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Effect of Short-Term Weight Vest Training on Muscle Strength During Soccer-Specific Drills in Amateur Player

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ABSTRACTS

Purpose This study aimed to examine the effect of weight vest training on lower-limb, core, and upper-body muscle strength in amateur soccer players.

Materials and Methods This quasi-experimental study employed a three-group pre-test–posttest design involving 31 male amateur soccer players randomly assigned to control (no weight vest, Group A, n = 10), 8.03 ± 0.79% weight vest (Group B, n = 10), and 11.45 ± 1.15% weight vest (Group C, n = 11) groups using stratified randomization based on baseline muscle strength. The participants had a mean height of 166.3 ± 5.7 cm, a mean body weight of 63.06 ± 6.49 kg, and a mean body mass index (BMI) of 21.42 ± 2.33 kg/m^2, with playing positions including defenders, midfielders, and forwards. Participants completed a five-week training program, and muscle strength was assessed using Leg Press, Sit-Up, and Push-Up tests. Participants took part in a five-week research program consisting of one week for pre-test assessments, three weeks of training intervention, and one week for posttest evaluations. Muscle strength was measured using the Leg Press, Sit-Up, and Push-Up tests. Data were analyzed using ANOVA for normally distributed variables and the Kruskal-Wallis test for non-normally distributed variables, with post hoc comparisons ($p < 0.05$). Effect sizes were reported using 95% confidence intervals and Cohen's d.

Result All participants showed improved muscle strength after the intervention. Leg Press increased in all groups, with Group C (11.45 ± 1.15% weight vest) significantly higher than the control ($p = 0.0322$). Sit-Up performance was also highest in Group C ($p \leq 0.0071$), while Push-Up showed no significant differences ($p = 0.8047$).

Conclusion Weight vest training during soccer-specific strength exercises effectively enhances lower-limb and core strength in amateur soccer players, especially at higher loads, but does not significantly affect upper-body strength.

Keywords Weight vest; Soccer training; Muscle strength; Lower limb strength; Core strength.

INTRODUCTION

Soccer is not only about technique and tactics but also requires strong physical fitness (Beato et al., 2021; Oliver et al., 2024). Muscle strength is a crucial component that supports a player's performance on the field. Lower-body strength is crucial for executing explosive movements, such

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as sprinting, jumping, and kicking, as well as for maintaining position during physical contact with opponents (Kadlubowski et al., 2024). Additionally, upper-body strength plays a crucial role in maintaining postural balance and body stability during contact or pressure situations, such as dribbling or competing for ball possession against opponents (Curovic et al., 2024). Players with higher levels of muscular strength tend to have an advantage in terms of speed, endurance, stability, and movement efficiency (Blechschmied et al., 2024). Therefore, muscle strength supports individual performance and contributes to the team's success on the field. Consequently, improving strength is a fundamental component of physical training programs for soccer players.

A common problem among soccer players, both amateur and professional, is lower-limb muscle injury (Ekstrand et al., 2021). Muscle injuries, such as hamstring and quadriceps strains, often occur during high-intensity activities like sprinting, jumping, and sudden changes of direction, which create eccentric muscle tension. These injuries lead to decreased player performance and pose a risk of prolonged absence and an increased likelihood of reinjury if not correctly managed (Nilsson et al., 2025). Amateur players are more vulnerable due to the dense match schedules (Ekstrand et al., 2023; Gurau et al., 2023). Muscle weakness is a primary contributing factor to injury, as insufficient lower limb strength is associated with a higher incidence of injuries in soccer (Mizutani et al., 2023). Therefore, training programs that specifically target the strengthening of these muscles are crucial for reducing injury risk while enhancing player performance. Various training models have been developed and implemented to enhance muscle strength in soccer players, including flywheel training, contrast training, velocity-based training (VBT), and functional strength training, among others (Herna'ndez-Belmonte, Luis M. Alegre, 2022; Allen et al., 2023). However, most of these programs still rely on isolated training models that lack focus on functional or sport-specific aspects, and they do not resemble a real match situation (Perna et al., 2024). As a result, the transfer of developed strength adaptations to on-field performance is limited, underscoring the need for a more specific and applicable strength training approach that aligns with actual match demands. Using alternative methods, such as a weight vest, can address this need by enhancing strength while also preserving the player's natural movement patterns on the field (Ltifi et al., 2023).

