

# The effect of back-up training on heading ability in football players: a study at the State School for Sports Talent in Aceh

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## ABSTRACT

This study examined the effect of back-up training—a trunk-strengthening exercise—on football heading ability among eighth-grade male students at the State School for Sports Talent, Aceh. A quasi-experimental design with a pretest-posttest approach was employed. A total of 22 students were purposively selected from a population of 107 and proportionally assigned across four classes: VIIla (n=6), VIIlb (n=5), VIIlc (n=6), and VIIld (n=5). The intervention consisted of structured back-up training sessions conducted three times per week for six weeks. Heading performance was assessed before and after the intervention using a standardized 60-second heading test evaluating both accuracy and technique. The results revealed a statistically significant improvement ( $t(21) = 22.52$ ,  $p < 0.001$ ) in heading performance, with a large effect size (Cohen's  $d = 4.80$ ). Regression analysis yielded a positive coefficient ( $B = 0.84$ ,  $R^2 = 0.72$ ), indicating that back-up training was a strong predictor of post-test heading outcomes. These findings offer a novel perspective for integrating trunk-focused exercises into school-based football coaching and physical education curricula. The study underscores the role of targeted neuromuscular conditioning in enhancing sport-specific skills and provides practical guidance for coaches and educators seeking effective, scalable interventions for youth development.

## KEYWORDS

Back-up Training; Football Heading; Physical Education; Junior High School; Motor Skills

## 1. INTRODUCTION

Football is one of the most popular and widely played sports across the globe (Kuswoyo, 2020). It engages people of all ages and backgrounds—children, adolescents, adults, men and

women—and holds a prominent place in formal education through physical education programs (Allison et al., 2017; Kuswoyo & Betaubun, 2019). Physical education is not merely about engaging in physical activity; it serves as a comprehensive medium for fostering cognitive, emotional, social, and physical development (Kuswoyo et al., 2020). As emphasized by Ahmed & Al Salim (2024), physical education promotes motor skill acquisition, creativity, fitness, and healthy lifestyle habits among students.

In football, technical proficiency is fundamental to both individual and team performance (Admin, 2025; Nurcahyo et al., 2025). Players who lack mastery of core skills—such as ball control, passing, shooting, dribbling, and heading—often experience performance limitations during matches (Ah et al., 2020; Reval, 2013). Among these, heading is a particularly critical skill, used in both attacking and defensive contexts. Effective headers require not only timing and coordination but also physical strength and body control (Wahyono, 2017; Nambi et al., 2020).

One promising approach to improving heading performance is back-up training, a form of isotonic exercise that primarily engages the trunk muscles, including the back and abdominal regions (Nambi et al., 2020; Ca et al., 2015). During a header, players initiate movement through trunk hyperextension, followed by a forward explosive action generated by the core muscles and leg drive (Cormie et al., 2011). Developing these muscle groups is therefore essential for enhancing heading power, accuracy, and control (Cohen et al., 2017). Back-up training typically involves movements such as torso lifts or leg raises that strengthen these regions.

At the State School for Sports Talent in Aceh, heading is part of the football training curriculum for eighth-grade students. However, observations indicate that many students struggle with proper heading technique, suggesting a need for targeted physical interventions. To address this, the current study evaluates the effect of structured back-up training on the heading ability of adolescent football players.

To the best of our knowledge, no prior empirical study has specifically investigated the isolated impact of back-up training on football heading performance among junior athletes. This study introduces a novel training framework that focuses on strengthening the trunk muscles essential for heading mechanics. By addressing this gap, the research contributes to the advancement of evidence-based physical training strategies in youth football development programs.

This study also holds practical significance for coaches, physical education teachers, and sports institutions seeking to implement effective and low-cost training methods to enhance technical

performance in young athletes. The integration of back-up training into the football curriculum may offer a structured pathway to improve students' heading ability through enhanced muscular coordination, strength, and control.

## **2. METHODS**

### **2.1. Participants**

This study was conducted at the State School for Sports Talent, Aceh, Indonesia, during the 2019–2020 academic year. A total of 22 healthy male eighth-grade students, aged approximately 15–18 years, were selected using purposive sampling, based on their availability, physical fitness, and absence of injuries. The population comprised 107 students across four classes: VIIIa (28 students), VIIIb (26 students), VIIIC (28 students), and VIIId (25 students). The sample was proportionally drawn as follows: VIIIa (n=6), VIIIb (n=5), VIIIC (n=6), and VIIId (n=5). Written informed consent was obtained from both school authorities and the participants' guardians prior to the intervention.

