The influence of weight vest training on the aerobic performance of soccer players

La Influencia del entrenamiento con chaleco lastrado en el rendimiento aeróbico de los futbolistas

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Abstract

Introduction: In modern soccer, aerobic capacity is crucial in sustaining high-intensity intermittent activity and maintaining performance stability throughout the match. Training strategies integrating external loads, such as weight vests, enhance physiological adaptations without altering players' fundamental movement patterns.
Objective: This study analysed the effects of training with a weight vest on soccer players' aerobic capacity.
Methodology: The study employed a quasi-experimental design with a pretest–posttest control group involving 20 male soccer players (mean age: 20.1 ± 0.73 years). Participants were randomly assigned to an experimental group (n = 10, weight vest: 11.62 ± 0.51% of body weight) and a control group (n = 10, weight vest: 0.00 ± 0.00 kg). Both groups completed 12 structured aerobic training sessions, including high-intensity interval running and technical drills. Aerobic capacity was measured using the Yo-Yo Intermittent Recovery Test Level 1, and data were analysed using the Shapiro–Wilk test, Levene's test, an Independent-Samples t-test, and Cohen's d for effect size.
Results: The results showed significant differences between the experimental and control groups for VO_2max (Δ4.37 vs. Δ2.65 ml/kg/min; p = 0.024, d = 0.88) and MAS (Δ0.40 vs. Δ0.25 m/s; p = 0.022, d = 0.82).
Discussion: These findings indicate that training with a weight vest provides substantial physiological benefits and accelerates aerobic adaptation in soccer players.
Conclusions: A weight vest can be recommended as an efficient and practical training strategy to optimise aerobic performance and support endurance in modern soccer.

Keywords

Aerobic capacity; weight vest; VO_2Max; maximal aerobic speed; soccer.

Resumen

Introducción: En el fútbol moderno, la capacidad aeróbica es fundamental para sostener la actividad intermitente de alta intensidad y mantener la estabilidad del rendimiento durante todo el partido. Las estrategias de entrenamiento que integran cargas externas, como los chalecos lastrados, mejoran las adaptaciones fisiológicas sin alterar los patrones básicos de movimiento de los jugadores.
Objetivo: Este estudio analizó los efectos del entrenamiento con chaleco lastrado sobre la capacidad aeróbica de los jugadores de fútbol.
Metodología: El estudio empleó un diseño cuasiexperimental con pretest–postest y grupo control, que involucró a 20 jugadores de fútbol masculinos (edad media: 20.1 ± 0.73 años). Los participantes fueron asignados aleatoriamente a un grupo experimental (n = 10, chaleco lastrado: 11.62 ± 0.51% del peso corporal) y a un grupo control (n = 10, chaleco lastrado: 0.00 ± 0.00 kg). Ambos grupos completaron 12 sesiones estructuradas de entrenamiento aeróbico, que incluyeron carreras intermitentes de alta intensidad y ejercicios técnicos. La capacidad aeróbica se evaluó mediante el Yo-Yo Intermittent Recovery Test Nivel 1, y los datos fueron analizados utilizando las pruebas de Shapiro–Wilk, Levene, la prueba t para muestras independientes y el d de Cohen para el tamaño del efecto.
Resultados: Los resultados mostraron diferencias significativas entre el grupo experimental y el grupo control para el VO_2max (Δ4.37 vs. Δ2.65 ml/kg/min; p = 0.024, d = 0.88) y la MAS (Δ0.40 vs. Δ0.25 m/s; p = 0.022, d = 0.82).
Discusión: Estos hallazgos indican que el entrenamiento con chaleco lastrado proporciona beneficios fisiológicos sustanciales y acelera la adaptación aeróbica en los jugadores de fútbol.
Conclusiones: El uso del chaleco lastrado puede recomendarse como una estrategia de entrenamiento eficiente y práctica para optimizar el rendimiento aeróbico y apoyar la resistencia en el fútbol moderno.

Palabras clave

Capacidad aeróbica; chaleco lastrado; VO_2max; velocidad aeróbica máxima; fútbol.