Using equipment such as the weight vest has emerged as a variation of functional strength training. A weight vest can provide an instant additional load without restricting the player's range of motion. Therefore, this tool is highly relevant to soccer, which demands strength under complex and rapid movement conditions. Training with external loads, such as a weight vest, is also believed to enhance neuromuscular capacity without disrupting movement technique, thereby potentially improving the transfer of training effects to match performance (Fernández-Galván et al., 2022). This approach allows players to develop strength while maintaining the efficiency of their natural movement patterns. In basketball, weight vest training has been shown to enhance explosive strength, as demonstrated by improvements in vertical jump performance (Cherni et al., 2025). Not only is weight vest training beneficial for athletes, but it also has positive effects on the non-athletic population. Studies in adults and older adults have shown that such training helps strengthen core muscles, improve postural stability, and prevent declines in muscle mass and bone density (Nithisup et al., 2024). These findings suggest that the weight vest has a broad application in enhancing athletic performance and promoting health, underscoring the importance of further research on its use in soccer.

Based on the aforementioned background, this study urgently addresses the scientific gap regarding the effectiveness of using a weight vest to enhance muscle strength in soccer players through a training approach that maintains the players' natural movement patterns. The purpose

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of the expectation is that the resulting adaptation can be more effectively transferred to actual on-field performance. Using a weight vest in a functional approach aligned with soccer's characteristics is expected to produce greater strength gains than conventional training without additional load.

METHODS

Study Participants

This study involved 31 male amateur soccer players who were active students at the State University of Surabaya. Initially, 36 participants were recruited; however, five were excluded due to illness (two from Group A, two from Group B, and one from Group C), resulting in a final sample of 31 participants (A = 10, B = 10, C = 11). The participants' mean height was 166.3 ± 5.7 cm, mean body weight was 63.06 ± 6.49 kg, and mean body mass index (BMI) was 21.42 ± 2.33 kg/m². Playing positions included defenders, midfielders, and forwards. Inclusion criteria were being physically healthy, having no history of injury within the past three months, having at least one year of soccer experience, actively training, and being willing to participate in all stages of the training and evaluation program. Exclusion criteria were having an active injury or being in recovery during the study, sustaining an injury during the intervention, or attending less than 90% of training sessions.

Study Organization

This study employed a quasi-experimental design with a pre-test–posttest control group. Participants were randomly assigned to three groups: Group A (control, no weight vest), Group B (weight vest 8.03 ± 0.79% of body weight), and Group C (weight vest 11.45 ± 1.15% of body weight). Randomization was stratified by baseline muscle strength tests (Leg Press, Sit-Up, and Push-Up) to ensure balanced initial abilities across groups. The intervention lasted 5 weeks. During the first week, participants completed two pre-test sessions to assess baseline performance, followed by a three-week training phase comprising 12 sessions (four sessions per week). In the final week, participants performed two posttest sessions to evaluate performance improvements after the intervention.

