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Effects of Resistance Band Training on Arm Muscle Strength and Lob Stroke Performance in Badminton Athletes

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Abstrac: This study examined the effect of resistance band training on arm muscle strength and lob stroke performance among PB Apor Payakumbuh badminton athletes. The study used a quasi-experimental one-group pretest-posttest design. The population consisted of 15 athletes, while eight male athletes aged 12-15 years were selected through purposive sampling. Arm muscle strength was measured with a push-up test, and lob performance was measured with a lob accuracy test. The treatment was carried out in 16 resistance band training sessions. Data were analyzed using normality tests and paired-sample t-tests. The results showed significant improvement in push-up performance ($p = 0.006$) and lob stroke performance ($p = 0.000$). It can be concluded that resistance band training significantly improves arm muscle strength and lob stroke performance in young badminton athletes.

Keyword: Arm Muscle Strength, Badminton, Lob Stroke, Resistance Band, Training

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INTRODUCTION

Sport has a strategic role in the development of human resources because it supports health, education, character formation, and achievement. In the Indonesian sport system, athlete development is expected to be carried out in a systematic, gradual, and continuous manner so that athletes can reach their best possible performance (Malm et al., 2019). Badminton is one of the sports that has a strong place in Indonesian society. It is practiced by children, adolescents, and adults, both as a recreational activity and as a competitive sport. This popularity also encourages the growth of badminton clubs that function as places for talent identification, coaching, and preparation for competition (Yustyana et al., 2024).

Badminton performance is influenced by the interaction between technical mastery and physical ability. The basic skills of badminton include grip, ready position, footwork, and stroke skills. Among these technical elements, the lob stroke is important because it sends the shuttlecock high and deep toward the opponent's back court (Pujangga et al., 2022). A good lob stroke can be used as a defensive strategy to gain time, restore body position, and reduce pressure from the opponent. At the same time, a deep and accurate lob can also become an offensive strategy because it pushes the opponent away from the center of the court and opens space for the next attack (Putra et al., 2025). The lob stroke is not only a matter of striking the shuttlecock upward. The movement requires proper body position, accurate racket contact, arm swing coordination, and appropriate wrist action. If the athlete has poor body balance or insufficient arm control, the shuttlecock may fall short, go out of court, or fail to reach the intended target. Therefore, the quality of a lob stroke is strongly related to the athlete's ability to coordinate technical movement with physical support (Putra et al., 2025).

Arm muscle strength is one of the physical components that supports the effectiveness of the lob stroke. Adequate arm strength helps athletes produce racket swing force, direct the shuttlecock farther, and maintain stroke control during repeated rallies. In badminton, the shoulder, upper arm, forearm, and wrist work together to accelerate the racket head (Fauzi & Imanudin, 2025). When these muscles are weak, athletes tend to compensate by using excessive body movement or stiff arm action. This compensation can reduce accuracy and increase the possibility of technical errors (Hardiansyah, 2018).

Preliminary observation at PB Apor Payakumbuh showed that several athletes still experienced difficulty when performing the lob stroke. The observed problems included inaccurate racket contact, a rigid arm position, unstable body posture at the moment of hitting, and shuttlecock direction that was not well controlled. Some lob strokes did not reach the back court, while others moved too far and left the court area. These technical problems were supported by the coach's push-up test results, in which the average score was only 13 repetitions in 60 seconds and was categorized as low according to the applied push-up norm. This field condition indicates that the problem faced by the athletes is not only a matter of technical explanation, but also a matter of physical preparation. Young badminton athletes need exercises that can strengthen the upper limb while remaining safe and suitable for their age (Hasyim et al., 2024). Strengthening exercises should not be separated from skill development because the purpose of conditioning in sport is to support game performance. In this context, a training method that is practical, progressive, and easy to apply in a club environment is needed (Novriansyah et al., 2019).

Resistance band training is one form of resistance exercise that uses elastic tension as an external load. The tool is simple, portable, and can be adjusted according to the athlete's ability by changing band color, band length, grip distance, and range of motion. Resistance bands allow athletes to train pushing, pulling, and stabilizing movements without requiring expensive machines or heavy free weights. This characteristic makes resistance band training suitable for club-based coaching, especially in training environments with limited equipment (Nasrulloh & Wicaksono, 2020).

