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Editorial Board

About USFD Journal of Physical Education Pedagogy and Sports Performance

The *USFD Journal of Physical Education Pedagogy and Sports Performance* is a peer-reviewed, open-access academic journal that advances scholarly work in physical education, inclusive pedagogy, exercise science, and sports performance. It provides an international platform for researchers, educators, coaches, and practitioners to publish innovative and evidence-based studies that promote quality physical activity, inclusive fitness education, and athletic development across diverse settings.

Rooted in the Unified System Fitness Design (USFD) framework, the journal supports interdisciplinary and contextualized approaches to movement literacy, instructional design, and performance evaluation.
The journal welcomes contributions including:

- Original research articles
- Theoretical analyses
- Best practice models
- Instrument validation studies
- Critical literature reviews

Aligned with the following focus areas:

- Physical education pedagogy and curriculum innovation
- Inclusive and holistic fitness education
- Sports science and performance optimization
- Educational assessment and evaluation
- Development and validation of instructional tools and instruments

Mission and Vision

Mission: To foster and disseminate scholarly knowledge that improves physical education practices, promotes inclusive fitness education, and enhances athletic performance through research, innovation, and evidence-based teaching.

Vision: To become a leading open-access journal in Asia and globally that bridges research and practice in physical education and sports performance, rooted in sustainable, inclusive, and culturally relevant pedagogical frameworks.

Audience and Focus

The journal serves a broad, interdisciplinary audience, including:

- Physical education teachers and curriculum developers
- Sports scientists and exercise physiologists
- Health and fitness professionals
- Graduate and doctoral researchers
- Coaches, athletic trainers, and policy advocates

It emphasizes actionable scholarship that can be applied in schools, community programs, athletic institutions, and higher education.

Frequency of Publication

The *USFD Journal of Physical Education Pedagogy and Sports Performance* is published **quarterly**, in **June, September, December, and March**. Special issues may be released in collaboration with academic conferences and institutional partners.

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The journal follows a **double-blind peer-review process** to ensure academic rigor, ethical integrity, and impartiality.

- Manuscripts are reviewed by at least **two qualified experts** in the field.
- Reviewers evaluate submissions based on originality, methodological quality, theoretical contribution, and relevance to the journal's scope.
- The editorial board oversees final publication decisions and ensures adherence to ethical standards, including conducting plagiarism checks, maintaining data transparency, and providing proper attribution.

Author Guidelines

Submission Requirements

Authors are invited to submit original, unpublished manuscripts that align with the aims and scope of the *USFD Journal of Physical Education Pedagogy and Sports Performance*. All submissions are initially evaluated by an editor. Those meeting the journal's criteria will proceed through a **double-blind peer review process**.
Before submission, authors must ensure:

- All co-authors have provided consent for submission and authorship.
- Permission has been secured for any third-party material (e.g., images, datasets, documents).
- If applicable, ethical clearance has been obtained from an institutional or national research ethics board.

Manuscripts may be **desk-rejected** if they do not meet the journal's standards for academic writing, methodological rigor, or alignment with the journal's scope. Authors are advised to submit a well-structured study with a clear research argument, a concise title, and a stand-alone abstract.

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Please confirm that the following conditions have been met before submitting:

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- All references have been checked for **accuracy and completeness**.
- All tables and figures are **numbered, labeled**, and properly formatted.
- All necessary **permissions** have been obtained for third-party materials included in the submission.

Formatting

- Manuscripts must be submitted in **.docx format**.
- Use **Times New Roman**, size 12, double-spacing, and 1-inch margins.
- Follow **APA 7th Edition** for references and citations.
- Manuscripts should include:
    - Title Page (with author names, affiliations, and contact details)
    - Abstract (200–250 words) and 5 keywords
    - Main Body (structured according to the research type)
    - References (APA 7 format)
    - Tables and figures placed appropriately or at the end

Privacy Statement

The names and email addresses submitted to this journal site will be used exclusively for the stated purposes of the *USFD Journal of Physical Education Pedagogy and Sports Performance* and will not be made available for any other purpose or to any other party.

Publication Ethics and Malpractice Statement

The *USFD Journal of Physical Education Pedagogy and Sports Performance* is committed to upholding the highest standards of publication ethics, research integrity, and scholarly transparency. The journal adheres to the guidelines of the Committee on Publication Ethics (COPE) and follows internationally recognized policies to ensure the credibility of the scientific record.

Responsibilities of Authors

- Authors must submit original and unpublished work that is not under review elsewhere.
- Proper citations and acknowledgments must be provided for all data, concepts, and prior work.
- Plagiarism, data fabrication or falsification, and redundant publication are strictly prohibited.
- Authors must disclose any conflicts of interest, funding sources, and institutional affiliations.
- When applicable, research involving human subjects must have ethical clearance from a recognized ethics board and must include documentation of informed consent.

Responsibilities of Editors and Reviewers

- Editors and reviewers must handle submissions objectively, confidentially, and without bias.
- Editors must recuse themselves from decisions where there is a conflict of interest.
- Reviewers must evaluate manuscripts based on scholarly merit, methodology, and relevance, and disclose any conflicts of interest or inability to review promptly.
- All editorial decisions are based on double-blind peer review.

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The journal recognizes the evolving role of AI-assisted tools in academic writing and analysis. To maintain integrity and transparency:

- AI-generated content (e.g., text, data interpretation, image generation) must be explicitly disclosed in the methodology or acknowledgments section.
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Plagiarism and Misconduct Screening

All submissions undergo plagiarism checks using tools such as Turnitin or iThenticate. Manuscripts with a similarity index exceeding acceptable thresholds or with evidence of academic misconduct will be rejected, and in severe cases, reported to the author's institution.

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- Substantive errors discovered post-publication may result in the issuance of a **correction**, **retraction**, or **editorial note**.
- Authors and readers may file complaints or appeals regarding editorial decisions or suspected misconduct. These will be investigated following COPE procedures.

This ethical policy is publicly available and applies to all contributors, reviewers, and editors involved in the publication process.

Editor's Note

Glocal Publication: From International Prestige to Local Relevance

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As part of its mission, USFD Philippines is committed to upgrading academic publication capabilities in Physical Education by offering "glocal" avenues for dissemination, combining global standards with local relevance. This mission takes on renewed urgency in light of recent shifts in the academic publishing landscape, particularly in the Philippines.

The implementation of CHED Memorandum Order No. 15, Series of 2019 formalizes the requirement for graduate students—both master's and doctoral—to publish or provide proof of acceptance of their research in refereed journals as a prerequisite for graduation (Quinto, 2022). This policy marks a transformative step in elevating research culture and output in the country, aligning national academic standards with global publishing practices.

However, this transformation is not without challenges. Recent studies (Damoco, 2024; Pangket et al., 2023) reveal that many Filipino graduate students feel ill-equipped to meet the demands of publication. They face steep learning curves in academic writing, a lack of institutional support, and significant psychological stress, often navigating the peer-review process alone. Merga et al. (2019) further illuminate the emotional toll of constant rejection and feedback fatigue, calling for more humanized publishing pathways.

It is in this context that glocal publication emerges as a compelling response. Glocal publishing acknowledges that not all high-quality research must be published in high-impact international journals to be impactful. As scholars and editors, we must resist the notion that internationalization equates to superiority. Instead, we must empower local scholars to publish where their work matters most—within and for their communities.

This inaugural issue of the USFD Journal of Physical Education Pedagogy and Sports Performance represents more than just a compilation of articles; it is a manifestation of our commitment to local empowerment through scholarly excellence. Each contribution is the product of rigorous inquiry, mentorship, and the belief that research must be both globally competitive and locally grounded.

To assist authors, we also recognize the importance of guided manuscript transformation, particularly in converting theses and dissertations into publishable journal articles. While generative AI may offer linguistic and formatting assistance, we stress that such tools must never replace the researcher's intellectual responsibility. All article reductions must be human-mediated to ensure the authenticity of findings and research integrity remains intact.

As we move forward, we urge fellow educators, institutions, and graduate programs to support the academic publishing journey, not only by requiring it but also by mentoring it. Let this journal be a space where knowledge is not only created but also shared, contextualized, and transformed for the greater good.

We dedicate this volume to the next generation of Physical Education researchers—may your voice find both platform and purpose.

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USFD Journal
of Physical Education Pedagogy and Sports Performance

Original Research Article

Balance or Burst: Comparing Two Training Paths to Volleyball Ball Control

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Abstract: Ball control is a fundamental skill in volleyball that serves as the foundation for successful game performance. This study aimed to determine the effectiveness of postural control exercises and agility drills on the self-bump passing ball control of Grade 8 students in volleyball, grounded on the need to enhance foundational motor skills in early adolescence, addressing the gap in the literature regarding comparative effects of balance- and agility-focused interventions, and justified by the importance of evidence-based physical education practices. A quasi-experimental pretest-posttest design was utilized involving 79 Grade 8 students divided into a postural control exercise group and an agility drills group, with interventions conducted over eight weeks while controlling for confounding variables through intact group assignment and health screening, and ball control was assessed using the Wall Volley Test adapted. Findings revealed that both postural control exercises and agility drills significantly improved participants' ball control scores, as determined by the paired samples t-test. However, the Analysis of Covariance showed that postural control exercises were more effective in enhancing ball control than agility drills. These results align with Motor Control Theory and Dynamic Systems Theory, emphasizing that both balance-oriented and agility-oriented pathways support the complex development of motor skills necessary for volleyball performance among novice PE students. In conclusion, while both interventions were effective in enhancing self-bump passing ball control, it is recommended that physical education programs flexibly integrate postural control exercises according to learner needs, resource availability, and instructional objectives.

Keywords: Postural control exercises, agility drills, volleyball, ball control, motor learning

Introduction

Mastering ball control in volleyball, particularly through self-bump passing, remains critical for developing both defensive stability and offensive opportunities (Chhiede, 2023; Khoirudin, 2023), yet it is notably challenging for beginners due to underdeveloped proprioception, muscular strength, and reaction timing (Sobko, 2023; Wicaksono & Rejarjo, 2020). Volleyball is a significant component of Physical Education (PE), providing not only physical fitness but also contributing to cognitive development and the enhancement of social skills (Astuti, 2023; Risma *et al.*, 2020; Yudiana *et al.*, 2022). Globally, coaching approaches range from sophisticated biomechanical analyses to sensor-based feedback systems and more traditional, community-based training methods, as seen in countries like the Philippines (Batez *et al.*, 2021, Đolo *et al.*, 2023; Khoirudin, 2023). Given the wide-ranging benefits of volleyball and its integration into youth development, understanding effective training strategies is crucial for both disciplinary advancement in sports education and broader societal health initiatives (Muharram *et al.*, 2023).

Improving self-bump passing ball control is essential in volleyball, as this skill requires technical precision, quick decision-making, and spatial awareness, with expert players relying on dynamic head movements to assess ball trajectory and opponent positioning (Fortin-Guichard *et al.*, 2020). Motor coordination further supports performance, as higher levels are associated with better execution of sport-specific skills (Marinho & Chagas, 2022). In PE, interactive drills and small-sided games have proven effective in enhancing forearm passing and promoting student engagement (Cruz, 2024). Moreover, integrating tactical and decision-making elements into instruction fosters self-regulation and teamwork, thereby contributing to improved volleyball performance and sustained interest in physical activity (Batez *et al.*, 2021).

Despite the recognition of volleyball's benefits, a specific gap persists in targeted interventions for improving ball control, especially self-bump passing, among beginners (Permana *et al.*, 2022; Pratama, 2023). Practical challenges include beginners' struggle with timing, body positioning, and coordination (Chhiede, 2023; Khoirudin, 2023). Although prior studies have tested plyometric exercises, Teaching Games for Understanding (TGfU), and generic drill-based training (Permana *et al.*, 2022; Pratama, 2023), little focus has been placed on comparing postural control exercises and agility drills for enhancing self-bump passing (Batez *et al.*, 2021; Castillo-Rodríguez *et al.*, 2023). Current educational trends favor evidence-based practice, making this investigation particularly timely (Selmi, 2024).

As selected interventions, postural control and agility are essential yet distinct elements in volleyball training that, when combined, enhance performance and skill acquisition. Postural control exercises develop core stability, balance, and proprioceptive awareness, which are vital for maintaining effective positioning and preventing injury during dynamic movements, while also refining motor control through neuromuscular activation (Khorjahani *et al.*, 2021; Yang & Butler, 2020). In contrast, agility drills improve rapid directional changes, reaction time, and dynamic coordination, directly benefiting defensive techniques and cognitive processing required in gameplay (Chuang *et al.*, 2022; Jiang & He, 2023; Latino *et al.*, 2021).

Previous studies confirmed that postural stability is crucial for effective volleyball performance (Ardigò *et al.*, 2020; Borzucka *et al.*, 2020), while agility development significantly improves reaction time and footwork (Pramono *et al.*, 2023; Selmi, 2024). Motor Control Theory (Bernstein, 1996) emphasizes neuromuscular coordination through organized muscle synergies, while Dynamic Systems Theory (Thelen & Smith, 1994) highlights how motor behavior emerges from the interaction of subsystems, including perception, cognition, and the environment (Saltarelli *et al.*, 2020). However, limited studies have simultaneously examined the impact of targeted postural control versus agility training on foundational volleyball skills in adolescent learners (Khoirudin, 2023). Currently, research and practice lack a clear, comparative understanding of how different training modalities—specifically, postural control exercises versus agility drills—influence self-bump passing ball control in early adolescent learners. Most existing studies (Batez *et al.*, 2021; Castillo-Rodríguez *et al.*, 2023; Đolo *et al.*, 2023; Khoirudin, 2023; Permana *et al.*, 2022; Pratama, 2023) focus on experienced players or general fitness gains, leaving a critical gap in evidence-based strategies for beginners within school-based Physical Education settings.

This study addresses the underexplored comparative effectiveness of postural control and agility drills in improving volleyball self-bump passing among early adolescents (Batez *et al.*, 2021; Pramono *et al.*, 2023). By focusing on a PE context with beginner students, it fills a gap left by prior research largely focused on elite or experienced athletes (Đolo *et al.*, 2023). Addressing this gap offers crucial insights for curriculum development and instructional design in sports education (Astuti, 2023; Castillo-Rodríguez *et al.*, 2023).

The purpose of this study was to determine the effectiveness of postural control exercises and agility drills in enhancing ball control through self-bump passing among Grade 8 students (Khoirudin, 2023; Pramono *et al.*, 2023). Specifically, it aimed to (1) measure pretest and posttest changes in ball control for each intervention, (2) compare the effectiveness of the two interventions, and (3) determine which training method better supports ball control skill development (Selmi, 2024; Wicaksono *et al.*, 2020).

This study contributes to both theoretical and practical domains by strengthening understanding of motor learning theories in practice (Bernstein, 1996; Thelen & Smith, 1994) and providing actionable strategies for PE teachers, coaches, and curriculum developers (Batez *et al.*, 2021 Risma *et al.*, 2020). Offering evidence-based training interventions benefits students, educators, and the broader school health programs, paving the way for future research on sport-specific skill acquisition strategies (Astuti, 2023; Castillo-Rodríguez *et al.*, 2023).

The remainder of this paper discusses the methods used, presents the results of the interventions, interprets the findings through theoretical and practical lenses, and concludes with recommendations for future research and practice (Pramono *et al.*, 2023; Saltarelli *et al.*, 2020).

Methods and Materials

This study employed a quasi-experimental pretest-posttest non-equivalent groups design (Genç, 2023). A quasi-experimental design was appropriate because random assignment was not feasible in a school-based setting where intact classroom groups were used (Genç, 2023; Özden & Yenice, 2020). Two comparison groups were created: one received postural control exercises, and the other received agility drills, allowing a structured comparison of interventions' effectiveness.

The participants consisted of Grade 8 students (aged 12 to 15 years) enrolled in a public high school in Macasandig, Cagayan de Oro (Republic of the Philippines, Department of Education, 2016). Group A consisted of 40 students and Group B, 39, totaling 79 participants. A convenience sampling method was utilized, as participants were drawn from intact sections assigned by the school (Genç, 2023). Inclusion criteria included Grade 8 enrollment, physical fitness certification, and parental consent; exclusion criteria included injury, musculoskeletal issues, or formal volleyball training. Informed assent and parental consent were secured following ethical research guidelines (Galozo & MacDonald, 2021; Soares *et al.*, 2023).

The study took place in the school gymnasium and surrounding open grounds, ensuring consistent environmental conditions such as surface type, space availability, and instructor supervision across all sessions. The same research assistants and lead researcher facilitated all sessions to maintain instructional uniformity.

The independent variable was the type of intervention: postural control exercises or agility drills. Each group trained three times a week for eight weeks, with each session lasting 45–60 minutes. The Postural Control group engaged in Single-Leg Stand (balance training), Plank exercises (core strengthening), and Dual-Task Walking (cognitive-motor coordination) (Jo *et al.*, 2022; Choi *et al.*, 2021). The Agility Drills group performed In-Out Ladder Drills, T-Drills (Cone Drills), and Forward Hurdle Hops (Pramono *et al.*, 2023; Selmi, 2024). All activities were standardized with scripted instructions and pre-intervention demonstrations.

To enhance the study's replicability and clarity, detailed protocols were followed for both the testing and the exercise interventions. The Wall Volley Test was administered in a controlled environment where participants performed continuous self-bump passes against a flat wall for 60 seconds. Each successful pass—defined as returning the ball to the wall without it touching the ground—was counted. Participants received a standardized demonstration and practiced the test in advance to reduce performance variability (Baumgartner *et al.*, 2016; Clem, 2020; Patenaude *et al.*, 2020).

The Postural Control Group followed a progressive intervention structure over the eight weeks. Initial sessions focused on building fundamental balance and core endurance, with Single-Leg Stands (10–15 seconds/leg) progressing to 30–45 seconds, eventually incorporating head turns or light arm movements. Planks progressed from static holds to dynamic variations, such as shoulder taps and leg lifts, with an increase in duration each week. Dual-Task Walking evolved from simple counting while walking to memory tasks and obstacle navigation, challenging both motor and cognitive functions (Jo *et al.*, 2022; Choi *et al.*, 2021)

The Agility Drills Group also underwent a structured progression. In-Out Ladder Drills began with slow, controlled steps and advanced to high-speed, multi-directional footwork by mid-intervention. T-Drills initially involved basic sprint-touch patterns and were scaled to timed circuits with reduced rest. Forward Hurdle Hops started with low, three-hurdle jumps and progressed to higher repetitions with lateral elements and faster turnover. All interventions adhered to a set warm-up, main activity, and cool-down format. Intensity and complexity were adjusted weekly to ensure physiological adaptation, skill reinforcement, and safe progression (Pramono *et al.*, 2023; Selmi, 2024)

The dependent variable was ball control in self-bump passing, measured using a standardized Wall Volley Test (Baumgartner *et al.*, 2016). Participants completed as many successful self-bump passes as possible within 60 seconds. The Wall Volley Test was validated for skill testing and had been previously tested for known-group validity and test-retest reliability in preliminary pilot trials (Clem, 2020; Patenaude *et al.*, 2020).

Data were collected in three phases: (1) pretest administration, (2) eight-week intervention implementation, and (3) posttest administration. Standardized scripts and protocols were used during testing to minimize bias. Pretest and posttest performances were recorded, with researchers blinded to group assignment during scoring.

Descriptive statistics (mean, standard deviation, frequency distribution) were computed. For within-group comparisons (pretest vs. posttest), the Paired Sample T-test was used. For between-group comparisons post-intervention, Analysis of Covariance (ANCOVA) was employed to determine the difference between the two interventions, controlling for the pretest scores, using adjusted scores. A significance level of $p < 0.05$ was set. Effect sizes, indicated by the partial eta squared (η^2p) were also calculated to interpret the magnitude of differences.

Results

Results are presented according to the sequence of research objectives: (1) within-group changes from pretest to posttest, (2) comparison of groups post-intervention, and (3) evaluation of which intervention was more effective. The data presented in the tables were obtained through the administration of the Wall Volley Test, a standardized psychomotor assessment tool designed to measure ball control in volleyball self-bump passing. Participants were evaluated individually by performing as many consecutive self-bump passes as possible against a flat wall within a 60-second time frame. A pass was considered successful if the ball rebounded cleanly off the wall without touching the ground. Scores were recorded as the total number of successful passes within the time limit. The test was administered in a controlled gymnasium environment, using standardized instructions, demonstrations, and scoring protocols to ensure consistency and reduce potential bias. All participants completed both pretest and posttest evaluations under identical conditions, and results were categorized into performance ranges (Poor to Outstanding) based on raw scores to facilitate analysis. Tables 1, 2, and 3 (*see p. 8*) clearly summarize descriptive statistics, within-group comparisons, and between-group comparisons. All tables are referenced and discussed within the text.

Group A (postural control exercises) started with the pretest mean score of 9.80, while Group B (agility drills) began at 9.59, falling under the border of the Fair performance category. After the intervention, Group A improved to a mean of 38.10, while Group B reached 26.87, classified as Good. Although both groups progressed to the Good category, Group A demonstrated a higher average increase. Standard deviation also increased in both groups, indicating more varied posttest scores. Group A's standard deviation (SD) rose from 4.75 to 10.72, while Group B's increased from 4.16 to 7.93. This suggests that while overall performance increased, the range of individual outcomes widened.

Table 2 holds for analyzing the first null hypothesis (Ho_1): the self-bump passing ball control scores between before and after interventions of the two groups are not significantly different. Based on the analysis, both the Postural Control Exercises and Agility Drills showed significant enhancement between the posttest and pretest in terms of task performance, with $t(39) = 17.70$, $p < .001$ for the postural control group, and $t(38) = 16.00$, $p < .001$ for the agility drills category.

In Table 3, the analysis indicated a significant effect of the intervention, $F(1, 76) = 32.20$, $p < 0.001$, suggesting that the intervention had a meaningful impact on the measured outcomes. Furthermore, the large effect size ($\eta_p^2 = 0.30$) underscores the practical significance of these results. This indicates that the intervention not only produced statistically significant changes but also a considerable degree of change in the dependent variable.

Moreover, while critiques suggesting deeper analysis are valid in broader experimental contexts, they are less applicable in this quasi-experimental study. This study focused on evaluating overall effectiveness within a school-based setting using intact, non-randomized groups. Subgroup analyses (e.g., by age or gender) were intentionally excluded due to the limited sample size and insufficient power for such stratified comparisons. Exploring individual-level variability—such as differences in standard deviation—was beyond the scope of this design, which aimed to capture group-level effects. Furthermore, potential confounding variables were statistically controlled through ANCOVA, strengthening internal validity by adjusting for baseline differences. Future studies using randomized or stratified designs may be better suited for such detailed subgroup exploration.

Discussion

These results suggest that both types of training interventions—postural control and agility drills—are effective in enhancing foundational volleyball skills among beginners. The improvements align with expectations based on motor learning and physical education frameworks, confirming that balance, core stability, and agility are critical elements in ball control development.

According to Bernstein's Motor Control Theory (1996), successful movement execution requires the nervous system to achieve ideal control over the various degrees of freedom of the musculoskeletal system. The postural control program, focusing on balance, core stability, and controlled movement patterns, may have directly maximized the students' neuromuscular coordination compared to the agility drills. In addition, the Dynamic Systems Theory (Thelen & Smith, 1994) also helps explain that motor behavior is the result of the real-time interplay between the properties of the individual, the task, and the environment. Postural control training probably has led to a more integrated adjustment by regulating these interacting subsystems, consequently eliciting a more economical motor pattern in volleyball self-bump passing.

In broad agreement with theoretical assumptions, the effects of visual specificity and articulatory difficulty on misalignments were replicated in the present investigation and further extended. For example, it supports the findings of Borzucka *et al.* (2020) and Ardigò *et al.* (2020), which state that better postural control is associated with improved volleyball performance, achieved by enhancing balance, timing, and precision. Additionally, core balance training influences muscle synergy and motor efficiency (Jo *et al.*, 2022; Choi *et al.*, 2021). Despite earlier reports (Pramono *et al.*, 2023; Selmi, 2024), positive effects of training on agility in terms of reaction time and sporting performance, the results of the present study provide a nuanced view, showing that balance-oriented exercises could offer greater effects on fine motor control and stabilization tasks, as in the case of self-bump in volleyball.

From a researcher's perspective, the outcome highlights the pedagogical relevance of designing early sports programs promoting elementary motor abilities (also concerning postural stability and control). Controlled exercise training that challenges balance is proposed to develop neuromuscular coordination in the early stages of learning and may be particularly relevant for preadolescents, who are early beginners, as opposed to fast-moving agility drills. This insight not only guides the teaching sequence in PE but also promotes evidence-based interventions tailored to learners' actual motor skills.

The researcher observed that students who initially struggled with body coordination began showing more confident and deliberate movements as the intervention progressed. These observations reinforced the quantitative findings and underscored the transformative potential of structured postural control training. The simplicity and adaptability of these exercises were especially valuable in real-world PE settings, particularly in resource-limited schools. The intervention's consistency, feasibility, and positive reception among students further validated the inclusion of postural control as a core strategy in developing foundational movement skills.

In addition, the ease with which postural control exercises can be implemented (i.e., requiring minimal equipment) and adapted for various environments suggests that the strategy is feasible and inclusive for use in schools with diverse characteristics. Therefore, the novel findings of this study advance theory and practice by introducing postural control exercises as a more effective training intervention to improve novice PE students' volleyball self-bump passing compared to other interventions.

Conclusion

This study was conducted to evaluate the effectiveness of postural control exercises and agility drills on ball control in self-bump passing among Grade 8 students. Based on the findings, the study's objectives have been met. A postural control intervention yielded more favorable improvements in ball control compared to agility exercises.

In terms of the theoretical frameworks, the findings support the Motor Control Theory, which emphasizes the importance of neuromuscular coordination and proprioception, and the Dynamic Systems Theory, which highlights the interplay between motor, sensory, and cognitive systems in the acquisition of skills.

Identifying the layer of proprioceptive control and integrating it into early-age physical education has significant implications for future training. This provides valuable insight when developing curriculum and program delivery, as it highlights the effectiveness of a structured, skill-based approach to improving motor performance in youth.

To enhance practical application, it is recommended that physical education programs integrate both postural control and agility training in a complementary manner. While postural control develops foundational balance and stability, agility drills enhance dynamic responsiveness, both of which are crucial for executing skills in sports like volleyball. Educators may consider incorporating these interventions progressively and developmentally, tailoring them to match students' readiness levels.

Moreover, emphasizing proprioceptive and skill-based approaches in early education can yield long-term benefits for students' motor development, injury prevention, and overall physical literacy. Such strategies not only foster improved performance but also greater confidence and sustained participation in physical activity, ultimately contributing to lifelong health and well-being.