Training Program

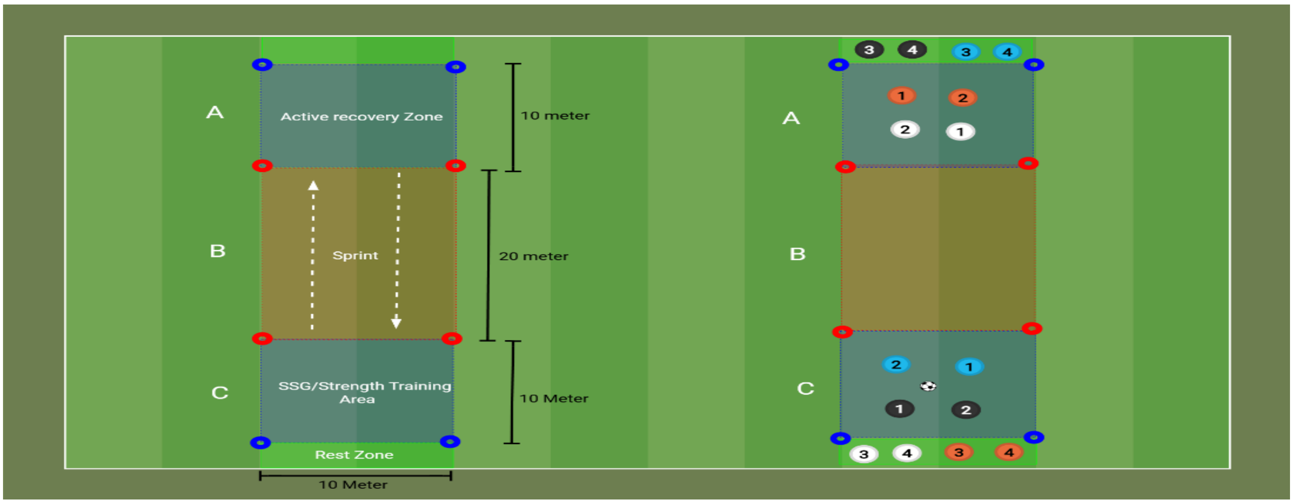

Figure 1. Design of the training area showing the distribution of exercise zones

Participants were divided into four groups: Groups 1 and 2 began the training first, while Groups 3 and 4 started after Groups 1 and 2 completed one set. This arrangement ensured continuous activity and efficient use of training space. The training session began with a warm-up phase lasting 10–15 minutes, consisting of 5 minutes of light jogging followed by dynamic stretching targeting major muscle groups, including the quadriceps, hamstrings, glutes, calves, lower back, and shoulders. Players then performed muscle activation drills, including high knees, butt kicks, lunges, and skipping, for 5 minutes, concluding with acceleration drills over 10–15 meters to prepare the neuromuscular system for the main training session. After the warm-up, the main training began in Zone A, where players sprinted 20 meters to Zone C through Zone B in approximately 4 seconds. Upon reaching Zone C, players engaged in strength training exercises consisting of squats, planks, and push-ups for 20 seconds. They then sprinted back to Zone A via Zone B for another 4 seconds, then maintained ball possession in Zone A for 20 seconds. Next, players repeated the 20-meter sprint to Zone C, then performed 20 seconds of strength training, sprinted back to Zone A, and finished with ball possession for 20 seconds. This entire sequence constituted a single training set, with a total work duration of approximately 96 seconds (1 minute 36 seconds). Each set included four sprints covering a total distance of 80 meters and 16 seconds of sprinting time. After completing one set, players moved to the rest zone and rested for the same duration as the work period, maintaining a 1:1 work-to-rest ratio. While one group rested, another group performed the same sequence. Each group completed eight sets in one training session, resulting in a total active work duration of approximately 12 minutes and 48 seconds and rest duration of 12 minutes and 48 seconds, for a total main session duration of 25 minutes and 36 seconds. In total, players performed 32 sprints covering 640 meters during one training session. After the main session, players underwent a cool-down phase lasting 5–10 minutes, which included light jogging and static stretching to gradually reduce heart rate, minimize lactic acid buildup, and accelerate muscle recovery. Therefore, the total duration of a complete training session, including warm-up and cool-down, was approximately 40–50 minutes.

Measurement

All measurements were conducted using standardized and validated procedures to ensure the reliability and accuracy of the data. Prior to testing, participants received a clear explanation of each assessment protocol and performed a 10- to 15-minute dynamic warm-up to prepare physiologically and reduce the risk of injury. Lower limb strength was assessed using the one-repetition maximum (1RM) test targeting the quadriceps and hamstrings. The load was progressively increased until only one successful repetition could be completed with correct technique. Core muscle strength was evaluated using the sit-up test performed for 60 seconds, while upper body strength was assessed using the push-up test performed for 60 seconds. The total number of correctly executed repetitions for each test was recorded according to standardized movement criteria, including the starting position, range of motion, and body stability. All tests were administered using properly calibrated equipment under consistent environmental conditions, and only when participants were in good physical condition, thereby ensuring measurement validity and minimizing bias.

