Physical Education Theory and Methodology
Теорія та методика фізичного виховання

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

Original Scientific Article

Enhancing Aerobic and Sprint Performance Through Weighted Vest-Based Anaerobic Soccer Training: Evidence From a Controlled Trial in Soccer Players

Dimas Hamdhan Vebrianto[1ABCD], Afif Dwi Nugraha[1BCD], Yanuar Alfan Triardhana[1CDE], Laily Mita Andriana[1ACD] and I Dewa Made Aryananda Wijaya Kusuma[1ACD]

[1]Universitas Negeri Surabaya

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Afif Dwi Nugraha, e-mail: afifnugraha@unesa.ac.id
Accepted for Publication: December 26, 2025
Published: January 30, 2026

DOI: 10.17309/tmfv.2026.1.13

Abstract

Background. Modern soccer requires repeated high-intensity, complex movements, making aerobic performance essential for players.

Objectives. This study aimed to examine the effect of Anaerobic Soccer Training (AnST) utilizing a weighted vest (WV) weighing 7.21 ± 0.72% of body mass on aerobic performance, measured by VO2max and speed.

Materials and Methods. This study employed a quasi-experimental design with two groups (Group A and Group B), utilizing a pre-test as a covariate and a post-test as the dependent variable. A total of 22 male soccer players were randomly divided into two groups: a control group with an additional load of 0% of body weight (Group A, n = 11) and an experimental group with an additional load of 7.21 ± 0.72% of body weight (Group B, n = 11). Aerobic performance was assessed using the Yo-Yo Intermittent Recovery Test Level 1 (YYIR1) before and after a three-week intervention involving four sessions per week. The YYIR1 results provided VO_2max and speed data for analysis. Statistical tests included the Shapiro–Wilk normality test, Levene's homogeneity test, and Quade's Non-parametric Analysis of Covariance using IBM SPSS 30 with a 0.05 significance level.

Results. Based on the results obtained using Quade's Non-parametric Analysis of Covariance, significant differences were found between groups A and B in terms of VO_2max ($p = 0.015$) and speed ($p = 0.005$) after controlling for pre-test values. These results indicate that the types of training given to each group had different effects on improving the players' aerobic performance and speed.

Conclusions. The findings confirm that three weeks of AnST with a weighted vest of 7.21 ± 0.72% of body mass may enhance VO_2max and running speed. However, these results are preliminary and should be interpreted with caution due to the short duration and small sample size.
Keywords: weight vest, AnST, VO_2max, speed.

Introduction

Soccer is a sport that involves various complex movements, such as acceleration, deceleration, jumping, and changes in direction, that are performed repeatedly at high intensity (Brahim et al., 2020; Naveen Raj A et al., 2024; Reynolds et al., 2021). As a result, soccer players can cover an average distance of around 13 km with a heart rate intensity reaching 85–90% of their maximal heart rate (HRmax) during a match. This high cardiovascular demand places an indirect physiological load on the players, making aerobic capacity a crucial factor for maintaining performance throughout the 90 minutes and supporting recovery between intense efforts (Beato & Jamil, 2018; Manzi et al., 2022).

To meet these demands, a training method that combines both aerobic and anaerobic qualities is essential in modern soccer. Complementing these physical requirements, the Anaerobic Soccer Training (AnST) model has emerged as the latest approach tailored to the game's specific needs. Research by Kusuma et al. (2025) shows that the AnST training model can improve players' aerobic physical performance.

Given the increasing demands of modern soccer, training models need to be both efficient and physiologically specific. While HIIT and SSG are effective in enhancing aerobic and anaerobic capacities, they do not provide an external resistance component that directly increases cardiovascular and musculoskeletal stress. One approach being explored is modifying training load using a Weighted Vest (WV). By adding WV to AnST, players are subjected to a controlled external load that enhances stress on the cardiovascular, metabolic, and musculoskeletal systems simultaneously, which is not achieved by standard HIIT or SSG sessions. For example, WV can improve performance across physiological, metabolic, cardiovascular, and musculoskeletal systems during training (Elsyam et al., 2025; Gleadhill et al., 2021).

Additionally, WV can shorten training time by increasing the load on the body's physiological systems (Gaffney et al., 2022). The use of WV has been extensively studied in sports such as athletics and rugby (Barr et al., 2015; Looney et al., 2024; Macadam et al., 2022). These studies show improved training adaptation efficiency, increased muscle capacity, and faster neuromuscular responses (Kang, 2018; Rey et al., 2017). However, there has been limited scientific discussion about the use of WV in soccer. Therefore, integrating WV into AnST offers a methodological advantage: it adds external load to soccer-specific training, maximizing cardiovascular and neuromuscular stimulus without increasing session duration or altering technical-tactical components.