From a training perspective, resistance band exercises can stimulate muscle contraction against external resistance and may improve strength, endurance, and neuromuscular control. The elastic property of the band also provides variable resistance throughout the movement (Zhou et al., 2025). As the band is stretched farther, the resistance increases, so athletes are

encouraged to control movement until the end of the range. This mechanism is relevant to badminton because stroke execution requires controlled acceleration and deceleration of the upper limb (Lestari & Nasrulloh, 2019).

Previous studies have reported positive effects of resistance band training on upper-limb strength and sport-specific skills. However, the implementation of this method in the context of young badminton athletes at local clubs still needs more applied evidence. A coach needs to know whether resistance band training can produce measurable improvement not only in a general strength test, but also in a badminton-specific skill such as the lob stroke (Lopes et al., 2019). Therefore, this study focused on the effect of resistance band training on arm muscle strength and lob stroke performance among PB Apor Payakumbuh badminton athletes (Darmawan et al., 2025). The importance of the lob stroke becomes clearer when it is connected to rally control. In many youth badminton matches, athletes lose points not because they cannot attack, but because they cannot return the shuttlecock deep enough when under pressure. A shallow lob gives the opponent an easy opportunity to smash or to play a steep drop shot. For this reason, the lob stroke should be trained as both a technical skill and a tactical instrument that helps athletes maintain rally stability.

In addition, adolescent athletes are still in a stage of physical growth and motor learning. Their training program must be designed to develop physical qualities without ignoring movement quality. Exercises that are too heavy or not controlled can increase fatigue and may reduce technical precision. Resistance band training offers a moderate and adjustable load, making it appropriate for athletes who are still developing basic strength and coordination (Tan et al., 2023). Another important aspect is the accessibility of training equipment. PB Apor Payakumbuh, like many local clubs, needs a training approach that can be carried out consistently in a regular practice environment. Resistance bands are relatively affordable, easy to store, and can be used by several athletes in rotation. These practical advantages make the method relevant not only for research, but also for the daily work of coaches who need efficient training tools.

In the coaching process, technical errors in the lob stroke are often corrected through repeated hitting drills. Repetition is necessary, but repetition without adequate physical support may only repeat the same error pattern. If the athlete cannot produce enough force or cannot stabilize the arm during the swing, the technical instruction given by the coach may not be fully translated into performance. Therefore, physical preparation becomes an important foundation for technical correction. The role of the upper limb in badminton is also connected to injury prevention. Young athletes who have weak shoulder and arm muscles may use sudden or uncontrolled movements when trying to send the shuttlecock deep. Over time, this pattern can place unnecessary stress on the shoulder, elbow, or wrist. A gradual strengthening program may help athletes perform strokes with better control and reduce the tendency to force movement at the end of the swing. Resistance band training is relevant to this condition because it can be performed with multiple movement directions. Athletes can train horizontal pulling, diagonal pulling, forward pressing, shoulder stabilization, and controlled arm extension. These patterns are not identical to the lob stroke, but they train the muscles and movement control needed to support the stroke. The elastic tension also requires athletes to control the returning phase of the movement, which is useful for developing movement discipline.

Several previous studies have discussed elastic resistance training as a method for improving upper-limb strength and movement control, while other badminton studies have examined lob technique, stroke accuracy, and tactical use of deep shots. However, most of these studies discuss the physical and technical aspects separately, and only limited applied evidence explains whether a short resistance band program can improve both arm muscle strength and lob stroke performance in young badminton athletes at the club level. Therefore, the novelty of this study lies in examining resistance band training as a practical club-based intervention that connects a physical outcome, namely arm muscle strength, with a badminton-specific technical outcome, namely lob stroke performance (Hermana et al., 2026).

This study is also important because many local clubs need evidence-based training alternatives that are realistic to apply. A training method may be scientifically useful, but it will not be adopted by coaches if it is too expensive, difficult to supervise, or unsuitable for young

athletes. Resistance bands answer this practical issue because the equipment is simple and the exercises can be modified according to the training situation. Conceptually, this study assumes that improved arm muscle strength will support better lob stroke performance. The relationship is not automatic, because a stronger athlete still needs correct technique. However, when strength is developed through a program that also pays attention to movement control, the athlete may become more capable of applying force at the correct time and direction. This is the reason why the treatment was designed to strengthen the upper limb while still being connected to badminton movement demands.

