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Development and feasibility testing of a chest rig resistance band for student-athlete strength training

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ABSTRACT

Background: Strength training is essential for developing physical performance in student-athletes, yet existing resistance-band tools generally target isolated limb movements and lack a wearable, integrated design. This creates a gap in the availability of portable and ergonomic training equipment suitable for the physical characteristics of adolescent athletes. **Objective**: This study aimed to develop a chest rig resistance band as a wearable strength-training device and to evaluate its feasibility and effectiveness. **Methods**: This research employed a mixed-method Research and Development (R&D) approach involving expert validation (three experts), a small-scale trial (12 student-athletes), a large-scale trial (60 student-athletes), product revisions, and an effectiveness test with 14 athletes. Data were analyzed using qualitative descriptive techniques for expert feedback and quantitative descriptive analysis for validation scores and performance improvements. **Finding/Results**: The Body Chest Rig Resistance Band RSZT 01 demonstrated high feasibility based on expert evaluations (81.94%-90%, very feasible category). Small-scale and large-scale trials also showed very feasible results (93% and 92%). Effectiveness testing revealed performance improvements, indicating that the device supports functional strength training for adolescent athletes. **Conclusion**: The Body Chest Rig Resistance Band RSZT 01 is feasible and effective as a portable, wearable strength-training device for student-athletes, offering a practical alternative to conventional equipment. Future studies should test the device on larger populations and over longer training periods to further validate its effectiveness.

Keywords: Strength training; resistance band; student-athletes

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INTRODUCTION

Physical education is a broad field that focusses on human physical movement and plays a critical role in equipping individuals to face the challenges of the 21st century (Dinafi et al., 2023; Mashud, 2015). As educational science continues to evolve rapidly, sports education has also seen significant growth, particularly in preparing the physical condition of student athletes for future success (Suhairi et al., 2020). Within schools,

physical education is an essential part of the educational system, aimed not only at enhancing physical fitness and skills but also at fostering critical thinking, emotional intelligence, and social abilities through sports activities (Karsam et al., 2023). By identifying and improving movement skills early on, physical education serves as a foundation for nurturing future athletes, contributing to their physical readiness and overall development from a young age (Khalifa et al., 2021).

A better understanding from coaches and athletes about improving physical condition is essential so that they can adapt optimally, both physically and psychologically, in activities and competitions (Hartmann et al., 2015). Training that prioritises biomechanical factors is crucial for achieving maximum body performance, particularly during competition (Suhairi et al., 2023). Strength, speed, and endurance dominate biomotor skills, which heavily influence sports performance (Suraci et al., 2021). In addition to strength, speed, and endurance, flexibility and balance are also important components in athlete performance (Rejapovich, 2021).

Strength is defined as the ability of a muscle or muscle group to contract maximally in a single effort to overcome a load (Andersen & Aagaard, 2020). Strength is the foundation in the development of other components such as speed, power, and agility, which result from trained muscles (Suchomel et al., 2018). Research also shows that strength has a significant influence on agility, speed, and acceleration in various sports (Lee, 2021). The physical maturation process strongly influences strength, making optimal training only possible after adolescence, when significant physiological changes related to growth and maturation occur (González-Hernández et al., 2019). We must tailor effective strength training to the athlete's initial abilities, carry it out regularly, measure it, and vary it, focusing on specific muscle groups and appropriate forms of movement in each training session (Saeterbakken et al., 2022).

Observations reveal ineffective execution of the extracurricular training process, particularly strength training, in several schools. Training that is monotonous, inappropriate for athletes' age characteristics, and lacks variation in the muscle groups trained leads to low enthusiasm and suboptimal results. Student athletes, especially in their teenage years, are more interested in strength training that is varied but still supports optimal physical performance (Lesinski et al., 2016). Training innovations tailored to the physical and emotional development of student athletes are necessary, given the importance of strength in physical activity (Behm et al., 2021). We should design strength training to be more interesting and varied, enabling its application to various sports and enhancing both leg and arm muscle strength (Arifin et al., 2024).

In this context, the development of a chest-rig resistance band-based strength training model for student athletes is one potential solution. Resistance bands are an excellent training tool compared to other fitness equipment that requires high cost, large space, and special expertise for operation (Haraldsson et al., 2021). The use of resistance bands in sports continues to increase every year due to their effectiveness, affordability, and ease of use (Konukman et al., 2022). Training with resistance bands can increase leg and arm muscle strength and have an impact on balance and speed (Kusumawati et al., 2022). Adolescent athletes can benefit greatly from explosive and multi-joint exercises using resistance bands (Hammami et al., 2022). This supports the statement of van Sluijs et al. (2022) that physical activity in adolescents contributes to global health, including cardiometabolic health. Resistance bands are an ideal tool due to their ease of use and affordability, particularly for a variety of exercise movements that target different muscle groups (Iversen et al., 2018). However, some limitations in the use of resistance bands, such as when performing stiff-legged deadlifts and squats, result in suboptimal movements as the rubber tends to shift (Iversen et al., 2017). Nonetheless, resistance bands remain an effective strategy for extracurricular coaches in schools in achieving training goals (Ponzano et al., 2017). Good training is training that familiarises athletes with the use of equipment according to the specific needs of the sport (Bompa & Buzzichelli, 2015).