Statistical Analysis

Data were analyzed using the Shapiro-Wilk normality test to determine the distribution of each variable. If the data were normally distributed ($p > 0.05$), a one-way ANOVA was conducted using parametric analysis to compare group differences. If the ANOVA indicated a significant difference,

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a Tukey post hoc test was performed to identify which groups differed. Conversely, non-parametric analysis was conducted using the Kruskal-Wallis test if the data were not normally distributed ($p \leq 0.05$). When a significant difference was found, Dunn's multiple comparisons test was applied to determine specific group differences. In addition, 95% confidence intervals (CIs) were calculated for each group's mean to provide a range of estimated population means, and Cohen's d was calculated to quantify effect sizes for key group comparisons. All statistical analyses were performed with a significance level set at $\alpha = 0.05$. A p-value < 0.05 was considered statistically significant.

RESULT

This study was designed to investigate the effects of weight-vest training on leg and core muscle strength in soccer players and to identify differences in strength adaptation across groups with varying loads.

Table 1. Descriptive statistics (mean ± SD)

Variable	Group	Pre-test	Posttest	Improvement
Leg Press (kg)	A	304.4 ± 89.6	391.8 ± 99.7	87.4 ± 134.0
	B	296.3 ± 78.1	395.6 ± 61.5	99.3 ± 99.4
	C	268.7 ± 83.0	399.7 ± 80.9	131.0 ± 115.9
Sit Up (times)	A	24.2 ± 2.7	26.4 ± 3.1	2.2 ± 4.1
	B	23.3 ± 3.7	25.7 ± 4.2	2.4 ± 5.6
	C	25.6 ± 2.8	32.2 ± 3.0	6.6 ± 4.1
Push Up (times)	A	30.6 ± 12.2	34.0 ± 14.3	3.4 ± 18.8
	B	31.4 ± 14.4	33.2 ± 15.1	1.8 ± 20.9
	C	35.1 ± 6.8	37.0 ± 8.4	1.9 ± 10.8

Note: Data are presented as mean ± standard deviation (SD)

The descriptive statistic results of the strength tests (Leg Press, Sit-Up, and Push-Up) for Group A and the weight vest groups (B and C). Overall, all groups showed improvements from pre-test to posttest, with the most significant increase observed in the leg press, particularly in Group C (131.0 ± 115.9). In contrast, improvements in sit-ups and push-ups were relatively small and similar across groups, suggesting that the weight vest had a greater impact on lower-limb muscle strength than on abdominal or arm muscles.

Table 2. Shapiro-Wilk Test

Variable	Group	W	P value	Normality ($\alpha = 0.05$)
Leg Press	A	0.8952	0.1940	Normal
	B	0.9642	0.8327	Normal
	C	0.9125	0.2608	Normal
Sit Up	A	0.7643	0.0053	Not Normal
	B	0.8972	0.2038	Normal
	C	0.9199	0.3178	Normal
Push Up	A	0.8124	0.0205	Not Normal
	B	0.9357	0.5063	Normal
	C	0.9509	0.6552	Normal

Table 2 shows the results of the Shapiro-Wilk normality test for all research variables (Leg Press, Sit-Up, and Push-Up) in each group. The results indicate that the Leg Press data for groups A, B, and C were normally distributed; therefore, group comparisons were analyzed using One-

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way ANOVA. For the Sit-Up variable, the data in group A were not normally distributed (p = 0.0053), whereas the data in groups B and C were normally distributed. Therefore, comparisons among groups were analyzed using the Kruskal-Wallis test. A similar pattern was observed for the Push-Up variable: group A data were not normally distributed (p = 0.0205), whereas groups B and C were normally distributed. Therefore, group comparisons were also analyzed using the Kruskal-Wallis test.

