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Effects of fartlek and continuous training across motivation levels on physical fitness in high school students

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ABSTRACT

This study aimed to examine the effects of Fartlek and continuous training and training motivation on physical fitness among senior high-school students. A quasi-experimental 2×2 factorial design involved 40 students assigned according to training model and high or low motivation. Physical fitness was assessed using the Indonesian Student Fitness Test (TKSI), and data were analyzed using two-way ANOVA and Tukey tests. Continuous training produced higher fitness scores than Fartlek training ($F = 8.11$), while motivation significantly affected fitness ($F = 7.62$). A significant interaction between training model and motivation was identified ($F = 7.33$). The highest fitness score occurred in the continuous-training/high-motivation group ($M = 23.00$). Continuous training was more effective, particularly among highly motivated students, confirming that training effectiveness depends on motivational characteristics.



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Introduction

Physical fitness is a fundamental indicator of health and functional capacity during adolescence, reflecting the ability to perform daily and physical activities efficiently while supporting cardiorespiratory, neuromuscular, and metabolic health. Adolescence represents a critical developmental period in which habitual physical activity and fitness behaviors are established and may persist into adulthood, making school-based exercise programs particularly important. Structured exercise interventions have demonstrated beneficial effects on cardiorespiratory fitness and other components of physical performance in children and adolescents; however, the magnitude of these adaptations varies considerably according to training characteristics, baseline fitness, and participant-related factors (Satria et al., 2024; Wijaya et al., 2024; Acevedo & Goldfarb, 1989; Belamjahad et al., 2024). This variability highlights the need to identify training approaches that can effectively develop multiple dimensions of physical fitness rather than focusing exclusively on a single physiological outcome.

The effectiveness of exercise is strongly influenced by the characteristics of the training stimulus, particularly intensity, duration, frequency, progression, and workload distribution. Continuous training provides a relatively stable and sustained physiological load that may facilitate cardiovascular efficiency, metabolic adaptation, and endurance development, whereas Fartlek training combines continuous exercise with systematic variations in speed and intensity, thereby imposing alternating aerobic and anaerobic demands. Evidence indicates that manipulating training intensity can produce different cardiorespiratory and performance adaptations in young populations (Gadeken, 1999; Liu et al., 2021). Interval- and variable-intensity approaches have also

demonstrated benefits for aerobic capacity, jumping performance, sprint ability, and change-of-direction performance, suggesting that training structure may influence several dimensions of physical fitness (Grivas et al., 2026; Toledo-Perez et al., 2021). Fartlek interventions have been associated with improvements in maximal oxygen uptake, particularly when implemented systematically over several weeks (Fitrian et al., 2023; Muslim et al., 2019), while continuous endurance exercise remains an established approach for improving cardiorespiratory fitness; nevertheless, comparative responses appear to depend on the population, training protocol, and outcome assessed (Foster et al., 2025; Jose & Sathyaraja, 2026).

Physiological characteristics of training alone, however, may not fully explain individual differences in physical fitness adaptation because successful participation in structured exercise also depends on psychological engagement. Training motivation may influence the effort exerted during exercise, persistence when training becomes demanding, adherence to prescribed workloads, and consistency across training sessions. Evidence involving children and adolescents has demonstrated positive relationships between self-determined motivation and physical activity participation, with autonomous motivation generally showing stronger associations with sustained activity than controlled forms of motivation (Owen et al., 2014). Motivation has also been identified as an important predictor of moderate-to-vigorous physical activity, although its influence may differ across school, leisure, and other activity contexts (Ferraz et al., 2010; Soulas et al., 2005). From the perspective of Self-Determination Theory, sustained engagement is more likely when individuals internalize the value of physical activity and develop autonomous reasons for participation (Lim et al., 2018; Wulandari, Pambudi, Jatmikanto, Hafidz, Fajar, Daulay, Widohardhono, Andriana, et al., 2026). Thus, motivation may contribute to training outcomes indirectly through behavioral mechanisms such as adherence, effort, and persistence, although these mechanisms should not be interpreted as direct physiological effects without empirical measurement.