In the complex nature of modern soccer, the need for training that efficiently improves physical performance is becoming increasingly important for coaches. Although past studies have shown that the AnST training model can enhance players' cardiovascular systems, research combining it with external loads such as WV to boost cardiovascular function in soccer remains very limited. Hence, the novelty of this research lies in its combined approach, where AnST with WV provides a simultaneous aerobic and anaerobic challenge, offering a more targeted and efficient adaptation than conventional HIIT or SSG methods.

Therefore, this study aimed to examine the effectiveness of the AnST model, both with and without the addition of a WV, on the aerobic capacity of amateur soccer players. VO_2max was established as the primary outcome, representing players' aerobic capacity and endurance performance, while sprint speed (Speed) served as the secondary outcome to assess high-intensity performance. The researcher hypothesized that implementing the AnST model with WV loading would lead to greater improvements in aerobic performance, reflected by higher VO_2max and Speed values, compared to the same model performed without additional external load among amateur soccer players.

Materials and Methods

Study Participants

In this study, researchers recruited 22 male participants who played university-level soccer. The average age of the participants was 20 ± 0.94 years. Anthropometric data showed an average height of 165 ± 6.07 cm, a body weight of 60.52 ± 6.07 kg, and a body mass index (BMI) of 22.36 ± 2.44 kg/m2. Additionally, the researchers outlined the inclusion criteria, which included having experience with soccer, being healthy and injury-free during the study, and not participating in any external training programs apart from the intervention. Exclusion criteria included missing more than 10% of the intervention sessions and having a musculoskeletal injury in the past few months. Ethics committee approval for this study was obtained from the Health Research Ethics Committee, Nahdlatul Ulama University of Surabaya (Date: 24 November 2024, Decision No: 0374/EC/KEPK/UNUSA/2024)

Study Organization

This study used a quasi-experimental design with two groups and pretest–posttest measurements. Participants were assigned to either a control group (Group A) or an experimental group (Group B) using the ordinal pairing method to ensure baseline comparability. The pretest was conducted over one week, during which all players performed the Yo-Yo Intermittent Recovery Test Level 1 (YYIR1) to assess aerobic capacity (primary outcome) and a 20-meter sprint test to measure sprint speed (secondary outcome). Subsequently, participants underwent a three-week training intervention, consisting of four sessions per week. Group B completed AnST while wearing a WV equivalent to 7.21 ± 0.72% of their body mass, whereas Group A performed the same training protocol without additional load (0%). In the final week, a posttest using the same YYIR1 and sprint tests was conducted. Throughout all training sessions, participants' heart rates were monitored using a Polar H10 device to ensure exercise intensity remained within the target range of 85–90% of maximum heart rate

Statistical Analysis

Normality was assessed using Shapiro–Wilk, and homogeneity of variance using Levene's test. Although data were normally distributed, homogeneity was violated ($p < 0.05$); therefore, between-group differences in post-test VO_2max and sprint speed were analyzed using Quade non-parametric ANCOVA, with pre-test scores as covariates. Effect sizes were reported as partial eta squared (η^2_p) and converted to Cohen's f. Within-group changes were quantified using Cohen's d. Post-hoc power analysis using G*Power indicated adequate sensitivity for detecting large effects (VO_2max: $f = 0.59$, power ≈ 0.78; sprint speed: $f = 0.71$, power ≈ 0.88). Given the modest sample size ($n = 22$), this study is considered a pilot controlled trial, and the findings should be interpreted as preliminary but practically meaningful.

Test Measurement

The primary variable in this study was aerobic capacity, measured using the Yo-Yo Intermittent Recovery Test Level 1 (YYIR1). This field test was selected for its proven validity and strong correlation with the aerobic performance of soccer players (Asimakidis et al., 2025; Krustrup et al., 2015). During the test, participants ran between two 20-metre lines, following an audio signal with progressively shorter intervals, and performed 10 seconds of active recovery between each shuttle. The test was terminated when participants failed to reach the line within the beep interval twice. In this study, VO_2max and speed were determined using the procedures and references proposed by Bangsbo et al. (2008). VO_2max (mL/min/kg) was estimated using the formula: $VO_2max = \text{IR1 distance (m)} \times 0.0084 + 36.4$. Speed was defined as the final running velocity corresponding to the last fully completed stage in the YYIR1 test, expressed in kilometres per hour (km·h^{-1}). Each stage in the YYIR1 corresponds to a predetermined running speed that progressively increases throughout the test. The YYIR1 test was conducted twice (pre- and post-intervention) under identical environmental and procedural conditions to minimize measurement bias and enhance test-retest reliability. The resulting VO_2max and speed data were then used to compare the effects of the training interventions between Group A and Group B.

Training Program

This study combined the AnST training model with the Speed Endurance Training (SET) and Small-Sided Game (SSG) approaches, adding WV at 1:1 intervals. There was a sprint area measuring 20 meters in distance and an SSG area of 25 meters by 20 meters, which was completed in 20 seconds. In one set, the players sprinted for 80 meters and the SSG for 80 seconds, divided into four repetitions.