Introduction

In soccer, the body's work pattern is characterised by intermittent activity, marked by explosive high-intensity movements followed by periods of lower-intensity activity (Asimakidis et al., 2024; Clemente et al., 2021). The physical ability of soccer players—particularly their aerobic capacity—has become a key topic in sports science, evolving within the context of modern soccer. Aerobic capacity is vital for player performance, as it optimises oxygen utilisation, supports physiological adaptation, and influences the intensity of physical work on the field (Michailidis, 2024; Tatlibal & Zencir, 2022). Therefore, soccer players must possess strong aerobic endurance to recover quickly after high-intensity efforts and maintain performance quality throughout the match. This requirement is supported by empirical findings showing that aerobic capacity significantly contributes to the stability of running performance and overall endurance among professional players during competition (Akyildiz et al., 2025; Yüksel et al., 2023). Players with higher aerobic capacity can sustain optimal work intensity longer and demonstrate more consistent performance throughout the game.

The High-Intensity Interval Training (HIIT) method is often chosen to develop aerobic capacity more effectively, as it has been proven to enhance endurance and improve cardiovascular efficiency. Among the various forms of resistance training equipment used to support HIIT, the weighted vest is considered the most practical and realistic option for providing additional load during soccer-specific training (Yusup et al., 2021). In this context, using external load technology, such as a weight vest, represents an important innovation, as it can enhance physiological quality without altering players' fundamental movement patterns (Sinulingga et al., 2022). A weighted vest is a form of resisted training that adds external resistance during exercise. Gaffney et al. (2022) reported that applying weight vests can significantly increase oxygen consumption, heart rate, glucose oxidation, and energy expenditure. Weight vests are frequently used as external loads to enhance athletic performance (Ioannides et al., 2024). They can be integrated into HIIT programs to increase training stimulus without disrupting soccer-specific movement patterns. The effectiveness of weight vest use depends on load management, training intensity, and recovery duration (Bright et al., 2022). Structured aerobic training supported by a weight vest thus becomes an effective strategy to improve VO_2max and the aerobic capacity required in modern soccer.

Although various studies have explored the effectiveness of training methods for improving VO_2max and muscle strength, many still have limitations. Several studies focus on non-soccer populations or elderly groups, while others do not systematically vary load intensity using weight vests. Moreover, few studies have integrated progressive load training with weight vests in the specific soccer context and have directly measured players' aerobic capacity. In modern soccer, however, training approaches must be physiologically efficient and relevant to players' movement patterns and performance demands (Arslanoglu et al., 2024). Consequently, there remains a gap in the literature concerning this approach, particularly studies that combine progressive external loading with individualised training principles. Such a gap underscores the need for more specific, controlled, and player-centred research in modern soccer.

Therefore, this study aims to scientifically evaluate the effects of weight vest training on improving the aerobic capacity of soccer players through a more individualised approach. In this model, each player receives a load intensity adjusted to their VO_2max profile, Maximal Aerobic Speed (MAS), and training load requirements, combined with technical drills such as passing, dribbling, and ball control under fatigue conditions. This approach seeks to enhance the effectiveness of physiological adaptation and ensure that each player receives a safe, proportional, and targeted training dose. Monitoring training load is essential in assessing individual physiological adaptation, understanding the dose–response relationship, and minimising injury risk (Barry et al., 2024; Costa et al., 2022; Teixeira et al., 2022). Previous studies have shown that weekly load management highly influences performance stability and neuromuscular readiness. At the same time, inter-individual physiological responses emphasise the need for individualised weight vest training combined with technical drills to achieve more optimal adaptations (Mandorino et al., 2024). Through this approach, it is expected that a more accurate understanding of the effectiveness and efficiency of external-load-based training models in practically improving soccer players' aerobic capacity will be obtained.