Table 3. One-way ANOVA Leg Press

ANOVA	SS	DF	MS	F (DFn, DFd)	P value
Treatment (between columns)	10768	2	5384	F (2.28) = 3.866	P=0.0329
Residual (within columns)	38997	28	1393		
Total	49764	30			

Table 3 presents the results of a One-way ANOVA for leg muscle strength measured using the Leg Press across three treatment groups (A, B, and C). The ANOVA results showed an F(2,28) = 3.866, p = 0.0329, indicating a significant difference among the groups. This result suggests that the intervention with varying weight vests had different effects on participants' leg muscle strength. A Tukey post-hoc test was conducted to determine which groups differed significantly.

Table 4. Multiple Comparison Leg Press

Tukey's multiple comparisons test	Mean Diff,	Summary	Adjusted P V alue		Cohen's d	95% CI
Group A vs. B	-11.90	ns	0.7579	A-B	-0.10	-0.98 – 0.78
Group A vs. C	-43.60	*	0.0322	A-C	-0.35	-1.21 – 0.51
Group B vs. C	-31.70	ns	0.1452	B-C	-0.29	-1.15 – 0.57

Table 4 presents the results of Tukey's multiple-comparison test for Leg Press performance among Groups A, B, and C. A significant difference in lower limb strength was observed only between Group A and Group C (Mean difference = -43.60, p = 0.0322, Cohen's d = -0.35, 95% CI = -1.21 to 0.51). No significant differences were found between Group A and Group B (Mean difference = -11.90, p = 0.7579, Cohen's d = -0.10, 95% CI = -0.98 to 0.78) or between Group B and Group C (Mean difference = -31.70, p = 0.1452, Cohen's d = -0.29, 95% CI = -1.15 to 0.57). These results indicate that the most significant improvement in leg strength occurred in the group with the highest weight vest load compared with the control group. In contrast, the intermediate load produced no significant difference from either the control or the highest load groups.

Table 5. Kruskal-Wallis test Sit-Up and Push-Up

Kruskal-Wallis test	Sit-Up	Push-Up
P value	0.0016	0.8047
P-value summary	**	ns
Number of groups	3	3
Kruskal-Wallis statistic	12.94	0.4345

Based on Table 5, the Kruskal-Wallis test showed a significant difference in Sit-Up performance among the three groups (Kruskal-Wallis statistic = 12.94, p = 0.0016). Dunn's multiple comparisons test was then performed to determine specific group differences. For Push-Up performance, no significant difference was observed (Kruskal-Wallis statistic = 0.4345, p = 0.8047), so no further multiple comparisons were conducted. Data are presented as mean ± SD.

Table 6. Multiple Comparison Sit-Up

Dunn's multiple comparisons test	Mean rank diff,	Summary	Adjusted P Value		Cohen's d	95% CI
Group A vs. B	-0.4000	ns	>0.9999	A-B	0.04	-0.84 – 0.92
Group A vs. C	-12.32	**	0.0051	A-C	1.07	0.16 – 1.99
Group B vs. C	-11.92	**	0.0071	B-C	0.86	-0.03 – 1.75

Table 6 presents the results of Dunn's multiple-comparison test for Sit-Up performance across the three groups. No significant difference was found between Group A and Group B (Mean rank difference = -0.4000, p > 0.9999). Significant differences were observed between Group A and Group C (Mean rank difference = -12.32, p = 0.0051) and between Group B and Group C (Mean rank difference = -11.92, p = 0.0071). These results indicate that Group C demonstrated significantly higher Sit-Up performance compared to both Group A and Group B, with a large effect size (Cohen's d > 0.8) and 95% confidence intervals supporting the magnitude of the differences.