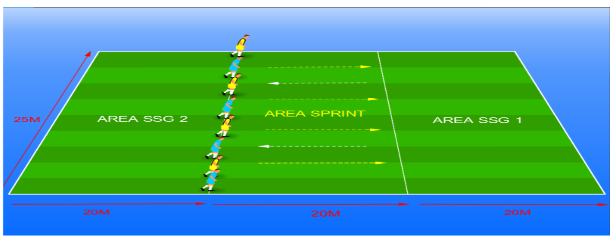

Fig. 1. Training area

At the start of the training, the players sprinted 20 metres to SSG 1 and immediately engaged in a game for 20 seconds, focusing on gameplay movements. After 20 seconds, the players sprinted 20 metres to SSG 2 and performed the same exercises as in SSG 1. This session consisted of four repetitions in one set, with a 1:1 training interval. The intervals were conducted systematically, beginning with the players stopping their activity after one repetition and moving outside the training area. During the recovery period, the players' heart rates remain high and gradually decrease, allowing their bodies to adapt to managing fatigue between intense activities. The total duration is the same as for the aforementioned activities, approximately 100 seconds (10-15 seconds of sprinting + 80 seconds of continuous training). Therefore, the interval concept serves as recovery and trains the cardiovascular system to respond to repeated intense work. The players perform eight sets of these activities, resulting in a total training session time (including sprinting, continuous training, and recovery) of approximately 26 minutes. This training improves aerobic endurance by targeting an average heart rate of more than 80% of HRmax during sprinting and continuous training, thereby reaching the high-intensity zone.

Each player completes 640 metres of total sprints in a 10-minute and 7-second training session. This training method aims to enhance players' aerobic endurance and ability to recover between high-intensity efforts.

Results

Table 1 presents the initial characteristics of all participants, divided into two groups: Group A (n = 11) and Group B (n = 11). The participants had an average age of 20.63 years. The average weight was 62.82 ± 5.60 kg for group A and 58.22 ± 6.08 kg for group B. The average height was 166 ± 7.06 cm for group A and 163.6 ± 3.99 cm for group B. Additionally, the body mass index (BMI) of both groups was recorded at 23 ± 2.89 for group A and 21.72 ± 1.80 for group B in this study.

Table 1. Characteristics of Subjects

Characteristics of Research Subjects	Group A n=11 (Mean ± SD)	Group B n=11 (Mean ± SD)
Age (years)	20.63 ± 0.80	21.09 ± 1.04
Weight (kg)	62.82 ± 5.60	58.22 ± 6.08
Height (cm)	166 ± 7.06	163.6 ± 3.99
BMI (kg/m^2)	23 ± 2.89	21.72 ± 1.80

Table 2. Descriptive statistics

Variable	Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Δ (Post-Pre)
VO_2max (mL/min/kg)	Group A	42.66 ± 1.86	45.56 ± 2.63	2.90
	Group B	43.54 ± 1.89	48.74 ± 2.57	5.20
Speed (km.h^{-1})	Group A	14.68 ± 0.46	15.27 ± 0.46	0.59
	Group B	14.82 ± 0.39	15.90 ± 0.53	1.08

Table 2 shows the changes in VO_2max and sprint speed (Speed) in Group A and Group B from pre-test to post-test. The results indicate that both groups experienced improvements in VO_2max and Speed following the intervention. Group B showed greater increases compared to Group A, both in VO_2max (Δ = 5.20 mL/min/kg vs. 2.90 mL/min/kg) and Speed (Δ = 1.08 km·h^{-1} vs. 0.59 km·h^{-1}). Data are presented as mean ± SD, and Δ (Delta) represents the mean change from pre-test to post-test.

Table 3. Normality Test

Shapiro-Wilk				
Assessment session	**Group**	**Statistic**	**df**	**Sig.**
Pretest VO_2max	Group A	.909	11	.235
	Group B	.953	11	.680
Posttest VO_2max	Group A	.908	11	.234
	Group B	.941	11	.538
Pretest Speed	Group A	.772	11	.004
	Group B	.868	11	.073
Posttest Speed	Group A	.887	11	.127
	Group B	.840	11	.032

Table 3 presents the results of the Shapiro-Wilk test for normality of VO_2max and Speed in Groups A and B at pre-test and post-test. VO_2max was normally distributed in all conditions (Sig. > 0.05) and thus followed by a test of homogeneity of variance. In contrast, speed was non-normally distributed in some conditions (Sig. < 0.05), and further analysis was conducted using the Quade non-parametric test.

