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RESEARCH ARTICLE

Improving Volleyball Setting Accuracy Using Arm Strengthening Exercises and Eye-Hand Coordination Drills

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ABSTRACT

Young Physical Education learners often struggle to perform accurate, consistent sets in volleyball due to limited physical preparation and underdeveloped perceptual-motor coordination. This study investigated the effectiveness of arm strengthening exercises and eye-hand coordination drills in improving the volleyball setting accuracy of Grade 8 students. Using a quasi-experimental non-equivalent pretest-posttest design, participants from a public secondary school in Valencia City, Bukidnon, were assigned to two intervention groups. Group 1 underwent arm-strengthening exercises, while Group 2 engaged in eye-hand coordination drills over an 8-week intervention period, with sessions conducted once a week. A validated volleyball setting accuracy test was used to measure performance before and after the intervention. Descriptive statistics revealed that both groups initially demonstrated very low to low setting accuracy but improved to moderate levels for the arm strengthening group and high levels for the eye-hand coordination group after the interventions. Paired samples t-test results indicated statistically significant differences between pretest and posttest scores in both groups, indicating that both interventions produced meaningful improvements in setting accuracy. Furthermore, analysis of covariance revealed a significant difference in posttest scores between the two groups, indicating that the type of intervention influenced performance outcomes. The eye-hand coordination drills group obtained significantly higher posttest scores, demonstrating greater effectiveness than the arm strengthening group, suggesting that eye-hand coordination drills yield superior gains in setting accuracy. These results underscore the value of integrating eye-hand coordination drills into school-based Physical Education programs and offer evidence-based guidance for designing effective volleyball training strategies.

KEYWORDS volleyball setting accuracy, eye-hand coordination, arm strengthening exercises, quasi-experimental design, motor skill development

INTRODUCTION

Volleyball, a fast-paced team sport, requires accurate control, coordination, and effective performance of several skills. Among volleyball skills, setting, which involves accurately delivering the ball to an attacker, is key to running an offensive play (Faihan, 2025). However, many young players have difficulty finding consistency with setting (Hrynchenko *et al.*, 2025). This problem may be related to limitations in physical capacity and perceptual coordination that prevent them from playing at the high pace the game demands.

Internationally, nations with successful volleyball programs have adopted scientific training innovations to enhance skill-specific performance. For instance, countries like Japan and Italy place importance on training young athletes by involving them in rigorous coordination and strength programs as part of their development (Altuncu & Bayram, 2024). Arm care and conditioning programs, such as the Thrower's Ten, have gained popularity in the United States to minimize the risk of injury and improve biomechanical control (Mullaney *et al.*, 2021). These methodologies highlight the role of both cognitively and physically organized training in sport performance. However, most training protocols focus on single abilities rather than whole-body approaches that encompass both physical and cognitive performance.

In the local context, evidence suggests a gap in integrated programs combining perceptual and motor skill training. For instance, Khanna and Koley (2020) identified substantial differences in handgrip strength and its relationship to skill execution in university-level volleyball. Similarly, Kurdi *et al.* (2021) reported a need for more varied and effective training modalities to improve overhead pass accuracy. Taken together, these findings point to the potential of evidence-based, integrative training approaches that address both physical conditioning and perceptual-motor coordination – going beyond conventional repetitive drills to produce more meaningful skill gains.

Despite the growing body of research on skill acquisition in volleyball, few studies examine the simultaneous effects of physical and perceptual training on setting accuracy. Most of the literature explores these domains separately, resulting in a fragmented understanding of how best to enhance setting performance (Beigul *et al.*, 2022). There is also a lack of experimental studies focusing on junior-level players in developing regions, including the Philippines.

In line with this, the study explores two key variables: arm-strengthening exercises and eye-hand coordination drills, which are believed to significantly improve setting accuracy in volleyball. Previous studies underscore the crucial role of arm-strengthening exercises in enhancing setting accuracy by improving muscle strength, coordination, and control in the upper limbs—specifically the triceps, deltoids, and forearms—which are essential for force-controlled sets. Targeted routines have demonstrated effectiveness in developing neuromuscular adaptations and improving performance in precision sports, including volleyball (Fikri *et al.*, 2022; Mullaney *et al.*, 2021). These exercises not only optimize muscular activation and motor control but also contribute to injury prevention and joint stability, thereby supporting both performance and athlete safety.