Furthermore, the existing strength training equipment often lacks variety and fails to capture the interest of young athletes who require innovative approaches tailored to their physical and psychological development. Previous studies have emphasized that the motivation and engagement of adolescent athletes in training are strongly influenced by the diversity of models and training media employed (Viramontes et al., 2024). In other words, although the benefits of strength training have been widely demonstrated, there remains a gap in the innovation of training tools that are accessible, practical, and relevant to the needs of student-athletes.

To date, research on the development of resistance band–based training media has been conducted extensively, particularly regarding its effectiveness in enhancing muscle strength (Colado & Triplett, 2008). However, studies that specifically develop strength training tools based on a chest rig resistance band designed for student-athletes are still very limited. This highlights a research gap that needs to be addressed—namely, the innovation of strength training tools that are not only physiologically effective but also engaging, portable, easy to use, and aligned with the characteristics of student-athletes.

Therefore, this study seeks to bridge that gap by developing a chest rig resistance band–based strength training tool in the form of a vest. This innovation is expected to serve as an alternative solution that can improve the physical performance of student-athletes while simultaneously fostering their interest in participating in strength training programs on a sustainable basis.

Accordingly, innovation in the development of strength training models for student-athletes utilizing a body-rig resistance band is required. The objectives of this study are (1) to develop a chest rig resistance band–based strength training model for student-athletes, and (2) to examine the feasibility and effectiveness of the tool. The novelty of this research lies in its systematic and structured design, in which the tool can be attached to the entire body—from the legs, torso (chest and back), to the arms—through an integrated vest system.

METHOD

Research Design

This study employed a Research and Development (R&D) design adapted from the ten-stage model developed by Borg and Gall, a widely used framework in educational product development (Gall et al., 2007; Borg et al., 2007). All major components of the model were retained, although several procedural steps were adjusted to align with the context and objectives of the study, as recommended in contemporary R&D research permitting flexible implementation (Plomp & Nieveen, 2010; van den Akker et al., 2013). Ethical approval and informed consent were obtained prior to data collection, following standard research ethics guidelines (Creswell & Creswell, 2018). Expert validation procedures followed established psychometric standards, including the use of Aiken's V and the Content Validity Index (CVI) for evaluating content relevance (Aiken, 1985; Polit & Beck, 2006) and Cronbach's Alpha for assessing internal consistency reliability (Tavakol & Dennick, 2011).

Participants

Participants were recruited in three stages corresponding to expert validation, small-scale testing, and large-scale field testing. Expert validators were selected purposively based on expertise in performance assessment, strength and conditioning, and biomechanics. Small-scale trials involved 12 student-athletes, followed by 60 athletes in the large-scale trial using simple random sampling to ensure group representativeness (Etikan, 2016). For the final effectiveness test, 14 adolescent athletes meeting specific inclusion criteria were recruited using purposive sampling commonly applied in sport intervention studies (Matz et al., 2016). A detailed summary of participant groups, sampling methods, and their respective roles is presented in **Table 1**.

Table 1. Summary of Participant Groups and Roles

Phase	Sample Size	Characteristics	Sampling Method	Purpose
Expert Validation.	3 experts.	Performance, training, biomechanics specialists.	Purposive.	Content validity & design review.
Small-Scale Trial.	12 athletes.	Ages 1517.	Simple Random.	Usability check & early feasibility.
Large-Scale Trial.	60 athletes.	Ages 15-17.	Simple Random.	Broader feasibility & acceptability.
Effectiveness Test.	14 athletes.	Talented youth athletes.	Purposive.	Pre–post outcome evaluation.

Instrumentation

Instrument development followed current psychometric guidelines emphasizing content validation and internal consistency. Content validity was assessed using Aiken's V and the Content Validity Index (CVI), both widely used to evaluate item relevance in instrument development (Polit & Beck, 2006). Reliability was determined using Cronbach's Alpha, following recommendations for internal consistency in applied measurement (Tavakol & Dennick, 2011). Instruments included checklists and evaluation questionnaires for experts and trial participants. A complete summary of all instruments, their purposes, and validation methods is presented in **Table 2**.