### **2.2. Intervention**

This study adopted a one-group pretest-posttest quasi-experimental design (16) to examine the impact of back-up training on football heading ability. Participants first completed a standardized 60-second football heading test to assess their baseline performance.

The intervention consisted of a structured back-up training program aimed at strengthening the trunk muscles (abdominal and back muscles), which are essential for effective heading mechanics. The program was implemented three times per week for six weeks, with each session lasting approximately 30 minutes. The exercises emphasized isotonic trunk movements including torso lifts and leg raises to improve neuromuscular coordination, core strength, and explosive power.

After the six-week training, participants repeated the same heading test as a post-test to measure changes in performance. The difference in scores between the pre-test and post-test was used to assess the effectiveness of the training.

### **2.3. Instrument**

The primary instrument was a football heading skill test designed to evaluate both accuracy and technique. Participants were instructed to head the ball against a wall target marked with scoring zones (see Figure 1). Each participant performed as many accurate headers as possible within 60 seconds. This test was administered before and after the training program under standardized conditions to ensure consistency.

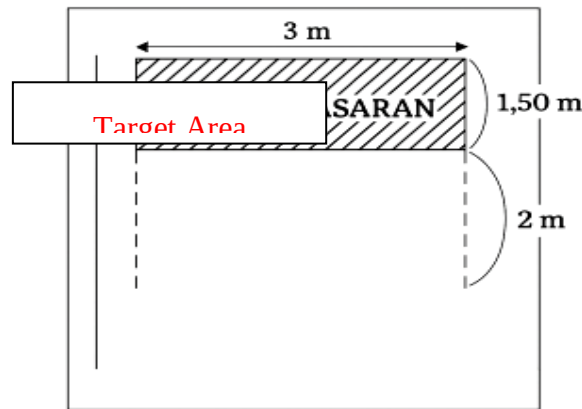


**Figure 1.** Design of the heading test wall used to assess accuracy and technique

## 2.4. Data Collection and Statistical Analysis

Data were collected from both pre-test and post-test phases using a standardized football heading skill test. The collected data were analyzed using SPSS software to assess the effectiveness of the back-up training intervention. Prior to hypothesis testing, the Shapiro-Wilk test was employed to assess the normality of the data distribution, while Levene's test was used to examine the homogeneity of variances.

To determine significant differences between pre-test and post-test scores, a paired sample t-test was conducted. In addition, simple linear regression analysis was performed to explore the relationship between the back-up training program and improvements in heading performance. To complement the statistical significance, effect size (Cohen's d) was calculated to evaluate the magnitude of the intervention's practical impact.

All statistical tests were conducted at a significance level of  $p < 0.05$ . Descriptive statistics and summary measures were also calculated. Relevant figures and data visualizations, including a comparison of pre-test and post-test scores, are presented in the Results section to enhance clarity and interpretation.

## 3. RESULTS

Before the intervention, participants completed a standardized 60-second football heading test to assess their baseline performance. As shown in Table 1, individual heading scores ranged from 35 to 60, reflecting varied levels of technical skill.

**Table 1.** Football heading scores in 60 seconds (pre-test)

| No. | Student Names | Heading Results | Score |
|-----|---------------|-----------------|-------|
| 1   | RK            | 9               | 45    |
| 2   | CS            | 7               | 35    |
| 3   | SR            | 11              | 55    |
| 4   | MS            | 10              | 50    |
| 5   | RSL           | 12              | 60    |
| 6   | AB            | 11              | 55    |
| 7   | AGE           | 10              | 50    |
| 8   | AGS           | 10              | 50    |
| 9   | DK            | 8               | 40    |
| 10  | DDK           | 8               | 40    |
| 11  | JL            | 10              | 50    |
| 12  | JMA           | 9               | 45    |
| 13  | MZ            | 10              | 50    |
| 14  | MZM           | 12              | 60    |
| 15  | YD            | 11              | 55    |
| 16  | FK            | 11              | 55    |
| 17  | KK            | 9               | 45    |
| 18  | RS            | 9               | 45    |
| 19  | MI            | 10              | 50    |
| 20  | ADR           | 11              | 55    |
| 21  | DP            | 12              | 60    |
| 22  | AY            | 10              | 50    |

To better interpret the distribution of ability, the scores were categorized into five ranges. Table 2 shows that the largest proportion of students (31.81%) scored between 46 and 50 points, while 13.63% scored below 40, indicating a generally below-average performance.