Meanwhile, eye-hand coordination drills have been shown to significantly improve reaction time, visual tracking, and motor accuracy—key components in executing precise sets under pressure. Exercises such as wall setting, reactive partner drills, and ball-bounce variations create unpredictable visual-motor scenarios that train athletes to adjust quickly and accurately (Formenti *et al.*, 2019; Munir *et al.*, 2024). These interventions engage the neural pathways responsible for visual-motor integration and are increasingly used not only in high-performance sports but also in therapeutic settings. Their effectiveness in enhancing perceptual speed and decision-making makes them especially relevant to volleyball, where the setter must constantly synchronize hand movements with rapidly changing ball trajectories.

This study posits that arm strengthening and eye-hand coordination exercises can improve volleyball setting accuracy. Arm training enhances endurance, stability, and power, all of which are crucial for executing

accurate and controlled sets (Mardiah *et al.*, 2023). Coordination drills improve timing, spatial awareness, and motor control, enabling athletes to perform setting movements more precisely (Ngadiyana, 2020). These methods enhance biomechanical efficiency and neuromuscular accuracy, directly supporting setting performance. Setting accuracy, the study's outcome variable, is defined as the setter's ability to send the ball accurately to a target spot for attack. This skill involves perceptual sensitivity, anticipation, and biomechanical control (Formenti *et al.*, 2020; Gonzalez-Silva *et al.*, 2020). Improving setting accuracy directly enhances a team's offensive efficiency and scoring opportunities.

This study is anchored on DeLorme's (1945) Overload Principle and Kelso's (1995) Coordination Dynamics Theory. The Overload Principle holds that muscular adaptation occurs when the body is subjected to progressively increasing resistance demands, thereby building the strength, endurance, and neuromuscular control necessary for precise setting execution. Arm exercises such as wrist curls, planks, and push-ups directly apply this principle by systematically challenging the upper limb muscles involved in force-controlled ball contact.

Kelso's Coordination Dynamics Theory explains how stable, coordinated movement patterns emerge and adapt through repeated interaction between the individual and the task environment. It posits that small changes in environmental stimuli can trigger significant reorganization of motor behavior, making it particularly relevant for training setters to maintain accuracy under fast-paced, variable game conditions. Eye-hand coordination drills – such as wall sets, reaction ball exercises, and partner target drills – operationalize this theory by exposing athletes to dynamic, unpredictable visual-motor scenarios that develop timing, spatial awareness, and adaptive control.

This study examined the effectiveness of arm strengthening exercises and eye-hand coordination drills in improving volleyball setting accuracy among Grade 8 students, with the following specific objectives: (1) to determine the level of volleyball setting accuracy of each intervention group before and after the interventions; (2) to test whether a significant difference exists in setting accuracy within each group between the pretest and posttest; and (3) to compare the effectiveness of the two interventions in improving volleyball setting accuracy.

This study is timely and relevant, given the researcher's experience with online Physical Education (PE), where hands-on skill development was limited. With the return to in-person learning, there is a need for structured, sport-specific interventions such as arm-strengthening and hand-eye coordination drills. These methods are low-cost, adaptable to resource-limited school settings, and suitable for varying skill levels, making them practical tools for improving volleyball setting accuracy in post-pandemic PE programs.

It also reflects SDG Goal 3 – Good Health and Well-Being, which seeks to ensure healthy lives and promote well-being for all at all ages, as well as SDG Goal 4 – Quality Education, which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (United Nations, 2015). The promotion of physical literacy and organized physical activity plays a role in advancing the growing literature linking physical fitness, mental health, and social health among adolescents, including athletic self-perceptions. It also promotes lifelong healthy practices and creates accessible opportunities for skill-building, particularly for those underserved by the education system.