Table 4. Levene's Test of Equality of Error Variances

F	df1	df2	Sig.
10.135	1	20	.005

Note: Tests the null hypothesis that the error variance of the dependent variable is equal across groups; Model includes Intercept, Pre_VO_2max, and Group; Dependent Variable: Post_ VO_2max.

Table 4 presents the results of Levene's Test for assessing the homogeneity of variances of Post_VO_2max across groups. The null hypothesis states that the error variance of the dependent variable is equal across all groups. The model included the Intercept, Pre_VO_2max as a covariate, and Group as the independent factor. A Sig. value of 0.005 indicates that the assumption of homogeneity of variances was violated, and therefore, further analysis was conducted using the Quade non-parametric test.

Table 5. Quade Non-parametric Analysis of Covariance

Variable	F	DFH	DFE	P Value
VO_2max	7.062	1	20	.015
Speed	10.015	1	20	.005

Notes: ANCOVA controlled for pre-test scores; DFH = degrees of freedom for hypothesis; DFE = degrees of freedom for error.

Table 5 presents the Quade ANCOVA results for VO_2max and sprint speed, showing significant differences between Group A and Group B after controlling for pre-test scores (VO_2max: $F_{1,20} = 7.062$, $p = 0.015$; speed: $F_{1,20} = 10.015$, $p = 0.005$). The magnitude of these effects was large, with partial eta-squared values of $\eta^2_p = 0.26$ (Cohen's f = 0.59) for VO_2max and $\eta^2_p = 0.33$ (Cohen's f = 0.71) for sprint speed, indicating substantial and practically meaningful performance improvements in favor of Group B. Within-group pre- to post-test changes (Δ) were quantified using Cohen's d: VO_2max (Group A: d = 1.27; Group B: d = 2.31) and sprint speed (Group A: d = 1.28; Group B: d = 2.32), confirming large and very large improvements, respectively. The 95% confidence intervals (CI) reported in Table 6 further support these findings, with Group B's post-test CI consistently higher than Group A's and Δ-CI entirely in the positive range, indicating directionally stable and reliable improvements.

Tabel 6. Confidence Interval 95% test for VO_2max and Speed

Variable	Group	Pre-test 95% CI	Post-test 95% CI	Δ (Post-Pre) 95% CI
VO_2max	Group A	41.41 – 43.91	43.79 – 47.33	1.71 – 4.09
	Group B	42.28 – 44.81	47.01 – 50.47	4.60 – 5.78
Speed	Group A	14.37 – 14.99	14.96 – 15.58	0.33 – 0.85
	Group B	14.56 – 15.08	15.54 – 16.26	0.88 – 1.28

Note: Δ= Post-test – Pre-test; 95% CI provides an estimate of the precision of the changes.

Table 6 shows that Group B experienced larger increases in both VO_2max and sprint speed compared to Group A. The lower bounds of Group B's Δ-CI did not overlap with Group A's lower bounds, indicating consistent and directionally stable post-intervention improvements. Combined with the large effect sizes, these results provide convergent evidence of practically meaningful performance enhancements in Group B.

Discussion

The results of this study indicate significant improvements in VO_2max (primary outcome) and sprint speed (secondary outcome) in both groups after the intervention, with Group B showing greater increases compared to Group A. These findings highlight the effectiveness of the implemented training model in enhancing both aerobic capacity and sprint performance among amateur soccer players. As part of a High-Intensity Interval Training (HIIT) framework, this model targets both the aerobic and anaerobic energy systems through repeated bouts of exercise and recovery periods. The application of a WV load of 7.21 ± 0.72% of body mass for three weeks, conducted four sessions per week, led to greater improvements in both aerobic capacity and sprint performance compared with the same model performed without additional load.

The use of a WV during AnST provides an additional external load during repeated high-intensity activities, which stimulates physiological adaptations in the cardiovascular system. This finding aligns with previous research, which shows that the amount of vest load directly influences the level of intensity experienced by the body and subsequently enhances cardiorespiratory adaptation (Bertochi et al., 2024; Kim et al., 2024). Higher training intensity also enhances activation of PGC-1α, supporting mitochondrial enlargement and density, which contributes to improved aerobic performance (Gurd et al., 2023; Thirupathi & de Souza, 2017). As a result, the integration of WV with AnST positively affects VO_2max, sprint speed, and distance, confirming that this training model can maintain beneficial adaptations during repeated high-intensity activities (Ahmad et al., 2025; Barnes et al., 2015; Rey et al., 2017).

Biomechanically, the use of WV influences sprint mechanics, including ground reaction forces, step frequency, step length, contact time, and flight time, while also increasing physiological stress without negatively affecting gait parameters (Bertochi et al., 2024; Cross et al., 2014; Gaffney et al., 2022). These changes provide a practical stimulus for improving both aerobic and anaerobic performance. However, careful consideration of load is essential, as excessive weight may limit muscle activation, reduce the efficiency of the stretch-shortening cycle, and increase the risk of injury (Fernández-Galván et al., 2022; Tillaar et al., 2018; Zabaloy et al., 2022). In this study, applying WV at 7.21 ± 0.72% of body mass maintained high training intensity while minimizing these risks.