Method

Participants

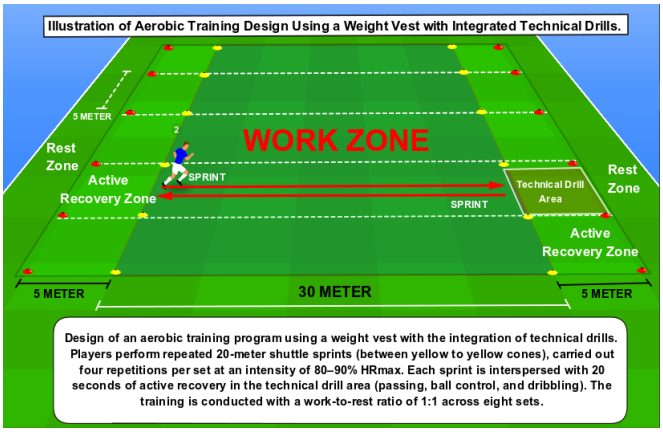
This study involved 20 active students from Universitas Negeri Surabaya who had experience playing soccer at either elite or amateur levels. The sample characteristics were as follows: mean age 20.1 ± 0.73 years, height 166.41 ± 6.37 cm, body weight 62.91 ± 5.92 kg, and body mass index (BMI) 22.7 ± 1.8 kg/m^2. Participants were selected based on the following inclusion criteria: no injuries or history of acute illness, active regular training, playing as defenders, midfielders, or forwards, and willingness to participate in all training sessions. The attendance rate was very high (95%), and the intervention comprised 12 training sessions, all of which were fully attended by participants. Based on a priori G*Power analysis ($\alpha = 0.05$; power = 0.80), the available sample size (10 participants per group) is sufficient to detect large effects, with a minimum detectable effect size of approximately Cohen's $d \approx 1.25$.

Procedure

The research design employed a quasi-experimental approach using a pretest–posttest control-group design. A total of 20 subjects were randomly assigned into two groups using a random sampling method: the control group (Group A; n = 10) without additional load (0.00 ± 0.00 kg), and the experimental group (Group B; n = 10) with an average weight vest load of 11.62 ± 0.51% of body weight. The study consisted of 12 training sessions, with one recovery day between each. Before the training program, all subjects completed a pretest to obtain baseline aerobic capacity data. After three weeks of weight-vest training, a posttest was conducted to compare outcomes. The mean difference for each participant was calculated as the change between pretest and posttest values.

This study utilised a repeated-measures design with counterbalancing in participant assignment. To ensure balanced baseline characteristics, an ordinal pairing method was used. All 20 participants were first ranked based on their pretest aerobic performance (VO_2max). Each adjacent pair (e.g., rank 1–2, 3–4, 5–6, etc.) was then randomly allocated into either the weight-vest group or the non-weight-vest group. This approach ensured that both groups had comparable initial fitness profiles while maintaining the randomisation procedure. The treatment order was balanced; half of the participants began with the weight vest condition, while the others started without it. Each training session involved two groups, each forming two lines of five players facing each other at a distance of 30 meters, with an additional 5-meter area designated for technical drills. The training protocol consisted of four repetitions of 30-meter shuttle sprints performed at 80–90% HRmax, interspersed with 20 seconds of active rest involving short passing, ball control, and basic soccer movements. Training was alternated between groups with a work-to-rest ratio of 1:1, and the circuit was repeated for eight sets per session.

Figure 1. Training Design Using a Weight Vest with Integrated Technical Drills



Instrument

Aerobic capacity was measured using the Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1). This field test was selected for its proven validity and strong correlation with soccer players' aerobic performance (Asimakidis et al., 2025; Krustrup et al., 2015). The test required participants to run back and forth over a 2 × 20-meter Distance, following an increasingly faster beep signal, interspersed with active recovery periods. The test continued until the participant failed to complete the shuttle twice consecutively according to the beep tempo. The primary variables analysed from the Yo-Yo IR1 were total Distance covered (m) and estimated aerobic capacity (VO_2max), calculated using the following formula: VO_2max (mL/kg/min) = Distance (m) x 0.0084 + 36.4 (Bangsbo et al., 2008).

Data analysis

All pretest and posttest data were analysed quantitatively using inferential statistical methods. Normality was assessed using the Shapiro–Wilk test, which indicated that all variables (VO_2max and MAS) were normally distributed ($p > 0.05$). Homogeneity of variance was tested using Levene's test, which indicated homogeneous results ($p > 0.05$). Since both normality and homogeneity assumptions were met, an Independent-Samples t-test was used to compare the means of VO_2max and MAS outcomes between the experimental and control groups. Additionally, effect size (Cohen's d) was calculated to assess the strength of the intervention effect, interpreted as small (0.2), medium (0.5), and large (≥ 0.8) (Cohen, 2013).