Moreover, this study aligns with key DepEd policies, particularly DepEd Order No. 21, s. 2019, which emphasizes inclusive and relevant K to 12 curriculum enhancement; DepEd Order No. 34, s. 2022, which outlines the school calendar and promotes the recovery of learning losses through focused interventions; and DepEd Order No. 13, s. 2022, which highlights the need for learning delivery strategies that support physical education and health. This study contributes to the development of performance-based outcomes and supports learners' holistic well-being through quality PE instruction.

Despite the growing recognition of both physical conditioning and perceptual-motor training in sport skill development, evidence comparing their relative effectiveness on volleyball setting accuracy among

junior-level learners in under-resourced school settings remains limited. This study addresses that gap by examining the differential effects of arm strengthening exercises and eye-hand coordination drills on the setting accuracy of Grade 8 students in a public secondary school in Valencia City, Bukidnon.

METHODS AND MATERIALS

This study utilized a quasi-experimental research design, a methodology that assesses the effectiveness of a treatment or intervention without full randomization, unlike true experimental designs, by controlling variation in an independent variable and measuring its effects on a dependent variable (Ouanhlee, 2023; Purba *et al.*, 2023). In this study, a non-equivalent pretest-posttest group design, a type of quasi-experimental research design with two experimental groups, was used to compare the effects of two distinct interventions, namely, arm strengthening exercises and eye-hand coordination drills, on the setting accuracy of Grade 8 students. Each group was assigned an intervention protocol without full randomization due to practical constraints such as pre-existing class sections. Pretest and posttest measurements using a volleyball setting accuracy test evaluated changes in setting accuracy within each group and compared the effectiveness of the interventions across groups.

The study involved Grade 8 students from a public school in Valencia City, Bukidnon, enrolled during the 2025–2026 school year. The total population was 242 students across five class sections. Due to the natural grouping, intact group sampling was used. A two-stage sampling process was implemented: first, four of five classes were randomly selected; the fifth served as a pilot group. Second, these sections were assigned to two experimental groups via coin toss: Group 1 with Arm Strengthening Exercises, and Group 2 with Eye-Hand Coordination Drills. All eligible students in these sections participated, considering safety and consent. Participants were evaluated with a pretest, underwent 8-week interventions, and then completed a posttest to measure performance changes.

The test assessed high school students' volleyball setting skills, focusing on accuracy to specific target zones, control, and consistency. Students completed 10 sets—five attempts each from Position 1 (right front) and Position 2 (left front)—both located approximately 3 meters from the net. The target zones were positioned in the front-row attack area on the opposite side of the court and consisted of three concentric rectangular zones: the innermost zone measured approximately 1 meter × 1 meter, the second zone 2 meters × 2 meters, and the outer zone 3 meters × 3 meters, all centered near the ideal setting area close to the net. Students were scored from 0 to 5 based on proximity to the target zones, with a total of 50 points that categorized accuracy levels from “very low” to “very high.” Good sets were required to cross the net at regulation height before landing in the target area. Scores ranged from five for precise landing to zero for unsuccessful attempts. A court diagram was used to illustrate the exact placement of the setting positions and target zones for consistent test administration. The instrument was validated by experts and demonstrated acceptable reliability with a split-half coefficient of 0.841, indicating that it effectively measures volleyball setting accuracy.

This study employed the following evaluation and their corresponding scores:

Score Range	Interpretation
40.1 - 50	Very High Accuracy
30.1 - 40	High Accuracy
20.1 - 30	Moderate Accuracy
10.1 - 20	Low Accuracy
0.0 - 10	Very Low Accuracy

The inclusion of minors in this study is justified due to its minimal risk and clear educational benefits. The activities, including arm strengthening and eye-hand coordination drills, are standard in Physical

Education and comparable to regular class activities. The intervention was designed with safety, gradual progression, and age-appropriate intensity under the supervision of the researcher and PE teachers. Participation was expected to improve students' motor coordination, physical fitness, and volleyball performance, aligning with K-12 PE outcomes and promoting lifelong physical activity and well-being.