Current evidence therefore reflects two important but insufficiently integrated research directions. One body of research has concentrated on the physiological effectiveness of Fartlek, continuous, high-intensity interval, and sprint-interval training, with cardiorespiratory fitness and VO_2max commonly serving as primary outcomes (Fatoni et al., 2019; Tahapary et al., 2019). Another body of research has examined behavioral and psychological determinants of physical activity, including motivation, participation, and persistence (Inozemtseva & Zemlyakova, 2021; Kurz et al., 2000). Despite these developments, limited evidence has directly investigated whether differences in physical fitness responses to Fartlek and continuous training are associated with students' training motivation within the same experimental framework. Moreover, previous training research has frequently emphasized aerobic capacity or sport-specific performance, leaving comparatively limited evidence on multidimensional physical fitness encompassing coordination, muscular power, agility, reaction speed, muscular endurance, and cardiorespiratory endurance. This separation between physiological training research and motivational research represents an important gap, particularly in senior high-school populations where both physical adaptation and sustained engagement are essential for effective training programs.

Accordingly, the present study integrates training methodology and motivational characteristics to provide a more comprehensive explanation of physical fitness development among senior high-school students. Its novelty lies in simultaneously comparing Fartlek and continuous training across different levels of training motivation while evaluating physical fitness through multiple domains, including hand-eye coordination, lower-limb explosive power, agility, reaction speed, upper-body muscular endurance, and cardiorespiratory endurance, rather than relying solely on VO_2max . This multidimensional perspective extends previous evidence concerning the effects of exercise modalities on physical fitness while recognizing motivation as a potentially important individual characteristic associated with training responses (Luo, 2008; Pribadi et al., 2024). Therefore, this study aimed to compare the effects of Fartlek and continuous training on physical fitness, determine differences in physical fitness according to training motivation, and examine the interaction between training model and motivation among senior high-school students. The findings are expected to provide an empirical basis for designing school-based training programs that consider both physiological training demands and the motivational characteristics of adolescent participants.

Method

Study Design

This study employed a quasi-experimental factorial design to examine the effects of training model and training motivation on physical fitness among senior high-school students. The first factor was training model, comprising Fartlek training (A_1) and continuous training (A_2), whereas the second factor was training motivation, categorized as high motivation (B_1) and low motivation (B_2). Physical fitness was treated as the dependent variable. The combination of these factors generated four experimental conditions: Fartlek training with high motivation (A_1B_1), Fartlek training with low motivation (A_1B_2), continuous training with high motivation (A_2B_1), and continuous training with low motivation (A_2B_2). A quasi-experimental approach was

adopted because participants were recruited from existing school-based extracurricular activities and complete random assignment was not feasible. Therefore, a matching procedure was applied to improve baseline comparability across the experimental conditions. Training motivation was treated as a measured participant factor rather than an experimentally manipulated variable; accordingly, the design examined the main effects of training model and motivation level and their interaction on changes in physical fitness.

Participants and Sampling

The study was conducted at SMA Negeri 2 Muko-Muko, Indonesia. The target population comprised 148 students participating in extracurricular sports activities, including 52 Grade X students, 49 Grade XI students, and 47 Grade XII students. Participants were recruited using purposive sampling based on the following eligibility criteria: regular attendance during the study period, active participation in extracurricular sports, absence of illness that could interfere with physical exercise, and willingness to participate throughout the study. Training motivation was assessed before participant allocation, and eligible students' scores were ranked from highest to lowest. The upper 27% and lower 27% of the score distribution were used to identify students with high and low training motivation, respectively. From these categories, 40 students were selected for participation. A matching procedure was subsequently used when allocating participants to the Fartlek and continuous-training conditions to minimize initial differences between groups. Because age, sex distribution, and previous training experience were not reported in the original dataset, these characteristics should be added to the final manuscript if the corresponding data are available.

Training Motivation Instrument

Training motivation was measured before the intervention using a structured self-report questionnaire developed from relevant theoretical indicators. The questionnaire employed a five-point Likert scale ranging from strongly disagree to strongly agree, with positively worded items scored from 5 to 1 and negatively worded items reverse-scored. The instrument assessed four dimensions: intrinsic motivation, extrinsic motivation, motivational intensity, and perceived effects of motivation on training. Intrinsic motivation represented students' internal reasons for training, including improving health, maintaining physical fitness, and achieving sporting performance, whereas extrinsic motivation reflected support from teachers or coaches, family, peers, school, and the surrounding environment. Motivational intensity represented consistency, frequency of participation, and persistence in overcoming training-related challenges, while perceived effects reflected satisfaction with training and confidence in its contribution to physical fitness. Total questionnaire scores were used to rank participants and classify them into high- and low-motivation categories. To establish the measurement quality of this instrument, the final manuscript should report the number of items, theoretical source, validity procedure, reliability coefficient, and evidence supporting the interpretation of the total score if these data are available.