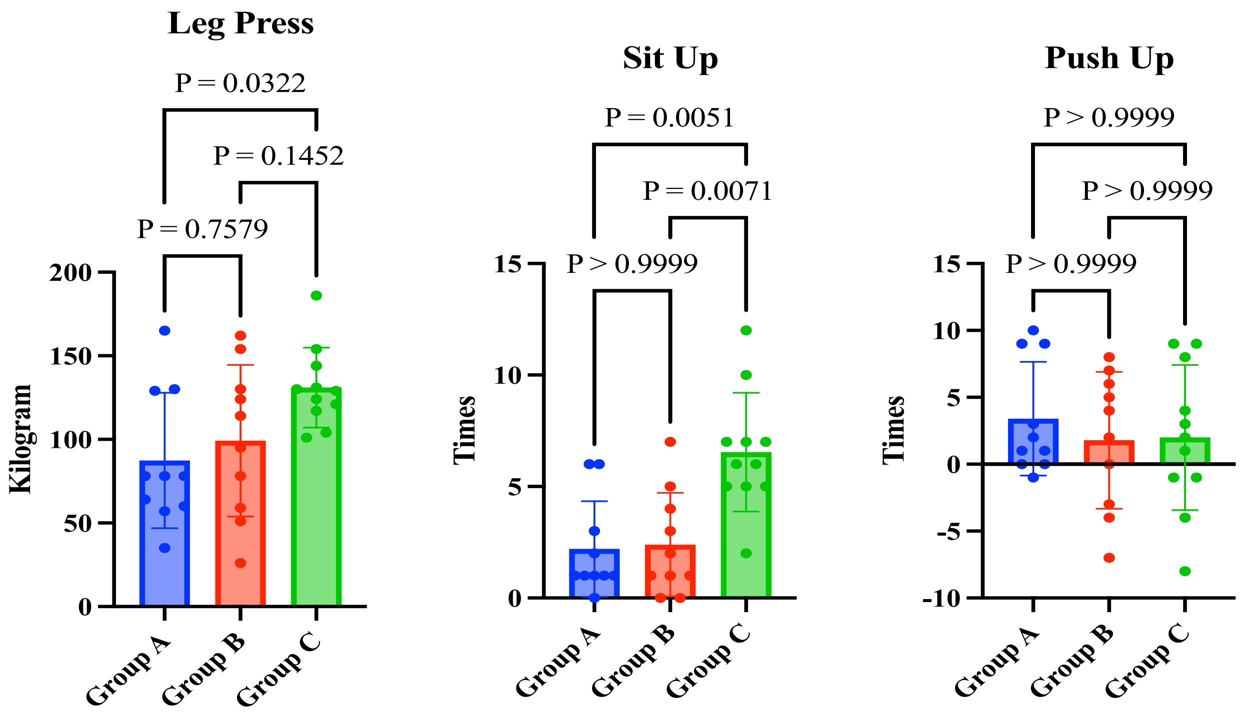

Figure 2. Comparison of muscle strength improvements among groups in the Leg Press, Sit-Up, and Push-Up tests.

Figure 2 illustrates differences in muscle strength test results among the treatment groups. In the Leg Press test, an increase was observed across all groups, with Group C (green) showing the highest mean value. This finding supports the statistical analysis results, which revealed a significant difference between Groups A and C (p = 0.0322). In contrast, the differences between Groups A and B (p = 0.7579) and between Groups B and C (p = 0.1452) were not significant. In the Sit-Up test, Group C (green) exhibited a markedly higher mean score compared to Groups A (blue) and B (red). Dunn's test confirmed significant differences between Groups A and C (p = 0.0051)

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and between Groups B and C (p = 0.0071), whereas the difference between Groups A and B was not significant (p > 0.9999). These results indicate that using a weight vest loaded to 11.45 ± 1.15% of body weight led to a notable improvement in core muscle strength. Meanwhile, in the Push-Up test, although individual variations were observed, the median and the distribution of data across the three groups were relatively similar. Statistical analysis showed no significant differences among the groups.