**Table 2.** Percentage distribution of pre-test scores

| Score Range | Number of Students | Percentage (%) |
|-------------|--------------------|----------------|
| 35–40       | 3                  | 13.63          |
| 41–45       | 4                  | 18.18          |
| 46–50       | 7                  | 31.81          |
| 51–55       | 5                  | 22.72          |
| 56–60       | 3                  | 13.63          |

These results indicate that the heading ability of participants before the intervention was generally below average, suggesting the need for targeted training to improve their skills.

Participants underwent a back-up training program focused on strengthening the core muscles (abdominal and lower back) essential for heading. The program was conducted three times per week for six weeks, with each session lasting 30 minutes. After the six-week intervention, the same

heading test was administered. The results showed considerable improvements, with all participants increasing their scores. As shown in Table 3, post-test scores ranged from 50 to 75.

**Table 3.** Football heading scores in 60 seconds (post-test)

| No. | Name | Heading Result | Score |
|-----|------|----------------|-------|
| 1   | RK   | 11             | 55    |
| 2   | CS   | 10             | 50    |
| 3   | SR   | 15             | 75    |
| 4   | MS   | 14             | 70    |
| 5   | RSL  | 15             | 75    |
| 6   | AB   | 13             | 65    |
| 7   | AGE  | 14             | 70    |
| 8   | AGS  | 14             | 70    |
| 9   | DK   | 12             | 60    |
| 10  | DDK  | 12             | 60    |
| 11  | JL   | 14             | 70    |
| 12  | JMA  | 13             | 65    |
| 13  | MZ   | 14             | 70    |
| 14  | MZM  | 15             | 75    |
| 15  | YD   | 14             | 70    |
| 16  | FK   | 14             | 70    |
| 17  | KK   | 13             | 65    |
| 18  | RS   | 13             | 65    |
| 19  | MI   | 14             | 70    |
| 20  | ADR  | 14             | 70    |
| 21  | DP   | 15             | 75    |
| 22  | RK   | 15             | 75    |

The distribution in Table 4 reveals a significant shift, with 36.36% of participants scoring between 66 and 70 points, compared to only 13.63% scoring in the highest range during the pre-test.

**Table 4.** Percentage distribution of post-test scores

| Score Range | Number of Students | Percentage (%) |
|-------------|--------------------|----------------|
| 50–55       | 3                  | 13.63          |
| 56–60       | 4                  | 18.18          |
| 61–65       | 7                  | 31.81          |
| 66–70       | 8                  | 36.36          |

The post-test results demonstrate that the back-up training effectively improved the participants' heading ability.

A paired sample t-test revealed a statistically significant increase in heading scores following the training ( $t(21) = 22.52$ ,  $p < 0.001$ ), indicating strong evidence of the program's effectiveness. To evaluate the magnitude of the improvement, Cohen's  $d$  was calculated at 4.80, representing a very

large effect size, which suggests that the improvement was not only statistically significant but also practically meaningful.

A simple linear regression was also conducted to examine the predictive relationship between pre-test scores and post-test performance. The resulting regression equation is:

$$Y = -14.94 + 1.65X$$

Where:

Y = predicted heading score after training

X = heading score before training

The model yielded an  $R^2$  value of 0.72, indicating that 72% of the variance in post-test performance could be explained by participants' baseline ability. This strong predictive value further supports the effectiveness of the intervention in enhancing football heading skills. Complementing these findings, Figure 2 visually illustrates the significant increase in mean heading scores between the pre-test and post-test, reinforcing the statistical outcomes.

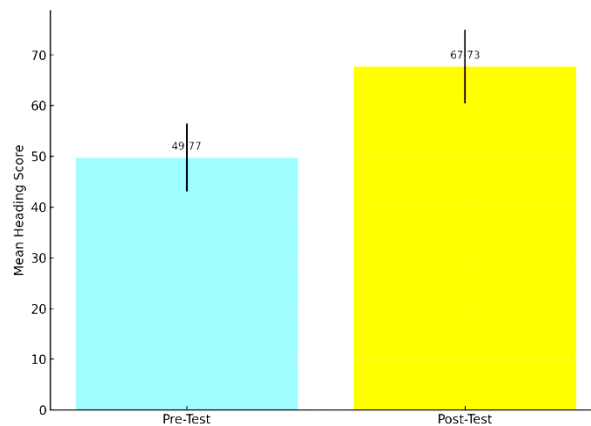


**Figure 2.** Comparison of pre-test and post-test heading scores

The bar chart presents the average football heading scores before and after the six-week back-up training program. The mean pre-test score was 49.77 (SD = 6.65), while the post-test mean increased significantly to 67.73 (SD = 7.33). Error bars indicate standard deviations. This visual reinforces the statistical evidence of the training's effectiveness.