Conflict of Interest: *The authors declare that there is no conflict of interest regarding the publication of this article.*

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Ethical Approval: *The study was reviewed and approved by the Ethics Committee of Lourdes College, Inc., the researcher's academic institution, in accordance with the ethical standards outlined in the Belmont Report. Informed assent was obtained from student participants, alongside written parental consent, ensuring full ethical compliance.*

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, ensuring academic rigor and integrity. Additionally, Grammarly AI was 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.*

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Table 1

Descriptive Statistics of Pretest and Posttest Scores by Performance Category for Postural Control Exercises and Agility Drills

			Group A Postural Control Exercises				Group B Agility Drills			
			Pretest		Posttest		Pretest		Posttest	
Range		**Description**	f	%	F	%	f	%	f	%
62	71	Outstanding	0	0	1	2.5	0	0	0	0
52	61	Very Good	0	0	4	10	0	0	0	0
24	51	Good	0	0	30	75	0	0	23	59
10	23	Fair	22	55	5	12.5	23	59	16	41
1	9	Poor	18	45	0	0	16	41	0	0
		TOTAL	40	100	40	100	39	100	39	100
		Mean	9.80		38.10		9.59		26.87	
		Description	Fair		Good		Fair		Good	
		Standard Deviation	4.75		10.72		4.16		7.93	

Table 2

Paired Samples T-test Results Comparing Pretest and Posttest Scores for Postural Control Exercises and Agility Drills

Groups	Pretest		Posttest		df	t	P
	M	SD	M	SD			
Postural Control Exercises	9.80	4.75	38.10	10.72	39	17.70*	<.001
Agility Drills	9.59	4.16	26.87	7.93	38	16.00*	<.001

** Significant at 0.05 level.*

Table 3

Analysis of Covariance Results for Posttest Scores Controlling for Pretest

Groups	Pretest		Posttest		F(1,76)	p	η_ρ^2
	M	SD	M	SD			
Postural Control Exercises	9.80	4.75	38.10	10.72	32.20*	<.001	0.30
Agility Drills	9.59	4.16	26.87	7.93			

**Significant at 0.05 level.*

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Original Research Article

The Speed Boost Comes More from Dynamic Running Drills Than Neuromuscular Training

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Abstract: Improving sprint performance in adolescents is essential for enhancing physical fitness and athletic development in school-based programs. This quasi-experimental study examined the effects of dynamic running drills and neuromuscular training on the 100-meter sprint performance of Grade 10 students. A total of 89 participants were divided into two groups, (dynamic running drills (n=43) and neuromuscular training (n=46), and underwent an eight-week intervention. The study aimed to determine the sprint performance level of each group before and after the interventions, assess within-group improvements, and evaluate whether there was a significant difference between the two interventions. Descriptive analysis revealed that both groups started with fair-level sprint speeds and improved to the good category after the intervention. Paired samples t-tests indicated significant improvements in both the dynamic running drills group and the neuromuscular training group, highlighting the effectiveness of both approaches in enhancing sprint performance. However, Analysis of Covariance results showed a significant difference in posttest scores between the two groups when pretest scores were controlled, favoring the dynamic running drills. These findings support the Specificity Principle and Feasibility Theory, emphasizing that targeted, sprint-specific training yields greater improvements in performance. The results also confirm existing literature advocating for sprint-focused interventions in adolescent fitness programs, suggesting that integrating such methods into school curricula can effectively develop students' speed and athletic performance.

Keywords: sprint performance, dynamic running drills, neuromuscular training, physical education, quasi-experimental design, adolescent fitness.

Introduction

Sprint performance is a critical component of athletic ability and general physical fitness (Cochrane & Monaghan, 2021). It embodies the integration of neuromuscular coordination, muscular power, biomechanics, and energy system efficiency, all fundamental to successful athletic performance and the promotion of lifelong health and fitness (Cochrane & Monaghan, 2021; Del Rio, 2021). As the sports and fitness industries have expanded, sprinting capabilities have gained increasing recognition beyond elite athletes. This recognition extends into school-based physical education programs, youth sports, and public health initiatives aimed at combating sedentary lifestyles (Bouchard *et al.*, 2015; Xie *et al.*, 2023). The World Health Organization (2022) emphasizes that incorporating sprint-related physical activities significantly contributes to cardiovascular health, muscular development, metabolic efficiency, and overall well-being. Nevertheless, recent reports indicate a decline in physical fitness among youth populations worldwide, particularly in terms of speed and agility. This decline underscores the urgent need for effective interventions that promote fundamental athletic skills, such as sprinting, from an early age (Maaouia *et al.*, 2023; WHO, 2022).

In light of this, the present study investigates the effectiveness of dynamic running drills and neuromuscular training in enhancing 100-meter sprint performance among junior high school students. While it is delimited to a single public high school, this localized scope is justified by recurring national trends in which physical education programs overemphasize traditional team sports. Studies reveal that Filipino high school PE programs consistently favor basketball and volleyball, often neglecting sprint-specific or biomechanics-focused training (Amoloza *et al.*, 2022; Graciano, 2022; Xie *et al.*, 2023). Challenges related to curriculum alignment and inadequate infrastructure further exacerbate this issue, hindering the integration of technical modules, such as sprinting (Tagare & Poblador, 2023).

Additionally, in the context of the Philippine Department of Education's MATATAG curriculum, while the curriculum integrates general fitness components, it offers minimal structured content on sprint-specific training, as revisions and teacher feedback reveal an emphasis on general movement and play rather than speed-focused instruction (Aquino, 2024). As a result, students have limited exposure to sprinting drills, biomechanics instruction, or speed development techniques, which have been identified as a critical gap in both curriculum delivery and teacher training assessments (Xie *et al.*, 2023). Unless enrolled in specialized tracks, such as the Special Program in Sports (SPS), most students do not receive focused training in sprint performance, highlighting a significant limitation in the development of individual athletic capacities within the mainstream physical education (PE) framework (Poblador & Lagunero-Tagare, 2023; Tagare & Poblador, 2023).

This results in limited structured sprint training opportunities (Cruz, 2022; Howard & Scott, 2019). Although previous quantitative studies have demonstrated that sprint-specific drills and neuromuscular conditioning independently enhance sprint outcomes (Álvarez-Serrano *et al.*, 2023; Haugen *et al.*, 2019), a direct comparative analysis of these interventions among adolescent populations has remained scarce. Furthermore, the long-term benefits and comparative effectiveness of these interventions within school settings have not been sufficiently explored.

Empirical evidence has shown that dynamic drills, such as block starts, flying sprints, and speed endurance runs, improve sprint kinematics by enhancing stride frequency, step length, ground contact time, and overall technical efficiency (Haugen *et al.*, 2019; Kovacs *et al.*, 2018; Skoglund *et al.*, 2023). Similarly, neuromuscular training interventions, which involve structured balance, proprioceptive, and strength drills, are quantitatively linked to significant improvements in sprint speed, postural control, and injury prevention (Deschenes, 2019; Grooms *et al.*, 2022; Zouhal *et al.*, 2019). However, many existing studies have primarily focused on adult, elite, or highly trained populations (Murphy *et al.*, 2023). Studies addressing adolescents in school settings have been limited and often characterized by small sample sizes, outdated training methodologies, or short intervention periods, resulting in inconclusive or non-generalizable findings (Grazioli *et al.*, 2020).

There remains a critical gap in understanding how dynamic running drills and neuromuscular training comparatively influence sprint performance among adolescents in structured educational settings (Crenshaw *et al.*, 2023). Addressing this gap is particularly timely given the Philippine Department of Education's renewed emphasis on physical fitness assessments through the Department of Education (DepEd) (2019). Additionally, the increasing prevalence of sedentary behavior among youth underscores the need to integrate evidence-based, scalable interventions into physical education programs (Bouchard *et al.*, 2015). Investigating accessible, efficient, and effective interventions for school-aged populations could directly inform curricular innovation, athletic development strategies, and public health initiatives (Cruz, 2022).

The purpose of this quantitative study is to determine the comparative effects of dynamic running drills and neuromuscular training on the 100-meter sprint performance of Grade 10 students enrolled in a public school in Cagayan de Oro City. The study's independent variables are the type of intervention program employed (dynamic running drills versus neuromuscular training), while the dependent variable is sprint speed, defined operationally as the meters per second achieved during the standardized 100-meter sprint test (Ariani, 2021; DepEd, 2019).

This study aims to address the following research question: What is the 100-meter sprint performance of participants before and after the intervention? Do the sprint performances of the two groups differ significantly before and after the interventions? Which intervention proves more effective in enhancing 100-meter sprint performance? Correspondingly, the hypotheses of the study are: Ho_1: There is no significant difference in the two groups' 100-meter sprint performance before and after the interventions. Ho_2: Neither intervention is significantly more effective than the other in enhancing sprint performance.

Ultimately, this study aims to make a meaningful contribution to the fields of sports science, education, and youth fitness by providing empirical evidence on low-cost, feasible methods to enhance sprint performance in school settings (Álvarez-Serrano *et al.*, 2023; Haugen *et al.*, 2019). Results may assist physical education teachers, athletic coaches, policymakers, and curriculum developers in designing evidence-based sprint training interventions that are adaptable to varied educational contexts (Barrera *et al.*, 2023). Additionally, findings could encourage broader participation in sprint-based and high-intensity activities, promoting health-related fitness, improving motor skills, and reducing obesity rates among adolescents (López-Samanés *et al.*, 2021). Furthermore, the study aims to provide scientific data to support policy revisions concerning physical education content standards, emphasizing the crucial role of sprinting in holistic youth fitness (DeEed, 2019).

The study is limited to Grade 10 students, aged 15–16, enrolled in a single public high school located in Cagayan de Oro City, Philippines. The intervention spans eight weeks and involves structured training sessions conducted three times per week during regular physical education classes (Cruz, 2022). This scope may seem limited, especially in light of the critique toward previous studies with small sample sizes or narrow populations. However, the study does not claim broad generalizability; instead, it aims to provide a context-specific, empirical contribution that addresses gaps in existing Philippine-based literature and serves as a practical pilot framework for future school-based interventions. Sprint performance is measured using the standardized 100-meter sprint test administered before and after the intervention period (Ariani, 2021). Generalizations beyond this demographic and geographical setting should be approached with caution; however, the findings offer valuable insights into the effectiveness of sprint interventions in comparable educational and age-group contexts (Bouchard *et al.*, 2015; Haugen *et al.*, 2019).

Methods and Materials

This study employed a quasi-experimental, pretest-posttest group design to investigate the effects of dynamic running drills and neuromuscular training on sprint performance. The quasi-experimental approach was selected due to the impracticality of random participant assignment within an educational setting, where class structures were determined by administrative schedules (Bärnighausen *et al.*, 2017; Gopalan *et al.*, 2020).

While quasi-experimental designs lack randomization and are thus more susceptible to selection bias, researchers employ several strategies to address this limitation effectively. Matching participants based on baseline characteristics, such as age, performance, or socioeconomic status, helps control for confounding variables (Lam & Wolfe, 2022). Statistical techniques, such as ANCOVA, regression analysis, and propensity score matching, further reduce initial group imbalances (Andrade, 2021). Pretest-posttest designs enable researchers to observe within-group changes, facilitating the isolation of the intervention's effects. Additionally, selecting comparable schools or classrooms and employing advanced methods, such as interrupted time series or regression discontinuity designs, can enhance internal validity without requiring randomization (Cham *et al.*, 2024).

To facilitate comparison, two experimental groups were established: one group underwent dynamic running drills while the other received neuromuscular training. Although a true control group was not included, the differences between the two intervention groups were analyzed (Bärnighausen *et al.*, 2017). While the absence of a non-intervention control group in quasi-experimental research may limit absolute comparisons, this design choice was intentional and rooted in educational ethics and feasibility (Andrade, 2021; Lam & Wolfe, 2022). In school-based studies, withholding physical activity from a group of students for extended periods raises ethical concerns, particularly when both interventions are evidence-based and aligned with curriculum goals (Lam & Wolfe, 2022). The quasi-experimental research prioritized ecological validity by embedding interventions into actual PE classes, which enhances real-world relevance and supports informed programmatic decisions in school contexts (Buenaventura *et al.*, 2024; Lam & Wolfe, 2022).

The sample consisted of 100 Grade 10 junior high school students, 53 of whom were males and 47 of whom were females, aged 15-16 years, from a public high school in Cagayan de Oro City, Philippines. Each intervention group contained 50 students, selected through complete enumeration sampling, where all eligible Grade 10 students were invited to participate based on specific inclusion criteria (Mohapatra, 2020; Turner, 2020). These criteria required students to submit a Health Appraisal Record (HAR), pass the Physical Activity Readiness Questionnaire (PAR-Q), attend a study orientation, and be free from injuries or health conditions. Students who did not satisfy these conditions were excluded from participation. To maintain logistical feasibility and minimize disruptions, assignment to the groups was based on existing class sections. Ethical approval was granted by the institutional Research Ethics Committee, with informed parental consent and student assent obtained prior to the commencement of the study.

The research was conducted in the school quadrangle, an expansive area suitable for sprinting drills. Data collection and interventions occurred during the students' scheduled MAPEH classes to ensure consistency throughout the study (DepEd, 2019). To minimize external variability, environmental conditions—such as surface type, weather, and supervision—were maintained at a constant level (Sánchez-Sánchez *et al.*, 2020).

The independent variables in this study comprised the two intervention types: dynamic running drills and neuromuscular training. This study implemented two targeted interventions, dynamic running drills and neuromuscular training, over eight weeks to enhance 100-meter sprint performance among high school participants. The dynamic running drills group engaged in sprint-specific exercises, including block starts, flying 30s, and speed endurance runs, structured to progressively increase in intensity and volume across three weekly sessions. These drills aligned with the Specificity Principle of Fitness Training, replicating sprint biomechanics and energy demands to improve acceleration, top speed, and anaerobic endurance. Meanwhile, the Neuromuscular Training Group performed lunges, ladder drills, and ball drop reaction drills, designed to develop lower-body strength, agility, balance, and reaction time. Grounded in Feasibility Theory, these exercises were chosen for their effectiveness and practical application within typical school settings. Both interventions followed a progressive overload model, with distinct warm-up, training, and cooldown phases, ensuring safety, consistency, and ecological validity in a real-world PE context.

Each intervention lasted eight weeks, with three sessions weekly, each lasting approximately 45-60 minutes. The dynamic running drills group engaged in block starts, flying 30s, and speed endurance runs aimed at enhancing stride length, stride frequency, and sprint mechanics (Haugen *et al.*, 2019; Kovacs *et al.*, 2018; Skoglund *et al.*, 2023). Conversely, the neuromuscular training group performed ball drop drills, lunges, and ladder drills to target proprioception, balance, and reaction time (Deschenes, 2019; Grooms *et al.*, 2022; Zouhal *et al.*, 2019). Both groups had standardized warm-up and cool-down exercises, and all interventions were supervised by trained MAPEH teachers to ensure uniformity.

The dependent variable measured was the 100-meter sprint performance, assessed in meters per second (m/s). The 100-meter sprint test adhered to the protocols outlined in the DepEd (2019) for the 40-meter sprint. Timing was conducted using digital stopwatches that recorded up to 0.01-second precision. This test has previously been validated for youth fitness assessments, demonstrating high reliability (ICCs ranging from 0.91 to 0.97) in earlier studies (Darrall-Jones *et al.*, 2016; Vanhelst *et al.*, 2016). The concurrent validity and reliability of sprint performance assessment tools were further supported by findings from Nagahara *et al.* (2017) and Simperingham *et al.* (2016). This research also determined the test-retest reliability of the instrument at $\varrho = 0.928$, ensuring that no modifications were made to the standard 100-meter sprint protocol.

Data collection was carried out in three phases: pretest, intervention, and posttest. During the pretest phase, all participants completed the 100-meter sprint test according to standardized instructions. This was followed by the eight-week intervention phase. Posttest measurements were taken immediately following the intervention, utilizing the same procedures as the pretest. To minimize measurement bias, standardized verbal encouragement and instructions were provided to all participants (Ghanati *et al.*, 2020; Palmer *et al.*, 2022). Furthermore, data collectors were blinded to group assignments during posttesting to reduce bias, thereby enhancing the study's integrity.

Descriptive statistics (mean, standard deviation, frequency distributions) summarized participant characteristics and sprint performance scores. Within-group comparisons (pretest vs. posttest) were analyzed using the Paired Samples t-test. Between-group comparisons were conducted using ANCOVA, which controlled for pretest scores. A significance level of $p < 0.05$ was established. Additionally, effect sizes were calculated to evaluate the magnitude of observed effects.

Results

The results were organized according to the study's research questions, focusing sequentially on (1) the descriptive statistics of the participants' sprint performances, (2) the within-group comparisons of pretest and posttest results, and (3) the between-group comparisons following the interventions.

Tables 1, 2, and 3 (*see p. 18*) summarize the descriptive and inferential statistics findings. The data in these tables were gathered using the 100-meter sprint test, administered before and after the eight-week intervention period. This test was conducted on a standardized surface in a school quadrangle in Cagayan de Oro City. Sprint performance was recorded in seconds using digital stopwatches with 0.01-second precision, and results were converted into meters per second (m/s) for analysis. Pretest and posttest data were recorded for each participant and categorized using established performance ranges, forming the basis for the descriptive statistics (Table 1), paired samples t-tests (Table 2), and ANCOVA (Table 3). All tables were labelled correctly and referenced in the text for clarity and ease of understanding.

As shown in Table 1, the descriptive statistics for the pretest and posttest results of both Group A (Dynamic Running Drills) and Group B (Neuromuscular Training) indicate increases in the mean sprint performance scores. Group A improved from a pretest mean of 5.38 m/s (SD = 1.01) to a posttest mean of 5.96 m/s (SD = 0.97), whereas Group B increased from 5.39 m/s (SD = 0.69) to 5.73 m/s (SD = 0.72). This also means that after the intervention, Group A became 2.26 seconds faster, while Group B also ran 1.35 seconds faster. Students in Group A (Dynamic Running Drills) initially had most participants at the ***fair*** level (44.19%), with no one at the ***outstanding*** level. There were no students categorized in the ***poor*** bracket after the intervention, and 25.58% of them made it to ***very good,*** and the average student changed their category from 5.38 m/s under ***fair*** to 5.96 m/s under ***good***.

In Table 2, there was a significantly higher mean average sprint speed of the dynamic running drills group from 5.38 m/s (SD = 1.01) to 5.96 m/s (SD = 0.97; $t(42) = -10.543$, $p < 001$), the effect size was large (-1.608). Likewise, the Neuromuscular Training group increased from a pretest mean of 5.39 (SD = 0.69) to a posttest mean of 5.73 (SD = 0.72), which was found to be also significantly different ($t(45) = -9.891$, $p < .001$) with a large effect size of -1.458.

Table 3 displays the ANCOVA results comparing posttest sprint performance between the dynamic running drills and neuromuscular training groups, while controlling for their pretest scores. The ANCOVA analyses of the post anchor posttest scores (rank transformed for normality) revealed a significant interaction effect between group and condition, $F(1, 86) = 580.283$, $p < .001$, and the effect size of the partial eta squared is large ($\eta_p^2 = 0.871$).

While the results reveal significant improvements across both groups, it is important to acknowledge potential confounding factors that may have influenced individual performance gains. Differences in biological maturity, motivation levels, diet quality, and sleep duration were not directly controlled or measured in this study. These variables may have affected participants' recovery, effort levels, and physiological adaptation to training. Although randomization was not feasible due to class-based groupings, consistent supervision, structured interventions, and standardized test administration were employed to reduce variability and promote internal validity.

Discussion

This discussion is organized in parallel with the structure of the results section, addressing the three research problems: (1) describing the overall sprint performance before and after the interventions, (2) comparing pretest and posttest outcomes within each group, and (3) determining which intervention was more effective. The clustering of posttest scores into the ***good*** and ***very good*** categories across both groups, and the absence of students in the ***poor*** category after the intervention, indicate significant improvements in sprint performance. This trend was especially pronounced in the dynamic running drills group, which showed an average improvement of 2.26 seconds compared to 1.35 seconds in the neuromuscular training group. These findings reflect gains in sprint velocity and suggest successful adaptation to the training stimuli (Cochrane & Monaghan, 2021; Kramer *et al.*, 2021).

These outcomes are consistent with the findings of Haugen *et al.* (2019) and Palmer *et al.* (2019), who demonstrated the efficacy of sprint-specific and neuromuscular-focused interventions in improving speed and biomechanical efficiency. The observed increases in mean sprint velocity and transition into higher performance categories support the assertion that repeated, structured exposure to either intervention yields substantial physiological benefits in adolescent populations (Murphy *et al.*, 2023; Tottori *et al.*, 2021).

Paired samples t-tests confirmed that both dynamic running drills and neuromuscular training groups experienced statistically significant improvements in 100-meter sprint performance. The large effect sizes suggest meaningful within-group progress, indicating the training programs elicited neuromuscular and biomechanical adaptations. These improvements align with Brearley and Bishop's (2019) Specificity Principle and Valero-Cuevas *et al.*'s (2023) Feasibility Theory, which suggest that properly dosed, context-specific exercises enhance task-relevant motor outputs (Monte & Zamparo, 2019).

Repetitive exposure to sprints, combined with structured warm-ups, rest intervals, and cooldown routines, likely enhances motor learning. Ghanati *et al.* (2020) found that consistent practice routines contribute to concentration and the efficient acquisition of motor patterns. The observed gains across both interventions can be partially attributed to this regimen. Students benefited from repeated movement cycles that likely enhanced their proprioception, limb coordination, and muscular response times, resulting in improved sprint mechanics (Baena-Raya *et al.*, 2021).

ANCOVA results further clarified the relative effectiveness of the interventions, controlling for pretest performance. Dynamic running drills were significantly more effective than Neuromuscular Training, suggesting that task-specific, sprint-focused activities elicit greater performance improvements than general strength or coordination exercises (Haugen *et al.*, 2019; Skoglund *et al.*, 2023).

Dynamic sprint drills such as block starts, flying 30s, and speed endurance training provided direct biomechanical and neuromuscular stimulation (Wang, 2023; Skoglund *et al.*, 2023). These drills focused on acceleration, cadence, and ground contact mechanics, which are crucial in 100-meter sprints. Wu *et al.* (2025) emphasize that speed endurance training enhances maximal effort capacity and reduces the risk of injury.

Conversely, neuromuscular training improved general coordination and muscle activation but lacked the specific biomechanical mimicry of actual sprinting. Lloria-Varella *et al.* (2023) and Wang *et al.* (2022) demonstrated that while neuromuscular training improves baseline fitness, it may be insufficient to trigger sprint-specific adaptations unless combined with more targeted drills.

Meanwhile, both interventions may have strengthened muscle-tendon units, improved joint stiffness regulation, and enhanced the stretch-shortening cycle. Regular exposure to maximal or near-maximal sprints contributes to anaerobic conditioning and lactate threshold shifts, both of which are necessary for improved sprint duration and recovery (Álvarez-Serrano *et al.*, 2023).

Although the interventions were effective, several uncontrolled variables could have contributed to performance changes. Differences in biological maturity, motivational states, dietary patterns, and sleep quality among participants may have influenced their adaptation rates (Matsumura *et al.*, 2022). These confounding variables were not directly controlled or measured due to logistical constraints inherent in the school-based setting.

Nonetheless, all training was implemented under consistent conditions with adequate teacher supervision and time-of-day control, minimizing environmental biases. The use of a standardized digital timing system ensured precision in outcome measurement (Sánchez-Sánchez *et al.*, 2020).

From a pedagogical standpoint, the findings underscore the need to integrate sprint-specific drills in school athletic programs. The feasibility and impact of dynamic drills suggest they can be readily adapted even in resource-limited settings. Teachers and coaches should prioritize movement-specific interventions, as these are more likely to result in measurable gains in adolescent performance (Alexander *et al.*, 2019; Faelli *et al.*, 2021).

Furthermore, the superior effect of dynamic running drills reinforces the importance of exercise specificity in Physical Education. These findings advocate for curriculum development that mirrors actual sports demands, ensuring alignment between training protocols and performance outcomes. This is especially relevant in junior athletic development programs where foundational speed, coordination, and agility are key (Rasyid *et al.*, 2023).

Conclusion

Based on the findings, the objective to evaluate the effectiveness of dynamic running drills and neuromuscular training on the 100-meter sprint performance of Grade 10 students has been met. Both interventions significantly improved sprint performance; however, dynamic running drills yielded more substantial gains, supporting the Specificity Principle, which emphasizes the role of task-specific practice in enhancing athletic performance, and the Feasibility Theory, which advocates for practical, context-appropriate training methods in real-world educational settings.

These results highlight the value of incorporating sprint-focused drills—such as block starts, flying sprints, and speed endurance runs—into school-based physical education programs. These drills directly simulate sprint biomechanics, leading to improved stride frequency, ground contact efficiency, and acceleration. While neuromuscular training also promoted improvements through enhanced proprioception, coordination, and balance, its effects were comparatively less pronounced in developing sprint-specific mechanics.

The study highlights that while both training approaches contribute to adolescent fitness and motor development, dynamic running drills are more effective in enhancing sprint speed within a structured school context. Importantly, this does not diminish the value of neuromuscular training, which remains a vital component of injury prevention and baseline movement quality. Instead, the findings suggest that integrating both modalities—sprint-specific drills for direct performance gains and neuromuscular training for foundational movement support—offers a balanced and developmentally appropriate approach to adolescent athletic development.

From a pedagogical standpoint, integrating such interventions into physical education curricula is both feasible and impactful, especially in resource-constrained settings. Teachers and curriculum developers are encouraged to design PE programs that include structured, progressive sprint drills alongside general strength and coordination training. Sample applications include: (1) embedding sprint drills into fitness modules; (2) allocating weekly sessions focused on acceleration and speed mechanics; (3) using task-specific warm-ups and cooldowns; and (4) rotating students through sprint and neuromuscular circuits tailored to their fitness levels.

While the quasi-experimental design and context-specific sample (Grade 10 students from a single public high school) limit generalizability, the findings provide a strong case for scaling similar interventions in comparable educational settings. Future research may explore the longitudinal effects of combined sprint and neuromuscular training, test these methods across different age groups and regions, and adopt randomized controlled trials (RCTs) to strengthen causal inferences. Such investigations can further guide evidence-based physical education reforms, promote functional fitness, and address the decline in youth sprint performance globally.

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AI Declaration: *This study utilized artificial intelligence tools to assist in the preparation of this article. Specifically, ChatGPT was used to convert the full thesis manuscript into a reduced journal article format with human supervision and editing, ensuring academic rigor and integrity. Additionally, Grammarly AI was 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.*

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Table 1

Descriptive Statistics of Pretest and Posttest Scores by Performance Category for Dynamic Running Drills and Neuromuscular Training

			Group A Dynamic Running Drills				Group B Neuromuscular Training			
			Pre-test		Posttest		Pre-test		Posttest	
Range (m/s)		Description	f	%	F	%	f	%	f	%
7.56	10.00	Outstanding	0	0.00	2	4.65	0	0.00	0	0.00
6.56	7.55	Very Good	6	13.95	11	25.58	2	4.35	8	17.39
5.46	6.55	Good	14	32.56	13	30.23	19	41.30	19	41.30
4.06	5.45	Fair	19	44.19	17	39.53	24	52.17	19	41.30
1.00	4.05	Poor	4	9.30	0	0.00	1	2.17	0	0.00
		TOTAL	40	100	43	100	43	100	46	100
		Mean	5.38		5.96		5.39		5.73	
		Description	Fair		Good		Fair		Good	
		Standard Deviation	1.01		0.97		0.69		0.72	

Table 2

Paired Samples T-test Results Comparing Pretest and Posttest Scores for Dynamic Running Drills and Neuromuscular Training

Groups	Pretest		Posttest		df	t	p
	M	SD	M	SD			
Dynamic Running Drills	5.38	1.01	5.96	0.97	42	-10.543*	<.001
Neuromuscular Training	5.39	0.69	5.73	0.72	45	-9.891*	<.001

** Significant at 0.05 level.*

Table 3

Analysis of Covariance Results for Posttest Scores Controlling for Pretest

Groups	Pretest		Posttest		F(1,86)	p	η_ρ^2
	M	SD	M	SD			
Dynamic Running Drills	5.38	1.01	5.96	0.97	580.283*	<.001	0.871
Neuromuscular Training	5.39	0.69	5.73	0.72			

**Significant at 0.05 level.*

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Original Research Article

From Dance Floors to Playgrounds: Improving Eye-Foot Coordination with Southeast Asian Traditions

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Abstract: In the modern digital era, where students spend long hours in front of screens and less time being physically active, the acquisition of fundamental motor skills—specifically eye-foot coordination—is usually overlooked. This research explores culturally embedded activities as potential alternatives by examining the effectiveness of Southeast Asian traditional dances and games as interventions to enhance eye-foot coordination among Grade 10 students. Using a quasi-experimental design, 69 students were divided into two groups: Group A (n=34) participated in traditional dances (Tinikling, Kuda Lumping, Palikatri) while Group B (n=35) engaged in traditional games (Chinlone, DaCau, Patintero). Eye-foot coordination was assessed using Johnson's Soccer Wall-Volley Test, both before and after intervention. Findings revealed that both interventions led to significant improvements in eye-foot coordination, with the traditional dances performing slightly better, as indicated by a mean increase from 28.40 to 35.90 in the posttest, compared to games, which showed a mean increase from 28.70 to 34.80 in the posttest. The research validated theories on Game-Based Learning, Sensory-Motor Theory, and Social Constructivism, highlighting the significance of structured rhythmic activities in enhancing motor skills. These findings promoted the inclusion of traditional Southeast Asian activities in physical education programs to foster motor development and cultural participation.