Physical Fitness Assessment

Physical fitness was assessed using the Indonesian Student Fitness Test (Tes Kebugaran Siswa Indonesia; TKSI), Phase E–F, developed for senior secondary school students in Grades X–XII. The battery comprises six assessments representing different dimensions of physical fitness: the Hand–Eye Coordination Test for coordination, Vertical Jump Test for lower-limb explosive power, T-Test for agility, Hand Touch Reaction Test for reaction speed, Dipping Test for upper-body muscular endurance, and 20-m Beep Test for cardiorespiratory endurance. In the Hand–Eye Coordination Test, participants performed alternating catches for 30 seconds, with the best result from two trials recorded. Vertical-jump performance was determined from the difference between standing reach and maximal jump reach, while agility was measured as the time required to complete the standardized T-Test course. Reaction speed was assessed through responses to directional cues in the Hand Touch Reaction Test. The Dipping Test recorded technically correct repetitions performed according to a standardized metronome rhythm, and cardiorespiratory endurance was assessed using the 20-m Beep Test, with completed levels and shuttles used to estimate maximal oxygen uptake (VO_{2max}). The same TKSI procedures were administered before and after the intervention under comparable testing conditions. Because these components use different measurement scales and units, the manuscript should explicitly describe the official TKSI scoring or conversion procedure used to derive the overall physical fitness score analyzed statistically and should report the validity and reliability evidence for the Phase E–F battery.

Experimental Procedure

Data collection was conducted through a standardized sequence comprising participant screening, motivation assessment, group classification, baseline physical fitness testing, training intervention, and post-intervention assessment. Before data collection, researchers coordinated with the school administration and prepared the participants, equipment, testing procedures, and training programs. Eligible participants completed the training motivation questionnaire and were classified into high- and low-motivation categories according to their ranked scores. Participants were then allocated to the Fartlek or continuous-training conditions using a matching

procedure, resulting in four combinations of training model and motivation level. All participants completed the TKSI Phase E–F pretest under standardized conditions before commencing the intervention.

The intervention comprised 16 training sessions conducted over approximately eight weeks from April to June 2026 at SMA Negeri 2 Muko-Muko. Participants assigned to Fartlek training performed continuous running interspersed with systematic variations in running speed and exercise intensity, whereas participants assigned to continuous training performed sustained exercise at a relatively stable workload according to the predetermined training program. Researchers monitored implementation to ensure that participants followed their assigned training condition. After all training sessions were completed, participants undertook the TKSI Phase E–F posttest using the same procedures and testing conditions as the baseline assessment. For methodological reproducibility, the final manuscript should additionally report the duration of each session, weekly frequency, prescribed exercise intensity, progression of training load, recovery structure, method of intensity monitoring, attendance or adherence criteria, and procedures used to equate or control training volume between Fartlek and continuous training, provided these records are available.

Statistical Analysis

Data were analyzed using descriptive and inferential statistical procedures appropriate for the factorial design. Descriptive statistics, including the mean and standard deviation, were calculated to summarize physical fitness outcomes across training models, motivation levels, and their combinations. Before inferential analysis, the assumptions underlying parametric testing were evaluated, including normality and homogeneity of variance. The primary analysis used two-way analysis of variance (ANOVA) to examine the main effect of training model (Fartlek vs. continuous training), the main effect of training motivation (high vs. low), and the training model $\times$ motivation interaction on changes in physical fitness. Because physical fitness was assessed before and after the intervention, the manuscript should explicitly identify whether the dependent variable entered into the ANOVA was the posttest score, raw change score (posttest minus pretest), or another derived improvement score; this specification is essential for interpreting the reported effects and should not be inferred from the available information. Where significant effects warranted further examination, Tukey's post-hoc procedure was used for pairwise comparisons. Statistical significance should be reported using exact p-values where available, together with effect sizes and 95% confidence intervals to indicate the magnitude and precision of the observed effects rather than relying solely on comparisons between observed and critical F values.

Results and Discussions

The results were organized according to the 2×2 factorial design, in which training model (Fartlek vs. continuous training) was treated as the first factor and training motivation (high vs. low) as the second factor. The source document reports descriptive statistics for the treatment groups and factorial cells, followed by assumption testing, two-way analysis of variance (ANOVA), and Tukey post-hoc comparisons.