From a practical standpoint, the use of a WV during both pre-season and in-season training has proven effective in enhancing the physical performance of soccer players. During the pre-season phase, WV training helps build a solid physical foundation, improving sprinting, jumping, change of direction (COD), as well as aerobic and anaerobic capacities (Lagodimos et al., 2024; Majkić et al., 2025). The external load provided by WV adds a physiological stimulus that promotes cardiovascular adaptation and reduces the risk of fatigue during competition (Swain et al., 2010). During the in-season period, integrating WV into SSG serves as an effective method to combine technical, tactical, and physical components without causing excessive fatigue. Studies have shown that SSGs with WV enhance sprinting, jumping, COD, and aerobic performance without significantly increasing fatigue (Sanchez-Sanchez et al., 2024). Overall, applying WV during both pre-season and in-season periods represents an evidence-based strategy to optimize physical performance and sustain players' physiological adaptations throughout the season.

The large observed effect sizes for both VO_2max ($\eta^2_p = 0.26$; $f = 0.59$) and sprint speed ($\eta^2_p = 0.33$; $f = 0.71$) indicate that weighted-vest–based anaerobic soccer training may provide meaningful physiological and performance benefits within a short-term training period. However, given the small sample size (n = 22) and the achieved power that is adequate primarily for detecting large effects, the findings should be interpreted with caution. Consistent with current methodological recommendations, these statistical characteristics indicate that the present investigation is best positioned as preliminary research rather than a fully powered efficacy trial. Accordingly, the study is more appropriately framed as a pilot controlled trial that aims to generate preliminary evidence, guide future sample size estimation, and refine the training and assessment procedures for subsequent large-scale randomized studies.

This study has several limitations that should be taken into consideration. First, the sample size was relatively small and limited to a specific group of soccer players, which may affect the generalizability of the findings. Second, the intervention lasted only three weeks, and variations in WV load were not explored, which limited the understanding of optimal training intensity. Third, this study primarily focused on VO_2max, sprint speed, and distance, without assessing other performance aspects, such as muscular strength, technical skills, or psychological factors. Finally, the effects were measured in a controlled training environment, not during actual match conditions, which may differ in real-game demands.

Future research should address these limitations by including larger and more diverse samples, longer intervention periods, and exploring different WV loads. Additionally, studies could examine other performance variables and assess outcomes during competitive match situations to provide a more comprehensive understanding of the physiological and practical effects of AnST training with WV.

Conclusions

This study concludes that AnST training with a WV at 7.21 ± 0.72% of body mass significantly improves players' aerobic capacity, as evidenced by greater increases in VO_2max and sprint speed compared to training without a WV. The addition of external load provides an extra physiological stimulus that enhances cardiovascular adaptation. This training approach is practical when applied during both pre-season and in-season periods as a strategic method to optimize aerobic performance. These findings provide further scientific evidence supporting the use of WV as an effective training tool in soccer.

Conflict of Interest

The author declares no conflict of interest.

AI Use Declaration

During the preparation of this manuscript, the authors made limited use of AI-assisted tools solely for language editing and text refinement. No AI tools were used for data analysis, interpretation, or scientific decision-making. All statistical analyses were conducted independently by the authors using IBM SPSS Statistics (version 30).

References

Brahim, M. Ben, Bougatfa, R., Makni, E., Gonzalez, P. P., Yasin, H., Tarwneh, R., Moalla, W., & Elloumi, M. (2021). Effects of Combined Strength and Resisted Sprint Training on Physical Performance in U-19 Elite Soccer Players. *Journal of Strength & Conditioning Research, 35*(12), 3432–3439. https://doi.org/10.1519/JSC.0000000000003829

Naveen Raj A, Kamalakannan M, Anitha A, & Ramana K. (2024). Recent Experimental Investigation on the Effectiveness of Complex Training for Intermediate Football Players. *Indian Journal of Physiotherapy & Occupational Therapy - An International Journal,* 18, 237–242. https://doi.org/10.37506/8rcwsf74

Reynolds, J., Connor, M., Jamil, M., & Beato, M. (2021). Quantifying and Comparing the Match Demands of U18, U23, and 1ST Team English Professional Soccer Players. *Frontiers in Physiology,* 12, 706451. https://doi.org/10.3389/fphys.2021.706451

Beato, M., & Jamil, M. (2018). Intra-system reliability of SicS: Video-tracking system (digital.Stadium®) for performance analysis in soccer. *Journal of Sports Medicine and Physical Fitness, 58*(6), 831–836. https://doi.org/10.23736/S0022-4707.17.07267-X