Prior to data collection, ethical clearance was secured from the Lourdes College Research Ethics Committee, followed by approval from the Schools Division Superintendent and the school principal. Informed consent and assent were obtained after an orientation explaining the study's purpose and procedures. Pretests were conducted before the intervention, and posttests were administered after completion.

Moreover, the study adhered to the Belmont Report principles—respect for persons, beneficence, and justice. Participants' rights were protected through voluntary participation, the option to withdraw, and confidentiality of data. All data were anonymized, securely stored, and retained for two years before proper disposal. Participant safety was ensured through proper warm-up, supervision, and monitoring. Fairness was maintained through clear selection criteria and equal treatment of all participants. The study lasted approximately 10 weeks, including an 8-week intervention conducted once a week. The schedule was designed to minimize disruption while ensuring sufficient exposure for measurable improvement.

The intervention lasted eight weeks, with one 60-minute session per week. Each session included a 5-minute warm-up (light jogging, arm circles, shoulder rotations, and dynamic stretching), 50 minutes of intervention activities, and a 5-minute cool-down (static stretching). Sessions were supervised to ensure proper execution and participant safety.

Group 1 performed arm-strengthening exercises, namely wrist curls, planks, and push-ups, with a progressive increase in intensity and volume. In Weeks 1–2, participants completed 3 sets of 12 repetitions (wrist curls), 3 sets of 20 seconds (planks), and 3 sets of 10 repetitions (push-ups). In Weeks 3–4, this progressed to 3 sets of 15 repetitions, 30 seconds, and 12 repetitions, respectively. In Weeks 5–8, participants performed 3 sets of 20 repetitions (wrist curls), 40 seconds (planks), and 15 repetitions (push-ups) at moderate-to-vigorous intensity.

Group 2 performed eye–hand coordination drills consisting of wall setting, reaction ball bounce, and partner hand–target drills. In Weeks 1–2, participants completed 3 sets of 12 repetitions (wall setting), 1 minute (reaction ball), and 10 attempts (partner drill). In Weeks 3–4, this increased to 3 sets of 15 repetitions, 2 minutes, and 12 attempts. In Weeks 5–8, participants performed 3 sets of 20 repetitions, 3 minutes, and 15 attempts, reflecting a progression to moderate-to-vigorous intensity.

In this study, the data were analyzed using appropriate statistical techniques. First, the pretest and posttest scores were summarized using descriptive statistics, including mean, standard deviation, frequency, and percentage. Next, a paired-samples t-test was used to assess differences between pretest and posttest scores within groups, assuming the statistical assumptions were satisfied for appropriate parametric analyses. Lastly, an analysis of covariance (ANCOVA) was performed to compare the posttest scores between the two groups while controlling for any differences in their pretest scores. The level of significance for all inferential statistical tests was set at 0.05.

RESULTS

Table 1 shows participants' volleyball setting accuracy in two groups—Eye–Hand Coordination Drills and Arm Strengthening Exercises—before and after interventions, detailing participant distribution by accuracy, including frequency, percentage, mean scores, standard deviations, and interpretations.

Table 1. Level of Participants' Volleyball Setting Accuracy Before and After the Eye-Hand Coordination Drills and Arm Strengthening Exercises

Range	Interpretation	Eye-Hand Coordination Drills				Arm Strengthening Exercises			
		Pretest		Posttest		Pretest		Posttest	
		f	%	f	%	f	%	f	%
40.1 - 50	Very High Accuracy	0	0	3	5	0	0	1	2
30.1 - 40	High Accuracy	0	0	21	35	0	0	8	12
20.1 - 30	Moderate Accuracy	4	7	27	45	6	9	32	49
10.1 - 20	Low Accuracy	12	20	9	15	11	17	24	37
0.0 - 10	Very Low Accuracy	44	73	0	0	48	74	0	0
TOTAL		60	100	60	100	65	100	65	100
Mean		5.7		28.4		6.2		23.7	
Interpretation		Very Low Accuracy		High Accuracy		Very Low Accuracy		Moderate Accuracy	
SD		8.4		7.2		9.0		6.3	

As shown in Table 1, the Eye-Hand Coordination Drills group's volleyball setting accuracy improved significantly from pretest to posttest, increasing from 5.7 (Very Low Accuracy) to 28.4 (High Accuracy). Similarly, the Arm Strengthening Exercises group also showed improvement, with scores rising from 6.2 (Very Low Accuracy) to 23.7 (Moderate Accuracy).