Keywords: Eye-foot coordination, Southeast Asia, traditional dances, traditional games, quasi-experimental design

Introduction

Eye-foot coordination remained a critical skill essential in various physical activities, including sports, dance, and daily functional movements (Barnes *et al.*, 2024; Doe & Smith, 2018). It facilitated individuals' ability to synchronize visual perception with precise foot movements, significantly contributing to agility, balance, motor control, and injury prevention (Basman & Gunawan, 2021; Ramli *et al.*, 2023). However, with the proliferation of digital screen usage, particularly among adolescents in the Philippines, where mobile device use accounted for about 32.5% of daily activities (Navarro, 2024), concerns about declining physical competencies, particularly motor coordination skills, escalated (Fadhli *et al.*, 2022). Addressing this deterioration became crucial in promoting public health, enhancing sports development, and enriching educational programs.

This study investigated the measurable improvement in eye-foot coordination through culturally embedded interventions that incorporated Southeast Asian traditional dances and games. Despite the known negative impact of high-speed digital gaming on visual processing and neuromotor responses (West *et al.*, 2020), few studies have quantitatively examined alternative interventions aligned with cultural and educational goals.

Prior quantitative research confirmed that structured physical activities, such as dance and game-based training, significantly improved motor skills, proprioception, and spatial awareness (Norouzi *et al.*, 2019; Sintia *et al.*, 2022). Traditional Southeast Asian activities, such as Tinikling, Kuda Lumping, Chinlone, and Patintero, offered dynamic footwork patterns that demanded coordination and sensory-motor integration (Aung-Thwin, 2020; Santos *et al.*, 2019). However, there remained a scarcity of controlled experimental designs quantifying these activities' specific effects on eye-foot coordination.

Although the cultural and physical benefits of Southeast Asian traditional activities have been acknowledged (Franco *et al.*, 2022; Rosala & Budiman, 2020), empirical validation through quasi-experimental methods has been lacking. This gap highlighted the need to scientifically validate the role of culturally relevant interventions in contemporary educational settings.

The purpose of this quantitative study was to determine the effectiveness of Southeast Asian traditional dances and games in enhancing the eye-foot coordination of Grade 10 students. The independent variable was the type of intervention (traditional dances versus traditional games), and the dependent variable was the eye-foot coordination performance measured through the Soccer Wall-Volley Test.

This study addressed three research questions: (1) How did participants in each group perform in the pretest and posttest in terms of eye-foot coordination? (2) Did each group's performance significantly improve from pretest to posttest? (3) Was there a significant difference in the increments of improvement between the two groups? The following hypotheses were tested: Ho1: There was no significant difference between the pretest and posttest within each group; Ho2: There was no significant difference between the groups in terms of performance increment.

The findings contributed to theory by supporting frameworks such as Game-Based Learning (Gee, 2003), Sensory-Motor Theory (Todd *et al.*, 2015), and Social Constructivism (Vygotsky, 1978). Practically, the results informed curriculum developers, educators, and policymakers about culturally relevant methods for improving motor skills. The study emphasized that integrating traditional activities into physical education curricula could simultaneously develop motor competence and cultural appreciation.

The study was delimited to Grade 10 students in a private sectarian school in Misamis Oriental during the 2024–2025 academic year. It employed a quasi-experimental design with a five-week intervention period, focusing on Southeast Asian traditional dances and games as primary interventions to enhance eye-foot coordination.

Methods and Materials

This study employed a quasi-experimental pretest-posttest non-equivalent groups design. A quasi-experimental design was appropriate due to the use of intact heterogeneous classes, which made randomization impractical yet allowed for comparisons between distinct intervention groups (Reichardt *et al.*, 2023).

Participants included 69 Grade 10 students, ages 15–16, from a private sectarian school in Misamis Oriental. Group A consisted of 34 students assigned to traditional dance interventions (Tinikling, Kuda Lumping, Palikatri) and Group B of 35 students assigned to traditional games (Chinlone, DaCau, Patintero). Convenience sampling was utilized. The inclusion criteria were Grade 10 enrollment, physical fitness, and parental consent; students with injuries or disabilities that affected motor function were excluded.

Prior to the intervention, both groups underwent a pretest using the Soccer Wall-Volley Test (Johnson, 1963) to establish baseline measurements of their eye-foot coordination. This validated tool has a test-retest reliability coefficient of 0.97 (Daneshjoo *et al.*, 2013). Participants volleyed a soccer ball against a wall for 30 seconds, and the number of successful volleys minus faults across three trials was recorded. Standardized instructions were used to minimize bias.

Group A participated in a structured five-week program that focused on traditional Southeast Asian dances. The intervention was conducted in the school's gymnasium under standardized conditions, with two sessions per week. Each session lasted approximately 45 minutes, including warm-up and cool-down routines. The dance activities were delivered sequentially, one per week. In Week 1, students learned the basic movements of Tinikling, a Filipino folk dance, and performed it in Week 2. In the same week, they were introduced to Kuda Lumping, a traditional Indonesian dance that they rehearsed and performed in Week 3. Week 4 was dedicated to learning Palikatri, a traditional dance form that involves synchronized footwork, culminating in a performance task in Week 5. Each session focused solely on one dance form, allowing students adequate time for skill development and mastery.

Group B followed the same session structure and schedule as Group A, but focused on traditional Southeast Asian games. In Week 1, students were introduced to Chinlone, a Myanmar-based game that involves juggling a rattan ball with the feet. A performance task was followed in Week 2, alongside the introduction of Da Cau, a Vietnamese foot badminton game. Students practiced and performed Da Cau in Week 3. In Week 4, they learned Patintero, a traditional Filipino game that emphasizes agility and coordination. This game was practiced throughout the week and performed in Week 5. Like Group A, each session for Group B focused on one game at a time, allowing structured and progressive skill development.

At the end of the five-week intervention, all participants underwent a posttest using the same Soccer Wall-Volley Test used in the pretest. This was done to determine any improvements in their eye-foot coordination following the intervention. Testing conditions and instructions were kept consistent with the pretest to ensure reliability and minimize bias.

Descriptive statistics, including means and standard deviations, were computed to summarize performance results. A Paired Sample t-test was used to analyze within-group differences between pre- and posttest scores. Additionally, ANCOVA was employed to compare posttest results between Group A and Group B, using pretest scores as covariates to control for baseline differences. Statistical significance was set at $p < .05$, allowing for a rigorous comparison of the effectiveness of the two interventions on improving eye-foot coordination.

Results

Data collected from the Soccer Wall-Volley Test (Johnson, 1963) pretest and posttest are organized using tables (*see p. 25*) according to the three research questions. Table 1 shows the descriptive statistics for pretest and posttest scores of each group. Group A (Dance) had a pretest mean score of 28.40 (SD = 6.36) and a posttest mean score of 35.90 (SD = 6.10). Group B (Games) had a pretest mean score of 28.70 (SD = 5.59) and a posttest mean score of 34.80 (SD = 5.35).

Table 2 presents the results of the paired sample t-test comparing pretest and posttest scores within each group. The paired sample t-test indicated that both groups demonstrated statistically significant improvements, with t-values of 50.60 and 37.60, respectively, and p-values < 0.001, thus, rejecting the null hypothesis (Ho_1), which stated that there is no significant difference in the eye-foot coordination test results of the two groups during the pretest and posttest.

Table 3 shows the ANCOVA results, comparing posttest scores between the groups while controlling for pretest scores. The ANCOVA results revealed a significant group effect ($F(1, 66) = 41.60$, $p < .001$). The posttest comparison indicated that Group A (Dance) performed better than Group B (Games) by a mean difference of 1.10 points, leading to the rejection of Ho_2. Partial eta squared ($\eta_\rho^2 = 0.39$) also indicates a large effect size. Thus, traditional dances were more effective in enhancing eye-foot coordination than traditional games.

Discussion

The major findings of this study indicated that both the dance group and the games group demonstrated significant improvements in eye-foot coordination from pretest to posttest. The null hypothesis Ho_1, which stated that there is no significant difference in the eye-foot coordination test results of both groups during the pretest and posttest, was rejected. Moreover, a significant difference was found between the two groups' posttest results, leading to the rejection of Ho_2. Traditional dances were found to be more effective than traditional games in enhancing eye-foot coordination.

The results suggest that participation in both Southeast Asian traditional dances and games positively influenced students' eye-foot coordination. These findings align with prior studies that emphasized the importance of rhythmic, movement-based activities in motor coordination development (Ramli *et al.*, 2023; Rosniawati *et al.*, 2024; Sintia *et al.*, 2022). The structured and rhythmic nature of dances such as Tinikling and Kuda Lumping likely provided more consistent motor learning opportunities compared to the more reactive and unpredictable movements required in traditional games like Chinlone and Patintero (Douka *et al.*, 2019; Wołoszyn *et al.*, 2021).

For Problem 1, the descriptive findings revealed that both the dance and games groups showed improvements in eye-foot coordination from pretest to posttest, aligning with previous studies that emphasized the positive effects of rhythmic activities and structured play on neuromuscular adaptation (Norouzi *et al.*, 2019; Wołoszyn *et al.*, 2021). This affirms that traditional movement practices, whether dance- or game-based, stimulate improvements in motor coordination.

For Problem 2, the Paired Sample t-Test results confirmed significant improvements within each group from pretest to posttest. This supports existing evidence that structured physical activities enhance coordination skills through consistent sensory-motor engagement (Douka *et al.*, 2019; Sintia *et al.*, 2022). Both interventions—traditional dances and traditional games—proved effective, underscoring that even culturally diverse movement activities can be vital components of motor skills development programs (Franco *et al.*, 2022; Rosniawati *et al.*, 2024).

For Problem 3, the ANCOVA results demonstrated a significant difference favoring traditional dance over games, suggesting that repetitive, rhythmically patterned movement may be more beneficial for developing eye-foot coordination. This finding complements earlier works on the superiority of rhythmic structured activities for motor learning (Todd *et al.*, 2015; Wołoszyn *et al.*, 2021). Traditional dances such as Tinikling and Kuda Lumping provided regular, predictable patterns that may have better reinforced neuromuscular efficiency compared to the dynamic, less predictable movement in games like Patintero and Chinlone (Sintia *et al.*, 2022; Wahyuniati *et al.*, 2023).

These findings corroborate the Sensory-Motor Theory (Todd *et al.*, 2015), which posits that consistent sensory input synchronized with motor output enhances motor learning and control. The results also support Social Constructivism Theory (Vygotsky, 1978), showing that collaborative learning in traditional dances enhanced not only motor skills but also cultural engagement. Furthermore, Game-Based Learning Theory (Gee, 2003) is partially supported, as game interventions yielded improvements, although to a lesser extent compared to dance-based interventions.

This study highlights the potential for integrating Southeast Asian traditional dances and games into physical education curricula to promote motor skill development and cultural appreciation (Franco *et al.*, 2022; Rajarajan & Palanikumar, 2023). Educators, practitioners, and curriculum developers could use these findings to design culturally enriched physical activities that also serve developmental purposes.

Conclusion

The purpose of this study was to evaluate and compare the effectiveness of Southeast Asian traditional dances and games in enhancing the eye-foot coordination of Grade 10 students. The study specifically addressed the gap concerning the quantitative impact of traditional movement-based activities on coordination.

Both groups showed significant improvements in eye-foot coordination from pretest to posttest, supporting the rejection of Ho_1. Furthermore, ANCOVA analysis revealed a significant difference favoring the dance group, leading to the rejection of Ho_2. Thus, traditional dances proved more effective than traditional games in enhancing eye-foot coordination.

The findings contribute to the growing body of evidence supporting the use of culturally relevant physical activities to enhance motor skills. Integrating Southeast Asian traditional dances and games into educational curricula can serve as a valuable approach for fostering both motor development and cultural appreciation among students.

While this study offers meaningful insights, it is limited to a relatively short intervention period and the specific sample of Grade 10 students from a single private school. Future research should explore longer intervention periods, larger and more diverse populations, and alternative coordination measurement tools.

Future studies may also investigate variations in intervention intensity, the effects of hybrid dance-game programs, and longitudinal impacts on coordination and physical fitness.

This study highlights the promise of culturally grounded movement activities in education, paving the way for broader inclusion of traditional arts in physical education for holistic student development.

Conflict of Interest: *The authors declare that there is no conflict of interest regarding the publication of this article.*

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AI Declaration: *This study utilized artificial intelligence tools to assist in the preparation of this article. Specifically, ChatGPT was used to convert the full thesis manuscript into a concise journal article format with human supervision and critical editing to maintain academic rigor and integrity. Additionally, Grammarly AI was employed to enhance the language clarity, tone, and grammatical quality of the final manuscript. All AI-generated outputs were thoroughly reviewed, verified, and edited by the authors to ensure scholarly standards were upheld.*

Data Availability Statement: *The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.*

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Table 1

Descriptive Statistics of Pretest and Posttest Scores by Performance Category for Southeast Asian Traditional Dances and Games

			Group A (Southeast Asian Traditional Dances)				**Group B** (Southeast Asian Traditional Games)			
			Pretest		Posttest		Pretest		Posttest	
Range		**Description**	f	%	F	%	f	%	f	%
>	42	Outstanding	0	0.0	7	20.0	0	0.0	4	11.4
37	41	Very Good	5	14.7	9	26.5	3	8.6	11	31.4
31	36	Good	8	23.5	9	26.5	11	31.4	9	25.7
25	30	Fair	10	29.4	9	26.5	11	31.4	11	31.4
<	24	Poor	11	32.3	0	0.0	10	28.6	0	0.0
		TOTAL	34	100.0	34	100.0	35	100.0	35	100.0
		Mean	28.40		35.90		28.70		34.80	
		Description	Fair		Good		Fair		Good	
		Standard Deviation	6.36		6.10		5.59		5.35	

Table 2

Paired Samples T-test Results Comparing Pretest and Posttest Scores for Southeast Asian Traditional Dances and Games

Groups	Pretest		Posttest		df	t	p
	M	SD	M	SD			
Southeast Asian Traditional Dances	28.40	6.36	35.90	6.10	33	50.60*	<.001
Southeast Asian Traditional Games	28.70	5.59	34.80	5.35	34	37.60*	<.001

** Significant at 0.05 level.*

Table 3

Analysis of Covariance Results for Posttest Scores Controlling for Pretest

Groups	Pretest		Posttest		F(1,66)	p	η_ρ^2
	M	SD	M	SD			
Southeast Asian Traditional Dances	28.40	6.36	35.90	6.10	41.60*	<.001	0.39
Southeast Asian Traditional Games	28.70	5.59	34.80	5.35			

**Significant at 0.05 level.*

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Original Research Article

Utilizing Balance and Hand Grip Strength Exercises in Improving Softball Overhand Throwing Accuracy

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Abstract: Accurate overhand throwing in softball is vital for defensive performance and overall game success, yet it is often underemphasized in training programs. This quasi-experimental study investigated the comparative effectiveness of handgrip strength exercises and balance exercises in improving softball throwing accuracy. A total of 120 male college students, aged 18-25 years, enrolled in a softball course were assigned to two intervention groups: one performed handgrip strength exercises, and the other underwent balance exercises. The diamond dispatch challenge test was used to assess throwing accuracy before and after an eight-week intervention. Results showed significant improvement in both groups. The handgrip strength group progressed from *developing* to *exceptional precision*, while the balance group improved to *high accuracy*. Statistical analysis using Analysis of Covariance revealed a significant difference between groups, favoring the handgrip exercises group. This suggests that while both interventions enhance overhand throwing accuracy, handgrip strength training produces greater gains. The findings align with biomechanical principles, emphasizing that the mechanics of ball release, particularly control of the forearm, hand, and fingers, are critical to accuracy. Strengthening these areas directly enhances precision and force regulation during release. Although balance contributes to postural stability, its effect on throwing accuracy is more indirect. These results support the integration of handgrip strength training into softball conditioning programs, with balance exercises included to address stability needs. Future studies may explore combined or extended interventions to further enhance effectiveness.

Keywords: Handgrip strength, balance exercises, softball overhand throwing accuracy, sports skill enhancement, quasi-experimental design

Introduction

Throwing accuracy in softball is a crucial skill that significantly contributes to effective defensive plays and overall team performance, such as making precise throws to bases to prevent scoring (Hermassi *et al.*, 2019; Ramsey & Crotin, 2019). One universal truth in fastpitch softball is that basic overhand throwing remains the most under-taught part of the game (Donaldson *et al.*, 2020; Elian, 2024). This is a major oversight, especially given that most errors in softball are attributed to poor throws (Painter *et al.*, 2024). Despite this, accuracy training continues to be underemphasized in favor of speed and strength development. This issue is particularly evident in the Philippine collegiate context, where training practices often face constraints due to limited resources and contextual challenges (Garcia, 2021; Roxas-Soriano *et al.*, 2020).

Softball coaches frequently struggle to apply consistent training interventions across athletes with varying skill levels, particularly due to differences in mechanics such as stride knee flexion, elbow flexion, and trunk rotation, all of which influence throwing precision (Donaldson *et al.*, 2020; Manzi *et al.*, 2022). Even elite athletes face difficulty maintaining high accuracy levels, as slight changes in release angle or finger positioning can drastically affect performance (Kusafuka *et al.*, 2023). On a biomechanical level, effective overhand throwing requires coordinated force transmission from the lower extremities and trunk to the upper body (Zaremski *et al.*, 2017). Yet, coaches often face challenges in implementing conditioning programs that target all relevant muscle groups (Downs *et al.*, 2021).

Locally, some research has addressed issues surrounding softball and sports in general, including the challenges that student-athletes face in balancing academics and athletics (Garcia, 2021), as well as the broader research culture in Philippine higher education institutions (Roxas-Soriano *et al.*, 2020). However, few studies have tackled the specific issue of improving overhand throwing accuracy.

Two main interventions were considered: balance training and handgrip strength exercises. Balance exercises have been shown to enhance throwing performance by improving dynamic stability, trunk control, and reactive balance—all of which contribute to more accurate and controlled throws (Cüre *et al.*, 2020; Kim *et al.*, 2022; Sookbat *et al.*, 2019). On the other hand, handgrip strength has been linked to improved force application and ball control during release, thereby enhancing both velocity and accuracy (Hermassi *et al.*, 2019; García-Carrillo *et al.*, 2023; Ab Razak *et al.*, 2018). Despite this, few studies have directly compared these two interventions in the context of softball accuracy.

Thus, this study aimed to determine the effectiveness of handgrip strength exercises and balance exercises in improving the accuracy of softball overhand throws among male college students. Specifically, it addressed the following research questions: (1) What was the softball overhand throwing accuracy of the groups before and after the interventions? (2) How did the two groups compare in their overhand throw accuracy before and after the interventions? (3) Which of the interventions was more effective in improving overhand throwing accuracy? Meanwhile, the following null hypotheses were tested: Ho_1: There is no significant difference between the pretest and posttest throwing accuracy within each group. Ho_2: Neither of the two interventions is more effective in improving the overhand throwing accuracy.

The theoretical framework supporting the alternative hypotheses was grounded on three key theories. The Kinetic Chain Biomechanical Principle posits that optimal throwing accuracy depends on the efficient and sequential generation and transfer of force through body segments (Ellenbecker & Aoki, 2020; Fasbender *et al.*, 2020). The Motor Control Theory emphasizes that stability, proprioception, and coordinated segmental actions are vital for precision-based motor skills such as throwing (Hug & Tucker, 2017). The Neuromuscular Adaptation Theory posits that targeted strength or balance training enhances motor unit recruitment and intermuscular coordination, leading to improved motor performance (Tomazin *et al.*, 2021).

The findings of this study offer practical applications for sports educators, coaches, and physical education teachers by validating that both balance and handgrip exercises can be effectively incorporated into training programs to enhance softball throwing accuracy. Theoretically, it contributes to a growing body of research affirming the role of neuromuscular and postural factors in sports performance (Fu *et al.*, 2022; Oyama & Palmer, 2022).

Methods and Materials

This study employed a quasi-experimental pretest-posttest design with non-equivalent groups. A quasi-experimental approach was deemed appropriate because random assignment of participants to groups was not feasible within the academic setting. Students were pre-assigned to intact classes, and reassigning them could have disrupted academic schedules. This design allowed the researchers to implement interventions and assess changes in softball overhand throwing accuracy over time (Edmonds & Kennedy, 2016).

The participants consisted of 120 male college students, aged 18 to 25 years, who were enrolled in the PED014 (Softball) class at a university in Lanao del Sur. Convenience sampling was employed by using pre-existing class sections, acknowledging the potential limitation of selection bias. Inclusion criteria included (1) enrollment in the PED014 (Softball) course, (2) physical fitness clearance, and (3) no current musculoskeletal injuries. Exclusion criteria included (1) prior participation in varsity-level softball or baseball teams and (2) any condition limiting participation in strength or balance exercises. Participants were divided into two experimental groups: Group A (Handgrip Strength Exercises) and Group B (Balance Exercises).

The study was conducted at the university's softball field. Contextual factors, such as weather conditions, field accessibility, and class schedules, were considered to maintain consistency in the training and testing environments. Efforts to minimize environmental variability included scheduling sessions during dry weather, ensuring equipment uniformity, and holding sessions at consistent times of day. During rainy days, training and testing sessions were moved indoors to the university's grandstand to ensure continuity under safe and consistent conditions.

Group A underwent a handgrip strength exercises program involving three main exercises: (1) finger extension exercises using rubber bands, where participants stretched the band outward using all fingers simultaneously to strengthen finger extensors (Rahmawati *et al.*, 2021); (2) tennis ball squeezes, requiring participants to grip and release a tennis ball with maximum force repeatedly (Subagio *et al.*, 2024); and (3) handgrip compressions using foam hand grippers, performed in sets to fatigue to enhance grip endurance (Cronin *et al.*, 2017). Participants completed three sets of 10–15 repetitions for each exercise during every session. Each repetition was performed slowly and under control, ensuring a full range of motion and maximal voluntary effort.

Group B underwent a balance training exercises program composed of (1) single-leg stance with leg swings, where participants balanced on one foot while swinging the opposite leg forward and backward to challenge dynamic stability (Promsri, 2022); (2) lateral bounds, involving side-to-side hopping movements with emphasis on maintaining balance upon landing (Avelar *et al.*, 2016); and (3) single-leg ball catching drills, requiring participants to catch and return a ball while balancing on one foot, promoting dynamic postural control (Brachman *et al.*, 2017). Balance activities were performed in sets lasting 30–60 seconds per drill. Participants were instructed to progressively increase the difficulty by either closing their eyes, increasing the range of leg swings, or catching balls of different weights and sizes as they advanced.

Both interventions lasted eight weeks, with sessions conducted three times per week, each session lasting approximately 45 minutes. Sessions were directly supervised by trained facilitators to ensure adherence to the protocols, correct execution of techniques, progressive overload based on participants' improvements, and immediate correction of improper form when necessary.

The Diamond Dispatch Challenge (Gomez *et al.*, 2025) was used to measure softball overhand throwing accuracy. It is a game-based test designed to assess overhand throwing accuracy in softball, particularly from the catcher's position to various fielding targets, including first base, second base, third base, the pitcher, and a roaming shortstop. It mimics real-game conditions by using standardized equipment and procedures to evaluate a player's precision when aiming at both stationary and moving targets. The test's reliability was confirmed through pilot testing with both female athletes and non-athlete groups, yielding strong statistical results (Cronbach's $\alpha = 0.81$) and additional trials (Spearman-Brown = 0.90), which support the test's consistency and accuracy for measuring overhand throwing performance in softball.

Before the intervention, participants completed a pretest using the Diamond Dispatch Challenge. Following the eight-week intervention, a posttest was administered under standardized conditions, with consistent equipment, environmental settings, and clear instructions. Attendance sheets and direct supervision were employed during training and testing sessions to monitor compliance and ensure fidelity to the intervention protocols.

Ethical approval was obtained from the Research Ethics Committee of Lourdes College, Inc., the host academic institution. Participants were informed about the study's purpose, procedures, and potential risks. Written informed consent was secured from all participants. Throughout the study, the ethical principles of respect for persons, beneficence, and justice, as outlined in the Belmont Report, were upheld. Confidentiality was maintained by anonymizing data and securely storing all research records.

Results

Tables 1, 2, and 3 (*see page 34*) summarize the study's results. Table 1 summarizes the pretest and posttest scores of softball overhand throwing accuracy for Group A (handgrip strength exercises) and Group B (balance exercises). It categorizes performance into five levels, with frequencies, percentages, mean scores, descriptions, and standard deviations for both tests.

As shown in Table 1, Group A, which underwent Handgrip Strength Exercises, recorded a pretest mean score of 7.38, categorized as ***developing***, and improved to a posttest mean of 16.93, classified as ***exceptional precision***. Correspondingly, Group B, Balance Exercises, exhibited a pretest mean of 7.03, also classified under ***developing***, and advanced to a posttest mean of 15.73, designated as ***high accuracy***. These findings indicate considerable advancements in overhand throwing accuracy for both groups following the interventions, with Group A achieving a marginally superior performance category compared to Group B. Furthermore, the standard deviations demonstrate a decrease from pretest to posttest in both groups, indicating more consistent performance among participants following the intervention.

Table 2 presents the mean scores of the pretest and posttest for both groups (handgrip exercise and balance exercises), which were compared using a paired-sample t-test. This analysis evaluates whether each intervention significantly enhances softball overhand throwing accuracy following eight weeks of training.

As presented, both groups exhibited statistically significant improvements in their overhand throwing accuracy following the interventions. For the handgrip strength exercises group, the mean score elevated from 7.383 to 16.933, accompanied by a t-value of -32.979 ($p < .001$) and a substantial effect size of -4.258.

Likewise, the balance exercises group demonstrated an increase from a mean score of 7.033 to 15.733, with a t-value of -21.052 ($p < .001$) and a considerable effect size of -2.718. These findings signify that both forms of exercises effectively contributed to a notable improvement in the overhand throwing accuracy of the participants, thereby invalidating the null hypothesis (H_{O1}), which posited that no significant difference would exist prior to and following the interventions within each group.

Table 3 presents the Analysis of Covariance for the two groups in improving overhand throwing accuracy. A rank-based transformation method was employed to normalize the dataset, enabling ANCOVA to differentiate between handgrip and balance exercises.