Based on the background above, this study was conducted to answer two research questions. First, does resistance band training significantly affect the arm muscle strength of PB Apor Payakumbuh badminton athletes? Second, does resistance band training significantly affect the lob stroke performance of PB Apor Payakumbuh badminton athletes? The findings are expected to provide practical information for coaches in designing training programs and to support the use of simple training equipment in badminton coaching.

METHOD

Research Design

This research used a quasi-experimental method with a one-group pretest-posttest design. The design was selected because the study aimed to compare the same athletes before and after the training treatment. In this design, all participants received the same treatment, and the effectiveness of the treatment was determined from the difference between pre-test and post-test scores (Arikunto, 2021). The design can be described as O1-X-O2, where O1 represents the pre-test, X represents the resistance band training treatment, and O2 represents the post-test. Although this design does not use a control group, it is appropriate for an applied club setting because the researcher can observe changes in the same participants after a structured training program. To reduce measurement error, the same instruments, procedures, and scoring rules were used in both the pre-test and the post-test (Syaiuddin & Indardi, 2023).

Participants

Participants were selected from PB Apor Payakumbuh badminton athletes. The research was conducted at the PB Apor Payakumbuh badminton court from April to May 2026. The population consisted of 15 athletes, and eight male athletes aged 12-15 years were selected through purposive sampling. Purposive sampling was used because the researcher needed participants who matched the criteria and were able to follow the complete training program (Sugiyono, 2021). The participant criteria were male athletes aged 12-15 years, active members of PB Apor Payakumbuh, not injured or sick during data collection, and willing to follow the training rules. Based on these criteria, eight athletes were included as research participants. The sample size was limited because the study focused on athletes who matched the age and participation requirements of the intervention.

Research Instruments

Arm muscle strength was measured using a 60-second push-up test. A repetition was counted only when the athlete maintained a straight trunk, lowered the body until the elbows reached approximately 90 degrees, and returned to full elbow extension. Incomplete repetitions or repetitions performed with incorrect body alignment were not counted. Thus, each athlete's push-up score was the total number of valid repetitions completed within 60 seconds. The score was then interpreted using the applied push-up norm (Abbad & Kusuma, 2023).

Lob stroke performance was measured using a badminton lob accuracy test standardized for badminton skill assessment (Wiratama & Karyono, 2017). The equipment consisted of a badminton court, net, racket, shuttlecocks, measuring tape, and a score sheet. Three officials assisted the test: one caller, one feeder, and one score recorder. From the marked ready position, each athlete responded to the “ready” and “go” commands, moved into the hitting position, and performed 10 consecutive lob strokes from feeds delivered by the feeder toward the numbered target zones in the opposite back court (Figure 1).

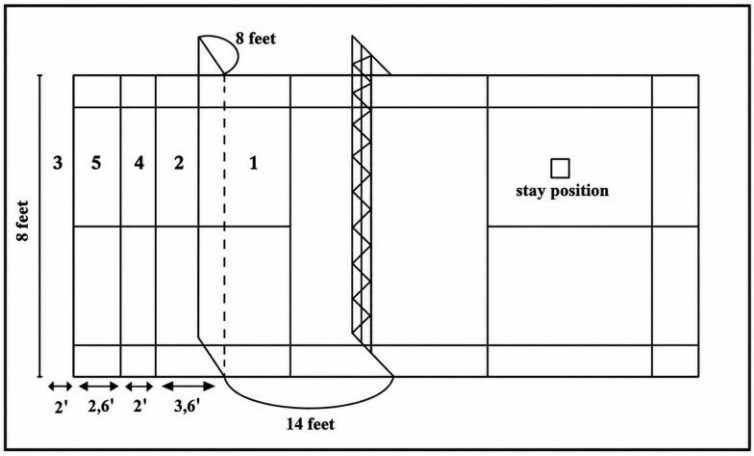

Figure 1. Court Layout of Instrumen

For each attempt, the point value was determined by the numbered zone in which the shuttlecock first landed: 1, 2, 3, 4, or 5 points. A stroke that failed to cross the net or landed outside the designated scoring area received 0 points. Each athlete's final lob score was calculated by adding the scores from all 10 attempts (total lob score = s1 + s2 + ... + s10), where each attempt score ranged from 0 to 5. Accordingly, the possible total score ranged from 0 to 50 points, and a higher total indicated better lob accuracy and depth. The use of two different instruments allowed the researcher to examine the physical and technical outcomes of the same training program. The push-up test represented a general physical component, while the lob accuracy test represented a badminton-specific technical skill. This combination is important because training effectiveness should be reflected not only in physical capacity but also in the ability to perform sport skills.