Manzi, V., Annino, G., Savoia, C., Caminiti, G., Padua, E., Masucci, M., D'Onofrio, R., & Iellamo, F. (2022). Relationship between aerobic fitness and metabolic power metrics in elite male soccer players. *Biology of Sport, 39*(3), 599–606. https://doi.org/10.5114/BIOLSPORT.2022.106389

Kusuma, I. D. M. A. W., Kusnanik, N. W., Pramono, B. A., Pranoto, A., Phanpheng, Y., Susanto, I. H., Amustikarani, D. A. P., Nirwansyah, W. T., & Bharlaman, M. B. F. (2025). Anaerobic Soccer Training Model: Enhancing Soccer Players' Performance through a Combination of Repeated Sprints and 4 vs 4 Games. *Physical Education Theory and Methodology, 25*(1), 7–14. https://doi.org/10.17309/tmfv.2025.1.01

Elsyam, M. F. B., Orhan, B. E., Nirwansyah, W. T., & Prianto, D. A. (2025). Effect of Short-Term Weight Vest Training on Muscle Strength During Soccer-Specific Drills in Amateur Player. *JSES Journal of Sport and Exercise Science, 8*(2), 95–105. https://doi.org/10.26740/jses.v8n2.p95-105

Gleadhill, S., Yuki, N., Wada, T., & Nagahara, R. (2021). Kinetic and kinematic characteristics of sprint running with a weighted vest. *Journal of Biomechanics,* 126, 110655. https://doi.org/10.1016/j.jbiomech.2021.110655

Gaffney, C. J., Cunnington, J., Rattley, K., Wrench, E., Dyche, C., & Bampouras, T. M. (2022). Weighted vests in

CrossFit increase physiological stress during walking and running without changes in spatiotemporal gait parameters. *Ergonomics, 65*(1), 147–158. https://doi.org/10.1080/00140139.2021.1961876

Barr, M. J., Gabbett, T. J., Newton, R. U., & Sheppard, J. M. (2015). Effect of 8 Days of a Hypergravity Condition on the Sprinting Speed and Lower-Body Power of Elite Rugby Players. *Journal of Strength and Conditioning Research, 29*(3), 722–729. https://doi.org/10.1519/JSC.0000000000000669

Looney, D. P., Lavoie, E. M., Notley, S. R., Holden, L. D., Arcidiacono, D. M., Potter, A. W., Silder, A., Pasiakos, S. M., Arellano, C. J., Karis, A. J., Pryor, J. L., Santee, W. R., & Friedl, K. E. (2024). Metabolic Costs of Walking with Weighted Vests. *Medicine & Science in Sports & Exercise, 56*(6), 1177–1185. https://doi.org/10.1249/MSS.0000000000003400

Macadam, P., Cronin, J. B., & Feser, E. H. (2022). Acute and longitudinal effects of weighted vest training on sprint-running performance: a systematic review. *Sports Biomechanics, 21*(3), 239–254. https://doi.org/10.1080/14763141.2019.1607542

Kang, S. (2018). Difference of neuromuscular responses by additional loads during plyometric jump. *Journal of Exercise Rehabilitation, 14*(6), 960–967. https://doi.org/10.12965/jer.1836428.214

Rey, E., Padrón-Cabo, A., & Fernández-Penedo, D. (2017). Effects of sprint training with and without weighted vest on speed and repeated sprint ability in male soccer players. *Journal of Strength and Conditioning Research, 31*(10). https://doi.org/10.1519/jsc.0000000000001726

Asimakidis, N. D., Bishop, C., Beato, M., & Turner, A. N. (2025). Assessment of Aerobic Fitness and Repeated Sprint Ability in Elite Male Soccer: A Systematic Review of Test Protocols Used in Practice and Research. *Sports Medicine, 55*(5), 1233–1264. https://doi.org/10.1007/s40279-025-02188-4

Krustrup, P., Bradley, P. S., Christensen, J. F., Castagna, C., Jackman, S., Connolly, L., Randers, M. B., Mohr, M., & Bangsbo, J. (2015). The Yo-Yo IE2 Test. *Medicine & Science in Sports & Exercise, 47*(1), 100–108. https://doi.org/10.1249/MSS.0000000000000377

Bangsbo, J., Iaia, F. M., & Krustrup, P. (2008). The Yo-Yo Intermittent Recovery Test. *Sports Medicine, 38*(1), 37–51. https://doi.org/10.2165/00007256-200838010-00004

Bertochi, G. F. A., Tasinafo Júnior, M. F., Santos, I. A., Sasaki, J. E., Mota, G. R., Jordão, G. G., & Puggina, E. F. (2024). The use of wearable resistance and weighted vest for sprint performance and kinematics: a systematic review and meta-analysis. *Scientific Reports, 14*(1). https://doi.org/10.1038/s41598-024-54282-8