The Eye-Hand Coordination Drills group shifted from predominantly Very Low (73%) and Low (20%) Accuracy during the pretest to higher performance levels after the intervention, with most participants achieving Moderate (45%) and High (35%) Accuracy, and some reaching Very High (5%) Accuracy, while no participants remained in the Very Low category. Similarly, the Arm Strengthening Exercises group showed improvement from mostly Very Low (74%) and Low (17%) Accuracy during the pretest to predominantly Moderate (49%) and Low (37%) Accuracy in the posttest, with fewer participants reaching High (12%) and Very High (2%) Accuracy levels. Overall, both groups demonstrated improvement; however, the Eye-Hand Coordination group exhibited a greater shift toward higher accuracy levels, as reflected in their score distributions.

The next research question examined whether there were significant differences in volleyball setting accuracy within each group before and after the interventions. The first hypothesis stated that each group's volleyball setting accuracy does not differ significantly between the pretest and posttest. Prior to conducting the paired samples t-test, the assumptions were examined to ensure the validity of the analysis. The Shapiro-Wilk test of normality indicated that the data were normally distributed for both groups, and the Q-Q plots showed that the residuals closely followed the diagonal line, supporting the assumption of normality. With these assumptions satisfied, Table 2 presents the paired samples t-test results comparing the pretest and posttest volleyball setting accuracy scores of the two groups.

Table 2. Paired Samples t-test for Pre-Test and Post-Test Scores in Eye-Hand Coordination Drills and Arm Strengthening Exercises

Group	Test	M	Interpretation	SD	t	p	Cohen's d
Eye-Hand Coordination Drills (n = 60)	Pre-test	5.733	Very Low Accuracy	8.393	-18.47**	<0.001	- 2.384
	Post-test	28.42	High Accuracy	7.207			
Arm Strengthening Exercises (n = 65)	Pre-test	6.328	Very Low Accuracy	9.019	-15.37**	<0.001	- 1.921
	Post-test	23.69	Moderate Accuracy	6.272			

**Significant at 0.01 two-tailed alpha level. M = mean, SD = standard deviation, t = t statistic, p = probability value, Cohen's d = effect size; df = 59 (Eye-Hand), 64 (Arm)

As shown in Table 2, the Eye–Hand Coordination Drills group obtained a mean score of 5.73 (Very Low Accuracy) in the pretest and 28.42 (High Accuracy) in the posttest. The computed t-value of -18.47 with a p-value of <0.001 indicates that the difference between the pretest and posttest scores is statistically significant at the 0.05 level. The effect size (Cohen's $d = -2.384$) indicates a very large effect, suggesting that the intervention had a substantial impact on participants' performance.

Similarly, the Arm Strengthening Exercises group obtained a pre-test mean of 6.328 (Very Low Accuracy) and a post-test mean of 23.69 (Moderate Accuracy). The computed t-value of -15.37, with a p-value < 0.001, indicates a statistically significant difference between pre-test and post-test scores. The effect size (Cohen's $d = -1.921$) likewise indicates a very large effect, suggesting that the intervention produced a strong impact on setting accuracy.

Given that the p-values for both groups are less than the 0.05 level of significance, the null hypothesis (H_{01}) stating that each group's volleyball setting accuracy did not differ significantly between the pretest and posttest was rejected. This indicates that there is sufficient statistical evidence to conclude that significant differences exist between pre-test and post-test scores within each group, with higher mean scores observed in the post-test. Therefore, the interventions were effective in improving volleyball setting accuracy.