The analysis of covariance assessed the effect of balance exercises versus handgrip exercises on the participants' overhand throwing accuracy, while controlling for pretest scores. The findings indicated a statistically significant effect on posttest performance once pretest differences were accounted for, $F(1, 117) = 5.82$, $p = .017$, partial $\eta_p^2 = .047$, reflecting a large effect size. Therefore, the null hypothesis, which states that none of the interventions is more effective than the others, is rejected. This finding suggests that while both types of throwing interventions may be effective among softball players, it is revealed that handgrip strengthening exercise yielded more effects in improving overhand throwing accuracy than balance exercises. available to them, without jeopardizing the effectiveness of either approach on overhand throwing accuracy.

Additionally, this study controlled confounding variables by using ANCOVA to account for pretest differences, ensuring that posttest improvements were due to the interventions. Standardized testing procedures, consistent training duration, and similar group baselines further minimized external influences, supporting the validity of the findings.

Discussion

Based on the results for Problem 1, the softball overhand throwing accuracy of both groups was initially at the ***developing*** level before the intervention. After undergoing their respective eight-week exercise programs, both groups showed significant improvements. The handgrip strength exercise group improved to an ***exceptional*** level of precision, while the balance exercise group improved to a ***high*** level of accuracy. This indicates that both interventions were effective in enhancing the participants' overhand throwing accuracy.

At the pretest, participants assigned to the handgrip strength exercises group showed a low mean score of 7.38, indicating a developmental level. This low performance could be attributed to limited baseline grip strength and insufficient neuromuscular control over ball release during throws. According to García-Carrillo *et al.* (2023), grip strength is a significant determinant of upper limb performance and precision in throwing sports, and deficits in hand strength can directly impair control. Without prior targeted grip conditioning, participants struggled to stabilize and release the ball accurately, explaining their initial low scores. Following the intervention, the group's mean score increased significantly to 16.93, reaching an ***exceptional*** level. This improvement can be linked to neuromuscular adaptations, as training interventions focused on handgrip strength enhance the activation and coordination of throwing muscles (Hermassi *et al.*, 2019). Furthermore, strengthening the hand and forearm allows for better force transmission during release and more stable ball control (Ferraz *et al.*, 2021). Thus, the posttest gains reflect the direct impact of handgrip-focused exercises in developing fine motor control and maximizing throwing precision.

Participants in the balance exercise group also started with a low pretest mean score of 7.03, categorized as ***developing***. This suggests a lack of sufficient postural control, dynamic balance, and coordination at baseline, which are crucial for efficient force generation during overhand throwing. Šarabon and Kozinc (2020) emphasized that inadequate balance reduces overall athletic performance by disrupting force transfer through the kinetic chain. Additionally, Park *et al.* (2024) explained that balance impairments hinder the body's ability to stabilize itself during complex motor actions, resulting in inconsistencies in performance tasks such as throwing. Following the balance training intervention, the group's posttest mean improved to 15.73, reaching a ***high*** level of accuracy. This progress can be attributed to enhanced neuromuscular coordination and trunk control developed through balance-focused exercises (Promsri, 2022). Improvements in dynamic postural stability enabled participants to manage body positioning more effectively throughout the throwing motion, resulting in greater precision in targeting and release (Ramsey & Crotin, 2019). Therefore, the posttest outcomes reflect the role of balance training in stabilizing movement sequences critical for overhand throwing accuracy.

In Problem 2, both groups showed significant improvement after their interventions. The handgrip strength exercises group achieved ***exceptional precision***, while the balance exercises group achieved ***high accuracy***. This means that both balance and handgrip strength exercises effectively enhanced the participants' softball overhand throwing accuracy after eight weeks of training. The results imply that both balance exercises and handgrip strength exercises are effective training interventions for improving overhand throwing accuracy in softball. This finding suggests that strength and balance are not just complementary but fundamental to executing more precise and controlled throwing motions. For coaches, PE teachers, and athletes, the evidence supports the integration of targeted balance and handgrip training into regular softball practice. By doing so, players can significantly enhance their throwing precision, potentially leading to improved in-game performance and reduced injury risks associated with poor mechanics. The findings also emphasize that even simple, structured interventions over a short period, such as eight weeks, can yield measurable improvements in a complex motor skill, such as overhand throwing.

These findings confirm the theoretical frameworks underpinning the research. According to the Kinetic Chain Biomechanical Principle (Ellenbecker & Aoki, 2020; Fasbender *et al.*, 2020), efficient throwing relies on the sequential activation and force transfer through the body segments, which requires both balance and muscle strength. The significant improvements following balance training support Motor Control Theory, which emphasizes the importance of stability, proprioception, and coordination in executing complex movements, such as throwing (Hug & Tucker, 2017). Similarly, the improvements after handgrip strength training validate the Neuromuscular Adaptation Theory, which proposes that specific strength exercises enhance motor unit recruitment, synchronization, and force production in targeted muscles (Tomazin *et al.*, 2021). In simple terms, the participants became better throwers because their balance training strengthened their control of whole-body movements, and their handgrip training improved the precision and power of their ball release, as the theories predicted.

Recent studies strongly support these results. Downs *et al.* (2021) found that enhancing trunk stability and pre-throwing balance significantly improves throwing mechanics, aligning with the improvements observed in the balance group. Promsri (2022) also demonstrated that challenging balance exercises improve muscle coordination, resulting in better throwing outcomes. For handgrip strength, García-Carrillo *et al.* (2023) emphasized that forearm and hand muscle conditioning is critical for improving upper limb throwing performance. Similarly, Hermassi *et al.* (2019) found that incorporating grip strength exercises into athletes' training programs resulted in improved ball velocity and control.

The findings of this study support previous research by providing both local and experimental evidence that neuromuscular conditioning and postural control interventions lead to improved sports performance. For example, the work of Ramsey and Crotin (2019) on stride mechanics in throwing emphasized the importance of lower body and balance control, which was evident in the balance group's results. Similarly, Ferraz *et al.* (2021) found that improving grip strength correlates with improvements in precise sports movements, such as shooting and throwing.

Finally, the findings regarding Problem 3, which analyzed the effect of balance exercises versus handgrip exercises on the transformed posttest scores of overhand throwing accuracy, were assessed while controlling for pretest scores. The findings indicated a statistically significant group effect on posttest performance once pretest differences were accounted for, $F(1, 117) = 5.82$, $p = .017$, $\eta_p^2 = .047$, reflecting a large effect size. Therefore, the null hypothesis, which states that none of the interventions is more effective than the others, is rejected. This finding suggests that while both types of throwing interventions may be effective among softball players, handgrip strengthening exercises yielded more significant effects in improving overhand throwing accuracy than balance exercises available to them, without jeopardizing the effectiveness of either approach on overhand throwing accuracy.

The line of action prediction is based on the kinetic chain biomechanical principle, and this paper focuses on segmented movement in these activities. With respect to overhand throwing, the terminal part of the projectile—ball release is greatly influenced by the strength and coordination of the forearm and hand musculature. Accordingly, increasing handgrip strength is directly related to improved precision and force control upon release. The result also agrees with Motor Control Theory, which argues that skilled performance of motor tasks depends not only on gross, but also fine, neuromuscular adaptations. From this perspective, handgrip strength training can be viewed as a local neuromuscular stimulator, allowing for more effective control of the terminal stage of the throwing process.

The better efficacy of handgrip training in our study is supported by the results of several past studies. Cronin *et al.* (2017) and Donaldson *et al.* (2020) demonstrated that grip strength is an essential factor for overall throwing performance (velocity and accuracy). In the same line of thought, handgrip exercise was reported to improve target shooting accuracy in archery significantly (Sezer, 2017), a skill that (like overhand throwing) demands fine motor control. These results reinforce the evidence that grip strength is directly involved in object-propelling tasks with accuracy.

However, the effect of balance on overhand throwing appears to be less direct, despite balance being identified as a fundamental motor skill that plays a crucial role in sports performance. Studies (Avelar *et al*., 2016; Brachman *et al*., 2017) emphasized that the role of balance is to provide adequate postural stability, movement economy, and coordination for skill acquisition, which do not directly impact the throwing mechanics of throwing accuracy. Therefore, the two interventions, although they are both useful, have distinct mechanisms of action.

From a researcher's point of view, it appears that handgrip strength is a core mechanism underpinning the overhand throw. Tap the edge of the ball, exercising the muscles used for squeezing and tapping. Athletes use more controlled force, producing more precise direction. Additionally, based on the researcher's observation, a firm grip enables participants to maintain a consistent grip and release point, resulting in improved accuracy of their throws. Furthermore, handgrip strength exercises increase the velocity and speed of throws. For instance, the long distance in the Diamond Dispatch Challenge was from second base to home plate, which is approximately 84 feet. Comparing the results in this area, Group A had a better result than Group B in terms of overhand accuracy. While balance, though necessary, is a foundational quality that supports athletic posture and body control, it does not, on its own, contribute to quantifiable gains in motion patterns for a precision task such as throwing.

Conclusion

The primary purpose of this study was to examine whether balance exercises or handgrip strength exercises would be more effective in enhancing softball overhand throwing accuracy among male college students. Based on the results, the purpose was successfully achieved, concluding that although both interventions significantly improved performance, neither was superior to the other.

The results affirm the theoretical frameworks guiding the study—the Motor Control Theory, the Kinetic Chain Biomechanical Principle, and the Neuromuscular Adaptation Theory. Both interventions contributed to enhancing neuromuscular coordination, proprioception, movement sequencing, and strength, thereby supporting the understanding that multiple training strategies can lead to improved skill execution.

The study implies that both balance exercises and handgrip strength exercises are effective in enhancing overhand throwing accuracy. This provides PE teachers, coaches, and trainers with greater flexibility to select training interventions based on program design, equipment availability, or individual student-athlete needs, knowing that either approach can yield beneficial results for throwing performance.

The study suggests that school administrators integrate balance and handgrip strength exercises into physical education to enhance throwing performance in sports such as softball. PE teachers and coaches may also develop flexible training programs that incorporate these exercises, tailored to the specific context and available resources. Student-athletes are encouraged to engage regularly in these exercises to improve control, coordination, strength, and accuracy in throwing. Future research may involve diverse populations, such as female athletes and secondary school students, to evaluate generalizability. Studies could also investigate the effects of combining balance and handgrip strength exercises in a hybrid training protocol over more extended periods to assess potential synergistic benefits.

Conflict of Interest: *The authors declare that there is no conflict of interest regarding the publication of this article.*

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AI Declaration: *AI tools were used to prepare this manuscript. ChatGPT was utilized to assist in refining language, structuring content, and summarizing information under the authors' direct supervision. Grammarly AI was also utilized to improve grammar, clarity, and tone. The authors conducted final writing, interpretation, and revisions manually.*

Data Availability Statement: *The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Data will be stored securely for a minimum of five years following publication.*

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Table 1

Descriptive Statistics of Pretest and Posttest Scores by Performance Category for Handgrip Strength and Balance Exercises

			Group A Handgrip Strength Exercises				Group B Balance Exercises			
			Pretest		Posttest		Pretest		Posttest	
Range		**Description**	f	%	F	%	f	%	f	%
17	20	Exceptional Precision	0	0.0	39	65.0	0	0.0	26	43.3
13	16	High Accuracy	2	3.3	18	30.0	3	5.0	24	40.0
9	12	Consistent	20	33.3	3	5.0	14	23.3	10	16.7
5	8	Developing	27	45.0	0	0.0	29	48.3	0	0.0
0	4	Limited	11	18.3	0	0.0	14	23.3	0	0.0
		TOTAL	60	100	60	100	60	100	60	100
		Mean	7.38		16.93		7.03		15.73	
		Description	Developing		Exceptional Precision		Developing		High Accuracy	
		Standard Deviation	2.89		2.40		3.20		2.90	

Table 2

Paired Samples T-test Results Comparing Pretest and Posttest Scores for Handgrip Strength and Balance Exercises

Groups	Pretest		Posttest		df	t	p
	M	SD	M	SD			
Handgrip Strength Exercises	7.38	2.89	16.93	3.20	59	-32.979*	<.001
Balance Exercises	7.03	2.40	15.73	2.90	59	-21.052*	<.001

** Significant at 0.05 level.*

Table 3

Analysis of Covariance Results for Posttest Scores Controlling for Pretest

Groups	Pretest		Posttest		F(1,117)	p	η_ρ^2
	M	SD	M	SD			
Handgrip Strength Exercises	7.38	2.89	16.93	3.20	5.818*	0.017	0.047
Balance Exercises	7.03	2.40	15.73	2.90			

**Significant at 0.05 level.*

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Original Research Article

Enhancing Arm Strength with High and Low Repetition Training

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Abstract: Arm strength is critical for functional movement, athletic performance, and overall fitness. This quasi-experimental study compared the effectiveness of two resistance training protocols—high-repetition, light-load (HRLL) and low-repetition, heavy-load (LRHL)—in improving arm strength among 57 male engineering students enrolled in PATHFit courses at a state university in Surigao del Sur. Anchored in Neuromuscular Adaptation Theory and the Specificity Principle, participants were assigned to HRLL ($n = 30$) or LRHL ($n = 27$) groups and completed a six-week training program involving functional upper-body exercises. Pre- and post-intervention arm strength was measured using the USFD Push-up Test, with performance converted to estimated one-repetition maximum (1RM) via the Epley formula. Both protocols resulted in statistically significant improvements in muscular strength ($p < .05$), but ANCOVA results showed that HRLL yielded more substantial gains ($F(1, 86) = 427.608$, $p < .001$, $\eta_p^2 = 0.888$). These findings challenge the conventional belief that low-repetition heavy-load training is superior for strength development. HRLL protocols appear particularly advantageous for beginners or individuals with limited training experience, due to their reduced injury risk, enhanced adherence, and improved neuromuscular efficiency. This study supports the integration of high-repetition training into tertiary physical education, aligning with CHED's inclusive fitness goals and contributing to SDG 3 (Good Health and Well-being) and SDG 4 (Quality Education). Ultimately, the research underscores the importance of adaptable, evidence-based training approaches that cater to diverse learner needs in both academic and recreational fitness contexts.

Keywords: Arm strength, high repetition training, low repetition training, resistance exercise, PATHFit

Introduction

Globally, resistance training research has increasingly questioned the traditional emphasis on low repetition, heavy-load exercise models. The "repetition continuum" posits that different loading schemes yield distinct physiological adaptations, i.e., heavy loads maximize strength, moderate loads enhance hypertrophy, and light loads improve muscular endurance (Schöenfeld *et al.*, 2021). Recent studies, however, suggest that high-repetition, low-load resistance training (HRLL) may also generate meaningful strength improvements through neural adaptations and reduced fatigue (Painter *et al.*, 2020). Beyond fatigue resistance and hypertrophy, HRLL is thought to be beneficial for cardiovascular health and to reduce the risk of injury (Ben-Zeev *et al.*, 2024; Grzyb *et al.*, 2020; João *et al.*, 2021), making it a multifaceted training regimen.

Despite the emerging evidence favoring HRLL, resistance training studies have mostly focused on high-load, low-repetition strategies (at the expense of greater muscle hypertrophy), while frequently disregarding the strength-enhancing potential of high-repetition protocols (Grgić *et al.*, 2020; Schöenfeld *et al.*, 2021). This gap is especially important for those who are not used to lifting, such as beginners or those in the rehabilitation phase. In the Philippines, strength training is mainly influenced by sports such as boxing and basketball, where maximal strength is developed using heavy weights (Galam 2022). Nevertheless, recent and evolving institutional practices and increasing awareness of diversity within the field of training (Jacomina *et al.*, 2024) demand more inclusive, flexible, and evidence-based PE to respond to a variety of learner needs and contexts.

Addressing this knowledge gap is consistent with the Commission on Higher Education (CHED) Memorandum Order No. 39, Series of 2021, which emphasizes inclusive and culturally relevant PE practices at the tertiary level (Commission on Higher Education, 2021). Additionally, this research contributes to the achievement of SDGs 3 and 4, specifically Good Health and Well-being, and Quality Education, by examining training procedures that are effective in increasing participation, preventing injuries, and promoting lifelong physical activity. Knowledge on the effectiveness of HRLL in strength development is important not only for refining physical education practices but also for creating inclusive and responsive fitness programming for Filipino learners (Engwerda *et al.*, 2020; Kato *et al.*, 2023; Martorelli *et al.*, 2020; Whittal *et al.*, 2020).

This investigation is grounded in a multifaceted theoretical framework that seeks to assess the efficacy of high-repetition, light-load (HRLL) and low-repetition, heavy-load (LRHL) resistance training for improving arm muscle strength. HRLL is based on the Metabolic Stress and Neural Adaptation theories, which involve hormonal responses and neuromuscular control resulting from submaximal repeated efforts (Fardi *et al.*, 2022; Naderi *et al.*, 2020). In turn, LRHL is underpinned by the Size Principle, Specificity Principle, and Mechanical Tension Theory, with all three emphasizing the relevance of maximal load and neural activation for force production (Joyce *et al.*, 2024; Schöenfeld *et al.*, 2021; Vossel *et al.*, 2023). With these, the study employed functional exercise interventions to test these mechanisms using overhead presses, rows, and lateral raises with varying rep-load protocols among college students.

As such, the primary objective of this investigation is to compare the efficacy of HRLL and LRHL resistance exercises in improving arm musculoskeletal resistance strength. It tests whether there is a fundamental difference between the two protocols before and after the intervention and assesses which of the two strategies provides a better outcome. The study's outcomes will provide practical implications for students and teachers in Physical Education, promote evidence-based work around strength development, and contribute to the literature by presenting inclusive resistance training schemes in school and sports environments.

Methods and Materials

This study employed a quasi-experimental, pretest-posttest non-equivalent group design to investigate the effectiveness of two resistance training protocols, high-repetition, light-load and low-repetition, heavy-load, in enhancing arm strength among tertiary-level students. Given the academic setting and logistical limitations in randomly assigning participants, this design was deemed suitable for maintaining ecological validity while enabling structured intervention comparisons (Rambe *et al.*, 2022; Tian & Chunara, 2020). The design has proven effective in similar applied research contexts in education and health sciences (Lapui *et al.*, 2023; Pamungkas, 2022), supporting its appropriateness for this study.

A total of 57 students participated in the study, with Group 1 (n = 30) performing the high-repetition, light-load protocol and Group 2 (n = 27) performing the low-repetition, heavy-load protocol. Participation criteria required that respondents be at least 18 years of age, enrolled in the course, taught by the researcher, and medically capable of performing the exercises. This purposive sampling helped ensure that participants were closely matched, context-rich, and had similar academic backgrounds in their studies, thereby minimizing variations and maximizing comparability.

The USFD Strength and Endurance Push-Up Test, as described by Gomez (2025), was the primary data-gathering tool, which includes the Epley formula for predicting one-repetition maximum (1RM) from push-up performance. This technique considers the average push-up load, which is the average between two conditions: when the arms are straight and when they are bent or in a forearm plank position. It also takes into account the number of repetitions performed. This approach provides a more accurate and personalized estimate of muscle strength compared to using absolute counts. During the testing protocol, all testing was conducted at a standardized 3-second cadence, and participants were familiarized to aid in the reliability and quality of the data that was collected.

The validity and reliability of the push-up protocol were demonstrated. The Epley-transformed scores also showed a strong concurrent validity with the seated chest press 1RM test ($r = 0.781$) and high test-retest reliability ($r = 0.91$), indicating the validity and consistency of the instrument. The design of the protocol minimized extraneous factors, such as pacing variation and fatigue, that affected the reliability of pre- and post-training measurements of strength compared with the two training methods (Gomez, 2025).

Scoring was based on percentile rank and developed using pilot data collected from 180 students. According to 1RM values, five performance levels were created: Outstanding (62.4–75.0 kg), Very Good (51.6–62.3 kg), Good (44.6–51.5 kg), Fair (37.7–44.5 kg), and Poor (24–37.6 kg). This categorization provided a general quantification of mass-normalized muscular strength, supporting comparisons between subjects.

The study received ethical clearance from the Lourdes College Research Ethics Committee (LC-REC) and was also granted preliminary approval from school authorities. An informed consent form explaining the purpose, procedures, benefits, and risks associated with study participation was provided to participants. A pre-intervention orientation and health screening were conducted, and a pilot test was used to refine implementation processes. All procedures adhered to the ethical principles of Belmont Report (i.e., respect for persons, beneficence, and justice), protecting the welfare and privacy of participants during the study.

The intervention lasted six weeks and consisted of structured exercise protocols tailored to the two groups. The high-repetition group performed lateral raises, overhead dumbbell presses, and dumbbell rows with two 500 ml water bottles, increasing the number of repetitions from 30 to 50 per set each week. The low-repetition group performed similar exercises using two 1-liter bottles filled with sand or gravel, increasing resistance every two weeks, while performing 8–10 repetitions per set. During each training session, warm-up and cool-down activities were incorporated, and the researcher and trained assistants closely observed the exercise performance to ensure correct execution and adherence to the training regimen. The objective was to compare endurance-focused versus intensity-focused training strategies in enhancing arm strength.

To evaluate outcomes, descriptive statistics were used to summarize arm strength levels before and after the intervention. Paired samples t-tests assessed within-group improvements, while Analysis of Covariance (ANCOVA) was applied to compare posttest results between groups, controlling for pretest scores. All statistical tests were conducted at a 0.05 level of significance to determine the effectiveness of each resistance training protocol.

Results

Results are presented based on the research questions: (1) What is the arm strength of the two groups before and after the intervention? (2) Do the two groups' arm strength significantly differ before and after the interventions? And (3) Which of the interventions is more effective in enhancing the participants' arm strength? Tables 1, 2, and 3 (*see p. 41*) summarize descriptive statistics, within-group comparisons, and between-group comparisons. All tables are referenced and discussed within the text.

In Group A, the mean performance increased from 52.44 kg (SD = 12.81) in the pretest to 58.20 kg (SD = 13.96) in the posttest, reflecting a gain of 5.76 kg. Similarly, Group B showed an increase from 55.87 kg (SD = 14.13) to 59.18 kg (SD = 13.89), with a mean difference of 3.31 kg. Both training modalities resulted in improvements but remained within the ***very good*** category before and after the intervention. The consistency in standard deviations across test periods suggests that participant scores remained comparably dispersed, even as overall performance improved.

For the HRLL group, the mean score significantly increased from 52.439 kg (SD = 12.814) to 58.202 kg (SD = 13.955), with a $t(29) = -8.365$, $p < .001$, and a large effect size of Cohen's $d = -1.527$. Similarly, the LRHL group showed a significant improvement from 55.869 kg (SD = 14.129) to 59.178 kg (SD = 13.890), $t(26) = -3.122$, $p < 0.004$, with a Cohen's d of -0.601, indicating a moderate to large effect. These findings confirm that the null hypothesis, stating there is no significant difference between the pretest and posttest scores for both training groups, is rejected. Thus, it can be concluded that both high- and low-repetition training programs significantly enhanced participants' performance from pretest to posttest.

As shown in Table 3, the ANCOVA revealed a statistically significant difference in posttest scores between the two training groups after controlling for pretest scores, $F(1, 86) = 427.608$, $p < .001$, with a partial eta squared (η_p^2) of 0.888, indicating a very large effect size. Given this result, the null hypothesis (Ho2) that none of the interventions is more effective is rejected. Therefore, it can be concluded that the HRLL training was significantly more effective in enhancing participants' arm strength compared to the LRHL training.

Discussion

The analysis of pretest and posttest scores revealed that both the HRLL (Group A) and LRHL (Group B) resistance training protocols significantly improved participants' arm strength, shifting their average performance from the ***very good*** category to the same category after the intervention. These findings align with the existing literature, which highlights the effectiveness of both high and low repetition training in untrained individuals, driven by mechanisms such as neuromuscular adaptation, motor unit recruitment, and progressive overload. High-repetition training likely enhanced local muscular endurance and stimulated hypertrophy through metabolic stress, while low-repetition training facilitated strength gains via maximal tension and neural adaptations. The 'Fair' strength rating at baseline was indicative of a likely absence of previous structured resistance training among participants, as well as supporting a requirement for exercise interventions in academic institutions. Both protocols led to strength improvements, and therefore, implying that one size does not fit all. Each protocol can be effective when consistent effort and load management are applied. These findings are a powerful argument for including a broad range of evidence based training methods in physical education to meet different needs, preferences, and fitness levels.

In addition, the results also indicate that both HRLL and LRHL training paradigms led to a significant increase in arm muscle strength from pre to post, demonstrating that both strength training techniques similarly increased strength. The results are consistent with theories such as the Specificity Principle and Neuromuscular Adaptation theory, which suggests that varying the resistance training protocols can target different adaptation pathways: muscular endurance for high repetitions and maximal strength for low repetitions. These findings are supported by previous studies (Gäbler *et al.*, 2021; Nugent *et al.*, 2022; Schöenfeld *et al.*, 2021), which indicate that both modalities are effective for strength development, provided that training is structured and progressive. These outcomes support the need for an adaptable individualized resistance training prescription, where load and volume can be manipulated without attenuating muscular strength outcomes, especially in untrained or moderately trained cohorts.

Furthermore, the results of the ANCOVA also established that HRLL training was significantly more effective than LRHL training for increasing arm strength. While the raw posttest means of the groups are close, the adjusted analysis shows that the high repetition group makes more reliable and statistically significant gains. High-repetition, low-load training may therefore have significant potential for untrained individuals, as it can improve neuromuscular efficiency, increase participant adherence, reduce the fear of injury, and enhance local muscular endurance through mechanisms such as time under tension or metabolic stress. Informed by the Neuromuscular Adaptation Theory and the Specificity Principle, the results align with previous research (e.g., Nugent *et al.*, 2022; Schöenfeld *et al.*, 2020), which supports the notion that high-repetition protocols provide a scalable and effective means of developing strength in different populations.

Conclusion

In this study, the researcher examined the effects of HRLL resistance training and LRHL resistance training on arm muscle strength in young, untrained participants. Recognizing the decline in upper limb strength in this population and the ongoing debate over optimal training strategies, the study aimed to identify accessible and practical approaches suitable for various groups, including beginners and those undergoing rehabilitation.

Grounded in neuromuscular adaptation theory and principles, such as specificity and progressive overload, the research addressed three key questions: baseline strength levels, intra-group changes, and the relative effectiveness of each intervention. Employing a quasi-experimental, pretest-posttest design with non-equivalent groups, college student participants engaged in progressive overload training, and arm strength was assessed using the USFD Push-up Test, converted to 1RM through Epley's formula. Data were analyzed using descriptive statistics, paired samples t-tests, and ANCOVA, with findings offering insights into evidence-based and adaptable resistance training methods.

The findings suggest that while both resistance training interventions can induce improvements in arm strength, incorporating high-repetition, light-load resistance training into PATHFit courses and fitness programs can offer a safer, more accessible, and more effective approach for enhancing muscular strength, especially among beginners and populations with limited training experience.