Table 2. Summary of Instruments Used

Instrument	Purpose	Validation
Expert validation questionnaire.	Assess feasibility, safety, ergonomics.	Aiken's V, CVI.
Athlete usability questionnaire.	Assess practicality & comfort.	Cronbach's Alpha.
Push-up performance test.	Measure upper-limb strength.	Established test reliability.

Development Procedures

The development process began with a needs analysis through literature review and field observation to identify limitations of existing resistance tools in youth strength training. The initial prototype was designed using ergonomic and functional movement principles aligned with current strength and conditioning literature (Suchomel et al., 2018). Iterative revisions were conducted based on expert feedback, following established R&D and design-based research refinement cycles (McKenney & Reeves, 2012).

Field Testing

Field testing consisted of two phases: small-scale usability evaluation and large-scale feasibility assessment. This aligns with contemporary practices stating that prototype testing should involve increasing sample sizes to strengthen ecological validity (Marcilly et al., 2024). Athlete feedback focused on functionality, comfort, safety, and training practicality. No adverse events occurred during field trials, supporting early evidence of usability and operational safety, similar to recent wearable-device feasibility studies (Seçkin et al., 2023; Longhini et al., 2024).

Training Protocol

Effectiveness was evaluated using a one-group pretest–posttest design, which is commonly applied in sport training studies (Raupach & van Schayck, 2011). Upper-limb strength was measured using the 1-minute push-up test, a validated field test for youth athletes (Roth et al., 2019; Ajisafe, 2019; Bohannon et al., 2020). Training followed progressive overload principles and current youth resistance training guidelines published by the NSCA (2021) and ACSM (2018). Training duration was six weeks, three sessions per week. Performance was recorded by two trained raters, and inter-rater reliability was assessed using the intraclass correlation coefficient (ICC), following current reliability reporting standards (Koo & Li, 2016).

Data Analysis

Data were analyzed using qualitative descriptive methods for expert feedback and quantitative descriptive analysis for validation scores. Pre–post comparisons followed standard parametric analysis procedures, with normality and reliability checks conducted in accordance with recent sport science statistical recommendations (Field, 2022). Interpretation of effectiveness data used updated athlete performance criteria to ensure relevance and methodological rigor.

RESULTS AND DISCUSSION

The results of the research on the development of a chest rig resistance band-based strength training model for student athletes are described in accordance with the research steps that have been selected, consisting of 7 stages adopted from the Brog and Gall stages by (Ade, 2025). The following results showcase the study's outcomes:

Table 3. Literature Review on the Development of Resistance Band–Based Training Models

No	Researchers & Year	Title of Study	Method	Main Findings	Relevance to This Study
1	(Lopes et al., 2019).	Effects of training with elastic resistance versus conventional resistance on muscular strength: A systematic review and meta-analysis.	Experimental.	Resistance bands have been shown to increase muscle strength with effectiveness nearly equivalent to that of free weights.	Serves as the basis that resistance bands can be used as an alternative for strength training.
2	(Heelas et al., 2021).	Muscle activation patterns during variable resistance deadlift training with and without elastic bands.	Experimental.	Resistance bands were able to generate significant muscle activation, especially in dynamic exercises.	Supports that resistance bands are effective for developing strength training models.
3	(Lesinski; et al., 2016).	Effects and dose–response relationships of resistance training on physical performance in youth athletes.	Systematic review & Meta-analysis.	Strength training (including resistance bands) significantly improves the physical performance of youth athletes.	Highlights the importance of innovation in strength training for student-athletes.
4	(Lopes et al., 2019).	Effects of training with elastic resistance versus conventional resistance on muscular strength: A systematic review and meta-analysis.	Review.	Resistance bands are effective in improving strength, power, and aerobic capacity.	Provides a theoretical foundation for the long-term effectiveness of resistance band use.
5	(Viramontes et al., 2024).	Strength training frequency and athletic performance in high school girls basketball players.	Experimental.	Variations in resistance band training frequency had a positive effect on strength, power, and motivation in young athletes.	Relevant as it confirms that variations in resistance band methods can increase student-athlete engagement.

At this stage, researchers conducted a literature study of some previous research results related to the development of the resistance band exercise model that had been developed. Researchers systematically sort the products of resistance band development from the oldest year to the year the researcher will develop. The purpose of this research was carried out to position the researcher in the next research related to the novelty of the product to be developed, find out the problems and possible suggestions from previous research, the usefulness of the product developed, and alternative solutions in making the product to be developed. To ensure the results of the literature review that has been obtained in this research, field research is also carried out by visiting several coaching centres both in schools and in clubs where athletes are trained in sports with sharing and question and answer activities related to strength training models, especially the use of resistance bands in training. From the results of sharing with the coach, it was obtained that training using resistance bands is often used in training all sports, especially in the workout movement, training for strength and power, and is believed to have an impact on physical strength, but there is no resistance band training model that can accommodate all limbs in training in the form of chest rig with chest and back fasteners, resistance bands are attached to the body and joint points from the feet to the fingers. The results of this literature study and field research form the basis for the importance of the product developed at the planning and model development stage. In field activities, researchers also distributed questionnaires via Google Forms as a basis for analyzing needs related to the development of tools to be carried out and obtaining data (see **Table 3**).