Table 1. Descriptive Statistics of Physical Fitness and Training Motivation

Factor	Group	n	Minimum	Maximum	Mean	SD
Training Model	Fartlek training (A1)	20	18	24	21.70	2.00
	Continuous training (A2)	20	19	24	22.10	1.66
Training Motivation	High motivation (B1)	20	173	199	192.40	7.52
	Low motivation (B2)	20	133	173	152.30	13.42

Table 1 presents the descriptive statistics for physical fitness scores according to training model and training motivation. Students in the continuous training group achieved a slightly higher mean physical fitness score ($M = 22.10$, $SD = 1.66$) than those in the Fartlek training group ($M = 21.70$, $SD = 2.00$), with score ranges of 19–24 and 18–24, respectively. Regarding training motivation, students classified as having high motivation recorded a mean score of 192.40 ($SD = 7.52$), ranging from 173 to 199, whereas those with low motivation obtained a mean score of 152.30 ($SD = 13.42$), ranging from 133 to 173. Overall, the descriptive results indicate a modest difference in physical fitness scores between the two training models and a clear numerical separation between the high- and low-motivation groups.

Physical Fitness Scores Across the Factorial Groups

Table 2 summarizes physical fitness scores for each combination of training model and motivation level. The continuous-training/high-motivation group (A2B1) demonstrated the highest mean physical fitness score (23.00 ± 1.00), followed closely by the Fartlek/high-motivation group (A1B1; 22.80 ± 1.30). Among students with low

motivation, the continuous-training group (A2B2) obtained a mean score of 21.20 ± 1.79 , whereas the Fartlek group (A1B2) recorded 20.60 ± 2.07 . Thus, based on the numerical results reported in Chapter IV, continuous training was associated with higher mean physical fitness scores at both levels of training motivation.

Table 2. Descriptive Statistics of Physical Fitness Scores Across the 2×2 Factorial Groups

Training Model	Motivation Level	Group	n	Minimum	Maximum	Mean	SD
Fartlek	High	A1B1	5	21	24	22.80	1.30
Fartlek	Low	A1B2	5	18	23	20.60	2.07
Continuous	High	A2B1	5	22	24	23.00	1.00
Continuous	Low	A2B2	5	19	23	21.20	1.79

Note. A1B1 = Fartlek training with high motivation; A1B2 = Fartlek training with low motivation; A2B1 = continuous training with high motivation; A2B2 = continuous training with low motivation.

Normality Test

Table 3. Results of the Lilliefors Normality Test

Group	n	L_0	$L_{critical}$	Decision
A1	20	0.237	0.292	Normal
A2	20	0.127	0.294	Normal
B1	20	0.127	0.294	Normal
B2	20	0.101	0.294	Normal
A1B1	10	0.179	0.337	Normal
A1B2	10	0.179	0.337	Normal
A2B1	10	0.159	0.337	Normal
A2B2	10	0.156	0.337	Normal

Note. L_0 = observed Lilliefors statistic; $L_{critical}$ = critical Lilliefors value at $\alpha = .05$.

Before conducting the factorial ANOVA, the normality assumption was examined using the Lilliefors test at $\alpha = .05$. As presented in Table 4, the observed Lilliefors statistic for every group was lower than its corresponding critical value ($L_0 < L_{critical}$). Therefore, all distributions satisfied the normality assumption, supporting the subsequent application of parametric two-way ANOVA.

Homogeneity of Variance

Table 4. Results of Bartlett's Test for Homogeneity of Variance

Factorial Group	Individual Variance	Pooled Variance	B	$\chi^2_{observed}$	$\chi^2_{critical}$	Decision
A1B1	1.70					
A1B2	4.30					
A2B1	1.00					
A2B2	3.20	2.48	6.31	2.699	9.28	Homogeneous

Note. $\chi^2_{observed}$ = observed chi-square statistic; $\chi^2_{critical}$ = critical chi-square value.

The homogeneity-of-variance assumption was evaluated using Bartlett's test. The four factorial groups showed individual variances ranging from 1.00 to 4.30, with a pooled variance of 2.48. The observed Bartlett chi-square statistic was $\chi^2 = 2.699$, which was lower than the critical value of 9.28 at $\alpha = .05$. Accordingly, the null hypothesis of equal variances was retained, indicating that the four treatment groups met the homogeneity assumption required for factorial ANOVA.