Results

The results of the descriptive statistical analysis of the pretest and posttest Yo-Yo IR1 scores for soccer players are presented in the table below.

Table 1. Descriptive Statistics (Mean ± SD)

Group	Experimental Group (n=20)					
	PRE	POST		PRE	POST	
	VO_2max (ml/kg/min)	VO_2max (ml/kg/min)	Δ VO_2max (ml/kg/min)	MAS (m/s)	MAS (m/s)	Δ MAS (m/s)
A (Control)	42.65 ± 1.97	45.30 ± 2.62	2.65 ± 1.66	3.95 ± 0.18	4.19 ± 0.24	0.25 ± 0.16
B (Weight Vest)	43.56 ± 1.91	47.93 ± 2.97	4.37 ± 1.44	4.03 ± 0.18	4.44 ± 0.27	0.40 ± 0.13

The descriptive results in Table 1 show the mean values of VO_2max and MAS in both the control and experimental groups. Both groups demonstrated improvements from pretest to posttest; however, the experimental group showed greater gains, with VO_2max increasing by 4.37 ml/kg/min and MAS by 0.40 m/s, compared to the control group, which showed increases of 2.65 ml/kg/min for VO_2max and 0.25 m/s for MAS. This trend indicates that using a weight vest provided a significant additional stimulus in improving players' aerobic capacity.

Table 2. Normality, Homogeneity, and Independent Sample t-Test Result

Variable	Group A (p-value)	Group B (p-value)	Shapiro-Wilk Distribution	Levene's Test (Sig.)	Homogeneity	t (df)	p-value	Significant
VO_2max	0.559	0.799	Normal	0.503	Homogen	2.465 (18)	0.024	Significant
MAS	0.564	0.799	Normal	0.497	Homogen	2.498 (18)	0.022	Significant

The Shapiro–Wilk test showed that all variables in Group A and Group B had p-values greater than 0.05, indicating that the data were normally distributed. Furthermore, Levene's test showed p-values> 0.05 for VO_2max and MAS, indicating homogeneous variances across groups. With the assumptions of normality and homogeneity fulfilled, the Independent Sample t-Test was conducted. The t-test results revealed significant differences between Group A and Group B in VO_2max ($p = 0.024$) and MAS ($p = 0.022$). These findings indicate that the weight vest training intervention produced a significant improvement in the players' aerobic capacity.

Figure 2. Significant Differences Between the Experimental and Control Groups in VO_2Max and MAS Variables

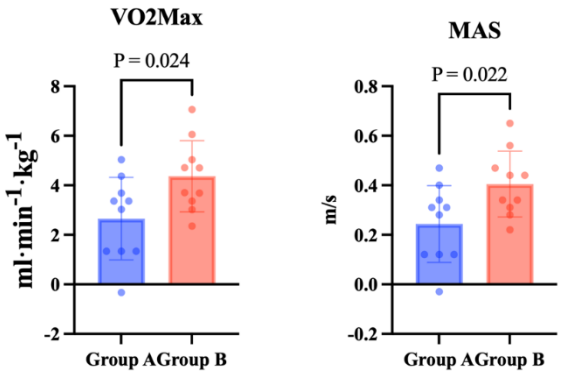


Figure 2 shows significant differences between Group A and Group B in the VO_2max and MAS variables. The p-values of 0.024 for VO_2max and 0.022 for MAS indicate that weight vest training significantly improved players' aerobic capacity and maximal running speed. Cohen's effect size calculation showed values of d = 0.88 for VO_2max and d = 0.82 for MAS—both categorised as large effects, indicating that the influence of weight vest training on aerobic capacity improvement was not only statistically significant but also practically substantial.