Table 3. Needs Analysis Results

No	Component	Percentage
1	Have you ever used resistance bands in training?	80%
2	Does the trainer recommend training with resistance bands?	75%
3	Have you mastered all the exercises using resistance bands?	75%

No	Component	Percentage
4	Do you frequently strength train using a variety of resistance bands?	65%
5	Do you need to develop a chest rig resistance band?	95%

Table 3 above presents the results of the needs analysis and describes the following data: (1) 80% of athletes have used resistance bands in training, (2) 75% of coaches recommend using resistance bands, (3) 65% of athletes often use resistance bands in strength training, and (4) 95% need to develop body chest rig resistance bands.

Model Planning and Development

The planning stage involves designing a chest rig resistance band-based strength training model specifically for student athletes. The planning stage includes: (a) preparation of the development flow with a storyboard outline of the product, (b) making a product display design for a chest rig resistance band-based strength training model for student athletes, (c) collecting materials and conducting several surveys related to the materials to be used in determining the specifications of the product to be made so that the process of making the tool can be estimated with time, lifetime, and costs that are close to good, (d) determining colleagues according to expertise in making tools, especially in permax and sewing tools to be made. **Figure 1** illustrates the design of the chest rig resistance band-based strength training model product for student athletes aged 15-17 years.

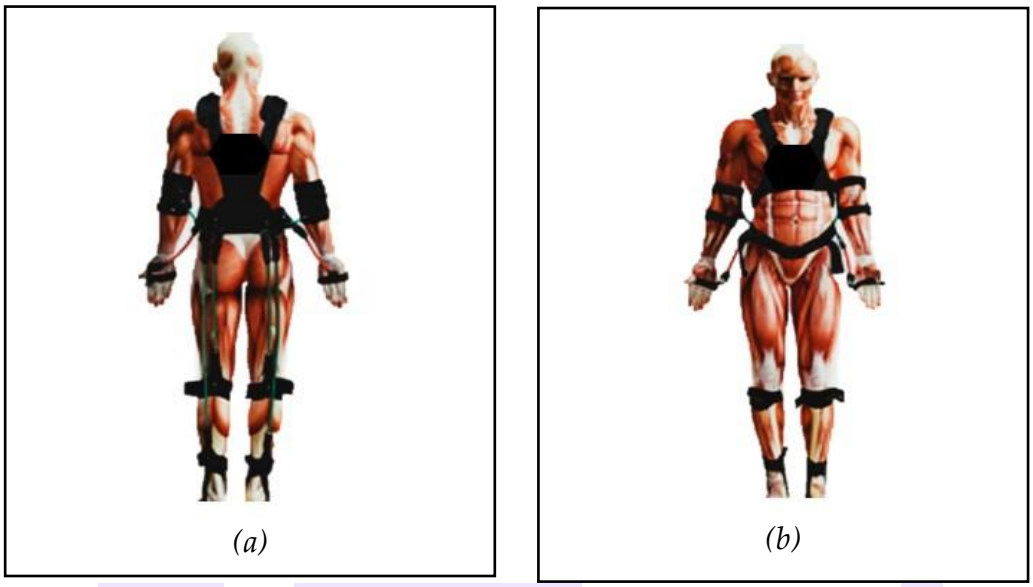

Figure 1. (a) Chest Rig Resistance Band-Based Strength Training Model Development Design for Student Athletes Rear View, and (b) Chest Rig Resistance Band-Based Strength Training Model Development Design for Student Athletes Front View

During this phase, researchers also incorporate activities aimed at creating strength training tools for student athletes using chest rig resistance bands, following the designs. During the model development stage, researchers change the steps and storyboards that were already made. They do this while considering the use of body-sticking fabric materials, the type of resistance band strength that will be used (which can be told apart by the colour of the resistance band rubber), the shape of the hook in each part (for upper and lower leg muscles, upper and lower arm muscles), and the quality of the stitches on the chest rig resistance band that was made.

