAIN and -1.17 for SIT_%, indicating no contribution to outcome variation. The baseline variables show exercise-specific patterns: PUSHUPS_PRE is significant in the PUSH_GAIN model (0.27 , $p < .001$), meaning initial push-up performance partly predicts absolute gains, though it remains nonsignificant for PUSH_%. SITUPS_PRE has a moderate significant effect on SIT_GAIN (0.18 , $p < .05$) but a nonsignificant negative trend for SIT_%. SQTs_PRE is nonsignificant in both SQT models. The CONST terms are large and nonsignificant, providing no interpretive value. Overall, the regression results clearly show that TRAINING is the dominant factor driving improvements across all exercises, while demographic and anthropometric variables contribute little or not at all.

Table 3. Regression Coefficients for Absolute and Percentage Gains in All Exercises

Variable	PUSH_GAIN	PUSH_%	SIT_GAIN	SIT_%	SQT_GAIN	SQT_%
CONST	13.28 (0.43)	99.87 (0.45)	28.26 (0.60)	136.50 (0.72)	-80.97 (-0.80)	-185.99 (-0.74)
TRAINING	***3.38 (7.96)	***24.81 (7.99)	***6.11 (9.32)	***25.77 (9.72)	***8.07 (5.48)	***20.56 (5.62)
MALE	-0.46 (-0.64)	-3.42 (-0.64)	-0.13 (-0.12)	-0.70 (-0.17)	0.63 (0.29)	1.67 (0.31)
HEIGHT_CM	-0.08 (-0.45)	-0.45 (-0.35)	-0.22 (-0.79)	-0.81 (-0.72)	0.45 (0.78)	1.19 (0.82)
WEIGHT_KG	0.15 (0.72)	0.73 (0.48)	0.25 (0.75)	0.80 (0.61)	-0.50 (-0.72)	-1.40 (-0.81)
BMI	-0.47 (-0.77)	-2.48 (-0.55)	-0.39 (-0.41)	-1.17 (-0.30)	1.65 (0.82)	4.48 (0.89)
PUSHUPS_PRE	***0.27 (4.77)	0.24 (0.58)	-	-	-	-
SITUPS_PRE	-	-	*0.18 (2.47)	-0.51 (-1.73)	-	-
SQTs_PRE	-	-	-	-	0.13 (1.20)	-0.28 (-1.00)

DISCUSSION

The supervised program in this study produced substantially greater gains in push-ups, sit-ups, and squats than unguided training, echoing prior evidence that structured guidance enhances muscular endurance (Fennell et al., 2016; Lacroix et al., 2017). Like findings by McNeil et al. (2015), the superior results of the supervised group suggest that consistent instruction and progression are key factors in driving strength adaptations. In contrast, the minimal improvements seen in the control group align with studies showing limited effectiveness of unsupervised routines, such as those reported by Mahjur and Norasteh (2021). The present findings are consistent with previous research indicating that supervised and systematically designed training programs lead to greater neuromuscular and performance adaptations than unsupervised approaches, regardless of participants' initial fitness levels (Gherman et al., 2018). The strong increases in squat performance mirror the robust lower-body adaptations observed in school-based circuit training studies (Stojanović et al., 2023), although our university sample displayed even larger absolute improvements. Similar to results reported in educational and applied sport studies, the effectiveness of the supervised program in the present research suggests that structured guidance may outweigh individual anthropometric or demographic factors in determining short-term training adaptations (Gherman et al., 2025).

The patterns of percentage gains in the supervised group also resemble responses reported in structured high-intensity functional training, despite our use of simpler methods (Sobrero et al., 2016). Regression analyses demonstrated that TRAINING was the dominant predictor of improvements, consistent with the broader conclusion of Sharp et al. (2024) that program structure outweighs participant characteristics in determining adaptation. Unlike the findings of Pihlainen et al. (2020), our models showed no significant influence of BMI or baseline anthropometrics, suggesting a more uniform response in this young adult cohort. Although sex was not a significant predictor in regression results, the slightly higher relative gains among women correspond partly with physiological trends described by Mwebaze et al. (2025). The variability seen in post-test scores resembles patterns noted in studies of remote or variable-intensity training (García-Suárez et al., 2022), though in our case likely reflects differences in adherence rather than program inconsistency.

CONCLUSIONS

This study showed that an eight-week supervised program using progressive overload, circuit training, and AMRAP produced significantly larger improvements in push-ups, sit-ups, and squats than unguided training in non-

sport major university students. The supervised group achieved both higher absolute increases and markedly greater percentage gains, confirming the clear advantage of structured instruction. Regression analyses reinforced this finding by identifying TRAINING as the strongest predictor across all performance outcomes, independent of sex, BMI, or anthropometric characteristics. An original contribution of this study is the combined use of three simple, low-technical training methods within a supervised model specifically tailored for non-athlete university populations. The results also provide practical evidence that accessible bodyweight-based programs can yield substantial fitness gains when implemented with guidance.

However, the study has limitations, including a relatively small sample size, reliance on self-reported adherence in the control group, and the absence of long-term follow-up to assess retention of gains. Another limitation is that training intensity was not objectively quantified, which limits comparisons with more advanced or periodized programs. Future research should explore the effects of supervised versus hybrid (partly supervised) models, as well as technology-supported remote supervision. Longitudinal studies examining how improvements evolve or decline over several months would also be valuable. Additionally, investigating the impact of psychological factors—such as motivation or perceived competence—could further clarify why supervised training is consistently more effective.

AUTHOR CONTRIBUTIONS

Păuna Răzvan-Dorel, Șerban Rau Tiberiu și Pop Sergiu contributed equally to the design and implementation of the research, to the data collection, analysis and interpretation of the results, and to the writing of the manuscript. All authors had equal rights and responsibilities in the preparation of this work. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest related to this research.

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