#### **4. DISCUSSION**

This study confirms that back-up training significantly enhances football heading ability in adolescent athletes, particularly when implemented consistently over a structured six-week program. The improvement is statistically significant and supported by a large effect size, suggesting not only effectiveness but also practical relevance in sports education contexts.

These findings are in line with international studies. For example, Ford et al. (2011) demonstrated that strengthening the trunk muscles—especially the abdominals and spinal extensors—improved heading accuracy and power among adolescent football players. Similarly, Di Salvo et al. (2010) highlighted how trunk-focused conditioning reduces injury risk and improves technique, underlining the mechanical importance of core stability in aerial duels. McGill et al. (2014) also emphasized the biomechanical role of spinal musculature in explosive athletic actions, supporting the linear regression results in this study, which show that heading performance improves proportionally with continued back-up training.

From a practical standpoint, these results have important implications for physical education teachers and football coaches. Back-up training, as a low-cost and bodyweight-focused method, can be easily integrated into existing school PE programs. It may be implemented as a 10–15 minute warm-up or supplementary core routine, three times per week. For younger students or those with lower physical capacity, exercise intensity should be reduced by modifying repetitions or providing additional support. Conversely, older or more advanced players may benefit from incorporating resistance variations or integrating balance-focused drills to increase challenge and coordination.

This study also helps address a gap in previous literature: while past research acknowledged the benefit of trunk strength for heading, few have empirically evaluated the isolated impact of back-up exercises on this specific skill. To the best of our knowledge, this is the first study to systematically test a structured back-up training protocol targeting football heading ability among junior-level athletes in a school-based context. Therefore, it not only supports prior findings but also extends the field by offering a focused intervention model.

Although consistent with Reval (2013), who found positive muscle adaptation from back-up training, prior studies often lacked statistical depth (e.g., effect size reporting) or were limited to general strength outcomes rather than skill-specific results. This study addresses those gaps through quantitative analysis (e.g., linear regression, paired t-test, and effect size), offering a stronger evidence base. Moreover, unlike previous work that typically used club or academy athletes, this

research demonstrates that back-up training is equally effective in educational settings, making it more applicable across diverse populations.

Despite its strengths, the study has several limitations. The sample was relatively small ( $n = 22$ ) and drawn from a single school, limiting the generalizability of the findings. Additionally, only male students were included, excluding possible gender-based responses to training. The study also did not assess long-term retention or transfer of heading performance in match settings. Future research should consider larger, more diverse samples, include female participants, and examine the durability of training effects over time.

This study offers a novel and practical training model that is both effective and accessible for improving football heading ability. It contributes to the body of sports education literature by showing how targeted back-up training can be adapted to school curricula, personalized based on age and fitness level, and aligned with global best practices in athlete development.

## 5. CONCLUSIONS

This study concludes that back-up training has a significant positive effect on students' football heading performance. The results demonstrate that students who consistently performed back-up exercises achieved better heading scores compared to those who did not engage in this training. This improvement can be attributed to enhanced muscular strength and a better understanding of proper heading techniques gained through the structured back-up training program.

The intervention effectively improved key physical attributes such as back and core muscle strength, which are essential for generating power and control in heading the ball. These findings highlight the suitability of incorporating back-up training into physical conditioning programs aimed at developing heading skills in adolescent football players.

This study contributes valuable evidence supporting the role of targeted strength training in improving sport-specific technical skills. Coaches and trainers are encouraged to implement back-up exercises as part of comprehensive training regimens to optimize heading performance in young athletes.

Future research should explore the long-term effects of back-up training across larger and more diverse samples, including female athletes and players at different competitive levels, to validate and extend these findings. Additionally, combining back-up training with other conditioning modalities may offer further improvements in football skill development.

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## **AUTHOR CONTRIBUTIONS**

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

## **CONFLICTS OF INTEREST**

The authors declare no conflict of interest.

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