Effects of Training Model and Training Motivation on Physical Fitness

Table 5. Two-Way ANOVA for the Effects of Training Model and Training Motivation on Physical Fitness

Source of Variation	SS	df	MS	F	$F_{critical}$	Decision
Training model (A)	21.90	1	21.90	8.11	4.49	Significant
Training motivation (B)	20.70	1	20.70	7.62	4.49	Significant
Training model $\times$ Motivation	19.80	1	19.80	7.33	4.49	Significant
Within/Error	43.80	16	2.70			
Total	61.80	19				

Note. SS = sum of squares; df = degrees of freedom; MS = mean square; $F_{critical} = 4.49$ at $\alpha = .05$.

The two-way ANOVA revealed statistically significant effects of both experimental factors on physical fitness. The main effect of training model was significant ($F = 8.11 > F_{\text{critical}} = 4.49$), indicating that physical fitness differed according to whether students received Fartlek or continuous training. Training motivation also showed a significant main effect ($F = 7.62 > 4.49$). Importantly, a significant training model $\times$ training motivation interaction was identified ($F = 7.33 > 4.49$), suggesting that the effect of the training model on physical fitness varied according to students' level of training motivation. Because the interaction was significant, the source document proceeded with Tukey post-hoc comparisons.

Tukey Post-Hoc Comparisons

Table 6. Tukey Post-Hoc Comparisons of Physical Fitness Scores

Comparison	Mean Group 1	Mean Group 2	Q _{observed}	Q _{critical}	Result
Fartlek (A1) vs. Continuous (A2)	21.70	22.10	25.93	3.15	Significant
Fartlek–High Motivation (A1B1) vs. Continuous–High Motivation (A2B1)	22.80	23.00	20.37	5.22	Significant
Fartlek–Low Motivation (A1B2) vs. Continuous–Low Motivation (A2B2)	20.60	21.20	10.19	5.22	Significant

Note. Q_{observed} = observed Tukey statistic; Q_{critical} = critical Tukey value. The values are reproduced from the statistical results reported in Chapter IV.

The Tukey post-hoc analysis indicated significant pairwise differences between the training conditions. Overall, students receiving continuous training achieved a higher mean physical fitness score ($M = 22.10$) than those receiving Fartlek training ($M = 21.70$), with the reported Tukey statistic exceeding the critical value ($Q = 25.93 > 3.15$). Among students with high motivation, continuous training ($M = 23.00$) also produced a higher mean score than Fartlek training ($M = 22.80$; $Q = 20.37 > 5.22$). Similarly, among students with low motivation, the continuous-training group ($M = 21.20$) outperformed the Fartlek group ($M = 20.60$; $Q = 10.19 > 5.22$). Thus, the numerical data reported in Chapter IV consistently favor continuous training in both motivation strata.

Summary of Hypothesis Testing

Table 7. Summary of the Study Findings Based on the Reported Statistical Results

Hypothesis	Statistical Evidence	Result	Interpretation
H1: Physical fitness differs between Fartlek and continuous training	$F = 8.11 > 4.49$; A1 $M = 21.70$; A2 $M = 22.10$	Significant	Continuous training produced a higher overall mean physical fitness score
H2: Training model interacts with training motivation	$F = 7.33 > 4.49$	Significant	The effect of training model was statistically dependent on motivation level
H3: Fartlek and continuous training differ among highly motivated students	A1B1 $M = 22.80$; A2B1 $M = 23.00$; $Q = 20.37 > 5.22$	Significant	Continuous training produced a higher mean score among highly motivated students
H4: Fartlek and continuous training differ among students with low motivation	A1B2 $M = 20.60$; A2B2 $M = 21.20$; $Q = 10.19 > 5.22$	Significant	Continuous training produced a higher mean score among students with low motivation

Table 7 integrates the principal inferential findings. The analysis showed a significant main effect of training model and a significant interaction between training model and training motivation. Continuous training yielded a higher overall mean physical fitness score than Fartlek training. The cell-level descriptive and Tukey results also showed higher physical fitness scores for continuous training among both highly motivated (23.00 vs. 22.80) and low-motivation students (21.20 vs. 20.60). Therefore, when the article is written strictly from the numerical results presented in Chapter IV, the evidence supports a statistically significant difference between the two training approaches and a significant interaction with training motivation.

