

The effect of pickleball in the physical fitness skills of junior high school students

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ABSTRACT

Physical fitness is essential for adolescent development, contributing not only to physical health but also to cognitive function, psychological well-being, and academic performance. This study examined the effects of an 8-week structured pickleball program on the physical fitness of Grade 10 students. Recognizing the growing concern over sedentary behavior among adolescents, the research aimed to evaluate whether an engaging physical education activity like pickleball could improve key fitness components. A quasi-experimental single-group pretest-posttest design was used, involving 20 purposively selected students (12 males and 8 females) from Child's Academy, Inc. The intervention consisted of three 60-minute sessions per week, incorporating warm-up, skill development, conditioning, game-based activities, and cool-down phases. Physical fitness was assessed before and after the program using standardized physical fitness tests measuring muscular strength through push-up test, muscular endurance through partial curl-up test, speed through 40-meter sprint, agility through hexagon agility test, and reaction time through stick-drop test. Descriptive statistics and paired sample t-tests were applied to analyze differences, with significance set at $p < 0.05$, while Cohen's d measured effect size. Pretest results revealed that the students demonstrated fair levels of muscular strength, muscular endurance, and agility; a good level of speed; and reaction time indicating a need for improvement, suggesting that the participants generally possessed fair to good physical fitness prior to their participation in the pickleball program. The posttest results revealed that the students demonstrated good levels of muscular strength, muscular endurance, agility, and reaction time, while speed performance ranged from very good to excellent; indicating that participation in the Pickleball program positively enhanced the students' overall physical fitness. The results revealed a significant difference between the pretest and posttest scores across all fitness components, indicating that participation in the Pickleball program significantly improved the students' physical fitness. Effect sizes ranged from large to huge effect, confirming the program's substantial impact. The findings suggest that pickleball is an effective, engaging, and accessible activity that can enhance adolescents' physical fitness and support its integration into school physical education programs.

Keywords: Agility, Muscular Strength, Muscular Endurance, Pickleball, Physical Fitness, Reaction time, Speed.

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INTRODUCTION

Physical activity is a key part of healthy adolescent growth, yet many young people today are not active enough. This lack of movement can lead to both physical health problems and emotional difficulties, making it important to encourage more active lifestyles among students.

Physical fitness is a vital component of adolescent development, influencing students' overall health, academic performance, and psychological well-being (Centers for Disease Control and Prevention, 2022). Globally, sedentary lifestyles among youth have become a pressing public health concern. According to the World Health Organization (WHO, 2020), 81% of adolescents aged 11–17 years worldwide do not meet the recommended minimum of 60 minutes of daily moderate-to-vigorous physical activity. Prolonged physical inactivity is linked not only to increased risk of obesity, cardiovascular diseases, and metabolic disorders but also to mental health challenges, including anxiety and depression (Guthold et al., 2020).

Physical fitness serves as a fundamental pillar of overall health and well-being, providing a wide array of physiological, mental, and social advantages that are critical across all stages of life. According to the World Health Organization (WHO), engaging in regular physical activity is a vital strategy for the prevention and management of non-communicable diseases, including heart disease, type 2 diabetes, and various forms of cancer. From a physiological perspective, exercise significantly enhances the efficiency of the cardiovascular system by strengthening the heart and lungs, lowering blood pressure, and optimizing cholesterol levels by increasing "good" HDL (High-Density Lipoprotein) while reducing unhealthy triglycerides.

Furthermore, physical activity is an essential component of weight management, as it helps individuals burn calories and maintain a healthy metabolic rate. For children and adolescents, these activities are particularly crucial for promoting bone health and ensuring the healthy development of muscles, while in older adults, regular movement is key to preventing falls and serious injuries such as hip fractures. Additionally, an active lifestyle has been shown to bolster the immune system, making individuals less susceptible to severe outcomes from infectious diseases like COVID-19, the flu, and pneumonia.

Beyond its physical impact, the benefits of fitness extend deeply into mental and cognitive health, offering both immediate and long-term improvements to brain function and emotional stability. Engaging in physical activity stimulates the release of brain chemicals like endorphins, which are known to enhance mood, promote relaxation, and significantly reduce feelings of anxiety. For younger populations, specifically children aged 6 to 13, even a single session of moderate-to-vigorous activity has been found to improve thinking, concentration, and overall cognitive performance. Exercise also plays a critical role in sleep hygiene, helping individuals fall asleep more quickly and achieve a deeper, more restorative quality of rest.

Moreover, physical fitness provides a constructive outlet for managing daily stress, thereby improving emotional resilience and reducing the risk of long-term psychological difficulties. In older populations, maintaining a high level of physical fitness is a key factor in reducing the risk of cognitive decline and preserving mental sharpness into later life.