Internal Testing of First-Stage Expert Validation

Following the development of the product, the internal testing stage encompasses the initial expert validation test. We then use the product and record it in video form, beginning with the material before it is

installed, followed by the installation of training equipment, and the use of chest-rig resistance band-based strength training equipment. Three expert validations are involved in assessing the developed products. These include (i) material experts, who are lecturers who teach training program preparation methodology courses, test measurements, and athlete performance, and who have been active as lecturers and research service providers for more than 10 years, (ii) biomechanics experts, who are lecturers who actively conduct research in sports biomechanics and teach sports biomechanics courses for at least 10 years, and (iii) expert validation from coaches who understand physiology, have been active in sports coaching for at least 10 years, have a National coach license, and possess a Expert validation provides assessments and suggestions through videos of training tools and the use of chest-rig resistance band-based strength training tools. The aspects of the assessment include the suitability of the tool's purpose, the attractiveness of the developed product, and the effectiveness of the tool's use. **Table 4** displays the results of the tool's feasibility test.

Table 4. Results of Material Expert Tests from Lecturers on the Development of Chest Rig Resistance Band-based Strength Training Equipment Models for Student Athletes

No	Aspect assessed	Score obtained	Maximum score	Percentage (%)	Category
1	Appropriateness of the tool (material).	13	16	81,25%	Very Decent
2	Effectiveness of tools in use.	26	32	81,25%	Very Decent
3	The attractiveness of the developed tool.	10	12	83,33%	Very Decent
	Total score	54	60		
	Average			81,94%	Very Decent

Based on the results of material expert validation from lecturers in **Table 5**, we obtained an average result of 81.94% for three aspects of assessment: (i) the suitability of the tool's purpose, (ii) the attractiveness of the developed product, and (iii) the effectiveness of the tool's use. In addition to obtaining an assessment of the tools developed, validators also provide suggestions and considerations to improve the quality of the tools developed. The suggestions and considerations include focusing the product on leg muscle strength training and arm muscles, providing installation manualbooks, and ensuring correct procedures are followed when using the tool.

Table 5. Biomechanics Expert Test Results on the Development of a Chest Rig Resistance Band-based Strength Training Tool Model for Student Athletes

No	Aspect assessed	Score obtained	Maximum score	Percentage (%)	Category
1	The tool's practicability and appearance.	10	12	83,3%	Very Decent
2	Effectiveness of the tool in use.	7	8	87,5%	Very Decent
3	The tool's biomechanical feasibility and safety during use are crucial considerations.	11	12	91,7%	Very Decent
	Total score	28	32		
	Average			87,5%	Very Decent

Based on the results of the biomechanics expert validation in **Table 5**, we obtained an average result of 87.5% in the category 'Very Feasible'. This result was based on three aspects of the assessment: (i) practicality and appearance of the tool, (ii) effectiveness of the tool in use, and (iii) feasibility of biomechanical tools and safety when used. In addition to obtaining an assessment of the tools developed, validators also provide suggestions and considerations to improve the quality of the tools developed. The suggestions and considerations given include: When using leg muscle strength training products and arm muscles, it's important to take into account the position of the rubber and joint motion when training. Using rubber alternatives ranging from low strength to complex ones that can be adjusted to the elastic level and length of rubber in all athletes, there are slopes to adjust the size of the user's body on the chest rig resistance band, especially on the chest and back. We provide installation manuals and procedures to ensure correct use of the tool.

Table 6. Results of the Practitioner Expert Test in Sports Physiology on the Development of a Chest Rig Resistance Band-based Strength Training Tool Model for Student Athletes

No	Aspect assessed	Score obtained	Maximum score	Percentage (%)	Category
1	Appropriateness of tool use.	15	16	87,5%	Very Decent
2	Effectiveness of the tool in use.	29	32	90,65%	Very Decent
3	Physiological feasibility of the tool.	11	12	91,7%	Very Decent
	Total score	54	60		
	Average			90%	Very Decent

Based on the expert validation results from practitioners in **Table 6**, we obtained an average result of 90% for three aspects of the assessment: (i) the suitability of the tool, (ii) the effectiveness of the tool in use, and (iii) the physiological feasibility of the tool. In addition to obtaining an assessment of the tools developed, validators also provide suggestions and considerations to improve the quality of the tools developed. The suggestions and considerations given include: there is a clip where the rubber replacement adjusts the elastic level and length of rubber on all athletes, considering the use of gloves and feet at the end of the rubber to make it stronger and make it easier for athletes to make movements when using the tool.

First Stage Product Revision

Stage one product revision received several suggestions and considerations regarding the development of strength training tools based on chest rig resistance bands for student athletes aged 15-17 years. The trainers' suggestions are consistent with those of all validators. **Table 7** displays the product revision action that the researchers implemented based on the given suggestions.