Finally, the next research question examined which intervention is more effective in improving volleyball setting accuracy. The second hypothesis stated that none of the interventions was more effective than the other in enhancing volleyball setting accuracy. Prior to conducting the Analysis of Covariance (ANCOVA), its assumptions were tested to ensure the validity of the results. Levene's test indicated a violation of the homogeneity of variance assumption, $F(1,123) = 7.191$, $p = 0.008$. However, this violation was considered acceptable for several reasons. First, the variance ratio between groups was within the commonly cited threshold of 4:1, above which results are considered substantially distorted (Tabachnick & Fidell, 2013). Second, the group sizes were approximately equal ($n = 60$ and $n = 65$), a condition under which ANCOVA has been shown to remain robust to moderate heterogeneity of variance (Field, 2018). Third, inspection of the Q–Q plot confirmed that the standardized residuals were approximately normally distributed, as the points closely followed the diagonal line. Taken together, these conditions support the validity of proceeding with ANCOVA despite Levene's test result. Table 3 presents the ANCOVA results comparing the posttest scores of the two intervention groups while controlling for differences in their pretest scores.

Table 3. ANCOVA Summary Table for Posttest Scores with Pretest Scores as Covariate

Group	n	Adjusted Mean	SE	95% CI	F(1, 122)	p	η^2p
Eye-Hand Coordination Drills	60	28.48	0.833	[26.83, 30.13]	17.57**	<0.001	0.126
Arm Strengthening Exercises	65	23.64	0.800	[22.05, 25.22]			

As shown in Table 3, the ANCOVA results revealed a statistically significant difference between the posttest scores of the two intervention groups after controlling for pretest scores, with $F(1,122) = 17.57$ and $p < 0.001$, which is lower than the 0.05 level of significance. This indicates that the type of intervention had a significant effect on volleyball setting accuracy. After controlling for pretest scores, the Eye–Hand Coordination Drills group obtained a higher adjusted posttest mean ($M_{adj} = 28.48$, $SE = 0.83$, 95% CI [26.83, 30.13]) than the Arm Strengthening Exercises group ($M_{adj} = 23.64$, $SE = 0.80$, 95% CI [22.05, 25.22]). The partial eta squared ($\eta^2p = 0.126$) indicates a moderate-to-large effect size, meaning that approximately 12.6% of the variance in posttest scores is attributable to the intervention. The pretest covariate was also a significant predictor of posttest scores, $F(1, 122) = 12.26$, $p < .001$, $\eta^2p = 0.091$.

Given that the p-value is less than the 0.05 level of significance, the null hypothesis (H_{02}) stating that none of the interventions was more effective than the other in improving volleyball setting accuracy was rejected. This indicates that there is sufficient statistical evidence to conclude that one intervention is significantly more effective than the other in improving volleyball setting accuracy, even after controlling for initial differences in pretest performance.

DISCUSSION

Both intervention groups initially demonstrated very low to low volleyball setting accuracy, reflecting limited skill levels consistent with the literature on beginner performance. After the intervention, performance improved, with the Arm Strengthening Exercises group reaching moderate accuracy and the Eye-Hand Coordination Drills group achieving high accuracy. The low pretest scores may be attributed to the participants being Grade 8 students with limited prior exposure to sport-specific volleyball training, particularly in executing accurate overhead sets under testing conditions. Volleyball setting accuracy requires refined visual tracking, timing, proper hand positioning, force regulation, and coordinated body movement, which may not yet be fully developed among learners at the basic skill level. The lack of formal volleyball training in school settings may have further contributed to weak baseline performance. Conversely, the improvement in posttest scores can be attributed to the structured, progressive, and supervised nature of the intervention. Through repeated practice, participants were able to develop better perceptual, coordinative, and physical skills. This led to enhanced motor control, improved body positioning, better timing, and greater consistency in directing the ball toward target areas, all of which are essential components of accurate volleyball setting.

Studies show that volleyball skill development was adversely affected during periods of reduced activity, when athletes experienced decreased training frequency and limited sports participation (Pagaduan *et al.*, 2022; Cruz *et al.*, 2022), explaining the very low to low accuracy pretest scores. This lack of consistent practice contributes to poor motor coordination, weak visual tracking, and inadequate control of force and direction during ball contact.