Kim, J., Kim, E., Kim, D., & Yoon, S. (2024). Weighted vest intervention during whole-body circuit training improves serum resistin, insulin resistance, and cardiometabolic risk factors in normal-weight obese women. *Journal of Exercise Science & Fitness, 22*(4), 463–473. https://doi.org/10.1016/j.jesf.2024.10.002

Gurd, B. J., Menezes, E. S., Arhen, B. B., & Islam, H. (2023). Impacts of altered exercise volume, intensity, and duration on the activation of AMPK and CaMKII and increases in PGC-1α mRNA. *Seminars in Cell & Developmental Biology,* 143, 17–27. https://doi.org/10.1016/j.semcdb.2022.05.016

Thirupathi, A., & de Souza, C. T. (2017). Multi-regulatory network of ROS: the interconnection of ROS, PGC-1 alpha, and AMPK-SIRT1 during exercise. *Journal of Physiology and Biochemistry, 73*(4), 487–494. https://doi.org/10.1007/s13105-017-0576-y

Ahmad, T. H. M., Kusuma, I. D. M. A. W., Pramono, B. A., Ramadhani, M. I., & Nirwansyah, W. T. (2025). Unveiling anaerobic soccer training: comparing its effects with small-sided games on youth performance enhancement. *Pedagogy of Physical Culture and Sports, 29*(3), 150–159. https://doi.org/10.15561/26649837.2025.0301

Barnes, K. R., Hopkins, W. G., McGuigan, M. R., & Kilding, A. E. (2015). Warm-up with a weighted vest improves running performance via leg stiffness and running economy. *Journal of Science and Medicine in Sport, 18*(1). https://doi.org/10.1016/j.jsams.2013.12.005

Cross, M. R., Brughelli, M. E., & Cronin, J. B. (2014). Effects of vest loading on sprint kinetics and kinematics. *Journal of Strength and Conditioning Research, 28*(7). https://doi.org/10.1519/JSC.0000000000000354

Fernández-Galván, L. M., Casado, A., García-Ramos, A., & Haff, G. G. (2022). Effects of Vest and Sled Resisted Sprint Training on Sprint Performance in Young Soccer Players: A Systematic Review and Meta-analysis. *Journal of Strength & Conditioning Research, 36*(7), 2023–2034. https://doi.org/10.1519/JSC.0000000000004255

Tillaar, R. Van Den, Teixeira, A., & Marinho, D. (2018). Acute effect of resisted sprinting upon regular sprint performance. *Acta Kinesiologiae Universitatis Tartuensis,* 23, 19. https://doi.org/10.12697/akut.2017.23.02

Zabaloy, S., Carlos-Vivas, J., Freitas, T. T., Pareja-Blanco, F., Loturco, I., Comyns, T., Gálvez-González, J., & Alcaraz, P. E. (2022). Muscle Activity, Leg Stiffness, and Kinematics During Unresisted and Resisted Sprinting Conditions. *Journal of Strength and Conditioning Research, 36*(7), 1839–1846. https://doi.org/10.1519/JSC.0000000000003723

Lagodimos, P., Thomakos, P., Methenitis, S., & Paizis, C. (2024). The effect of weighted vest use during in-season, small-sided games training on young soccer players' performance. *Journal of Sports Sciences, 42*(11), 993–1001. https://doi.org/10.1080/02640414.2024.2378267

Majkić, B., Stojanović, N., Lilić, A., & Milanović, Z. (2025). The Effects of a 6-Week Resisted Small-Sided Games Training Program on the Power Performance of Young Soccer Players. *Journal of Strength & Conditioning Research, 39*(7), e870–e877. https://doi.org/10.1519/JSC.0000000000005120

Swain, D. P., Onate, J. A., Ringleb, S. I., Naik, D. N., & Demaio, M. (2010). Effects of training on physical performance wearing personal protective equipment. *Military Medicine, 175*(9). https://doi.org/10.7205/MILMED-D-09-00198

Sanchez-Sanchez, J., Raya-González, J., Ramirez-Campillo, R., Clemente, F. M., & Rodríguez-Fernández, A. (2024). Improvement of physical performance and match demands after warm-ups with small-sided soccer games wearing weighted vests of different loads. *Science & Sports, 39*(8), 688–697. https://doi.org/10.1016/j.scispo.2024.01.006

Підвищення аеробної та спринтерської продуктивності за допомогою анаеробних тренувань з футболу із використанням жилета-обважнювача: Дані контрольованого дослідження серед футболістів

Дімас Гамдган Вебріанто[1ABCD], Афіф Дві Нуграга[1BCD], Януар Алфан Тріардхана[1CDE], Лайлі Міта Андріана[1ACD], І Дева Маде Ар'янанда Віджая Кусума[1ACD]

[1]Державний університет Сурабая

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 6 табл., 1 рис., 31 джерело.