Conflict of Interest: *The author declares that there is no conflict of interest regarding the publication of this article.*

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Ethical Approval: *The study was reviewed and approved by the Institutional Ethics Committee of the researcher's academic institution, adhering to the ethical standards outlined in the Belmont Report. Informed assent was obtained from student participants, alongside written parental consent, ensuring full ethical compliance.*

AI Declaration: *This study utilized artificial intelligence tools to assist in the preparation of this article. Specifically, ChatGPT was used to convert the full thesis manuscript into a reduced journal article format with human supervision and editing, ensuring academic rigor and integrity. Additionally, Grammarly AI was used to enhance the language quality, clarity, and tone of the final manuscript. All outputs were carefully reviewed and edited by the authors 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. Access requests will be evaluated by ethical guidelines and data privacy policies.*

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Table 1

Descriptive Statistics of Pretest and Posttest Scores by Performance Category for High and Low Repetition Trainings

			Group A Handgrip Strength Exercises				Group B Balance Exercises			
			Pretest		Posttest		Pretest		Posttest	
Range (kg)		Description	f	%	F	%	f	%	f	%
62.4	75	Outstanding	6	20.0	12	40.0	7	25.9	10	37.0
51.5	62.3	Very Good	10	33.3	9	30.0	11	40.7	11	40.7
44.6	51.5	Good	5	16.7	3	10.0	3	11.1	2	7.4
37.7	44.5	Fair	6	20.0	4	13.3	2	7.4	3	11.1
24	37.6	Poor	3	10.0	2	6.7	4	14.8	1	3.7
		TOTAL	30	100	30	100	27	100	27	100
		Mean	52.44		58.20		55.87		59.18	
		Description	Very Good		Very Good		Very Good		Very Good	
		Standard Deviation	12.81		13.96		14.13		13.89	

Table 2

Paired Samples T-test Results Comparing Pretest and Posttest Scores for High and Low Repetition Trainings

Groups	Pretest		Posttest		df	t	p	Cohen's d
	M	SD	M	SD				
High Repetition Light-Load Training	52.439	12.814	58.202	13.955	29	-8.365*	<.001	-1.527
Low Repetition, High -Load Training	55.869	14.129	59.178	13.890	26	-3.122*	0.004	-0.601

** Significant at 0.05 level.*

Table 3

Analysis of Covariance Results for Posttest Scores Controlling for Pretest

Groups	Pretest		Posttest		F(1,86)	p	η_p^2
	M	SD	M	SD			
High Repetition Light-Load Training	52.439	12.814	58.202	13.955	427.608*	<.001	0.888
Low Repetition, High -Load Training	55.869	14.129	59.178	13.890			

**Significant at 0.05 level.*

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Original Research Article

Development of the *BiboAktibo Manual:* Making Exercise a Rewarding Experience for the MAPEH Learners

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Abstract: The use of exercise as punishment in educational settings can harm students' physical health, emotional well-being, and attitudes toward fitness, creating negative feelings about exercise, reducing motivation, and causing a long-term aversion to physical activity. To address these issues, the study developed a manual titled *BiboAktibo: Making Exercise a Rewarding Experience*, designed to help Music, Arts, Physical Education and Health (MAPEH) teachers incorporate reward-based strategies based on the Exercise as a Reward (EAR) approach. Guided by the ADDIE instructional design model and rooted in behaviorist learning theory, the research used a qualitative descriptive design. Data were gathered from nine purposively selected participants: three MAPEH teachers for needs analysis, three subject matter experts for review, and three teacher-implementers for feedback after classroom use. The findings highlighted ongoing challenges in PE instruction, including inadequate facilities, limited time, and student disengagement. The *BiboAktibo Manual* offers practical, cost-effective, and developmentally appropriate strategies that enhance student motivation and participation. Expert reviewers confirmed its pedagogical value but recommended revisions to improve safety, structure, and age appropriateness. Teachers reported that the manual fostered a more inclusive, engaging, and student-centered PE environment. Overall, incorporating EAR-based strategies through the BiboAktibo Manual presents a feasible and ethical alternative to punitive practices in PE. The study encourages broader adoption of the manual and advocates for future research to assess its long-term impact and potential for scaling across various educational settings.

Keywords: Exercise as punishment, Exercise as reward, PE, MAPEH Manual, ADDIE model

Introduction

The continued use of exercise as punishment (EAP) in physical education (PE) remains a deeply embedded yet problematic practice in many Philippine public schools. Often used to discipline latecomers, uncooperative students, or those who fail to meet performance expectations, EAP reinforces fear-based compliance rather than fostering positive attitudes toward exercise (Kerr *et al.*, 2016). Despite the growing discourse around ethical teaching practices, many teachers continue this approach due to a lack of accessible, practical alternatives (Paulson & Knipe, 2023). To support the shift toward more positive and inclusive practices, the development of a structured instructional manual emerges as a proactive and practical intervention. Such manuals, when anchored in theory and empirical evidence, can offer Music, Arts, Physical Education, and Health (MAPEH) teachers concrete, low-cost, and context-responsive strategies that reframe exercise from a punitive task to a rewarding experience—providing both pedagogical clarity and practical utility (Branch, 2018).

A growing body of literature documents the use of exercise as punishment not only in schools but also in sports training and correctional institutions. Research by Kerr *et al.* (2016) and Paulson and Knipe (2023) reveals that punitive exercise leads to increased anxiety, diminished self-worth, and negative associations with fitness. Cuartas (2025) warns that EAP can be internalized by young learners, fostering a long-term aversion to exercise. In athletic and military settings, exercise has historically been used to instill discipline and obedience, yet such practices are increasingly scrutinized due to their psychological impact (Kerr *et al.*, 2020). In educational environments, these methods contradict inclusive and developmentally appropriate teaching philosophies that prioritize motivation, equity, and student well-being (Ryan & Deci, 2000).

Adopting an *Exercise as a Reward* (EAR) approach in PE aligns with modern educational and psychological theories that emphasize motivation, reinforcement, and engagement. Research supports the use of reward-based strategies to enhance classroom climate, increase participation, and promote intrinsic motivation toward exercise (Jeong & So, 2020; Park & Jung, 2023). EAR is particularly beneficial in resource-limited settings, as it enhances student morale and fosters inclusivity without requiring substantial financial investment (Park & Jung, 2023). Emphasizing enjoyment, autonomy, and competence through EAR echoes behavioral economics findings that recognize the reinforcing value of exercise (Foxx *et al.*, 2022), while also supporting mental well-being and nurturing a lifelong commitment to fitness (Bull *et al.*, 2020; Gastelum-Acosta *et al.*, 2024). Teacher preparation plays a crucial role in this paradigm; educators trained in developmentally appropriate reward strategies—such as token economies and social recognition—are more effective in engaging diverse learners, including those less inclined toward exercise (Hanashiro-Parson & Miltenberger, 2021).

To develop an effective and context-sensitive intervention, this study employs the ADDIE instructional design model, a systematic yet flexible framework widely used for creating educational tools that respond to learner needs and instructional challenges (Branch, 2018; Razak *et al.*, 2020). Comprising five interrelated phases—Analysis, Design, Development, Implementation, and Evaluation—the ADDIE model ensures the intervention is grounded in pedagogical rigor and contextual relevance (Priatna *et al.*, 2024). In the Analysis phase, instructional gaps were identified through consultations with MAPEH teachers, aligning the manual with real-world classroom needs (Dayanti *et al.*, 2023). The Design and Development phases focused on translating these needs into structured, age-appropriate, and culturally responsive learning activities, informed by educational design principles (Chen *et al.*, 2022; Huriyah *et al.*, 2022). In the Implementation phase, the manual was pilot-tested in actual classroom settings to examine its usability and effectiveness in authentic learning environments (Nurhasanah *et al.*, 2022). Lastly, the Evaluation phase included both expert validation and user feedback from teacher-implementers to refine the content and format, promoting continuous improvement and practical utility (Sayekti *et al.*, 2023; Suwartini *et al.*, 2022). This structured application of ADDIE ensured that the developed manual was not only pedagogically sound but also highly responsive to the specific needs of Filipino PE teachers and learners.

The purpose of this study was to design, implement, and evaluate a teacher-friendly, context-appropriate supplemental manual that encourages the use of exercise as a form of positive reinforcement. The manual is intended to support MAPEH teachers in transitioning from punitive practices to strategies that foster student motivation, inclusion, and meaningful engagement in PE. It addresses a pressing ethical and pedagogical issue in PE by offering an alternative that is both humane and effective. It contributes to the MATATAG Curriculum's vision of a child-friendly, values-integrated learning environment (Department of Education, 2023) and supports the Philippine Professional Standards for Teachers by advocating for reflective and ethical teaching practices (Cena & Bual, 2021). The study also aligns with the Sustainable Development Goals (SDGs), specifically Goals 3 (Good Health and Well-being) and 4 (Quality Education) (United Nations, 2015). Methodologically, while qualitative inquiry was deemed appropriate, approaches such as phenomenology were avoided to minimize ethical risks. Teachers might feel personally accused or scrutinized if asked to narrate experiences involving EAP, potentially compromising trust and openness. Instead, the use of interviews, expert validations, and focus group discussions allowed for constructive engagement without compromising ethical safeguards.

Methods and Materials

This study employed a Design and Development Research (DDR) methodology, a systematic approach focused on generating practical solutions through structured design processes (Adeoye, 2023). At its core, DDR frequently employs a Research through Design (RtD) approach, wherein the design activity itself becomes a method of inquiry and knowledge generation (Suberi, 2022). This method enables researchers to collaborate with stakeholders, facilitating the co-construction of context-specific interventions (Whelan *et al.*, 2022). A rigorous research framework is essential in DDR, including the careful selection of participants, the operationalization of variables, and the application of appropriate analytical methods (Jacobs & Cornelius, 2022). In education, DDR is often guided by instructional models such as ADDIE, ensuring that solutions are both pedagogically sound and practically relevant (Lochmiller *et al.*, 2023). Moreover, research shows that interdisciplinary collaboration—particularly between designers and professionals from related fields—enhances innovation and accelerates product development (Hanahara, 2021). This collaborative dynamic enhances DDR's capacity to respond to real-world challenges by integrating diverse perspectives into the design process (Hemonnet-Goujot *et al.*, 2020). The relevance of DDR extends across domains such as urban planning and public health, where its iterative, user-centered approach has led to impactful innovations (Sanchez, 2021; Scientific and Technical Advisory Council (STAC), 2020). In contexts such as educational reform, DDR has been shown to yield inclusive, scalable, and sustainable tools by blending theoretical insights with practical applications (Suchá *et al.*, 2021). Ultimately, DDR's value lies in its ability to produce context-sensitive innovations through methodological rigor and collaborative design (Whelan *et al.*, 2022).

Three participants were involved in the needs analysis phase through semi-structured interviews that explored their current PE teaching practices, challenges faced, and perspectives on the use of exercise as punishment. Another set of three experts in PE and instructional design was engaged during the peer review phase. They reviewed the manual draft using a structured evaluation form focusing on clarity, relevance, cultural sensitivity, and alignment with DepEd's curriculum. Finally, three implementers participated in the implementation and evaluation phases by integrating selected manual components into their actual classroom sessions within a week trial period.

Data were gathered using a combination of in-depth interviews to capture individual insights, expert review checklists for validation scoring, post-implementation questionnaires to assess perceived effectiveness and feasibility, and a focus group discussion to collectively reflect on practical challenges and recommendations. The qualitative data were analyzed using descriptive narrative techniques, with themes organized around the study's key objectives: identifying instructional gaps, reviewing content, and assessing usability. Feedback gathered during implementation was especially critical in informing revisions related to technical accuracy, activity safety, curriculum fit, and the inclusive appeal of the manual's design and language.

Ethical standards were upheld in accordance with the Belmont Report (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). The study obtained ethical clearance from the Lourdes College Research Ethics Committee. Informed consent was secured from all participants, with confidentiality and voluntary participation strictly maintained.

Results

Participants reported that a lack of updated instructional materials, limited access to equipment and facilities, and inadequate professional development hindered PE instruction. Teachers also noted difficulties in managing student motivation and classroom behavior, which often led them to adopt punitive approaches. One teacher remarked, *"We just search online for any material we can use since we don't have PE books."* This highlights the improvisational nature of PE instruction in underserved contexts. These findings support previous studies that have shown how inadequate support structures hinder the effective implementation of PE.

In response to these challenges, the *BiboAktibo Manual* (derived from *"bibo,"* meaning energetic, and *"aktibo,"* meaning active) proposes a manual about the use of low-cost, inclusive, and motivational exercises rooted in the EAR approach. The activities were designed to be adaptable to different grade levels, classroom settings, and available resources. Teachers found that using exercises as rewards increased student enthusiasm and participation. This approach aligns with Skinner's reinforcement theory and confirms findings by Hardy and McLeod (2020), who emphasized the motivational benefits of using positive reinforcement in PE. *Table 1* shows the proposed structure of the supplemental manual (*see p. 51*).

Moreover, *Table 2* summarizes the expert reviewers' feedback by manual section, along with the overall feedback from the experts (*see p. 51*). Experts evaluated the manual based on criteria such as relevance, content clarity, design, and alignment with the K to 12 PE curriculum. They affirmed the manual's contextual suitability and pedagogical value, but also recommended improvements. Suggestions included integrating more safety reminders, strengthening age-appropriate instructions, and aligning with SMART objectives. These recommendations guided the revision of the manual and contributed to its overall quality and alignment with curriculum goals (Rebryna *et al.*, 2024; Kaufman *et al.*, 2005).

Lastly, *Table 3* provides a summary of the feedback from the teacher implementers on the manual's implementation (*see p. 52*). Implementers reported that the manual improved student engagement, classroom discipline, and instructional organization. One implementer shared, *"Students are more excited when we use rewards; they even ask when the next game will be."* Feedback emphasized the need to improve further the layout, simplicity of language, and visual aids. Overall, the implementers endorsed the manual's use and believed it had transformed how students perceived physical activity, making PE more enjoyable and less fearful.

Moreover, incorporating expert and implementer feedback, the final version of *BiboAktibo Manual* was revised to include more precise instructions, enhanced visual layout, age-differentiated activities, and SMART-aligned objectives. The revisions aimed to enhance usability and safety while maintaining the manual's core goal: utilizing the EAR model to promote positive behavior and participation.

Discussion

Participants' reports of lacking updated instructional materials, limited access to equipment and facilities, and insufficient professional development underscore long-standing systemic challenges in the delivery of PE in the Philippines. The absence of standardized PE resources often leads teachers to depend on improvised or online content, revealing inconsistencies in instructional quality (Poblador & Tagare, 2023). A teacher highlighted the reactive and makeshift nature of instruction in underserved contexts—a finding echoed in Aboagye *et al.* (2022), which emphasizes the value of improvisation as a coping strategy in resource-scarce educational settings. However, while improvisation allows for creative adaptation, it may compromise curricular alignment and pedagogical rigor, especially in the absence of structured professional training.

The lack of facilities and instructional tools also impacts the physical and motivational aspects of PE, limiting students' opportunities for active participation, particularly in skill-based activities (Cheng, 2024; Edralin & Pastrana, 2023). Additionally, teachers in this study reported struggling to manage student motivation and behavior, sometimes defaulting to punitive strategies, which reflects broader cultural and systemic tensions in valuing PE compared to academic subjects (Tagare, 2022; Thompson & Nigg, 2020). These practices not only contradict contemporary pedagogical standards but also perpetuate negative attitudes toward physical activity among learners.

Moreover, the findings highlight a persistent gap in professional development for PE teachers. Teachers are often underprepared for modern PE challenges, especially in post-pandemic educational environments that demand digital literacy and inclusive, motivational strategies (Belleza *et al.*, 2021; Daw-as & Pelila, 2024). As Gobbi *et al.* (2021) and Mercier *et al.* (2021) show, the transition to remote learning further exacerbated teachers' need for relevant, continuous training. Without these supports, the effective implementation of PE curricula remains hampered.

In response, this study proposes the *BiboAktibo Manual*, which offers a practical and low-cost solution to common challenges in PE by promoting EAR approach—a strategy grounded in Skinner's reinforcement theory, which emphasizes that positive reinforcement strengthens desirable behaviors. Designed to be adaptable across grade levels and learning environments, the manual includes motivational exercises that encourage student participation. Teachers reported increased enthusiasm and engagement when exercises were framed as rewards, aligning with findings by Hardy and McLeod (2020) and Centeno *et al.* (2022), who affirmed the motivational benefits of positive reinforcement in PE contexts.

Additionally, the manual leverages the impact of teacher enthusiasm, which plays a crucial role in motivating students, even if it is not always directly tied to academic achievement (Centeno *et al.*, 2022). *BiboAktibo Manual* supports sustained engagement in physical activity through fostering a lively and supportive classroom atmosphere. Its focus on adaptability also reflects current educational priorities. Zhang (2021) emphasized that situational teaching strategies in PE—where lessons adapt to specific contexts—boost student action and enjoyment. The *BiboAktibo Manual* aligns with this principle, offering flexible, inclusive exercises suited for diverse and evolving classroom realities.

The *BiboAktibo Manual* is strategically structured to guide educators through a comprehensive, inclusive, and motivational approach to PE. Chapter 1 serves as its philosophical foundation, promoting a shift from punitive methods to positive reinforcement, grounded in Skinner's theory of behavior (Casey *et al.*, 2021; Hill *et al.*, 2020). This is operationalized through the EAR model, which emphasizes rewards over punishment to enhance motivation and learning (Ayvaci *et al.*, 2024; Nall & Shahan, 2020). Chapter 2 addresses systemic constraints in Filipino schools—such as limited resources and insufficient support—by offering low-cost, tech-assisted, and collaborative strategies, aligning with best practices for equitable PE delivery (Gazali *et al.*, 2022; Holincheck *et al.*, 2024). It also integrates advocacy and leadership-building to sustain PE value beyond the classroom (Jette *et al.*, 2022). Chapter 3 focuses on curriculum adaptation and instructional planning, introducing gamified and student-choice activities that promote autonomy and intrinsic motivation, which have been proven to increase participation and physical outcomes in PE (Carriedo *et al.*, 2023; Prontenko *et al.*, 2020).

Moreover, Chapter 4 emphasizes behavioral and psychological strategies, fostering a safe, inclusive environment that reduces anxiety and encourages engagement. Reflective assessments empower student ownership of learning (Gustiawati *et al.*, 2023; Huhtiniemi *et al.*, 2020). Chapter 5 synthesizes key principles for sustainable application, highlighting the importance of teacher well-being, professional development, and joyful learning environments (Shrivastava *et al.*, 2024; Wen & Liu, 2024). Finally, Chapter 6 includes ready-to-use reward-based movement activities that are fun, functional, and aligned with inclusive education principles, reinforcing the manual's commitment to motivation-based PE pedagogy (Jonaria & Ardi, 2020).

Regarding the findings in Table 2, which present the consolidated feedback from expert reviewers on the structure, content, and contextual relevance of the *BiboAktibo Manual*. Reviewers assessed the manual's alignment with key pedagogical criteria, including clarity of content, age-appropriateness, instructional coherence, curriculum alignment, and technical accuracy. Overall, experts affirmed the manual's relevance and practical value, especially in addressing challenges in PE instruction within resource-constrained Philippine schools.

Chapter-specific feedback emphasized the need for revisions that would enhance the manual's curriculum integration and pedagogical soundness. Recommendations included the inclusion of more safety measures, SMART-aligned instructional tips, and sample implementations to support diverse learning contexts. Notably, experts encouraged the integration of clear grade-level indicators, the use of inclusive language, and consistency in formatting, ensuring accessibility and usability across various educational settings.

The expert review process served not only as a validation mechanism but also as a framework for iterative refinement, ensuring that the manual would meet both curriculum expectations and the needs of teachers. As highlighted in curriculum design literature, structured expert evaluation is essential for enhancing instructional tools, particularly in health and PE contexts where engagement, safety, and inclusion are paramount (Kaufman *et al.*, 2005; Rebryna *et al.*, 2024). The incorporation of this feedback substantially strengthened the manual's educational utility and alignment with the goals of the K to 12 PE curriculum.

In terms of feedback from teacher implementers, Table 3 captures insightful comments on the *BiboAktibo Manual*, affirming its positive impact on student engagement, classroom discipline, and instructional organization. Teachers reported heightened enthusiasm among students, with one implementer noting, *"Students are more excited when we use rewards; they even ask when the next game will be"* (Teacher A, Lines 429–431). This reflects existing evidence that reward-based learning in PE enhances motivation and participation, helping to reframe exercise as an enjoyable, rather than punitive, activity (Tendinha *et al.*, 2021; Hamad, 2023).

Several teachers also emphasized how the manual humanized PE instruction, encouraging empathy and ethical teaching. One remarked, *"It's not just about improving fitness, but also protecting students' self-esteem and confidence… bring more compassion"* (Teacher C, Lines 55–58). This sentiment aligns with the manual's goal to shift from exercise-as-punishment to positive reinforcement and student well-being, which is consistent with the principles of trauma-informed and inclusive education (Centeno *et al.*, 2022).

Feedback also highlighted the manual's adaptability, particularly in low-resource environments. Teacher A shared, *"You can use the stairs… even the water bottles… regardless, you can use that for the activities"* (Lines 110–115), while Teacher B emphasized the power of low-tech tools: *"The digital strategies... QR codes and offline apps... modernized PE without needing too much budget"* (Lines 117–120). These reflections validate the manual's alignment with adaptive teaching practices, reinforcing the findings of Calderón *et al.* (2020) on the value of resource-flexible PE approaches.

Equally significant were suggestions for improvement. Implementers called for simplified language, improved layout, and stronger visual aids, recognizing that visual supports can deepen student comprehension. Teacher C noted, *"Very engaging and adaptable... students will have very good time doing that activity"* (Lines 391–394), but also hinted at the potential for more clarity. This aligns with research suggesting that instructional design must prioritize visual and linguistic accessibility, especially in heterogeneous classrooms (Cuenca *et al.*, 2024; Jasadijaya *et al.*, 2023).

Finally, implementers strongly endorsed the manual's transformative potential. Teacher B concluded, *"It leaves you feeling empowered, motivated and better equipped to make a real difference in your students' lives"* (Lines 437–441), while Teacher C affirmed, *"It's a manual that can create real change… emotionally, physically, and also socially"* (Lines 446–449). These testimonials underscore that when instructional materials are pedagogically sound, emotionally resonant, and context-sensitive, they become powerful tools for sustainable change in PE culture.

Conclusion

This study aimed to develop, implement, and evaluate a supplemental instructional manual that reframes physical activity through the EAR approach. In alignment with this aim, the study identified key barriers to effective PE instruction, including the continued use of punitive exercise, lack of professional development, and scarcity of accessible, context-appropriate teaching resources. Through a design and development methodology guided by the ADDIE model, the study responded to these challenges by producing a research-informed, teacher-validated tool that promotes positive reinforcement and learner engagement in PE classrooms.

The manual, developed with roots in behaviorist theory and aligned with the DepEd K to 12 curriculum, features low-cost, inclusive, and motivational physical activities. Its content is tailored to varying grade levels and available school resources, incorporating SMART-aligned objectives, safety precautions, culturally relevant examples, and simple visual aids. The manual underwent expert review and field implementation, with feedback confirming its contextual fit and practical utility. It addresses not only the immediate instructional needs of MAPEH teachers in Bukidnon but also holds potential for broader adoption across Philippine public schools. Its development marks a significant contribution to the national discourse on ethical, student-centered

PE instruction, positioning the manual as a replicable model that can enhance physical education delivery in under-resourced environments.

Based on the study's findings, it is recommended that local school divisions and regional education units promote the integration of reward-based physical activities through in-service training, continuing professional development (CPD), and curriculum enhancement initiatives. Teacher education institutions (TEIs) are also encouraged to embed the EAR framework in pre-service PE training to prevent the normalization of punitive exercise. Moreover, future studies may explore the long-term behavioral and psychosocial outcomes of implementing the manual across different regions and grade levels. Such efforts will further strengthen inclusive and values-oriented education, supporting the Department of Education's MATATAG agenda and the Sustainable Development Goals on Good Health and Quality Education.

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Ethical Approval: *This study was conducted in compliance with institutional ethical protocols. Approval was granted by Lourdes College, Inc. Research Ethics Committee. All participants signed informed consent forms and were assured of confidentiality and the voluntary nature of their participation.*

AI Declaration: *AI tools, such as ChatGPT, were used to assist in converting portions of the thesis into a journal-ready structure and language under human supervision. Grammarly AI assisted with grammar checking. Thematic coding, data interpretation, and final manuscript writing were conducted by the author.*

Data Availability Statement: *Anonymized data, including transcripts and coding summaries, are available upon reasonable request from the corresponding author, subject to ethical guidelines and approval for academic use.*

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Table 1

Proposed Structure of the Supplemental Manual

Chapters	Sections
Chapter 1: Introduction	1.1 Background of the Manual 1.2 Purpose and Goals 1.3 Philosophy: From Punishment to Positive Reinforcement 1.4 How to Use This Manual
Chapter 2: Overcoming Resource, Facility, and Faculty Constraints	2.1 Low-Cost, Space-Saving, and No-Equipment Activities 2.2 Digital, Multimedia, and Tech-Assisted PE Resources 2.3 Teacher Support Systems and Training Templates 2.4 Advocacy for PE and Lifelong Fitness 2.5 Promoting Leadership, Collaboration, and Peer Learning 2.6 Sports-Based Learning and Talent Development
Chapter 3: Instructional Planning, Pedagogical Adaptation, and Instructional Challenges	3.1 Gamified and Choice-Based Movement Routines 3.2 "PE Snack Time" and "Power Hour" Activities 3.3 Integrated Theory-and-Play Activities 3.4 Addressing Curriculum Gaps and Policy Alignment
Chapter 4: Enhancing Student Engagement, Motivation, and Classroom Management	4.1 Strategies for Boosting Student Motivation and Engagement 4.2 Addressing Barriers to Participation and Confidence 4.3 Effort-Based and Reflective Assessment Tools 4.4 Positive Discipline and Reducing Performance Anxiety 4.5 Feedback and Behavior Monitoring Tools
Chapter 5: Conclusion	5.1 Summary of Key Principles 5.2 Practical Tips for Sustained Implementation 5.3 Future Directions for Positive PE Practices 5.4 Final Reflection: Building a Culture of Movement Enjoyment
Chapter 6: Suggested activities and exercises for a Rewarding Classroom Experience	6.1 Activity 1: Rock-Paper-Scissors Reward 6.2 Activity 2: Sideline Rock-Paper-Scissors Movement Relay 6.3 Activity 3: Around the World Movement Challenge 6.4 Tips for Creating Movement-Based Reward Games (Like Activities 1–3)

Table 2

Summary of the Expert Reviewers' Feedback by Manual Section

Chapter/Aspect	Feedback Summary	Expert Reviewer
1. Introduction	• Move the background to the preface; retain overview, purpose, goals in Chapter 1. • Include the Matatag Curriculum as a legal basis.	Reviewer 1
	• Content is interesting and fair. • Use consistent terms (MAPEH vs. PE). • Cite sources on "exercise as punishment" (pp. 4–5). • Language is satisfactory. • Organization, accuracy, and contextualization are fair.	Reviewer 2
	• In place (no further suggestions).	Reviewer 3
2. Overcoming Resource, Facility, and Faculty Constraints	• Add safety and risk management section. • Revise impractical tips; ensure they are SMART. • Adjust terms to be grade-appropriate.	Reviewer 1
	• Concepts are useful but idealistic; improve clarity. • Include sample implementation with illustrations. • Language is satisfactory; other categories rated fair.	Reviewer 2
	• Specify age/grade level and activity intensity for each activity.	Reviewer 3
3. Instructional Planning, Pedagogical Adaptation, and Instructional Challenges	• Cite sources from the last 5 years. • Check activity alignment with PE Curriculum Guide.	Reviewer 1
	• Add sample implementations with visuals. • Language is satisfactory; other aspects rated fair.	Reviewer 2
	• In place (no further suggestions).	Reviewer 3

4. Enhancing Student Engagement, Motivation, and Classroom Management	• Add citations. • Prioritize actionable strategies. • Include examples of real-world PE applications.	Reviewer 1
	• Include sample implementation with illustrations. • Language is satisfactory; other aspects rated fair.	Reviewer 2
	• Align with revised K–10 Curriculum and PPST competencies.	Reviewer 3
5. Towards Sustainability	• Add citations. • Ensure consistency in manual title. • Include an evaluation section.	Reviewer 1
	• Add illustrations of sample implementation. • Language is satisfactory; other aspects rated fair.	Reviewer 2
	• In place (no further suggestions).	Reviewer 3
6. Suggested Activities and Exercises	• Cite sources. • Add objectives to activities. • Ensure inclusion of Students With Additional Needs (SWANs).	Reviewer 1
	• Provide sample implementations with visuals. • Language is satisfactory; other aspects rated fair.	Reviewer 2
	• In place (no further suggestions).	Reviewer 3
7. Overall Strength	• Provides a comprehensive guide for PE teachers. • The title "BiboAktibo" is catchy and should be clearly explained in the preface for international understanding.	Reviewer 1
	• The manual is full of brilliant ideas that need to be unpacked with practical applications and illustrations to make it truly manual in nature.	Reviewer 2
	• Demonstrates thoughtful planning and structure. • Suggested activities are clearly guided, age-appropriate, inclusive, and promote exercise as a bias-free experience.	Reviewer 3
8. Areas for Improvement	• Improve technical accuracy, especially citations. • Consider regular updates to reflect current best practices, research, and curriculum changes.	Reviewer 1
	• Include illustrations and detailed procedures for the activities.	Reviewer 2
	• Align all activities with the revised K to 10 curriculum. - Specify suggested grade level/age group and activity intensity to ensure safety and effectiveness.	Reviewer 3
9. General Recommendations	• Polish the manual with a focus on technical accuracy. • Ensure logical organization and progression of topics. • Maintain consistent formatting (fonts, sizes, etc.). • Congratulations!	Reviewer 1
	• Emphasize that the manual supports making exercise a rewarding experience for all learners.	Reviewer 2
	• Align activities with DepEd curriculum and PPST standards. - Include age or grade-level indicators and recommended intensity levels. - Keep the inclusive, guided, and practical nature of the manual while updating for relevance.	Reviewer 3

Table 3

Summary of the Focus Group Discussion Feedback from the Teacher Implementers on the Implementation of the Manual

Parts/ Aspects	Verbatim
Chapter 1	Chapter one also talks about how deep is the connection between suffering and exercises… promoted exercises as a very grateful experience for the students. *(Teacher A: Lines 44-48)*
	The call for teachers to act ethically really stood out… made me more mindful of the need to create positive experiences. *(Teacher B: Lines 50-53)*
	It's not just about improving fitness, but also protecting students' self-esteem and confidence… bring more compassion. (*Teacher C: Lines 55-58)*
Chapter 2	You can use the stairs… even the water bottles… regardless, you can use that for the activities.