Furthermore, evidence suggests that beginners typically exhibit low competence in overhead passing, a skill closely related to setting, prior to structured intervention (Krivyca *et al.*, 2023). Since volleyball setting accuracy depends on precise hand positioning, coordinated body mechanics, and visuomotor integration (Aini *et al.*, 2021; Petrovici, 2021), the low pretest performance observed in both groups reflects the expected condition of learners who have not yet developed these foundational abilities. Additionally, the literature highlights that coordination, particularly eye-hand coordination, is a critical determinant of accurate ball control, yet remains underdeveloped in novice players (Kholid *et al.*, 2021; Syahrudin *et al.*, 2022), further explaining the low baseline scores obtained prior to the intervention.

Meanwhile, the posttest accuracy levels, which reached moderate accuracy for the Arm Strengthening Exercises group and high accuracy for the Eye-Hand Coordination Drills group, are consistent with the literature. Research emphasizes that setting accuracy improves when athletes develop better visuomotor integration, enabling them to synchronize visual input with precise motor execution (Formenti *et al.*, 2019; Trecroci *et al.*, 2021). Moreover, biomechanical studies indicate that effective setting relies on improved postural alignment, coordinated force transfer across the kinetic chain, and refined arm mechanics, all of which contribute to more consistent and accurate ball placement (Gonzalez-Silva *et al.*, 2020; Dutton *et al.*, 2024).

The literature also notes that physical capacities such as upper-limb strength and core stability support consistent movement patterns and controlled force application during setting (Phát, 2021; Çakır & Ergin, 2022). In addition, coordination-based training enhances reaction time and motor accuracy, allowing athletes to better adjust to ball trajectory and execute precise overhead contacts (Formenti *et al.*, 2019; Sheikh *et al.*, 2020). These findings help explain the observed posttest performance, where the Arm Strengthening Exercises group achieved moderate accuracy, and the Eye-Hand Coordination Drills group reached high accuracy. This improvement reflects more stable coordination patterns, enhanced control of movement execution, and greater precision in directing the ball toward intended targets, which are key characteristics of developed volleyball skill.

Furthermore, the comparison of pretest and posttest results revealed that both groups demonstrated statistically significant differences in their volleyball setting accuracy scores between the two tests, leading

to the rejection of the null hypothesis. This indicates that the interventions produced meaningful improvements in participants' performance, reflecting the effectiveness of both approaches in enhancing their ability to execute accurate volleyball sets.

The significant differences between pretest and posttest scores can be attributed to several practical features of the intervention design. The 8-week duration, combined with progressive intensity and once-weekly sessions, provided sufficient time for participants to develop new motor skills without being overwhelmed. The interventions were aligned with the actual demands of the volleyball setting, ensuring task-relevant practice throughout. Guided supervision reinforced correct technique and minimized errors, while the participants' low baseline performance meant they had considerable room to develop fundamental skills in control, timing, and body positioning.

Beyond these implementation factors, the improvements are also explained by the specific mechanisms each intervention engaged. Structured and repeated practice enhanced overhead passing and setting-related skills by strengthening the perceptual-motor pathways responsible for timing, force regulation, and directional control (Aini *et al.*, 2021). At the biomechanical level, the interventions reinforced proper hand positioning, postural alignment, and coordinated force transmission through the kinetic chain, supporting greater consistency in setting performance. The structured progression also developed kinesthetic differentiation – the capacity to regulate movement precision during brief ball-contact phases (Đolo *et al.*, 2023) – while physical conditioning components such as upper-limb strength and core stability further reinforced the movement consistency described earlier.

The results align with both theoretical frameworks underpinning this study. Consistent with the Overload Principle (DeLorme, 1945), the progressive structure of the arm strengthening exercises produced measurable gains in muscular strength and neuromuscular control, enabling participants to generate more consistent and controlled force during ball contact. Similarly, the performance gains observed in the eye-hand coordination group reflect the core premise of Coordination Dynamics Theory (Kelso, 1995): through repeated exposure to dynamic, variable practice conditions, participants' motor systems self-organized toward more stable and adaptive movement patterns, resulting in improved timing, spatial accuracy, and setting control.