Treatment Procedure

The treatment consisted of resistance band training conducted in 16 training meetings, excluding the pre-test and post-test sessions. Each training meeting included warm-up, main resistance band exercises, badminton technical practice, and cool-down. The program was arranged progressively by considering exercise principles such as repetition, overload, adaptation, and movement control (Pratama & Hariyanto, 2022). The treatment program was organized around three main goals. The first goal was to improve basic upper-limb strength through controlled pushing and pulling movement. The second goal was to increase movement stability around the shoulder and elbow so that the athletes could maintain racket control during the stroke. The third goal was to connect the strengthening exercise with badminton technique by using movement directions that were relevant to racket swing and lob preparation.

Each session began with general warm-up activities such as jogging, dynamic stretching, and mobility movement. After that, athletes performed resistance band exercises in the main part of the session. The exercise volume was adjusted to the athletes' condition, and the coach provided feedback when the athletes showed excessive shoulder elevation, bent posture, or uncontrolled arm movement. The session ended with cool-down activities to reduce tension and restore the body after exercise. During the treatment, the researcher and coach supervised the athletes to ensure that each movement was performed safely and according to the program. The condition of the resistance band was checked before use to avoid band breakage or unsafe pulling positions. The athletes were also reminded to control the pulling motion, maintain posture, and avoid sudden jerking movements because proper supervision is important in resistance training with elastic tools (Özsu, 2018).

The training load was controlled by using a similar band length and elasticity during the sessions. Progression was applied by adjusting the number of repetitions, sets, and movement control rather than by using excessive resistance. This approach was selected because the objective of the program was to improve strength that supports stroke performance, not to create

maximal fatigue. The athletes were also reminded to maintain correct posture, stable shoulder position, and smooth arm action during each repetition.

Table 1. General Structure of the Resistance Band Training Session

Session Part	Main Activity	Training Emphasis	Purpose
Warm-up	Jogging, dynamic stretching, mobility drills	Body temperature and joint readiness	Prepare athletes for safe movement
Main resistance exercise	Elastic pulling, pushing, and stabilizing movements	Upper-limb strength and control	Improve muscles used in racket swing
Badminton technical practice	Lob stroke practice and movement correction	Transfer of strength to skill	Connect physical training with lob performance
Cool-down	Light stretching and breathing control	Recovery and relaxation	Reduce fatigue after training

The implementation of the treatment was controlled through supervision, attendance, and standardization of movement instructions. Athletes were asked to follow the movement rhythm determined by the coach and to avoid rushing through the exercise. This control was important because resistance band exercises can lose their training value when athletes perform them too quickly or with incorrect posture.

The coach also monitored signs of fatigue. When an athlete showed loss of movement control, the coach provided a short rest or corrected the technique. This procedure helped ensure that the training remained safe and that the athletes continued to perform movements related to the training objective. The structure in Table 1 was used to keep the treatment consistent from one meeting to another. The main emphasis of the program was not to make the athletes tired, but to help them perform controlled strengthening exercises and then apply the improved control to badminton movement. This sequence was important because the study measured not only a strength test, but also lob stroke performance.

Data Collection Procedure

The pre-test was conducted before the treatment began. All athletes received the same explanation about the test procedure and were given enough time to warm up. The push-up test was administered first, followed by the lob accuracy test. The order of testing was kept the same in the post-test to make the measurements more comparable.

During the lob test, the feeder delivered the shuttlecock to the athlete in a consistent manner. The athlete was instructed to perform the lob toward the target area in the back court. The score was recorded immediately after the shuttlecock landed. When the shuttlecock did not cross the net or landed outside the court, the athlete received a score of zero. This rule was used to maintain objectivity in scoring.

The post-test was carried out after all treatment sessions had been completed. The researcher used the same test location, instruments, and scoring procedure as in the pre-test. By keeping the procedure consistent, the difference between pre-test and post-test scores could be interpreted as a change that occurred after the training program.