DISCUSSION

The results of this study indicate that training with a weight vest led to a significant improvement in strength in the group using a load of 11.45 ± 1.15% of body weight, compared with both the no-load and the 8.03 ± 0.79% of body weight groups. The most significant gains occurred in the lower limbs and core muscles, as shown by the ANOVA and Kruskal–Wallis tests, which revealed significant differences, particularly between the control and 11.45 ± 1.15% of body weight groups. Conversely, no significant changes were observed in the push-up test, likely because the training program focused on sprinting, directional changes, and body-weight movements that primarily engaged the lower kinetic chain. Although the added load increased stress on the legs and trunk, it did not provide sufficient mechanical stimulus to enhance upper-body strength. Consequently, upper body strength did not show notable improvement, consistent with prior studies indicating that weighted vest exercises are more effective for enhancing lower body and core strength than upper body performance (Bartolomei et al., 2018). These findings suggest that an optimal external load can promote neuromuscular adaptation and hypertrophy in the primary working muscles, although specific resistance training remains necessary to improve upper-body strength (Saeterbakken et al., 2025).

The increase in strength observed in the weight vest groups occurred due to increased mechanical overload, which stimulates muscle adaptation through greater motor unit activation and muscle fibre hypertrophy (Chaves et al., 2024; Santos et al., 2023; Schoenfeld, 2020). This principle aligns with the theory of progressive overload in coaching, where the addition of a measured external load can encourage the neuromuscular system to adapt to higher training demands (Bertochi et al., 2024; Liu et al., 2025; Plotkin et al., 2022). In soccer training, adding a load equivalent to 11.45 ± 1.15% of body weight creates a training condition that mimics match situations, where players must generate significant force and power within a short period (Ben Brahim et al., 2021). This adaptation also strengthens the connection between strength and functional abilities, such as acceleration and change of direction (Aloui et al., 2021). Furthermore, the training characteristic, which combines sprinting, small-sided games, and muscle strengthening, reflects an integrated training approach, a modern principle in strength and conditioning. Therefore, these strength gains are not solely the result of the additional load but also the application of the principles of specificity and load variation tailored to the physiological needs of soccer players.

Given these results, weight vest training programs can be widely applied in soccer development at the academy, amateur, and professional levels. This training can be an effective alternative in the pre-season phase to build fundamental strength and improve physical readiness before competition (Gołaś et al., 2024). Furthermore, a weight vest can be utilized in functional training sessions or conditioning drills to strengthen leg and core muscles without compromising a player's fundamental technique. This approach is also relevant for fitness coaches who want to develop specific strength without the need for heavy gym equipment, allowing training to be performed directly on the field at a consistent high intensity (Zachary M., 2022). The use of a weight vest is also beneficial in post-injury rehabilitation, where the load can be gradually adjusted to aid muscle recovery without putting undue stress on the joints (Srisaphonphusitti et al., 2022; Talbot et al., 2021).

Despite its effectiveness, several limitations to applying weight vest training must be considered. Using an inappropriate load or incorrect technique can increase the risk of injury, particularly to the knee joint. Therefore, adjusting the load proportionally and progressively, and ensuring close supervision during training, are important. This study also has limitations: it focused solely on static strength tests (leg press, sit-ups, and push-ups) and did not directly assess transferability to running or jumping performance. Future research should investigate the impact of weight vest training on specific athletic abilities, including sprint performance, change of direction (COD), and vertical jump. Such studies would provide a more comprehensive understanding of how functional strength adaptations transfer to sport performance and further support the scientific evidence for the weight vest as an effective and safe training tool for athletes.

CONCLUSION

Training with a weight vest accounting for 11.45 ± 1.15% of body weight during sprinting, change-of-direction drills, small-sided games, and body-weight exercises effectively enhanced lower-limb and core muscle strength. However, it did not significantly affect upper-body strength. Properly applied external load can stimulate muscle adaptation and be used in pre-season, functional, or rehabilitation training under supervision.

CONFLICT OF INTEREST

The authors declare no conflicts of interest that could affect the results or process of this research.

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