Обґрунтування. Сучасний футбол потребує виконання повторюваних високоінтенсивних, комплексних рухів, що робить аеробну продуктивність надзвичайно важливою для гравців.

Цілі. Мета цього дослідження полягала у вивченні впливу анаеробного тренування з футболу (АнФТ) із використанням жилета-обважнювача (ЖО) вагою 7.21 ± 0.72% від маси тіла на аеробну продуктивність, що вимірювалася за показниками максимального споживання кисню і швидкості.

Матеріали та методи. У цьому дослідженні застосовано квазіекспериментальний дизайн з двома групами (група A та група B), використовуючи претест як коваріату і постест як залежну змінну. Загалом 22 футболісти-чоловіки було розподілено за методом рандомізації на дві групи: контрольну групу з додатковим навантаженням 0% від маси тіла (група A, n = 11) та експериментальну групу з додатковим навантаженням 7.21 ± 0.72% від маси тіла (група B, n = 11). Аеробна продуктивність оцінювалася за допомогою тесту переривчастого відновлення Йо-Йо рівня 1 (Yo-Yo Intermittent Recovery Test Level 1, YYIR1) перед початком і після трьох тижнів інтервенції, що передбачала проведення чотирьох сесій на тиждень. За результатами YYIR1 було отримано дані щодо максимального споживання кисню та швидкості для аналізу. Статистичні тести включали тест нормальності Шапіро-Вілка, тест гомогенності Левене та непараметричний коваріаційний аналіз за методом Кваде з використанням програмного забезпечення IBM SPSS 30 з рівнем значущості 0.05.

Результати. На основі результатів, отриманих шляхом непараметричного коваріаційного аналізу за методом Кваде, встановлено значні відмінності між групами A і B за показниками максимального споживання кисню (p = 0.015) і швидкості (p = 0.005) після контролю претестових значень. Зазначені результати свідчать про різний вплив типів тренувань, проведених для кожної групи, на поліпшення аеробної продуктивності та швидкості гравців.

Висновки. Результати дослідження підтверджують, що три тижні анаеробного тренування з футболу з використанням жилета-обважнювача 7.21 ± 0.72% від маси тіла сприяють підвищенню максимального споживання кисню і швидкості бігу. Однак ці результати є попередніми і їх слід інтерпретувати з обережністю через коротку тривалість дослідження і невеликий розмір вибірки.

Ключові слова: жилет-обважнювач, анаеробне тренування з футболу, максимальне споживання кисню, швидкість.

Information about the Authors:

Vebrianto, Dimas Hamdhan: dimas.22131@mhs.unesa.ac.id; https://orcid.org/0009-0004-2097-458X; Department of Sports Coaching Education, Faculty of Sport and Health Science, Universitas Negeri Surabaya, Lidah Wetan Street, Lidah Wetan, Lakarsantri, Surabaya City, East Java 60213, Indonesia.

Nugraha, Afif Dwi: afifnugraha@unesa.ac.id; https://orcid.org/0009-0003-0557-4118; Department of Sports Coaching Education, Faculty of Sport and Health Science, Universitas Negeri Surabaya, Lidah Wetan Street, Lidah Wetan, Lakarsantri, Surabaya City, East Java 60213, Indonesia.

Triardhana, Yanuar Alfan: yanuartriardhana@unesa.ac.id; https://orcid.org/0000-0002-8355-4070; Department of Sports Coaching Education, Faculty of Sport and Health Science, Universitas Negeri Surabaya, Lidah Wetan Street, Lidah Wetan, Lakarsantri, Surabaya City, East Java 60213, Indonesia.

Andriana, Laily Mita: lailyandriana@unesa.ac.id; https://orcid.org/0009-0002-9845-6577; Department of Sports Coaching Education, Faculty of Sport and Health Science, Universitas Negeri Surabaya, Lidah Wetan Street, Lidah Wetan, Lakarsantri, Surabaya City, East Java 60213, Indonesia.

Kusuma, I Dewa Made Aryananda Wijaya: dewawijaya@unesa.ac.id; https://orcid.org/0000-0002-4939-7294; Department of Sports Coaching Education, Faculty of Sport and Health Science, Universitas Negeri Surabaya, Lidah Wetan Street, Lidah Wetan, Lakarsantri, Surabaya City, East Java 60213, Indonesia.

Cite this article as: Vebrianto, D. H., Nugraha, A. D., Triardhana, Y. A., Andriana, L. M., & Kusuma, I. D. M. A. W. (2026). Enhancing Aerobic and Sprint Performance Through Weighted Vest-Based Anaerobic Soccer Training: Evidence From a Controlled Trial in Soccer Players. *Physical Education Theory and Methodology, 26*(1), 143-149. https://doi.org/10.17309/tmfv.2026.1.13

Received: 04.11.2025. Accepted: 26.12.2025. Published: 30.01.2026