Data Analysis

Data were analyzed using descriptive statistics, normality testing, and paired-sample t-tests. Descriptive statistics were used to present the mean and standard deviation of the pre-test and post-test scores. The Shapiro-Wilk test was used to examine the normality of the data because the sample size was small. Statistical procedures were carried out to determine whether the difference between pre-test and post-test scores was significant (Siyoto & Sodik, 2015). After the normality assumption was met, a paired-sample t-test was used to examine whether there was a significant difference between the pre-test and post-test scores. The hypothesis was accepted when the significance value was lower than 0.05. The analysis followed the results reported in the thesis using SPSS.

RESULT

The descriptive results showed that the athletes improved in both measured variables after receiving resistance band training. The mean push-up score increased from 11.50 repetitions in the pre-test to 17.25 repetitions in the post-test. The mean lob stroke score increased from 22.25 points in the pre-test to 42.75 points in the post-test. These changes indicate that the training program was followed by improvement in both upper-limb strength and lob stroke performance.

Table 2. Descriptive Statistics of Pre-Test and Post-Test Scores

Variable	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Improvement
Push-up	8	11.50	4.47	17.25	7.94	50.00%
Lob stroke	8	22.25	4.30	42.75	3.28	92.13%

Table 2 shows that the increase in the lob stroke score was larger than the increase in the push-up score when viewed as a percentage. The push-up score improved by 50.00%, while the lob stroke score improved by 92.13%. This pattern suggests that the training program may have influenced technical performance more strongly because the athletes were able to transfer improved arm control and strength into the lob movement.

Table 3. Normality Test Results

Variable	Test	Shapiro-Wilk Sig.	Alpha	Decision
Push-up	Pre-test	0.610	0.05	Normal
Push-up	Post-test	0.722	0.05	Normal
Lob stroke	Pre-test	0.367	0.05	Normal
Lob stroke	Post-test	0.287	0.05	Normal

The Shapiro-Wilk significance values for all pre-test and post-test data were greater than 0.05. Therefore, the data were normally distributed and could be analyzed using paired-sample t-tests. The normality results also support the use of parametric analysis even though the sample size was small.

Table 4. Paired-Sample T-Test Results

Pair	N	Mean Difference	t	df	Sig. (2-tailed)	Decision
Pre-post push-up	8	-5.750	-3.841	7	0.006	Significant
Pre-post lob stroke	8	-20.500	-18.079	7	0.000	Significant

The paired-sample t-test showed that resistance band training had a significant effect on arm muscle strength. The significance value for push-up performance was 0.006, which was lower than 0.05. Therefore, the first hypothesis was accepted. The t-test also showed a significant effect on lob stroke performance. The significance value for lob stroke performance was 0.000, which was lower than 0.05. Therefore, the second hypothesis was accepted.

Individual score records were reviewed for internal analysis but are not displayed in the manuscript to protect participant confidentiality. The anonymous data showed that all eight participants improved in lob stroke performance after the treatment, and all participants also improved in push-up performance with different magnitudes of change. This variation may be related to differences in initial strength, training response, movement technique, and consistency during the treatment sessions.

The results also show that improvement occurred in two different forms. First, there was improvement in physical output, as represented by the push-up score. Second, there was improvement in technical accuracy, as represented by the lob score. The combination of these two outcomes is important because a training program in badminton should ideally improve physical readiness and contribute to the quality of stroke execution. In practical terms, the descriptive data indicate that the training program produced meaningful changes for the athletes. The average push-up improvement of 5.75 repetitions shows better ability to maintain repeated upper-body effort. The average lob improvement of 20.50 points shows better ability to direct

the shuttlecock to the intended back-court area. These improvements are relevant because badminton performance requires repeated stroke execution during rallies rather than a single isolated movement.

The results should also be interpreted in relation to the initial condition of the athletes. The pre-test push-up mean of 11.50 was still below the category expected for good upper-body strength in the applied norm. After treatment, the mean increased to 17.25, which shows movement toward a better category even though the athletes still need continued training. For lob performance, the improvement was more visible because the post-test scores of most athletes were close to or above 40 points.