Table 7. Suggestions and Forms of Product Revision Action Development of Chest Rig Resistance Band-Based Strength Training Equipment Model for Student Athletes in the First Stage

Validator	Suggestions and Considerations	Action Product Revision
Material Expert	a) The product is focused on muscle strength training. b) Provide a manualbook on the correct installation and usage of the equipment..	a) The product focused on strength training of leg muscles and arm muscles. b) A manualbook on the installation and proper use of the equipment is provided.
Biomechanics Expert	a) The position of the rubber and joint motion during exercise using the device is easy to shift. b) The strength of the rubber varies. c) There is a buckle or checklock to adjust the size of the user's body on the chest rig resistance band, especially on the chest and back. d) provide guidance on the use of tools.	a) The position of the rubber has been adjusted and joint motion during exercise using the tool by adding a replacement at each end of the rubber. b) Use alternative rubbers ranging in weight from: 1. Yellow (10 lb) 2. Green (15 lb) 3. Red (20 lb) 4. Blue (25 lb) 5. Black (30 lb). c) Add a buckle or checklock on the webbing to regulate the size of the user's body on the body chest rig resistance band, especially on the chest and back. d) Provide a manualbook for installation and proper use of the equipment.
Expert of Physiological Trainer	a) Provide a clip where the rubber replacement adjusts the length of the rubber during use. b) Consider using gloves and feet at the end of the rubber so that athletes can relax, not hurt. c) Pay attention to the type of exercise in relation to the dominant muscle group in each exercise model.	a) Provide a clip where rubber replacement adjusts the elastic level and length of rubber for all athletes b) Attach gloves and feet to the rubber end to make it stronger and easier for athletes to move when using the tool. c) Describe the dominant muscular imposition in each exercise model.

Internal Testing Phase Two: Small-Scale Test and Large-Scale Test

After revising the product based on the results of the validator's suggestions and considerations, a small-scale test was conducted. The small-scale test was carried out in Pontianak district on 27 April 2024 at the Universitas PGRI Pontianak Sport Hall with a total of 12 student athlete participants from Kubu Raya Regency

who participated in the preparation of regional student championships in West Kalimantan in 2024. The scale test results cover 7 aspects as follows: (i) the practicality of the developed tool, (ii) the effectiveness of the tool in leg muscle strength training, (iii) the effectiveness of the tool in arm muscle strength training, (iv) portable design, (v) safety of tool use, (vi) easy to operate, (vii) fun tool in use.

Table 8. Small Group Test Results of Chest Rig Resistance Band-Based Strength Training Tool Model Development for Student Athletes

No	Aspect assessed	Score obtained	Maximum score	Percentage (%)	Category
1	Practicality of the developed tool.	115	120	96%	Very Decent
2	The effectiveness of tools in leg muscle strength training is worth considering.	112	120	93%	Very Decent
3	The tool is effective in arm muscle strength training.	112	120	93%	Very Decent
4	Portable design.	114	120	95%	Very Decent
5	Safety of tool use.	115	120	96%	Very Decent
6	Easy to operate.	115	120	96%	Very Decent
7	Tool is fun to use.	95	120	79%	Very Decent
	Total score	778	840		
	Average			93%	Very Decent

The small group test results obtained an average score of 89%, with performance results worth using. We declare it feasible to proceed to the next stage, the large group test, based on the results of the small group test.

Table 9. Large Group Test Results: Development of a Chest Rig Resistance Band-Based Strength Training Equipment Model for Student Athletes

No	Aspect assessed	Score obtained	Maximum score	Percentage (%)	Category
1	Practicality of the developed tool.	224	240	93%	Very Decent
2	The effectiveness of tools in leg muscle strength training is worth considering.	190	240	79%	Very Decent
3	The tool is effective in arm muscle strength training.	224	240	93%	Very Decent
4	Portable design.	230	240	96%	Very Decent
5	Safety of tool use.				Very Decent
6	Easy to operate.	228	240	95%	Very Decent
7	Tool is fun to use.	230	240	96%	Very Decent
	Total score	1326	1440		
	Average			92%	Very Decent

The large-scale test was conducted in Pontianak City on 8 June 2024 at the Universitas PGRI Pontianak Sport Hall with a total of 60 subjects of Pontianak City student athletes who participated in the preparation of regional student championships in West Kalimantan, which were held in June 2024. The scale test results cover 7 aspects as follows: (i) the practicality of the developed tool, (ii) the effectiveness of the tool in leg muscle strength training, (iii) the effectiveness of the tool in arm muscle strength training, (iv) portable design, (v) safety of tool use, (vi) easy to operate, (vii) fun tool in use. The results of the small group test obtained an average score of 90%, with performance results worth using. With the results of the small group test, it was declared feasible to proceed to the next stage, namely stage II product revision before the final product.