	(Teacher A: Lines 110–115)
	I also like the digital strategies... using QR codes and offline fitness apps... modernized PE without needing too much budget. *(Teacher B: Lines 117–120)*
	The peer coaching and reflective journaling ideas are simple but powerful... sometimes the best resources we have is each other. *(Teacher C: Lines 160–162)*
Chapter 3	It was introduced to the students as a game... amazing idea that sparked their motivation. *(Teacher A: Lines 174–179)*
	Integration of academic subjects into PE... a great way to keep students learning holistically. *(Teacher B: Lines 185–187)*
	The PE snack time idea... can refresh students' brain and keep them more focused. *(Teacher C: Lines 190–193)*
Chapter 4	It also addresses auditory learners, and all the other types of learners... rewarding effort and creativity.
	Creating chill zones and using positive language makes PE a safe place... *(Teacher A: Lines 239–244)*
	Kindness circles impressed me... building a positive social climate... *(Teacher C: Lines 280–282)*
Chapter 5	It recognizes that this is not really easy... starting small and building momentum... *(Teacher A: Lines 308–312)*
	When students have voice, they are more committed to the program and its success. *(Teacher B: Lines 318–319)*
	If teachers stay curious and keep reflecting... positive energy even when challenges come up. *(Teacher C: Lines 328–330)*
Chapter 6	Very engaging and adaptable... students will have very good time doing that activity. *(Teacher A: Lines 391–394)*
	Celebrating movement rather than penalizing mistakes... encourages a positive relationship with physical activity. *(Teacher B: Lines 401–404)*
	Partner up, meet new classmates... build community while exercising. *(Teacher C: Lines 417–419)*
Overall	Introducing a fun way, a creative way, in a very enjoyable way of teaching physical... *(Teacher A: Lines 429–431)*
	It respects real-world challenges teachers face... leaves you feeling empowered and better equipped... *(Teacher B: Lines 438–441)*
	It's a manual that can create real change, emotionally, physically and also socially... *(Teacher C: Lines 447–449)*
Usefulness of the Manual	Overall thought to be the manual request to understand it, or if you really do or if you really can be deeper, it is a new way of thinking about it, like transforming in a new way. It's like introducing a fun way, a creative way, in a very enjoyable way of teaching physical. *(Teacher A: Lines 428–431)*
	Yes, mom with it will be a very, very, very help for us, especially all of our textbooks are outdated during my time or during in my career...with these new activities, I think it would be very fun for them. *(Teacher A: Lines 461–467)*
	The manual is incredibly helpful for teachers. It offers clear, practical guidance and creative ideas that make planning and leading activities easier and more engaging. *(Teacher B: Lines 472–475)*
	For me, Maam it's practical, but also incredible inspiring. It's truly respects the real world challenges teacher face, while providing the full suitable tools to help us move forward in a positive and meaningful way, instead of feeling overwhelmed, it leaves you feeling empowered, motivated and better equipped to make a real difference in your student lives. *(Teacher B: Lines 437–441)*
	My overall thoughts about the Bibo manual is, I think it's a manual that can create real change, change emotionally, physically and also socially. Change for both teachers, not just for teachers, but also students. *(Teacher C: Lines 446–449)*
	For me, ma'am, the manual is a great help. Wow. It can help both the teachers and the students for a guide in their PE classes. *(Teacher C: Lines 480–482)*

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Original Research Article

Development of Instructor's Manual for Physical Activity Towards Health and Fitness (PATHFit 2): Exercise-Based Fitness Activities

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Abstract: Creating a well-crafted instructor's manual is both an art and a strategic response to educational disparities. This study presents the development and evaluation of a contextualized PATHFIT-2 Instructor's Manual designed to support the effective implementation of Exercise-Based Fitness Activities in rural higher education institutions in the Philippines, particularly in Camiguin Island. Addressing significant challenges such as inadequate facilities, limited access to updated instructional materials, and a lack of inclusive pedagogical strategies, the manual offers a structured, culturally responsive, and adaptable resource aligned with the Commission on Higher Education's Memorandum Order No. 39, Series of 2021. Grounded in the Technological Pedagogical Content Knowledge (TPCK) framework and Universal Design for Learning (UDL), the manual was designed using the Successive Approximation Model (SAM) and underwent expert validation. The manual features modular content, traditional Filipino games, QR-coded demonstrations, and inclusive assessment tools designed to cater to diverse learners. Evaluation results revealed high ratings in pedagogical design, contextual relevance, and assessment alignment, with recommendations for deeper theoretical integration and the development of reflective practice. This study contributes to sustainable and equitable PE instruction in resource-constrained environments and aligns with the Sustainable Development Goal (SDG). It advocates for capacity-building among educators, improved learner outcomes, and standardized PE delivery through inclusive and context-sensitive instructional design.

Keywords: PATHFit 2, instructor's manual, physical education, rural higher education, instructional design, inclusive pedagogy

Introduction

In the contemporary higher education landscape, the development and use of structured instructional manuals are increasingly recognized as essential tools for supporting effective pedagogy, particularly in skills-based disciplines such as Physical Education (PE). Despite widespread acknowledgment of their value, the reliance on experience-based approaches to teaching persists, rather than relying on standardized guides. While this flexibility allows for responsiveness to unique classroom dynamics (Gao & Zhang, 2020; Zhu, 2021), it often results in inconsistencies in instructional quality and misalignment with institutional and national standards (Alamri, 2023; Paudel, 2020).

Instructional manuals provide a crucial framework to address this gap. In the context of this study, this foundational role of manuals justifies the development of a standardized, validated instructional guide tailored for PATHFit 2 instructors. They enhance teaching effectiveness by aligning content with defined objectives, supporting diverse learners, and facilitating professional collaboration (Couch *et al.*, 2023; Martin *et al.*, 2020; Zhu, 2021). Moreover, structured manuals reduce instructional ambiguity and enhance transparency, ultimately benefiting both students and instructors by creating a predictable and equitable learning environment and supporting consistent evaluation standards (Shin, 2024; Schussler *et al.*, 2021). In the Philippine context, particularly after the disruptions caused by the COVID-19 pandemic, the need for standardized resources became more pronounced (Malabanan *et al.*, 2022; Talimodao & Madrigal, 2021). National efforts, including the Results-Based Performance Management System (RPMS) and the Philippine Professional Standards for Teachers (PPST), reflect the increasing institutional commitment to structured instructional support (Torres *et al.*, 2024).

This study focuses on the development of a validated instructor's manual for PATHFit 2: Exercise-Based Fitness Activities, a core course mandated by the Commission on Higher Education (CHED, 2021) under Memorandum Order No. 39, s. 2021. PATHFit 2 aims to promote lifelong fitness habits among tertiary students through structured, evidence-based physical training. However, the absence of standardized instructional guides leads to inconsistent teaching methodologies. This inconsistency contributes to significant disparities in student learning outcomes, as evidenced by studies linking structured teacher development and clear instructional design to improved educational effectiveness (Fadil & Aryani, 2021; Kintu *et al.*, 2017; Steinert *et al.*, 2006; Zeitlin, 2020)., as evidenced by studies linking structured teacher development and clear instructional design to improved educational effectiveness. Without unified guidelines, teachers often rely on disparate approaches, resulting in pedagogical gaps and reduced alignment with learning objectives (Okanlawon, 2022; Ouchen *et al.*, 2023).

This study proposes a manual that addresses current instructional challenges by integrating the Technological Pedagogical Content Knowledge (TPACK) framework and the Universal Design for Learning (UDL) model. TPACK offers educators a comprehensive understanding of how content, pedagogy, and technology intersect to support effective and responsive teaching practices (Annazar, 2023; Koehler & Mishra, 2008; Valtonen *et al.*, 2020; Zhang & Tang, 2021). Meanwhile, UDL enhances instructional inclusivity by promoting flexible approaches to engagement, representation, and expression, ensuring all learners can access and participate meaningfully in the learning process (CAST, 2024; Frolli *et al.*, 2023; Lieberman *et al.*, 2024; Wells, 2024). The manual is designed to be dynamic, incorporating these pedagogical frameworks, and serves as a CHED-aligned resource that empowers tertiary-level physical education instructors to deliver equitable and adaptable instruction.

Developed using the Successive Approximation Model (SAM), the manual follows a process of iterative design, expert validation, and systematic refinement to ensure academic integrity and contextual suitability. As a flexible instructional design framework, SAM emphasizes collaboration, feedback-driven development, and continuous enhancement of learning materials (Almekhlafi, 2020; Palupi, 2024). Its cyclical nature supports adaptability and learner engagement, with demonstrated effectiveness in diverse settings, including virtual education, higher education, and professional training (Evanick, 2024; Raman *et al.*, 2021; Sinha *et al.*, 2021). This study aims to strengthen PE instruction, promote inclusive access, and standardize teaching practices across different educational environments. However, due to time constraints on the part of the researcher, the implementation and evaluation phases of the model were not included in this study.

In the context of Camiguin Island—a geographically isolated province with limited access to continuous professional development—this study bears significant educational and social value. For instructors, the PATHFit 2 manual offers an accessible, standardized, and context-responsive tool that enhances instructional quality regardless of resource disparities. For institutions, it provides a mechanism for aligning their fitness education programs with national mandates such as CHED Memorandum No. 39, s. 2021, and supports the implementation of consistent and equitable pedagogical standards. Moreover, the manual encourages community-wide promotion of health literacy and lifelong fitness, such as by fostering habits that reduce preventable illnesses and enhance overall well-being, especially important in rural island settings.

Additionally, this initiative directly aligns with the United Nations Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 10 (Reduced Inequalities). The study addresses systemic instructional gaps, promotes health-enhancing behaviors among students, and supports the broader goal of inclusive education in underserved communities. The development of this manual represents an essential and timely response to the pressing need for standardized and inclusive PE instruction, contributing meaningfully to both national and global education and public health agendas.

Methodology

This study employed Design and Development Research (DDR) to create and validate an instructor's manual for PATHFit 2: Exercise-Based Fitness Activities. DDR is a methodological approach that combines theoretical insight with practical problem-solving to develop and refine educational interventions (McKenney & Reeves, 2020). Specifically, this research followed SAM proposed by Allen (2016), which emphasizes iterative cycles of design, feedback, and refinement.

The methodology consisted of two phases: (1) *Preparation and Planning* and (2) *Iterative Design and Development*. The third phase in the SAM process, *Implementation and Evaluation*, was excluded from this study due to time constraints. During the first phase, surveys and focus group discussions (FGDs) were conducted among Physical Education instructors from a rural higher education institution in Camiguin to assess existing instructional practices and determine alignment gaps in the current PATHFit 2 course delivery. Document analysis of CHED Memorandum Order No. 39, s. 2021 and institutional policies also informed its content.

The second phase involved the initial drafting of the instructor's manual based on the findings from Phase 1 and the integration of pedagogical theories (TPACK and UDL). Prototypes were created and improved through several cycles of expert review. Three experts—one from the CHED Region 10, one institutional Vice President for Academic Affairs (VPAA) from Camiguin Island, and one PE professor, who is also a VPAA from a nearby community college—provided detailed feedback. Comments were recorded, and revisions were applied accordingly until no further critical feedback was received, indicating content saturation.

Still part of the iterative design and development process, the expert reviewers evaluated the refined manual using a rating scale that assessed content clarity, pedagogical appropriateness, technological integration, and alignment with CHED standards. Both qualitative and quantitative feedback were analyzed to finalize the manual. The ethical standards of research, including voluntary participation, informed consent, and data confidentiality, were observed throughout the process. This methodological rigor ensured the development of a standardized, practical, and inclusive PATHFit 2 instructor's manual grounded in evidence and national educational mandates.

Results

The results of this study are presented in alignment with the Design and Development Research (DDR) framework, specifically following the *Preparation* and *Iterative Design Phases* of the SAM. Due to time constraints on the part of the researcher, the *Implementation and Evaluation* were excluded. The study aimed to develop a context-responsive, pedagogically sound, and CHED-aligned *PATHFit 2 Instructor's Manual* that could address instructional gaps in tertiary-level physical education. The outcomes are detailed in the following three tables: (1) the prototype description, (2) expert evaluation ratings, and (3) expert feedback and enhancement recommendations.

Table 1 outlines the prototype design of the *PATHFit 2 Instructor's Manual*, presenting key recommendations and their corresponding components aimed at enhancing instructional quality and contextual relevance (*see p. 62*). The manual begins with a preface that articulates its purpose, intended users, and alignment with local settings. Course content is introduced through clearly defined objectives and intended learning outcomes (ILOs) that reflect CHED standards and national fitness goals. Inclusivity and contextual sensitivity are emphasized through guidelines for rural adaptation, community engagement, and safety protocols. A modular 18-week instructional plan is provided, offering structured yet flexible delivery formats, including asynchronous options. To sustain engagement and address classroom challenges, the manual incorporates inclusive pedagogical strategies and culturally relevant learning materials, such as traditional Filipino fitness games and QR-linked exercises. Additionally, the manual integrates outcome-based assessment tools—including rubrics, self-assessments, peer assessments, and pre- and post-tests—while prioritizing student safety and instructional clarity. Supporting features include a glossary of fitness terms and a full APA-formatted reference list to ensure academic rigor.

Table 2 presents the expert evaluation report of the prototype manual, assessing five key domains: (1) pedagogical strategies and instructional design, (2) teacher professional development and support, (3) formative and summative assessments, (4) reflective teaching practices, and (5) overall usability and alignment with educational standards (*see p. 62*). Across all 25 indicators, the manual received consistently high ratings, with a majority categorized as *very good* (Mean = 4.67, SD = 0.58). These include aligning lesson plans with curriculum objectives, utilizing active learning strategies, implementing differentiated instruction, and employing assessment practices based on learning outcomes. Other positively rated areas include strategies for inclusive teaching, motivational techniques, and student-centered learning. A few indicators received *good* ratings, particularly in relation to the integration of theoretical perspectives and professional self-assessment tools. Overall, the evaluation confirmed the manual's clarity, usability, and effectiveness as an instructional resource, affirming its potential to enhance teaching quality in tertiary PE settings.

Table 3 summarizes the qualitative reviews and recommendations provided by experts for further refinement of the manual (*see p. 64*). For the preliminary pages, suggestions included professional formatting of author and reviewer details, explicit alignment with CHED Memorandum Order No. 39, s. 2021, and the inclusion of a liability disclaimer and improved structural organization. In Chapter 1, experts recommended reordering subtopics for better instructional flow and avoiding abbreviated technical jargon. Chapter 2 was advised to adopt a complete Outcome-Based Education (OBE) format and incorporate adaptive PE activities, traditional games, and collaboration strategies. Feedback for Chapter 3 emphasized the need for functional categorization of workouts, visual enhancements, and safety guidelines. Chapter 4 was recommended to include common PE terms with definitions in student-friendly language. Chapter 5 required more straightforward integration of teaching activities within the OBE syllabus format, while Chapter 6 was enhanced with reflection prompts, assessment domains, and reminders to prioritize safety and inclusion. Collectively, these insights contributed to strengthening the manual's content structure, pedagogical coherence, and practical applicability.

Discussion

Delivering PATHFit 2 in rural colleges faces major barriers, including limited facilities, inconsistent schedules, low student motivation, and a lack of inclusive training. These structural issues hinder effective PE instruction and highlight the need for adaptive, standardized resources (Fang, 2022; Koricich *et al.*, 2020). Instructors also reported challenges in accessing updated teaching materials and professional development, often leading to reliance on outdated or improvised practices (Chen *et al.*, 2023; Hong, 2023). Health-related student needs further compound these difficulties. Safe and inclusive instruction remains a concern, with classes frequently held in unsuitable environments (Susanti *et al.*, 2020; Urien & E, 2024).

To address these issues, instructors employ culturally responsive strategies—such as traditional Filipino games—to enhance engagement and continuity of learning (Leibold *et al.*, 2022; Taneri & Özbek, 2023). However, without proper guidance and resources, these efforts remain fragmented. Literature supports the integration of adaptive physical education (APE) and inclusive training tools as essential for student development, especially for learners with disabilities (Guo *et al.*, 2022; Subroto *et al.*, 2021). This context highlights the importance of developing a research-based, flexible, and inclusive PATHFit 2 instructor's manual that aligns with national standards.

The PATHFit 2 Instructor's Manual was designed based on feedback from rural PE instructors. Key design features include a clearly defined purpose, alignment with CHED standards, and adaptability to various school environments (Bull *et al.*, 2020; Ndabezitha, 2024). An 18-week modular format supports asynchronous learning amid disruptions (Tolentino & Sinio, 2024).

The manual emphasizes culturally responsive and inclusive teaching, integrating traditional games and improvised tools for schools with limited facilities (Buch *et al.*, 2023). It includes print-based guides, QR-coded demonstrations, and assessment tools aligned with OBE principles. Special focus is given to inclusivity and safety, offering options for learners with physical challenges and ensuring teacher preparedness through structured rubrics and peer/self-assessments (Burhaeın *et al.*, 2024; Guo *et al.*, 2022).

Expert review, conducted using the SAM, confirmed the PATHFit 2 manual as a pedagogically sound and inclusive resource for rural PE contexts. Reviewers consistently rated pedagogical design, instructional coherence, cultural responsiveness, and structured assessment tools highly (M = 4.67), supporting claims from Aelterman *et al.* (2019) and Vasconcellos *et al.* (2020) that well-structured, student-centered approaches improve motivation and learning in PE. Multimedia components scored moderately (M = 4.33), reflecting technological limitations in rural areas (Hakiki *et al.*, 2023; Yu, 2024).

Support for teacher usability was affirmed, but reviewers emphasized the need for deeper integration of pedagogical theories and reflective tools to promote continuous professional development (Afandi & Ratno, 2022; Kalajas-Tilga *et al.*, 2020). The manual's alignment with CHED standards and OBE principles also received strong endorsement, affirming its contextual relevance and readiness for implementation.

Final expert feedback refined the manual's structure and clarity, aligning it with recognized instructional design principles (Wiggins & McTighe, 2005). Preliminary sections were enhanced to reflect CHED compliance and academic credibility. Experts advised reorganizing chapters to strengthen logical progression, particularly in the articulation of goals, terminology consistency, and the inclusion of adaptive strategies tailored to varied school contexts (Bull *et al.*, 2020).

The application of Outcome-Based Education (OBE) was further deepened, integrating reflection prompts and scenario-based assessments to support metacognition and real-world application (Arribas *et al.*, 2021). Culturally embedded elements such as traditional games, cooperative activities, and visual learning tools supported inclusive education practices, in line with Universal Design for Learning (UDL) principles (Kalajas-Tilga *et al.*, 2020; Lieberman *et al.*, 2024). These refinements collectively strengthen the manual's pedagogical alignment, cultural responsiveness, and functional utility for rural PE instruction.

Conclusion

This study sought to develop and refine a contextually grounded PATHFit 2 prototype instructor's manual tailored for higher education institutions in rural areas, particularly under resource-constrained conditions. Guided by the SAM framework, the research employed a multi-phase process involving preliminary surveys, focus group discussions (FGDs), literature review integration, iterative design, and expert feedback. The alignment analysis revealed that while instructors recognized the value of CHED-aligned learning outcomes, content delivery and assessment strategies were inconsistently implemented due to contextual limitations such as facility constraints and low student engagement.

Drawing from these insights, the proposed manual emphasized practical adaptability, localized content, and student-centered strategies that are feasible in rural settings. Feedback from CHED and institutional experts affirmed the relevance, accuracy, and usability of the manual, while also recommending refinements in legal alignment, instructional clarity, and cultural contextualization. The final recommended version of the PATHFit 2 manual responds to both pedagogical and logistical challenges faced by instructors in underserved settings.

Ultimately, this study highlights the importance of developing instructional resources that are both academically sound and contextually realistic. The PATHFit 2 manual contributes to the broader mission of fostering active, inclusive, and health-promoting learning environments in Philippine higher education.

In light of the findings and conclusions of this study, it is recommended that higher education institutions formally adopt the finalized PATHFit 2 instructor's manual as a standard reference to ensure curriculum alignment with CHED Memorandum Order No. 39, Series of 2021, and to promote uniformity in instructional delivery across campuses, particularly in rural areas. PE instructors are encouraged to participate in regular capacity-building programs focused on the manual's pedagogical framework, instructional strategies, and assessment tools, with emphasis on integrating the FITT principle and accessible exercise-based activities. Curriculum developers and PE coordinators may contextualize the manual's contents to suit local teaching environments, adapting strategies based on facility availability, learner diversity, and community health needs. Program implementers and school administrators may establish continuous feedback mechanisms, such as semester-end focus groups or teaching reflections, to evaluate the manual's usability and inform iterative improvements. Finally, future researchers are advised to extend implementation studies across diverse institutional contexts and investigate the manual's long-term effects on student fitness outcomes, instructional quality, and satisfaction with the PATHFit 2 course.

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Table 1

Prototype Description of PATHFit 2 Instructor's Manual

Key Recommendations	Proposed Components
Clearly define the manual's purpose and contextual applicability	Preface detailing scope, users, and relevance to local settings
Align course content with CHED outcomes and fitness goals	Introduction to the course, objectives, intended learning outcomes (ILOs), and significance of fitness education
Adapt instruction to rural contexts and promote inclusive, safe PE practices	Guidelines for localized teaching, safety protocols, and community involvement
Provide a modular, structured, and flexible implementation plan	18-week modular plan with asynchronous delivery options
Address classroom disruptions and sustain student motivation	Pedagogical strategies for inclusive, engaging, and motivational instruction
Offer diverse, visual, and culturally grounded learning materials	Exercise guides, QR-linked activities, and traditional Filipino fitness games
Include outcome-based and flexible assessment tools	Pre/post-tests, rubrics, self/peer assessments, and templates aligned to OBE
Prioritize safety, especially in limited or non-specialized environments	Injury prevention tips, warm-up/cool-down activities, and small-space adaptations
Support clarity and academic rigor	Glossary of fitness terms and a complete APA-formatted reference list

Table 2

Experts Evaluation Report of the PATHFit 2 Instructor's Manual

Indicators	Mean	SD	Description
I. Pedagogical Strategies and Instructional Design			
1. The guide provides structured lesson plans and activities that align with curriculum objectives.	4.67	0.58	Very Good
2. It offers clear and effective instructional strategies to facilitate student learning.	4.67	0.58	Very Good
3. The guide supports student engagement through active learning techniques (e.g., group work, discussions, hands-on activities).	4.67	0.58	Very Good
4. It encourages differentiated instruction to meet the diverse learning needs of students.	4.67	0.58	Very Good
5. The guide incorporates technology and multimedia resources to enhance teaching and learning.	4.33	0.58	Good
II. Teacher's Professional Development and Support			

1.	The guide provides clear, step-by-step instructional guidance for lesson implementation.	4.33	0.58	Good
2.	It equips teachers with best practices for effective classroom management.	4.33	0.58	Good
3.	The guide includes strategies for motivating and engaging students.	4.67	0.58	Very Good
4.	It offers professional insights on teaching strategies, subject matter expertise, and educational theories.	4	0	Good
5.	The guide integrates inclusive teaching approaches to accommodate diverse learners.	4.67	0.58	Very Good
III. Formative and Summative Assessments				
1.	The guide provides guidelines for implementing formative assessments to track student progress.	4.67	0.58	Very Good
2.	It includes well-structured summative assessments that align with learning objectives.	4.67	0.58	Very Good
3.	The guide offers clear rubrics, scoring guides, and grading criteria for student evaluation.	4.67	0.58	Very Good
4.	It ensures that assessments measure not just content knowledge but also skills and critical thinking.	4.33	0.58	Good
5.	The guide provides strategies for self-assessment and peer assessment to encourage student reflection.	4.33	0.58	Good
IV. Reflective Practices for Teachers				
1.	The guide encourages teachers to reflect on their teaching strategies for continuous improvement.	4.33	0.58	Good
2.	It provides opportunities for teachers to adjust lesson plans based on student feedback and learning outcomes.	4.67	0.58	Very Good
3.	The guide includes case studies, best practices, or real-world applications to help teachers refine their instruction.	4.33	0.58	Good
4.	It offers professional self-assessment tools to help teachers evaluate their teaching effectiveness.	4	1	Good
5.	The guide fosters a culture of continuous learning and adaptation in teaching.	4	0	Good
V. Overall Usability and Alignment with Educational Standards				
1.	The guide is well-organized, easy to navigate, and practical for instructional use.	4.67	0.58	Very Good
2.	It aligns with national and institutional curriculum standards.	4.67	0.58	Very Good
3.	The content is comprehensive, covering key concepts, teaching methodologies, and learning activities.	4.67	0.58	Very Good
4.	The guide effectively supports student-centered learning and real-world applications.	4.33	0.58	Good
5.	It enhances the overall teaching and learning experience, making lesson delivery more effective.	4.67	0.58	Very Good

Table 3

Reviews and Feedback of Experts to Enhance the PATHFit 2Prototype Manual

Chapter		Major Recommendations
Preliminary Pages	-	Use professional formatting for author and reviewer names, including terminal degrees and affiliations.
	-	Indicate the subject of CMO 39 s. 2021 and align the course title consistently with CHED standards.
	-	Add a liability disclaimer and encourage adaptation based on local health and context.
	-	- Group chapters into parts, include appendices, and restructure the inclusivity note for clarity.
Chapter 1	-	Reorder subtopics for better instructional flow (Overview → Importance → Outcomes → Objectives).
	-	Use non-abbreviated technical terms to increase clarity for readers unfamiliar with PE jargon.
Chapter 2	-	Use OBE format including unit focus, teaching strategies, and assessments.
	-	Add adaptive PE activities and elaborate on collaboration strategies and traditional games.
Chapter 3	-	Apply OBE syllabus format; make workouts visual and categorize them by function with safety tips.
Chapter 4	-	Add common PE technical terms and define them in student-friendly language.
Chapter 5	-	Integrate teaching activities and instructional materials within the OBE syllabus section.
Chapter 6	-	Include student reflection prompts, assessment domains, and reminders for safety and inclusion.