The normality results support the use of the paired-sample t-test. Since all Shapiro-Wilk significance values were greater than 0.05, the distribution of scores did not violate the normality assumption. This is important because the paired-sample t-test compares the mean difference between two related measurements. The significant results in both variables therefore provide statistical support for the observed descriptive improvement.

DISCUSSION

The results of this study show that resistance band training significantly improved arm muscle strength among PB Apor Payakumbuh badminton athletes. The increase in the push-up mean score from 11.50 to 17.25 indicates that the athletes became more capable of producing upper-body force after the training program. This finding is consistent with studies reporting that elastic resistance training can improve upper-limb strength when it is performed regularly with progressive control (Devi et al., 2022).

The improvement in arm muscle strength is consistent with the basic principle of resistance training. When muscles are repeatedly required to contract against an external load, the body gradually adapts by improving muscular strength and movement efficiency. In resistance band training, the load increases as the band is stretched, so athletes must control the movement from the beginning to the end of the range of motion. This variable resistance may support better muscular control in the shoulder, arm, and wrist (Lestari & Nasrulloh, 2019). For young athletes, this type of training has practical value. Resistance bands are lighter and safer than heavy equipment when the exercise is supervised correctly. They are also easy to carry and do not require a large training space. This is important for badminton clubs because not all clubs have complete strength-training facilities. In a community-based club such as PB Apor Payakumbuh, a simple tool that can be used repeatedly and adjusted to athlete ability is useful for daily coaching (Aloui et al., 2025).

The second finding shows that resistance band training significantly improved lob stroke performance. The mean lob score increased from 22.25 to 42.75 points, and all athletes showed higher post-test scores than pre-test scores. This improvement indicates that the training treatment was not only related to general physical ability, but also to a badminton-specific movement outcome. This result is relevant because the lob is a key stroke used to direct the shuttlecock high and deep into the opponent's back court (Karyono & Paluris, 2022).

The lob stroke has a tactical function in badminton. When an athlete is under pressure, a high and deep lob gives time to return to the center position and prepare for the next rally. When used offensively, the lob can push the opponent backward and create an opportunity for the next attacking stroke. Therefore, an improvement in lob performance can provide practical benefit during competition because it helps athletes control space and rhythm (Putra et al., 2025). The link between arm strength and lob performance can be understood through the movement demands of the stroke. During a lob, the athlete must coordinate the shoulder, elbow, forearm, wrist, and racket swing so that the shuttlecock can travel high and deep. Stronger arm muscles can help athletes maintain racket acceleration and contact stability. However, strength must be supported by correct technique because a strong swing without accurate timing may still produce an inaccurate shot (Kamaruddin et al., 2025).

This result also supports the view that technical training and physical training should be integrated in badminton coaching. Teaching athletes to perform a lob stroke is important, but technique alone may not be sufficient when athletes lack the strength to send the shuttlecock to

the back court. Conversely, strength training without technical application may not transfer well to match performance. Therefore, resistance band training should be connected with lob stroke drills so that physical improvement can support movement execution (Shofiana, 2021).

The significant t-test result for push-up performance ($p = 0.006$) indicates that the difference between pre-test and post-test scores was not caused by chance at the 0.05 significance level. The significant t-test result for lob stroke performance ($p = 0.000$) also indicates a strong difference after treatment. Although the sample was small, the direction of improvement was consistent across athletes, especially in lob performance. This consistency strengthens the practical meaning of the findings for the club context. From a coaching perspective, resistance band training can be included in a warm-up extension, conditioning session, or technical preparation session. Coaches may use the band for shoulder external rotation, pulling movement, forward pressing, and diagonal movement patterns that resemble racket action. The training should be adjusted to the athlete's age, strength level, and ability to maintain movement control. Safety checking of the band and anchor point is also necessary before exercise (Nasrulloh & Wicaksono, 2020).

The findings also show the importance of monitoring individual progress. Although all athletes improved, the size of improvement was not identical. Some athletes had low pre-test scores and improved moderately, while others had higher initial scores and improved more strongly. This means that coaches should not assume that all athletes respond in the same way. Training loads, repetitions, and feedback should be adjusted based on each athlete's strength level, technical ability, and fatigue condition. The practical implication of these findings is that coaches can use resistance band training as part of a weekly conditioning program. The exercises may be placed before technical drills when the aim is activation and movement preparation, or after technical drills when the aim is additional strengthening. However, in young athletes, the coach should avoid using resistance that is too heavy before skill practice because excessive fatigue may reduce stroke quality.