Discussion

This study investigated the effects of weight vest training on the aerobic capacity of soccer players. The training program incorporated technical drills during active recovery phases to maintain soccer-specific demands throughout the sessions. This approach allowed players to improve their physiological capacity while simultaneously engaging in basic technical actions such as ball control, passing, and dribbling, even under fatigue (Filipas et al., 2021; Hardiansyah et al., 2025). The results of this study revealed a significant difference in aerobic capacity between the experimental group undergoing the weight vest training program and the control group following the same program without added load. The weight vest group demonstrated an improvement in VO_2max of +4.37 ml/kg/min and an increase in MAS of +0.41 m/s, which can be explained by the increased metabolic stimulus and duration of exposure to the load over 12 training sessions. Other studies employing endurance training without external load reported minor improvements (an average increase ≈ of +2.22 ml/kg/min in a pure endurance group), thus reinforcing the notion that adding external resistance via weight vests substantially contributes to aerobic adaptation (Cobar & Madrigal, 2016).

This model of weight vest training is considered more functional and field-applicable (Dambroz et al., 2022; Teixeira et al., 2022; Wang et al., 2024). These findings align with previous research asserting that progressive weight vest use enhances endurance in athletes (Mehmood et al., 2025). With consistent training structure and intensity, adaptation processes can occur progressively and in a controlled manner (González-Ravé et al., 2022; Nyberg et al., 2022; Šiška et al., 2023). The addition of an external load, such as a weight vest, increases metabolic demands during training, thereby providing a more potent stimulus for cardiorespiratory adaptation and the development of aerobic capacity in endurance variables (Bertochi et al., 2024; Biswas & Ghosh, 2022).

Analysis of the endurance variables (VO_2max and MAS) showed significant improvements in both groups from pretest to posttest. However, the group with 11.62 ± 0.51% of body weight external load showed greater gains than the control group (0%), indicating that using weight vests provides additional stimulus to improve aerobic capacity in soccer players. This finding is consistent with Dharmadi et al. (2021), who found that using a weight vest can significantly enhance endurance in soccer players.

From a practical perspective, this improvement can be explained through physiological adaptations during the training program. The additional load from the weight vest systematically increases metabolic and cardiovascular demands during exercise, stimulating greater oxygen utilisation efficiency by the muscles during high-intensity activities (Dharmadi et al., 2021; Xiao et al., 2025). Sprint intervals with short rest periods interspersed with technical drills help maintain heart rate and oxygen consumption

at elevated levels, allowing players to spend more time in the aerobic zone, the key stimulus for aerobic capacity enhancement in high-intensity interval training protocols (Archiza et al., 2020). This mechanism aligns with meta-analysis findings reporting that vest-resisted sprint training enhances metabolic efficiency, acceleration, and aerobic capacity in young soccer players (Fernández-Galván et al., 2022). Furthermore, recent studies have shown that short rest intervals amplify physiological stimuli during resisted sprint sessions (Jung & Hong, 2024).

Meanwhile, the control group showed a minor improvement in aerobic capacity compared to the experimental group. The observed difference suggests that adding external resistance via the weight vest significantly accelerates and enhances the training effects on aerobic performance (Ltifi et al., 2023; Martínez-Noguera et al., 2024). These findings strengthen the hypothesis that a weight vest is not merely an external load device, but a practical training instrument capable of increasing physiological intensity without disrupting players' natural movement patterns (Fernández-Galván et al., 2022; Shiraz et al., 2024).

Therefore, this intervention is both statistically effective and practically relevant in enhancing the aerobic quality of modern soccer players. However, a limitation of this study is the lack of measurements of players' technical skill development, such as passing and ball control, with and without a weight vest. Hence, future research is recommended to comprehensively evaluate how this training intervention affects physiological capacity and technical performance, which are crucial in actual soccer matches (Bertochi et al., 2024; Dharmadi et al., 2021).

Conclusions

This study confirms that aerobic training with a weight vest produces distinct changes in aerobic capacity in soccer players compared to training without additional load. The experimental group demonstrated greater improvements in VO_2max and MAS, with a large effect size, indicating that the intervention is not only statistically significant but also practically relevant. Therefore, using a weight vest can be recommended as an efficient training strategy to stimulate physiological adaptations, enhance cardiovascular efficiency, and improve the endurance performance of modern soccer players.

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