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Original Research Article

Stronger Legs, Quicker Moves: Why Body Mass Didn't Stand in the Way of Agility

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Abstract: This study investigated the mediating effect of body mass index (BMI) on the relationship between leg power and agility among college students enrolled in Physical Activity Towards Health and Fitness (PATHFit) classes on Camiguin Island. Grounded in the Biomechanical Principles of Force and Momentum, which suggest that greater body mass may hinder acceleration despite muscular force, the research examined whether BMI impairs agility by limiting the influence of muscular power. A total of 165 students aged 18 to 25 participated, with measurements taken for BMI (using World Health Organization standards), leg power (using the Sprint Power Test), and agility (using the Illinois Agility Test). A significant negative correlation was found between leg power and agility; however, no significant mediating effect was observed from BMI. While higher BMI was individually associated with poorer agility and greater leg power—possibly due to increased absolute force from higher body mass—it did not account for the overall power-agility link. These findings highlight the critical role of muscular strength in agility performance and suggest that PE interventions should prioritize leg power development over BMI-based categorization. The study advocates for more inclusive and individualized approaches in physical education programming, particularly in under-resourced academic settings, such as Camiguin Island.

Keywords: agility, body mass index, leg power, physical education, mediation analysis

Introduction

Obesity is a pressing global public health concern that has been extensively studied within the fields of Physical Education (PE), sports science, and health disciplines (Leszczak *et al.*, 2022; World Health Organization, 2020). Overweight and obesity rates globally now exceed those of underweight adults, indicating a pervasive health issue (World Health Organization, 2020). In the Philippines, the obesity rate among university students (33.0%) surpasses the national average (31.1%), demonstrating a unique vulnerability in this group. This is likely driven by sedentary behavior, poor dietary choices, and academic stress (Ramosa & Bulusan, 2020). These lifestyle patterns, alongside reduced engagement in structured physical activity and limited access to fitness programs, underscore the need to address obesity within educational and healthcare frameworks (Leszczak *et al.*, 2022; Liu & Kan, 2021).

In light of this pressing issue, this study investigates the mediating role of body mass in the relationship between leg power and agility among college students. A practical problem arises in current physical education (PE) instruction: standardized assessments and uniform programming often overlook individual differences in body composition and physical ability (Essel *et al.*, 2022; Leszczak *et al.*, 2022). Such uniformity can be detrimental, especially for overweight students who struggle with shuttle runs, jumping exercises, or endurance circuits. These experiences may lead to embarrassment, discouragement, and disengagement from PE (Essel *et al.*, 2022; Witkoś & Hartman-Petrycka, 2021).

Further compounding this problem are findings that confirm obesity has an adverse effect on motor skills, agility, and overall athletic performance (Hsieh *et al.*, 2021; Leszczak *et al.*, 2022; Muin & Nugroho, 2022). Obese individuals often show reduced coordination, postural control, and neuromuscular efficiency—key factors in athletic tasks (Fiori *et al.*, 2020; Hariadi *et al.*, 2019). Notably, higher body fat, particularly in females due to hormonal and physiological differences, negatively correlates with vertical jump performance—an essential marker of lower-body power relevant to sports such as basketball, volleyball, and track and field. Additionally, leg power itself varies by gender and body mass (Fischerova *et al.*, 2021; Liu *et al.*, 2020). The mechanisms at play here indicate that excess body weight has been shown to lower mechanical efficiency and increase ground reaction forces, thereby reducing agility and movement economy (Kondapalli *et al.*, 2019; Verlaan *et al.*, 2021). Despite these findings, few studies have explored body mass as a mediating factor in the power–agility relationship, especially in practical physical education contexts.

Recognizing this gap, the mediating effect of body mass on the relationship between leg power and agility remains underexplored. Addressing this knowledge gap is crucial for developing inclusive physical education (PE) strategies that support learners with diverse physiological profiles. Scholars emphasize that equitable PE instruction must consider body composition and muscular capacity to enhance participation and outcomes (Essel *et al.*, 2022; Witkoś & Hartman-Petrycka, 2021). This study examines this issue among college students in Camiguin Island, Northern Mindanao, a rural setting characterized by limited PE facilities, minimal instructional equipment, and a scarcity of specialized instructors. These constraints influence students' ability to participate fully in physical activities, illustrating the importance of localized research. Indeed, Camiguin serves as a model for understanding how under-resourced environments impact the effectiveness of PE programming when body mass differences are not addressed.

Therefore, this study aims to examine the mediating effect of body mass on the relationship between leg power and agility among college students. Anchored in the Biomechanical Principles of Force and Momentum (Knudson, 2003), this research assumes that leg power directly influences agility, but this effect may be moderated by an individual's body mass. Additionally, the study relies on Newton's Second Law ($F = ma$), which suggests that greater body mass requires more force to produce equivalent acceleration—a key dynamic in understanding agility tasks.

This assumption is further corroborated by the idea that higher body mass, while contributing to force production, may also hinder the efficient execution of agile movements due to the physiological and mechanical load on the body. Hence, the study hypothesizes that body mass mediates the link between leg power and agility.

The research specifically addresses the following objectives:

1. To measure and analyze the leg power, agility, and body mass index of participants.
2. To determine if there is a significant direct relationship between leg power and agility.
3. To assess whether body mass mediates the relationship between leg power and agility.

To explore these objectives, the following null hypotheses will be tested:

- Ho_1: The participants' leg power does not significantly influence their agility.
- Ho_2: There is no mediation effect of the body mass index on the relationship between leg power and agility.

This study contributes to the theoretical and practical discourse by examining how body mass affects agility through leg power. It offers actionable insight for PE teachers, coaches, and curriculum developers by encouraging individualized instruction, such as adapting fitness assessments or incorporating alternative movement formats. Findings may inform more inclusive, equitable practices in PE, particularly in under-resourced academic settings. This research also aims to spark further studies addressing similar performance disparities caused by physiological diversity.

Methods and Materials

The study employed a descriptive correlational design to examine the relationships between leg power, agility, and body mass index (BMI) without manipulating the variables (Essel *et al.*, 2022; Saputra *et al.*, 2024). This design was chosen because it allowed the researcher to observe associations among naturally occurring variables in a real-world educational setting, where experimental manipulation (e.g., altering body mass) was neither practical nor ethical. Furthermore, mediation analysis was employed to elucidate the role of BMI in the relationship between leg power and agility, as it facilitates the identification of indirect pathways and mechanisms between the independent and dependent variables.

The study involved 165 college students enrolled in PATHFit courses during the first semester of the 2024–2025 academic year. All 280 enrolled students were invited, and the final sample of 165 participants was selected using total sampling and a drawing-of-lots method stratified by class section to ensure balanced representation. Inclusion criteria required participants to be 18–25 years old, consistently enrolled, medically cleared, and willing to provide informed consent.

To accurately measure the variables in question, BMI was calculated using height and weight data based on the World Health Organization (WHO) standards (Dieny *et al.*, 2022). Agility was assessed using the Illinois Agility Test, a reliable change-of-direction ability (Hachana *et al.*, 2013). Leg power was evaluated using the Sprint Power Test validated in Tomopong (2024), which involved a 20-meter sprint. This comprehensive test calculated acceleration, force, and average power and was shown to have high reliability and validity. Notably, the test was pilot-tested in the current study prior to full-scale implementation to ensure contextual suitability.

In adherence to ethical research standards, the study followed protocols approved by the institution's Research Ethics Committee. Participants underwent an orientation session, a health screening using the Physical Activity Readiness Questionnaire (PAR-Q), and then signed an informed consent form. Additionally, data were collected over four weeks and were anonymized using coded identifiers. Records were stored securely and handled in compliance with the Data Privacy Act to protect participant confidentiality.

To analyze the data, descriptive statistics (mean, standard deviation, and frequency) were employed for summarization. Subsequently, multiple regression was used to determine predictive relationships between leg power and agility. Following this, mediation analysis was conducted to assess whether BMI explained part of the relationship between these variables (Joyce *et al.*, 2022). Overall, these methods ensured an ethical, systematic, and evidence-based approach to addressing the research questions.

Results

Table 1 presents the descriptive statistics on the participants' BMI, classified according to the WHO standards (*see p. 73*). The mean BMI of the participants was 20.37 kg/m², with a standard deviation of 3.53, corresponding to the *normal* weight category, indicating that most participants maintained a healthy body composition. The majority of the participants, specifically, 51.7% (n = 61), have a *normal* weight (18.5–24.9 kg/m²). However, a notable portion of the sample exhibited *undernutrition*, as indicated by the relatively high prevalence of underweight individuals. A considerable proportion, 34.7% (n = 41), were classified as *under-weight*, while 11.0% (n = 13) were categorized as *overweight*. Only a small percentage, 2.5% (n = 3), were classified as *obese*.

Table 2 presents the descriptive statistics on the participants' agility performance based on the Illinois Agility Test norms for male and female participants (*see p. 73*). The table revealed the mean agility time for females was 25.67 seconds (SD = 4.07), while the mean for males was 23.27 seconds (SD = 5.01), both falling within the poor performance description. These findings indicate that, overall, both male and female participants exhibited *poor* agility performance levels. Moreover, the majority of participants demonstrated *poor* agility performance, as noted in the Illinois Agility Test norms. Among the female participants, 75.0% (n = 66) were classified in the *poor* category, while among the male participants, 81.0% (n = 34) fell within the same classification. Only a small proportion of participants achieved *good* agility ratings, with 11.4% (n = 10) of females and 2.4% (n = 1) of males categorized as *good* performers. A further 13.6% (n = 12) of females and 14.3% (n = 6) of males obtained a *fair* agility rating. Notably, none of the female participants achieved *outstanding* or *very good* agility ratings, whereas one male participant (2.4%) reached the *outstanding* category.

Table 3 presents descriptive statistics of the participants' leg power, as measured by the Sprint Power Test, according to sex-specific class standards (*see p. 73*). The participants' leg power performance showed generally moderate results. The mean leg power for female participants was 255.84 watts (*SD* = 264.87), corresponding to the *good* category, while the mean for male participants was 427.40 watts (*SD* = 439.38), corresponding to the *fair* category based on the Sprint Power Test class norms. Among the female participants, 42.0% (*n* = 37) were categorized as having *poor* leg power, while 26.1% (*n* = 23) were classified as having *fair* leg power. For male participants, a majority (59.5%, *n* = 25) also fell under the *poor* category. Only a small proportion achieved outstanding or very good leg power ratings, with 17.0% (*n* = 15) of females and 19.0% (*n* = 8) of males classified as outstanding.

Regarding the significant influence of participants' leg power on agility, Table 4 presents the regression analysis of the relationship between participants' leg power and agility (*see p. 74*). Prior to analysis, the data for BMI, leg power, and agility were transformed to ensure that the assumptions of normality and linearity were met. The Shapiro-Wilk test and Q-Q plot assessments confirmed that the transformed data met the necessary statistical assumptions. Moreover, the table shows a statistically significant influence of leg power on agility, with a standardized beta coefficient of -0.394 (t = -4.789, p < .001). The model had an R value of 0.394 and an R^2 of 0.155, indicating that approximately 15.5% of the variance in agility scores could be explained by leg power. The F-statistic (F = 22.930, p < .001) further confirmed the model's significance. These findings suggest that leg power is a meaningful predictor of agility performance, with greater power associated with lower agility times (i.e., better performance). Accordingly, the null hypothesis, stating that the participants' leg power does not significantly influence their agility, is rejected.

Furthermore, Table 5 presents the results of the mediation analysis examining whether body mass index (BMI) mediates the relationship between agility and leg power among the participants (*see p. 74*). The study revealed a significant direct effect of leg power on agility (β = 0.251, z = -4.354, p < .004), confirming that higher leg power is associated with better agility performance. However, the indirect effect of leg power on agility through BMI was not significant (β = -0.10, z = -1.214, p = 0.257), indicating that BMI did not mediate the relationship between leg power and agility. The total effect remained significant (β = 25.34, z = -4.827, p < .001), further reinforcing the direct influence of leg power on agility. Thus, there is not enough evidence to reject the null hypothesis, indicating that BMI does not have a mediating effect on the relationship between leg power and agility.

Despite this, the path coefficients provide additional insight. Figure 1 visually represents the statistical paths and supports the conclusion that while leg power significantly predicts BMI, it does not significantly predict agility, thereby disconfirming a mediation effect (*see p. 74*).

The path coefficients revealed that leg power significantly predicted BMI (β = 0.003, p = 0.003), while BMI itself did not predict substantial agility (β = -0.142, p = 0.185). This suggests that while BMI increases in association with higher leg power, possibly due to increased absolute body mass, this increased BMI does not subsequently explain changes in agility. In other words, the demand for greater force production rises with increased body mass, but this does not automatically translate to improved agility performance.

Discussion

The BMI results of the participants in this study align with previous findings among college students and young adults. Dewi *et al.* (2021) reported a normal BMI among school-aged participants, with a notable percentage also found to be underweight or overweight, consistent with the trends observed in this study. Similarly, Roy *et al.* (2022) observed normal BMI levels among Asian adolescents, although some are underweight or overweight due to variations in nutritional habits and activity levels across the population. Suhaimi *et al.* (2021) also noted increased rates of overweight and obesity in young Filipino adults, but many still fell within the normal BMI range. The mean BMI in this study was estimated at 20.37 kg/m², with 51.7% of participants in a healthy weight range, 34.7% classified as underweight, and 11.0% as overweight. These findings highlight the double burden of malnutrition among young adults, where undernutrition persists alongside a rising prevalence of overweight, especially among Asians and island populations experiencing rapid lifestyle and dietary changes.

The participants' BMI profiles indicated that most were of normal weight, although a substantial proportion was either underweight or overweight. This finding is consistent with previous research on college-aged samples, particularly in Asia. A study (Dewi *et al.*, 2021) suggests that the high prevalence of underweight in Southeast Asia is contributed to by inadequate dietary consumption, maladaptive dieting behaviors, and socioeconomic constraints that hinder access to a balanced diet. Additionally, Roy *et al.* (2022) noted that differences in BMI are generally due to irregularities in routine meals and Western dietary habits, leading to undernutrition or excessive consumption. In the Philippines, Mangompit (2024) describes a phenomenon termed the *festival food syndrome*, which refers to periodic feasting and daily caloric deficit, both of which may mean variability in BMI. Suhaimi *et al.* (2021) also noted that increased overweight trends, even among traditionally lower body mass index (BMI) groups, due to less physical activity associated with academic challenges and sedentary behavior, were augmented among university students. Together, these factors indicated that nutritional imbalances, changing lifestyles, and reduced routine physical activity were affecting the BMI distribution of participants, as well as the everyday struggles faced by college students living in areas such as Camiguin Island.

Findings regarding agility align with previous research, which revealed equally low levels of agility performance in both general college and non-athletic samples. Dewi *et al.* (2021) reported that both overweight and underweight adolescents exhibited lower agility performance compared to those of a healthy weight, suggesting that obesity or underweight may impact movement efficiency. Likewise, Fiori *et al.* (2020) demonstrated that overweight youths had significantly lower agility and coordination scores in fitness tests conducted in school settings, which aligns with the observation in this study that the majority of participants received only fair to poor agility ratings. Furthermore, body composition and physical inactivity were identified as essential factors associated with performance in agility, in line with previous findings established in Patel and Thakrar (2024), stating that university students with higher body fat percentages exhibited slower agility performances.

Regarding leg sprinting power, the results are consistent with prior research assessing leg power in general college student populations. As highlighted in Pituk and Cagas (2019), the leg power performance levels of male and female university students in the Philippines were moderate and low, respectively, when compared to those of other international athletes. This is likely due to decreased muscular strength and power that result from limited strength training and lower habitual physical activity levels.

Similarly, Irawan *et al.* (2020) also noted that non-athletic university students have lower explosive power, particularly in the lower limbs, due to a sedentary lifestyle, and they tend not to participate in organized sports. This notion is supported in Gunasekar and Balamurugan (2021), stating that explosive strength must be developed through structured neuromuscular training, which is typically lacking in the general education environment. The current result is consistent with previously conducted studies. It indicates that without targeted intervention and proper physical conditioning, leg power may remain within a fair to poor classification amongst non-athletic college students.

The result regarding the significant influence of participants' leg power on agility has important implications for physical education programming. It suggests that targeted development of lower body strength and power, through sprints, jumps, and resistance exercises, can enhance agility among college students. These findings align with previous research. Fischerova *et al.* (2021) emphasized that anaerobic leg power significantly contributes to agility and sport performance. Pituk and Cagas (2019) further reported that non-athletic students often lack sufficient leg power, negatively impacting their agility performance. Thus, the present findings reinforce the consensus that leg power is a crucial determinant of agility.

Furthermore, the findings align well with the Biomechanical Principles of Force and Momentum (Knudson, 2003), which underpin this study's theoretical framework. According to Newton's Second Law (F = ma), increased muscular force, such as that generated by powerful legs, leads to greater acceleration and improved change-of-direction ability—both critical components of agility. The significant relationship observed supports this biomechanical assumption and validates the theoretical model applied.

From the researcher's perspective, these findings suggest that inclusive PE instruction needs to prioritize neuromuscular development over body mass categorization when aiming to improve movement competencies such as agility. Especially in resource-limited settings like Camiguin Island, low-cost interventions focusing on leg power can yield significant improvements in agility without requiring advanced facilities. This approach fosters equity and encourages continuous participation regardless of a student's BMI classification.

Furthermore, the finding that BMI does not have a mediating effect on the relationship between leg power and agility is grounded in the Biomechanical Principle of Force and Momentum (Knudson, 2003), which posits that heavier bodies require greater force to accelerate. The data imply that higher BMI increases the mechanical demand for force, requiring greater neuromuscular control and power output to achieve similar agility levels. However, since higher BMI individuals do not inherently generate more power, they are at a disadvantage in agility tasks, highlighting that BMI is not a sufficient explanation for agility variation.

These findings are consistent with the literature that emphasizes the role of muscular power and neuromuscular coordination as primary determinants of agility (Chenoweth & Belgioioso, 2019; Fischerova *et al.*, 2021). As such, the study highlights the need for targeted interventions that develop neuromuscular strength and coordination, particularly in overweight and obese non-athletic individuals, to compensate for the increased physical demands associated with higher body mass.

In summary, BMI does not mediate the relationship between leg power and agility; however, it influences the force required to maintain agility. This highlights the importance of individualized PE programming that enhances muscular capacity and movement efficiency, rather than relying solely on anthropometric classification. Nevertheless, even though BMI did not significantly mediate the relationship, BMI still correlated with the performance metrics, highlighting its relevance in differentiated instruction planning.

Conclusion

This study aimed to assess whether BMI mediates the relationship between leg power and agility among college students enrolled in PATHFit courses in Camiguin Island. More specifically, the study aimed to determine whether leg power and agility are related and whether the relative BMI has an impact on the relationship between the two variables. While a direct link between leg power and agility was confirmed, the results showed that BMI only minimally and not significantly mediated this relationship. However, the findings are consistent with previous literature suggesting that muscular power and neuromuscular control, rather than body mass itself, are essential determinants of agility. Therefore, despite body mass not acting as a mediator as initially expected, this outcome aligns with existing research. Although the mediation hypothesis was not supported, the study successfully investigated and clarified the relationship between leg power, agility, and body mass.

Furthermore, the study results have additional implications in relation to the theoretical framework employed. Grounded in the Biomechanical Principle of Force and Momentum, the findings confirmed the established principle that force production and movement effectiveness are directly correlated to muscle power and acceleration. While body mass contributes to force and momentum values, the results indicate that it is neither the sole nor primary factor driving agility performance in non-athletic college populations. Instead, this research emphasizes neuromuscular control and explosive strength as more direct determinants of agility. This suggests that, although the core principles of the theoretical framework were supported, body mass may be interpreted as merely one of several influencing factors, rather than a key mediator.

In addition, the study identified significant research gaps. It was found that while many previous studies have suggested body mass is a critical factor in physical performance, BMI did not mediate the relationship between leg power and agility in a non-athletic college population. Thus, future studies could explore alternative mediators such as neuromuscular coordination, training frequency, psychological readiness, or muscle quality. Investigating these different contexts could provide better explanations for the variations observed in agility performance. Furthermore, this suggests a need for more research to engage underrepresented students who are not involved in sports and to facilitate targeted interventions within physical education contexts that prioritize developing power and skill beyond traditional demographic classifications based on body mass. These gaps highlight the need for a more comprehensive and nuanced understanding of fitness performance, surpassing what traditional anthropometric markers can offer.

Considering the results of this study, PE teachers may want to consider developing fitness programs that directly enhance leg power and agility, rather than relying solely on body mass classifications as indicators of physical ability. Similarly, PE curriculum developers could incorporate more flexible and individualized approaches to fitness into lesson plans, enabling students to tailor their training to focus on leg power and agility based on their body mass profiles. Such strategies may encourage students to engage continually in lower body strength and agility exercises, such as sprint drills, plyometrics, or balance activities, while focusing on improving their skills rather than their body weight. Moreover, school administrators may support initiatives that ensure facilities, equipment, and programs are available to promote strength and agility development among students across a wide range of body mass classifications in physical education programs. Finally, future studies may consider additional potential mediators, like neuromuscular coordination, frequency of physical activity, and psychological readiness, to gain a comprehensive understanding of the factors influencing agility performance beyond BMI.

Conflict of Interest: *The author declares that there is no conflict of interest regarding the publication of this article.*

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Ethical Approval: *The study was reviewed and approved by the Research Ethics Committee of Lourdes College, Inc., in accordance with the ethical standards outlined in the Belmont Report. Informed consent was obtained from student participants, ensuring full ethical compliance.*

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, ensuring academic rigor and integrity. Additionally, Grammarly AI was 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.*

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Table 1

Descriptive Statistics of the Participants' BMI

		BMI	
Range in kg/m2	**Description**	**Frequency**	**Percentage**
≥ 30	Obese	3	2.5
25.00 29.90	Overweight	13	11.0
18.50 24.90	Normal Weight	61	51.7
<18.5	Underweight	41	34.7
	TOTAL	118	100
	Mean	**20.37**	
	Description	**Normal Weight**	
	Standard Deviation	**3.53**	

Table 2

Descriptive Statistics of the Participants' Agility Performance

					Agility			
Range (Seconds)					**Female**		**Male**	
Female		**Male**		**Description**	**f**	**%**	**f**	**%**
< 16.9		< 15.1		Outstanding	0	0.0	1	2.4
17.00	17.90	15.20	16.10	Very Good	0	0.0	0	0.0
18.00	21.70	16.20	18.10	Good	10	11.4	1	2.4
21.80	23.00	18.20	19.30	Fair	12	13.6	6	14.3
> 23.1		> 19.4		Poor	66	75.0	34	81.0
				TOTAL	**88**	**100**	**42**	**100**
				Mean	**25.67**		**23.27**	
				Description	**Poor**		**Poor**	
				Standard Deviation	**4.07**		**5.01**	

Table 3

Descriptive Statistics of the Participants' Leg Power Performance

					LEG POWER			
Range (Seconds)					**Female**		**Male**	
Female		**Male**		**Description**	**f**	**%**	**f**	**%**
	> 380		> 653	Outstanding	15	17.0	8	19.0
303.00	379.00	542.00	652.00	Very Good	7	8.0	3	7.1
224.00	302.00	429.00	541.00	Good	6	6.8	0	0.0
147.00	223.00	318.00	428.00	Fair	23	26.1	6	14.3
< 146		< 317		Poor	37	42.0	25	59.5
				TOTAL	**88**	**100**	**42**	**100**
				Mean	**255.84**		**427.40**	
				Description	**Good**		**Fair**	
				Standard Deviation	**264.87**		**439.38**	

Table 4

Regression Analysis of the Influence of Leg Power on Agility

Individual Influence of Predictor	Agility		
	Standardized Coefficient	**t**	**p**
Leg Power	-0.394	-4.789	<0.001
Model Summary			
R=0.394	R^2=0.155	F=22.930	p <0.001

Table 5

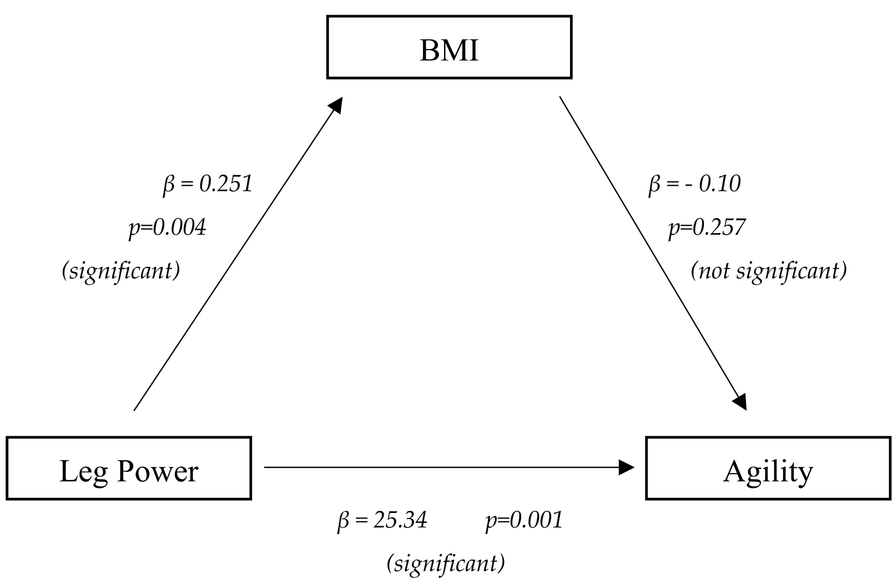
Mediation Analysis of the Relationship Between Leg Power and Agility with BMI as Mediator

Effect Type	Path	Estimate	z	p	Interpretation
Direct	Leg Power → Agility	0.251	-4.354	< .004	Significant
Indirect	Leg Power → BMI → Agility	-0.10	-1.214	0.257	Not significant
Total	Leg Power → Agility	25.34	-4.827	0.001	Significant

Note: *Estimation method = Maximum Likelihood (ML).*

Figure 1

Path Plot Illustrating the Mediation Model of BMI on the Relationship Between Leg Power and Agility



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Original Research Article

Validation of the USFD 20-Meter Sprint Power Test

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Abstract: Addressing the lack of context-responsive and scalable tools for assessing sprint-specific muscular power in Philippine physical education and athletic settings, this study developed and validated the USFD 20-Meter Sprint Power Test (USFD-20MSPT). Designed as a field-based performance test, it measures average muscular power during sprinting while accounting for individual differences in body mass. It aims to provide a practical, scientifically grounded alternative to traditional vertical jump assessments, particularly where equipment or space limitations exist. The test protocol is based on Newtonian mechanics, estimating power output using sprint time and mass. A multi-phase validation process was implemented. Content validity was determined through expert ratings by ten physical educators, resulting in a high Content Validity Index (CVI = 0.90). Convergent validity was demonstrated by a strong correlation with the Vertical Jump Test (r = 0.789), affirming that both tools measure the same construct. Discriminant validity was supported by a weak, non-significant correlation with the Ruler Drop Test (r = –0.243), indicating that the USFD-20MSPT does not assess unrelated constructs, such as reaction time. Test-retest reliability using rank-transformed data showed excellent stability (r = 0.980), indicating consistency across sessions. The USFD-20MSPT stands as a reliable, accessible tool for PE instruction, fitness monitoring, and athlete development. It is recommended for integration into school-based fitness programs and further validation across broader contexts to establish nationwide normative values that support national adoption.