Another implication is that coaches need to observe how athletes transfer strength gains into technique. A higher push-up score does not automatically guarantee a better lob if the athlete still has poor timing, wrong grip, or unstable footwork. Therefore, resistance band training should be followed by feedback on racket contact, body position, and shuttlecock direction. The combination of physical exercise and technical correction is likely to produce better results than either component alone.

The study also highlights the importance of simple monitoring in club training. The push-up test and lob accuracy test are relatively easy to administer and can be used by coaches to evaluate athlete progress. By recording scores before and after a training cycle, coaches can make decisions based on evidence rather than impression. This habit is useful for building a more systematic coaching culture in local badminton clubs. From a physiological perspective, the improvement may be associated with better recruitment and coordination of upper-limb muscles. Resistance band exercises require the athlete to control movement against changing tension. This condition can stimulate not only force production but also stability at the shoulder and elbow joints. In badminton, this kind of control is useful because stroke movement must be fast but still directed toward the target (Tan et al., 2023).

From a motor learning perspective, repeated movement with feedback may help athletes become more aware of the direction and rhythm of their arm action. When resistance band exercises are performed slowly and correctly, athletes learn to feel the pathway of the movement. This awareness can support technical practice because the athlete becomes less dependent on random hitting and more capable of controlling the racket swing. The magnitude of the lob improvement is also worth discussing. The lob score improved by more than 90% based on the mean scores. This large improvement may have occurred because the athletes had considerable technical room for development at the beginning of the study. When athletes start with low or moderate skill levels, a structured training program combined with repeated technical practice can produce visible gains in a relatively short period.

The improvement in push-up scores was smaller in percentage than the improvement in lob scores, but it remains important. Strength adaptation usually requires continuous training

over time. The 16-session program was enough to produce significant change, yet it should be considered an early stage of development rather than the final result. Continued resistance band training may be needed to move athletes into a stronger physical category.

The findings may also be explained by increased confidence. Athletes who feel stronger and more stable during arm movement may be more willing to swing through the shuttlecock and aim for the back-court target. Confidence does not replace technique, but it can influence how athletes execute a stroke during testing. When the athlete is not afraid that the shuttlecock will fall short, the movement can become more completes and decisive. The use of resistance bands should be integrated with periodized training. In the preparation phase, the coach may use more general strengthening exercises to build a foundation. In the pre-competition phase, the exercises should become more specific to badminton movement and be combined with tactical drills. During competition periods, resistance band exercises can be used with lower volume to maintain strength and support warm-up routines. The study also suggests that coaches should document training programs in writing. A written program helps maintain consistency across sessions and makes it easier to evaluate what has been done. In this study, the program structure helped the researcher keep the treatment organized. In regular coaching, the same habit can help coaches track athlete progress and make adjustments based on actual training records.

There are several limitations in this study. First, the research used one group without a comparison group, so other factors such as regular badminton practice and learning effects cannot be fully controlled. Second, the sample size was limited to eight male athletes from one club. Third, the study measured only push-up performance and lob stroke accuracy. These limitations are important because quasi-experimental findings should be interpreted carefully when the sample and control conditions are limited (Arikunto, 2016; Sugiyono, 2015).

Future research should use a larger sample and include a control group so that the effect of resistance band training can be compared with other training methods. Future studies may also examine different resistance levels, training durations, and combinations of resistance band exercises with technical drills. In addition, other badminton skills such as smash, serve, drive, dropshot, and netting can be included as outcome variables to provide a broader understanding of training effectiveness.

CONCLUSION

Resistance band training had a significant effect on arm muscle strength and lob stroke performance among PB Apor Payakumbuh badminton athletes. The improvement after the treatment indicates that elastic resistance exercises can support upper-limb strength development and help athletes perform lob strokes with better control and accuracy. Based on these findings, resistance band training can be used as an alternative training method for young badminton athletes when it is applied progressively, supervised properly, and combined with badminton-specific technical practice. Coaches are advised to adjust the load to the athletes' age and ability, monitor movement quality, check band safety before use, and integrate strengthening exercises with lob stroke drills. Future researchers are encouraged to use larger samples, include control groups, and examine the effect of resistance band training on other badminton skills.

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