Regarding the third research question, the findings revealed that the Eye-Hand Coordination Drills were more effective than the Arm Strengthening Exercises in improving volleyball setting accuracy. This suggests that interventions that directly target perceptual-motor coordination produce greater improvements in setting performance compared to those that focus primarily on physical conditioning alone.

Eye-hand coordination drills were found to be more effective than arm strengthening exercises in improving volleyball setting accuracy because they directly simulate the perceptual and motor demands of real game situations. Since volleyball setting is a visuomotor skill requiring the integration of visual tracking, timing, and precise motor execution (Aini *et al.*, 2021; Petrovici, 2021), activities such as wall setting, reaction ball bounce, and partner target drills are inherently aligned with the skill's actual demands – requiring participants to track the ball, adjust hand positioning, and control the direction and timing of each set, with immediate feedback allowing rapid error correction and technique refinement (Sepriwandi & Alimuddin, 2022). This alignment supports the Coordination Dynamics Theory (Kelso, 1995), which posits that coordinated movement patterns improve through repeated interaction with task-specific environmental demands, enabling the motor system to self-organize toward more efficient and adaptive patterns. In contrast, while arm strengthening exercises build the muscular support and control described by the Overload Principle (DeLorme, 1945), the literature suggests that physical conditioning alone does not directly translate to improved accuracy without task-specific application (Çakır & Ergin, 2022; Lee *et al.*, 2024).

CONCLUSION

The study successfully achieved its purpose of determining the effectiveness of arm strengthening exercises and eye-hand coordination drills in improving volleyball setting accuracy among Grade 8 students. The findings demonstrated that both interventions significantly enhanced participants' performance, providing empirical evidence that structured, school-based training programs can improve skill-specific outcomes in volleyball. Moreover, the study contributes to existing knowledge by establishing that while both physical and coordination-based training are beneficial, eye-hand coordination drills yield greater improvements in setting accuracy, particularly among learners with initially low skill levels.

The findings also validate both theoretical frameworks. The progressive gains in the arm strengthening group support the Overload Principle, while the superior accuracy achieved by the eye-hand coordination group corroborates Coordination Dynamics Theory – confirming that both physiological adaptation and perceptual-motor coordination are essential mechanisms in sport skill development.

The implications of this study highlight the importance of integrating task-specific, coordination-focused training in Physical Education and volleyball instruction. For educators and coaches, the findings suggest placing greater emphasis on drills that replicate actual game conditions to maximize skill acquisition. Additionally, the study underscores the value of combining physical conditioning with perceptual-motor training in developing comprehensive training programs. In the broader context, this research supports the implementation of accessible, low-cost, and evidence-based interventions in school settings to enhance students' motor skills, physical fitness, and overall sports performance.

Based on the findings, the following recommendations are proposed: Student-athletes are encouraged to incorporate eye-hand coordination drills, such as wall setting and partner target drills, into their regular practice routines, as these activities enhance setting accuracy, timing, and ball control. Teachers and coaches are advised to integrate coordination-based and sport-specific drills into their instructional programs, with greater emphasis on eye-hand coordination activities due to their effectiveness and alignment with actual game demands. School leaders are encouraged to support the implementation of structured, evidence-based Physical Education training programs that include both coordination and strength components, given their practicality, low cost, and adaptability. Future researchers may consider longer intervention periods, include additional variables, and examine other volleyball skills, such as serving or spiking, to further expand understanding of training effects and address the limitations of the present study.

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AI Declaration: This study utilized artificial intelligence tools to assist in preparing this article. Specifically, ChatGPT was used to convert the full thesis manuscript into a reduced journal article format, with human supervision and editing, to ensure academic rigor and integrity. Additionally, ChatGPT and Grammarly AI were used to enhance the language quality, clarity, and tone of the final manuscript. The author carefully reviewed and edited all outputs to maintain scholarly standards.

Data Availability Statement: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Requests for access will be evaluated in accordance with ethical guidelines and data privacy policies.