Second-Stage Product Revision

After passing the small-scale and large-scale tests at the product revision stage, the researcher did not find any product revision complaints or field test problems. During the second stage of product revision, the researchers implemented several changes: (i) they inspected the tool after heavy use, (ii) they ensured that all tool parts, the rubber connection, and the hook were intact and functioning properly, and (iii) they renamed the tool to make it easier to read the development history of the current resistance band tool. As a result, we can conclude that the product deserves to advance to the final product stage.

Finalisation of The Final Product

After many steps of research, such as (i) reading books and doing fieldwork, (ii) planning and building a model, (iii) testing the model internally with stage I experts, (iv) making changes to stage one products, (v) testing the tool internally with stage two experts using small and large tests, (vi) making modifications to stage two products, and finally (vii) finalising the tool, the researcher makes sure it is complete and in good shape. The strength training model product's development has reached its final stage, culminating in the creation of the Body Chest Rig Resistance Band RSZT 01. The specifications of the Body Chest Rig Resistance Band RSZT 01 tool include: (i) a set of chest and back parts; (ii) a set of gloves to support the rubber hook clip for the arms; (iii) a set of leg gloves to support the rubber clip for the legs; and (iv) a set for the leg joints in the area of both knees and elbows on both hands. Rubber Resistance Bands: Yellow (10 lb), Green (15 lb), Red (20 lb), Blue (25 lb), Black (30 lb). **Figure 2** shows a picture of the Body Chest Rig Resistance Band RSZT 01 equipment.

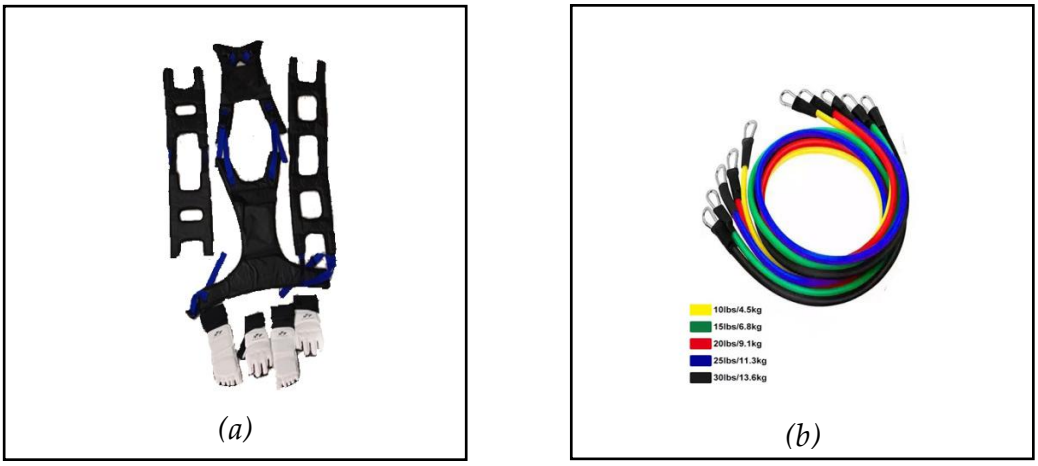

Figure 2. Final Product Development of Chest Rig Resistance Band-Based Strength Training Model for Student Athletes (a) Body Chest Rig Resistance Band, (b) Resistance Band Options

After developing the final product, we conduct an effectiveness test for the Body Chest Rig Resistance Band RSZT 01 training tool. We conduct the effectiveness test and analyze the results. We conduct the effectiveness test results by comparing the old product with the newly developed Body Chest Rig Resistance Band RSZT 01, which is used by student athletes from Mempawah Regency. Each conducted an arm muscle strength test by first going through a sample normality test and a sample homogeneity test. The results of the pretest and posttest for arm muscle strength and leg muscle exterior strength in Mempawah Regency student bolavoli athletes are presented in **Table 10**.

Table 10. Descriptive Statistics of Arm Muscle Strength Pretest and Posttest

Statistics	Pretest	Posttest
N	14	14
Mean	41.33	42.63
Std. Deviasion	4.54	5.15
Minimum	35.00	36.00
Maximum	49.00	52.00

According to **Table 10**, the pretest arm muscle strength of Mempawah Regency student athletes averaged 41.33 and increased to 42.63. The analysis results are presented in **Table 11**.

Table 11. T-test of Pertest and Posttest Results of Arm Muscle Strength after Chest Rig Resistance Band Exercise RSZT 01

Limb Muscle Strength	Average	t_{hitung}	t_{tabel}	Significance
Pretest	41.33	5.454	2.069	0.000
Posttest	42.63			

This study examines the outcomes of developing a resistance band training device in the context of maximal muscle strength training. Rubber bands (resistance bands), based on submaximal endurance testing, serve as effective training tools across various sports by increasing strength in targeted muscle groups. According to previous research (Bauer et al., 2021), the use of resistance bands can improve both leg and arm muscle strength, which contributes to an increase in throwing power and speed of up to 2.0 mph in handball. The number of repetitions performed during training and the level of elasticity of the rubber band, which are related to training intensity, determine the optimization of resistance band utilization (Aume & Aeterbakken, 2016). In addition to its effect on strength, resistance band training can also enhance kicking power, as stated by Lopes et al. (2019) The use of rubber bands has been shown to affect the improvement of kicking strength in martial arts athletes.