Keywords: Sprint power, psychomotor test validation, measurement and evaluation in physical education, psychometric research, skill test assessment

Introduction

Muscular power, the ability to exert force rapidly, is a critical element of athletic performance, particularly in movements such as sprinting, jumping, and throwing (Fraser *et al.*, 2021). It is calculated as the rate at which work is performed, or the product of force and velocity (Merrigan *et al.*, 2021). For example, a sprinter who accelerates quickly from the starting line demonstrates high muscular power by applying significant force over a short period. In physical education (PE) settings, power is frequently assessed through Vertical Jump Tests (VJT), which focus solely on jump height and omit the time component essential to accurate power measurement (Merrigan *et al.*, 2021). This limitation undermines the test's ability to fully represent muscular power output, as actual power requires kinematic data that includes time, for instance, the duration of ground contact or movement speed during an explosive task (Hetherington-Rauth *et al.*, 2021).

Training protocols and baseline fitness levels have a significant influence on muscular power. Isokinetic and resistance training enhance power among young men (Na'aim *et al.*, 2022), while strength gains are positively associated with performance in power-related tasks, such as the standing long jump (Chae & So, 2020). Longitudinal studies confirm a close relationship between muscular strength and power across the lifespan (Fraser *et al.*, 2021). However, traditional strength training may not be sufficient for adequately developing explosive power. Therefore, researchers recommend incorporating time-sensitive metrics, such as peak force and rate of force development, into training and assessment practices to address this gap (Bergwell *et al.*, 2022). For instance, applying these metrics through high-speed resistance training or isokinetic testing in schools can more effectively target explosive strength. This is particularly relevant in functional contexts, such as elderly care, where muscular power predicts the ability to perform daily activities independently (Moura *et al.*, 2020). A more comprehensive evaluation of muscular power should thus include temporal measures to improve validity and broaden applicability (Hetherington-Rauth *et al.*, 2021; Moura *et al.*, 2020).

The popularity of VJT in PE highlights a significant limitation in evaluating athletic power among students. Relying solely on jump height accounts for less than half the variance in actual lower limb power output (AlTaweel *et al.*, 2022). Although convenient, vertical jumps fail to accurately reflect the complex muscular coordination and kinetic patterns required in explosive movements, such as sprinting (Donskov *et al.*, 2021). In contrast to these limitations, sprint assessments provide a more precise measure of anaerobic power, which is essential for sports involving rapid acceleration, as they enable direct measurement of key variables such as force, time, and displacement (Pandoyo *et al.*, 2020).

Moreover, diverse training methods, including plyometric exercises and Olympic lifts, improve multiple facets of power beyond what vertical jump performance reveals. These methods engage both neural and muscular systems in a way that mirrors the explosive demands of sprinting (Atalay *et al.*, 2023; Kim *et al.*, 2021; Permana *et al.*, 2022). While vertical jump results may correlate with factors such as bone strength, their dependence on muscle fiber composition and training history limits their generalizability (Alalyani *et al.*, 2020; Yingling *et al.*, 2021). Hence, integrating various power assessments in PE provides a more holistic view of athletic potential (Moura & Okazaki, 2022; Rakholiya & Gadesha, 2020).

In response to the limitations associated with traditional jump-based power assessments, this study proposes sprinting as a theoretically grounded and empirically supported alternative to the VJT. Before introducing this method, it is helpful to understand that Newtonian mechanics provides a framework in which force, mass, and acceleration can be used to derive power, enabling a more profound insight into athletic explosiveness. Sprinting enables the accurate calculation of power using known values of time, distance, and body mass (Farr *et al.*, 2023; Nicholson *et al.*, 2021). Unlike jump tests, sprinting allows the direct application of kinematic equations, enhancing analytical precision (Nicholson *et al.*, 2020). Research supports sprint performance as an indicator of power, particularly when optimized through resisted sprinting and post-activation performance enhancement techniques (Godwin *et al.*, 2023; Rodríguez-Rosell *et al.*, 2020). This innovation is especially beneficial in schools by streamlining assessments, aligning with curricular goals, and increasing student engagement (Barney & Kahaialii, 2020).

Additionally, this approach addresses time constraints in PE classes by offering a single, efficient test that does not compromise validity (Stojanović *et al.*, 2023). Training based on sprint mechanics improves speed and enhances general fitness, reinforcing the method's relevance to PE fitness evaluation frameworks (Edwards *et al.*, 2022; Wang & Zhao, 2023). Consequently, sprint-based assessments contribute to accurate power measurement and promote student motivation, engagement, and the development of lifelong fitness habits (Barney & Kahaialii, 2020; Stojanović *et al.*, 2023).

To ensure the psychometric soundness of the USFD-20MSPT—essential for its use in educational and athletic settings—this study employed two critical forms in construct validity: convergent and discriminant validity. These concepts are crucial in educational test development to verify that the instrument effectively measures its intended construct while remaining distinct from unrelated ones. The study follows the unified framework of modern validity theory (AERA, APA, & NCME, 2014; Reeves & Marbach-Ad, 2016). Convergent validity determines whether two tools designed to measure the exact construct yield similar results. Here, the USFD-20MSPT was correlated with the widely used VJT, utilizing power estimation formulas that incorporate jump height, body mass, and height (Johnson & Bahamonde, 1996; Wood, 2008). A strong positive correlation (typically $r \geq 0.60$ or ≥ 0.70) was observed, affirming that both tests measure muscular power (Lee *et al.*, 2021; Thi *et al.*, 2024).

Discriminant validity, on the other hand, ensures a test does not inadvertently measure unrelated constructs. This was assessed by correlating the USFD-20MSPT with the Ruler Drop Test (RDT), a measure of reaction time. The expected low correlation ($r \leq 0.30$ or ≤ 0.40) confirmed that the USFD-20MSPT specifically measures muscular power, not cognitive response speed (Farrell, 2010; Susmarini *et al.*, 2023).

These validity types are foundational in psychometrics, establishing both internal coherence and conceptual distinction. When theoretically similar constructs show high correlations, convergent validity is demonstrated; when unrelated constructs show low correlations, discriminant validity is confirmed. Supporting evidence may include technical metrics like Average Variance Extracted (AVE)—a measure of the variance captured by a construct relative to error—and the Fornell–Larcker criterion, which confirms discriminant validity by comparing the square root of AVE to inter-construct correlations (Hançer & Tokgöz-Yılmaz, 2024; Lim, 2024). Collectively, these validity forms enhance the theoretical and practical credibility of measurement tools in PE, psychology, and health sciences (Rönkkö & Cho, 2020; Salahuddin *et al.*, 2023).

To evaluate the consistency of the USFD-20MSPT over time, reliability testing was conducted using the test-retest method. This widely accepted approach in psychomotor assessment confirms that a tool yields stable results when repeated under similar conditions (Abe & Olofin, 2024; Alvarez-López *et al.*, 2020). Participants repeated the test after a one-week interval to assess the stability of their scores. Establishing reliability is crucial, as fluctuations may reflect external factors rather than true changes in motor ability (Amorim *et al.*, 2022; Shankman *et al.*, 2020). Emphasizing standardized administration and consistent intervals aligns with best practices in psychomotor research, especially when tests involve both motor execution and cognitive processing (Horoszkiewicz & Horoszkiewicz, 2022; Paquet *et al.*, 2022). By confirming score reproducibility, this reliability analysis supports the USFD-20MSPT's measurement integrity and suitability for PE and skill development programs.

Importantly, the study addresses a critical gap in the Philippine context. Despite the recognized importance of muscular power assessment, no locally validated sprint-based psychomotor test exists. Current practices rely heavily on vertical jumping, overlooking more dynamic alternatives. This study offers a practical, evidence-based, and culturally relevant fitness assessment tool for Philippine physical education programs. The findings have the potential to transform how power is measured in schools by offering a more accurate, engaging, and versatile assessment model that aligns with local educational needs, existing PE standards, national fitness protocols, and global best practices—and may serve as a model for future test development in other areas of fitness assessment.

Methods and Materials

This study employed a psychometric research design to evaluate and validate the USFD-20MSPT. Psychometric design plays a critical role in assessing and establishing the reliability and validity of test instruments, particularly those measuring psychomotor performance. This design supports the development and rigorous evaluation of measurement tools to ensure they yield accurate and meaningful results across varied contexts (Aachal *et al.*, 2024; Ripping *et al.*, 2021).

The research process focused on psychometric properties, including content validity, construct validity (convergent and discriminant), and reliability (test-retest). Reliability was examined using repeated measures across time and different raters, while validity was assessed by comparing the new test with both related and unrelated constructs (Amorim *et al.*, 2022; Badenes-Ribera *et al.*, 2020).

The study involved field experts and student participants from a city in Bukidnon, Philippines. The field experts, comprising ten physical education instructors and one physics educator, reviewed and validated the developed test. Specifically, the experts consisted of three Junior High School (JHS) PE teachers, three Senior High School (SHS) PE teachers, and four college-level PE instructors. The inclusion criteria were based on teaching experience and educational attainment to ensure that the test components were appropriate for specific student age groups.

Student participants were selected through purposive sampling to ensure relevance to the study. The sample consisted of 30 students evenly distributed across gender and educational levels: ten JHS students (ages 14–16), ten SHS students (ages 17–18), and ten college students (ages 19–21). All participants were assessed as physically capable of performing sprint tasks. Only college students were considered part of the non-vulnerable group because of their legal age. However, the final group of participants, excluding the outlier from the college students, is 29.

Three instruments were employed to establish validity and reliability. Test 1 was the revised USFD-20MSPT, developed in response to feedback from physical educators. It measured sprint time, which was converted into a power score. Test 2 was the VJT, widely accepted as a measure of lower-body power. Participants used chalk to mark their highest vertical reach, and the best of two attempts was recorded. Test 3 was the RDT, which assessed reaction time. Participants attempted to catch a ruler dropped by an assistant, and the distance it fell before being caught was measured over two trials.

The USFD-20MSPT serves as a diagnostic tool to estimate average total body power during sprint performance. Designed to emphasize acceleration and lower-body power, this test accounts for individual body mass and evaluates the force generated in a short sprint burst. The protocol begins with a skill rehearsal phase in which the participant practices the sprint start: kneeling on one knee at the "ready" command, assuming the sprinting posture at "set," and sprinting at full effort upon hearing "go." The test is conducted on a level surface with a marked 20-meter lane, requiring a stopwatch, weighing scale, and a digital HTML calculator.

Before the test, participants' body weight is measured. Each participant performs two trials, with time recorded by two timekeepers at the finish line; the final time is the average of both readings. Performance indicators include rapid acceleration, upright posture, synchronized arm and leg movement, and ground force generation with minimal airborne time. Scoring involves calculating the participant's velocity, acceleration, force, work, and average power using physics-based formulas. These steps enable a quantifiable estimation of sprint power based on motion mechanics and the effort exerted.

For the tests of convergence and discrimination, the VJT evaluated lower-body explosive power. Participants stood next to a wall, marked their standing reach with chalk, then jumped as high as possible and marked their highest reach. The difference between the standing and jumping reaches was recorded, with the best of two trials used for analysis. The VJT measured reaction time. An assistant held a ruler vertically between the participant's thumb and forefinger, with the participant prepared to catch it. Without warning, the ruler was released, and the participant tried to catch it as quickly as possible. The distance the ruler fell before being caught was recorded, and the average of two trials was used.

Field experts evaluated the USFD-20MSPT using a standardized rubric covering aspects such as equipment, setup, safety, scoring, and administration. Content validity was calculated using Lawshe's Content Validity Ratio (CVR) and the Content Validity Index (CVI).

Scoring and interpretation addressed five core areas: content validity, convergent validity, discriminant validity, inter-rater reliability, and test-retest reliability. Content validity was assessed using Lawshe's CVR, where a value of 0.800 or higher indicated acceptability, particularly for panels of 10 experts (Ayre & Scally, 2014; Yusoff, 2019; Fernández-Gómez *et al.*, 2020). Convergent validity was evaluated by correlating the USFD-20MSPT with the VJT. A correlation coefficient of 0.50 or above was considered acceptable (Abma *et al.*, 2016; Cheah *et al.*, 2018; Maciel & Vargas, 2020). Discriminant validity was determined through the correlation of the USFD-20MSPT with the VJT, where a coefficient of 0.50 or below confirmed validity (Nikolopoulou, 2022).

Reliability analysis included both inter-rater and test-retest methods. Inter-rater reliability measured the consistency of scores among different raters, while test-retest reliability examined the consistency of results from two testing sessions conducted one week apart. The Intraclass Correlation Coefficient (ICC) was used to interpret the results. ICC values of 0.90 and above indicated excellent reliability, 0.80–0.89 indicated good reliability, 0.70–0.79 indicated adequate reliability, and values below 0.70 were considered to have limited applicability (Price *et al.*, 2018; Saad *et al.*, 1999).

The researcher obtained ethical clearance from the institution's Research Ethics Committee and secured approvals from school administrators. Qualitative feedback from three PE teachers and one physics teacher guided initial revisions to the test. The updated version was sent to ten PE instructors for formal validation.

Formal requests, either printed or emailed, were issued to department heads and school leaders. Following approvals, limited face-to-face orientations were held to explain procedures and ensure transparency. Participants completed the Physical Activity Readiness Questionnaire (PARQ) and a health appraisal to confirm their fitness for participation.

Pilot testing was conducted in two rounds, separated by a one-week interval. PE major student assistants helped ensure accurate recording of scores. Assent and parental consent forms were collected from the student participants, while informed consent was obtained from the field experts. All participants were briefed about the study's purpose, procedures, and their rights.

Confidentiality was maintained in accordance with the Data Privacy Act of 2012. Participant identities were coded, and no identifying information was disclosed. Participation was entirely voluntary and free from coercion or incentives.

Descriptive statistics were used to summarize the data. Content validity was evaluated using CVR and CVI based on Lawshe's method. Convergent and discriminant validity were examined using correlation coefficients. The USFD-20MSPT was correlated with the VJT to assess convergent validity and with the RDT to assess discriminant validity. Reliability was assessed using ICC to evaluate consistency in test-retest scenarios. Results were interpreted based on ICC thresholds ranging from limited to excellent. These analyses provided robust evidence for the USFD-20MSPT's psychometric properties, confirming its validity and reliability across educational levels and settings.

Results

The results of this study are presented in the following order: content validity, convergent validity, discriminant validity, and stability reliability. Table 1 summarizes the ratings given by ten physical educators for various aspects of the USFD-20MSPT, including purpose, equipment, setup and dimensions, skill rehearsal, test administration, and scoring (*see p. 86*). The table shows whether each expert rated the aspect as 'essential' or not and provides information on the ratings' CVR and CVI. A brief explanation of CVR and CVI may help readers understand the numerical basis for item relevance.

Table 1 (Summary of the Physical Educators' Ratings on the USFD-20MSPT Aspects) indicates that physical educators found the items relevant. The CVI of the overall aspects of the USFD-20MSPT, as rated by physical educators, is 0.90, indicating that the test is a valid measure. This means that the elements of the test evaluated were relevant and appropriate for measuring the construct of sprint power. On the other hand, the CVR of all aspects of the test is above the recommended minimum value of 0.78, indicating that the expert ratings are valid.

Moreover, in preparing the data for statistical analysis, the researcher conducted a pairwise Shapiro-Wilk bivariate normality test to assess whether the data met the assumption of normal distribution required for correlation analysis. This test was applied to the paired variables to ensure that the relationships being analyzed reflected true linear associations rather than being skewed by non-normal data. Among the 30 original participants, one participant—identified as an outlier—was deliberately removed from the dataset. This participant, from the college-level group, exhibited time and power values that significantly deviated from the normal range, potentially distorting the validity of the correlation results. After this exclusion, the final sample size used for the validity testing consisted of 29 participants, thereby ensuring a more accurate and reliable analysis.

The results of the Pearson's correlation analysis in Table 2 (Pearson's Correlation Between Average Sprint Power and Vertical Jump Power) revealed a strong and statistically significant positive relationship between the USFD-20MSPT and the VJT using the Johnson & Bahamonde (1996) formula, $r(29) = 0.789$ (*see p. 86*). This indicates that participants who performed well in the USFD-20MSPT also tended to produce higher power estimates in the VJT. The strength of this correlation supports the convergent validity of the USFD-20MSPT, suggesting that it effectively measures the same construct—muscular power—as the established vertical jump method.

For the discriminant validity analysis, the correlation between the USFD-20MSPT and the VJT in Table 3 revealed a weak and statistically non-significant negative relationship, $r(29) = -0.243$ (*see p. 86*). This low correlation suggests that the two tests measure distinct constructs, with the VJT assessing reaction time and the USFD-20MSPT evaluating muscular power. The absence of a significant association supports the discriminant validity of the USFD-20MSPT, indicating that it does not overlap with unrelated abilities such as reaction speed. This distinction confirms that the USFD-20MSPT measures a distinct aspect of physical performance, thereby strengthening its psychometric soundness as a specialized tool for assessing sprint-specific power.

To further evaluate the test's consistency and address the violation of normality assumptions based on the Shapiro-Wilk test, the USFD-20MSPT data were transformed into ranks before conducting the test-retest reliability analysis. This rank-based transformation allowed for a more robust evaluation by minimizing the influence of outliers and skewed distributions, which are common in physical performance data. As a result, the analysis focused on the consistency of participant rankings across test sessions, ensuring a reliable assessment of stability over time.

The test-retest reliability analysis of the USFD-20MSPT using rank-transformed data in Table 4 revealed a very strong and statistically significant positive correlation between the test and retest scores, $r(29) = 0.980$ (*see p. 86*). This result indicates an exceptionally high level of consistency in participants' relative rankings across two testing occasions, demonstrating that the USFD-20MSPT yields stable and reliable outcomes over time when used in similar contexts.

Overall, the findings confirm that the USFD-20MSPT exhibits strong content, convergent, and discriminant validity, as well as excellent test-retest reliability. These results support the test's psychometric robustness and its suitability for assessing sprint-specific power in various physical performance contexts, including athletic training, educational assessments, and performance diagnostics.

Discussion

The USFD-20MSPT demonstrated strong content, convergent, and discriminant validity. It also exhibited high test-retest reliability, making it a robust tool for measuring sprint-specific power. The content validation yielded strong results, indicating that physical education experts found the test's components highly relevant, clear, and appropriate for measuring sprint power. The CVR values were generally above the recommended threshold of .78, supporting the test's overall validity. Most components exceeded this benchmark; however, the CVR for the setup and dimensions component was .60, suggesting that this aspect may require further refinement to enhance its content validity. This score raises concerns about the clarity or appropriateness of the test's physical setup, which may impact its effectiveness in accurately measuring the intended construct. As emphasized by Zamanzadeh *et al.* (2015), expert feedback and item impact scores are valuable in assessing face validity, while Polit *et al.* (2007) note that expert panel input is essential in ensuring the representativeness and clarity of measurement instruments.

The USFD-20MSPT's convergent validity was supported by a strong and statistically significant correlation with the VJT, r(29) = 0.789. This indicates that both assessments effectively measure muscular power, affirming that the USFD-20MSPT captures the same physiological construct as the established VJT. According to Alalyani *et al.* (2020), Campbell *et al.* (2021), and Santos *et al.* (2022), vertical jumping and sprinting exhibit similar neuromuscular and biomechanical characteristics, including peak power output and muscle activation patterns.

Beyond statistical significance, this finding has significant implications for the practice of physical education and sports science. The USFD-20MSPT provides a viable and accessible alternative to jump-based assessments, particularly in environments where equipment or space for vertical jumps is limited (Chaabène *et al.*, 2021; García-Baños *et al.*, 2020; Zhao *et al.*, 2022). Its utility is heightened in school and field-based settings, making muscular power testing more inclusive. Furthermore, training approaches such as plyometrics have been shown to improve both sprint and jump performance, underscoring the physiological interconnectedness of these movements. The high correlation between USFD-20MSPT and VJT not only supports the validity of USFD-20MSPT but also highlights its practicality as both an evaluative and pedagogical tool in athletic and educational contexts.

The weak and statistically non-significant negative correlation between the USFD-20MSPT and the RDT (r(29) = –0.243) reinforces the discriminant validity of the USFD-20MSPT. This finding confirms that the USFD-20MSPT measures a construct different from that assessed by the RDT—specifically, muscular power rather than reaction time. In psychometric evaluation, discriminant validity ensures that an instrument does not inadvertently measure unrelated traits (Ceylan *et al.*, 2022; Cortina *et al.*, 2020; Lempke *et al.*, 2020). This result aligns with research showing little to no correlation between reaction time assessments and physical power outputs. The RDT targets cognitive processing speed, while the USFD-20MSPT involves neuromuscular strength and anaerobic capacity—distinct performance domains (Boutios *et al.*, 2021; Szabo *et al.*, 2021). The literature supports the specificity of the SPT, which does not depend on reflexes or sensory processing but focuses on explosive muscular output, making it especially suited for contexts prioritizing sprint performance (Haugen *et al.*, 2021; Luu *et al.*, 2021; Piredda *et al.*, 2021; Warneke *et al.*, 2025). The non-significant correlation further validates that the USFD-20MSPT is unaffected by cognitive factors, strengthening its psychometric soundness and practical relevance.

The USFD-20MSPT also demonstrated exceptionally high test-retest reliability using rank-transformed data, with a statistically significant correlation indicating outstanding temporal stability in participants' relative rankings across two testing sessions. This level of reliability confirms that the USFD-20MSPT consistently measures sprint-specific power over time and can be confidently used for longitudinal assessments in athletic and educational contexts. Such consistency is critical for coaches and practitioners who monitor performance changes and evaluate training interventions. Longitudinal reliability, particularly when using standardized protocols, enhances the credibility of physical performance assessments (Asimakidis *et al.*, 2024; Loturco *et al.*, 2022). The SPT's consistent rankings align with findings that power-based assessments, such as knee flexion or resisted sprints, predict performance outcomes (Nagahara & Murata, 2020; Thompson *et al.*, 2020). Moreover, the use of rank-based transformation due to non-normality in the dataset reinforced the psychometric rigor of the test. This method minimized the influence of outliers and skewed distributions, enhancing the interpretability of reliability estimates. Non-parametric methods, such as rank transformations, are effective in improving score stability and comparability across heterogeneous populations (Bulgarelli *et al.*, 2025; Chakrabartty, 2020; Grazziotin *et al.*, 2023). Ultimately, the stability of the USFD-20MSPT, supported by robust data handling, validates its use as a repeatable and meaningful tool for assessing muscular power output with broad implications for athlete development, educational assessment, and research.

Taken together, these findings underscore the educational and practical value of the USFD-20MSPT. For educators, the validated USFD-20MSPT offers a reliable and field-friendly tool for assessing muscular power among students, even in low-resource environments. Its proven content, convergent, and discriminant validity—as well as high test-retest reliability—suggest that physical education programs can adopt the USFD-20MSPT to objectively evaluate and monitor students' athletic development over time. This enables data-driven instruction, targeted skill development, and personalized training interventions. For practitioners and coaches, the USFD-20MSPT provides a practical alternative to laboratory-based or equipment-intensive tests, supporting effective athlete profiling, progress tracking, and evidence-based training adjustments. Its use in schools, training facilities, and research programs can foster a culture of performance monitoring, empowering learners and athletes through measurable, repeatable feedback.

Conclusion

The USFD-20MSPT offers a validated, reliable, and accessible tool for assessing sprint-specific muscular power in educational and athletic contexts. With strong psychometric properties—content, convergent, and discriminant validity, as well as excellent test-retest reliability—it stands as a viable alternative to traditional jump-based assessments. Unlike vertical jumps, the USFD-20MSPT captures horizontal power and accounts for body mass, enhancing fairness and precision. Its basis in Newtonian mechanics and minimal equipment needs make it ideal for schools and field settings, especially where resources are limited. The test fills a key gap in Philippine PE practices while contributing to global fitness evaluation research.

For recommendations, this study first encourages PE teachers to adopt the USFD-20MSPT as a simple, field-friendly measure of lower-body power. Its ease of use and strong validity make it an effective alternative when vertical jump tests are not feasible due to space or equipment limitations. Using sprint-based measures also provides biomechanical relevance to real-world movement demands. Second, schools and curriculum developers may consider incorporating the USFD-20MSPT into fitness testing standards. Its practicality and scientific soundness make it suitable for both classroom evaluations and athlete development. It can be used to track progress, guide instruction, and generate data for personalized training. Third, large-scale implementation of the USFD-20MSPT is recommended to confirm its applicability across different settings, including various age groups, regions, and performance levels. Establishing nationwide normative values will support its adoption as a standard fitness assessment tool and facilitate policy integration into national PE programs. Finally, researchers may replicate this study's validation process to develop other localized tools. The use of expert input, correlation analyses, and test-retest methods offers a model for psychomotor test validation. This approach encourages the development of evidence-based, inclusive assessment tools tailored to diverse environments.

Conflict of Interest: *The researcher and one of the editors of the USFD Journal are co-developers and co-owners of the USFD 20-Meter Sprint Power Test used in this study. This shared intellectual property is hereby disclosed as a potential conflict of interest. However, the acceptance and editorial decision regarding this article were made through a blind peer review process and handled by an editor who had no involvement in the development of the test or the research process. The editorial management was independent to ensure objectivity, integrity, and adherence to ethical publication standards.*

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Ethical Approval: *The study was reviewed and approved by the Research Ethics Committee of Lourdes College, Inc., in accordance with the ethical standards. Informed consent was obtained from student participants, ensuring full ethical compliance.*

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, ensuring academic rigor and integrity. Additionally, Grammarly AI was 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.*

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Table 1

Summary of the Physical Educators' Ratings on the Sprint Power Test Aspects

Physical educator	Aspects of the Sprint Power Test					
	Purpose	Equipment	Setup and Dimensions	Skill Rehearsal	Test Administration	Scoring
1	✓	✓	✓	✓	✓	✓
2	✓	✓		✓	✓	✓
3	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓
5	✓	✓	✓	✓	✓	✓
6	✓	✓		✓	✓	✓
7	✓	✓	✓			✓
8	✓	✓	✓	✓	✓	✓
9	✓	✓	✓	✓	✓	✓
10	✓	✓	✓	✓	✓	✓
CVR	1.00	1.00	.60	.80	.80	1.00
CVI				.90		
Description				valid		

✓ – The Physical Educator rated the item relevant
For 10 validators, a minimum of .78 is considered valid (Yusoff, 2019).

Table 2

Pearson's Correlation Between Average Sprint Power and Vertical Jump Power

Variable Pair	**n**	***r***	**Description**
Sprint Power Test × Vertical Jump Test	29	0.789	Acceptable Convergent Validity

Note. Vertical Jump Power was calculated using the Johnson & Bahamonde (1996) formula.

Table 3

Pearson's Correlation Between Average Sprint Power and Vertical Jump Power

Variable Pair	**n**	***r***	**Description**
Sprint Power Test × Ruler Drop Test	29	-0.204	Acceptable Discriminant Validity

Table 4

Pearson's Correlation Between the Test and Retest of the Average Sprint Power

Variable Pair	**n**	***r***	**Description**
Sprint Power Test × Ruler Drop Test	29	0.98	Excellent Stability Reliability

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