The present study demonstrated that the training model significantly influenced students' physical fitness ($F = 8.11 > F_{\text{critical}} = 4.49$), with continuous training producing a higher overall score ($M = 22.10$, $SD = 1.66$) than Fartlek training ($M = 21.70$, $SD = 2.00$). Continuous exercise may provide a sustained physiological stimulus that promotes cardiovascular efficiency and endurance adaptation through prolonged exposure to a relatively stable workload. Nevertheless, Fartlek training remains an effective conditioning approach, particularly for improving aerobic capacity in adolescents, with previous evidence reporting meaningful improvements in $VO_2\text{max}$ following structured Fartlek interventions (Bahtra et al., 2024; Grossman et al., 2021; Hough, 2021; Muryadi et al., 2023).

Training motivation also significantly affected physical fitness ($F = 7.62 > F_{\text{critical}} = 4.49$). Students with high motivation achieved better physical fitness outcomes under both Fartlek ($M = 22.80$) and continuous training ($M = 23.00$) than their low-motivation counterparts ($M = 20.60$ and $M = 21.20$, respectively). This finding indicates that motivation may strengthen training outcomes by encouraging greater effort, persistence, adherence, and consistency during exercise. Evidence among adolescents similarly suggests that exercise motivation contributes substantially to adherence and sustained participation in structured physical activity (Braunsperger et al., 2026; Csepregi et al., 2020; Kotadiya & Shah, 2026; Pratama et al., 2026).

A significant interaction between training model and training motivation was also identified ($F = 7.33 > F_{\text{critical}} = 4.49$), indicating that physical fitness outcomes were influenced by the combined contribution of training characteristics and students' motivational levels. The highest physical fitness score was observed in the continuous-training/high-motivation group ($M = 23.00$, $SD = 1.00$), followed by the Fartlek/high-motivation group ($M = 22.80$, $SD = 1.30$). Highly motivated students may be better able to maintain training intensity, comply with prescribed exercises, and consistently complete training sessions, thereby facilitating greater physiological adaptation (Fatoni et al., 2026; Hidayat et al., 2025; Ramadhani, 2026; Wulandari, Pambudi, Jatmikanto, Hafidz, Fajar, Daulay, Widohardhono, & Andriana, 2026).

The Tukey post-hoc analysis further confirmed significant differences between the training conditions. Continuous training was superior to Fartlek training overall ($Q = 25.93 > Q_{\text{critical}} = 3.15$), among students with high motivation (23.00 vs. 22.80; $Q = 20.37 > Q_{\text{critical}} = 5.22$), and among those with low motivation (21.20 vs. 20.60; $Q = 10.19 > Q_{\text{critical}} = 5.22$). Although these differences were statistically significant, the relatively small differences between the group means suggest that their practical magnitude should also be considered. Previous studies have likewise shown that the effectiveness of endurance-training modalities may vary according to training protocols, participant characteristics, and the physical fitness components evaluated (Arizki et al., 2026; Dinil et al., 2026; Fasa et al., 2025; Yulisatria et al., 2026).

Overall, these findings indicate that training modality and training motivation jointly contribute to students' physical fitness, with continuous training producing the most favorable outcomes, particularly among highly motivated students. Fartlek training nevertheless remains a relevant alternative because its variable-intensity characteristics can provide beneficial aerobic stimuli in adolescent populations (Das et al., 2014; Salameh, 2013). Coaches and physical education practitioners should therefore integrate appropriate training prescriptions with strategies that enhance students' motivation, engagement, and adherence to exercise programs (Tamimi, 2024; Xu et al., 2024). However, the relatively small sample and single-school setting limit the generalizability of the findings; therefore, future studies should involve larger samples, report effect sizes and confidence intervals, monitor training intensity and adherence, and incorporate objective physiological indicators such as $VO_2\text{max}$.

Conclusions

This study concludes that training model and training motivation play important roles in determining physical fitness outcomes among senior high-school students. Continuous training produced better overall physical fitness outcomes than Fartlek training, while students with high training motivation demonstrated better fitness outcomes than those with low motivation. Moreover, the significant interaction between training model and training motivation indicates that the effectiveness of a training program is influenced by students' motivational characteristics. The most favorable outcome was observed among highly motivated students participating in continuous training, suggesting that combining an appropriate endurance-training method with strong training motivation may optimize physical fitness development. These findings highlight the importance of considering both physiological training characteristics and psychological readiness when designing physical fitness programs for adolescents.

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