Furthermore, resistance band training is a practical and effective method for increasing muscle strength (Yasuda et al., 2015). Research has also shown that resistance bands are able to enhance the performance of volleyball athletes. Govardhan and Gopinathan (2020) reported that volleyball players experienced improvements in physical performance, including strength, speed, and power, after undergoing training using resistance bands. Measured, regular, and structured resistance band training for eight weeks (two days per week, 60 minutes per session) contributes to improvements in spike power and jumping height in volleyball, although it has only a limited effect on the speed of the dominant arm (Agopyan et al., 2018).

However, the use of a body chest rig resistance band may also pose certain weaknesses and biomechanical risks if it is not used according to proper procedures. Improper strap placement, excessive resistance, or incorrect movement patterns can increase stress on the shoulder (glenohumeral) joint, the elbow, and the upper spine, thereby increasing the risk of injury due to overuse or unbalanced movement compensation (Foley & Washabaugh, 2024). In addition, users' adaptation to a new training device—such as comfort level, stability of the device on the body, and neuromuscular coordination during the initial phase of use—may influence movement quality and training effectiveness (Behm et al., 2020). The relatively small yet statistically significant improvement observed in this study can be explained by the homogeneity of the sample characteristics, the sensitivity of the measurement instruments, and the early neuromuscular adaptation response, which typically occurs rapidly in individuals who are not yet accustomed to external resistance stimuli (Slimani et al., 2018; Behm et al., 2016). Although the numerical difference appears small, the change remains statistically meaningful due to the consistency of training responses in the majority of participants, indicating that the intervention had a real effect on improving upper-limb muscle performance.

In addition to the provision of training equipment, a coach's understanding of specific training priorities and the ability to adapt to the dominant energy system also enhances athletes' confidence in achieving optimal training outcomes (Hadi & Yudhistira, 2023). The developed body chest rig resistance band can be directly used in sport movement activities, thereby familiarizing athletes with proper movement techniques and appropriate loading using the device. A good training program is one that familiarizes athletes with equipment that is relevant to the demands of their specific sport (Bompa & Buzzichelli, 2015).

Based on the research findings and the previous discussion, the researcher recommends the use of the chest rig resistance band training method for strength training. This method can increase both leg and arm power in various sports by tailoring the training to the dominant muscle groups used in each discipline. Resistance band training also shows physiological suitability for adolescent athletes (Gadruni et al., 2015). Esmaielzadeh et al., (2021) similarly stated that adolescents, both athletes and non-athletes, can safely and effectively perform resistance training using resistance bands for an eight-week period.

CONCLUSION

The use of resistance bands in the form of a chest rig for strength training has proven to be an effective alternative to conventional weight-training equipment. This device provides progressive resistance that is not offered by traditional weights and has advantages in terms of affordability, portability, ease of use, and flexibility. Resistance bands are able to target both large muscle groups and smaller stabilizing muscles, improve strength, balance, and flexibility, and generate greater neuromuscular fatigue compared to isometric exercises. In addition, this tool offers additional benefits such as reducing the risk of injury and increasing muscle explosive power, making it suitable for use at home or while on the move.

This study contributes to the innovative development of a Chest Rig Resistance Band–based strength training device specifically designed for student athletes. The device has the capacity to increase strength and, in turn, enhance individual athletes' explosive power, thereby potentially improving their performance in student-level competitions. The chest rig resistance band demonstrates potential as a feasible and practical strength training tool for young athletes. However, its effectiveness still requires further verification through controlled trials with a larger sample size and the implementation of standardized training protocols.

Nevertheless, this study has several limitations, such as a relatively small number of participants and a limited focus on adolescent volleyball athletes aged 15-17 years. In addition, the research has only reached the final product development stage, meaning that comprehensive effectiveness testing and direct comparisons with other conventional strength-training equipment in long-term training programs have not yet been conducted. Therefore, it is recommended that future studies involve participants from various regions, clubs, and different sports, employ more robust experimental designs, extend the duration of the intervention, and measure a wider range of physical variables, such as maximal strength, explosive power, muscular endurance, and sport-specific performance. This approach is expected to strengthen the scientific evidence regarding the effectiveness of using chest rig resistance bands in the development of young athletes.

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CONFLICT OF INTEREST

The authors declare that this research has no conflict of interest from any party.

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