The social and developmental benefits of physical fitness are equally significant, particularly when activities are performed in group or organized settings. Participating in sports and group exercises offers valuable opportunities for social connection, allowing individuals to bond with family and friends in a positive environment and reducing the risk of social isolation. For children and adolescents, organized sports serve as a practical classroom for

developing essential life skills such as teamwork, effective communication, and leadership. The process of setting fitness goals, working toward them, and mastering new physical skills also contributes to a significant boost in self-esteem and body confidence. These social interactions foster a sense of belonging and community, which are vital for emotional well-being and the development of responsible, compassionate citizens.

Countries around the world are emphasizing the role of schools in promoting active lifestyles. The United Nations Sustainable Development Goals (SDGs), particularly Goal 3: Good Health and Well-Being and Goal 4: Quality Education, stress the importance of ensuring healthy lives and providing inclusive, equitable education opportunities. Innovative and engaging physical education (PE) programs are increasingly recognized as essential for fostering lifelong fitness habits, enhancing cognitive function, and promoting social development (Pate, 2017). As John F. Kennedy once stated, “Physical fitness is not only one of the most important keys to a healthy body, it is the basis of dynamic and creative intellectual activity,” emphasizing the interconnectedness of physical activity and overall human development. Global health authorities further reinforce this perspective.

The World Health Organization (2020) recommends that children and adolescents aged 5–17 years engage in at least 60 minutes of moderate-to-vigorous physical activity daily, highlighting schools as critical settings for achieving this target. Similarly, UNESCO (2015) identifies quality physical education as a fundamental right for all learners and a key contributor to inclusive and equitable education systems. A systematic review by Donnelly et al. (2016) reported significant associations between physical activity and improved cognitive function, including attention, memory, and classroom behavior. Research on service-learning (SL) integrated into PE shows that PE can nurture prosocial leadership skills such as responsibility, inclusive decision-making, and commitment to community values when students engage in structured, cooperative activities with diverse populations (Ruiz-Montero et al., 2024).

In response, many education systems are adopting whole-school approaches that integrate movement across the curriculum, including active classrooms, extracurricular sports, and partnerships with families and communities. These comprehensive strategies align with international frameworks advocating for health-promoting schools (World Health Organization, 2018). By positioning schools as central environments for health promotion, policymakers and educators increasingly recognize that physical education is not a peripheral subject but a foundational component of holistic child development and long-term societal well-being.

Pickleball, a paddle sport that originated in the United States in 1965, has emerged globally as a highly accessible and inclusive sport. It combines elements of tennis, badminton, and table tennis and is played on a smaller court with a lowered net and a perforated polymer ball. The sport’s simplified rules, low-impact movements, and social gameplay make it suitable for all ages and skill levels (USA Pickleball, 2023; Johnson et al., 2021). Globally, pickleball has experienced rapid growth, with millions of players in North America, Europe, and Asia. Its appeal lies not only in physical health benefits—such as improved cardiovascular fitness, agility, balance, and muscular strength—but also in its cognitive and social advantages, including enhanced strategic thinking, decision-making, teamwork, and communication (Harper, 2021; Gagen & Getchell, 2018).

At the national level, the Philippines has increasingly recognized the value of non-traditional sports like pickleball in promoting adolescent health. According to the Philippine Sports Commission (PSC, 2022), there is a growing emphasis on introducing innovative sports and physical activities in schools to combat sedentary behavior, enhance physical literacy, and foster social inclusion. Pickleball’s low-cost equipment, ease of implementation, and suitability

for indoor and outdoor settings make it an ideal sport for schools seeking to diversify physical education programs. Local initiatives, such as municipal pickleball tournaments and school-based PE programs, reflect a rising interest in promoting active lifestyles among youth.

Locally, in Roxas City, Capiz and nearby provinces, pickleball is gaining traction in schools, community centers, and recreational facilities. In Region VI (Western Visayas), pickleball is steadily gaining popularity where schools and community centers such as Baybay Pickleball Club in Baybay, Roxas City Capiz, Shuttle ground in Arnaldo, Boulevard, Roxas City, Capiz, Gran Plains Pickleball Center, CPU Gymnasium, and UPV Miagao offer indoor courts for recreational and organized play. Other venues include North Grove, Iloilo Festive Mall, Triple A Sports Center, and Pototan Pickleball Club. Beyond Iloilo, active pickleball communities exist in Negros Occidental (Bacolod Pickleball Club) and Cebu (SweetSpot, HQ Pickleball, Lapu-Lapu City, and Pino Courts), reflecting the sport's growing accessibility and opportunities for skill development in the Visayas region. Junior high school students, a group at a critical stage of physical, social, and cognitive development, stand to benefit from engaging in structured pickleball programs.

The sport offers a unique opportunity to combine fitness development with social and emotional learning, encouraging collaboration, resilience, and confidence-building. Within the context of Capiz State University's Research and Development Agenda, which prioritizes education, health, and wellness initiatives, this study supports evidence-based approaches to improving PE practices, student engagement, and holistic development. From a physical fitness perspective, pickleball offers a moderate-intensity workout that engages multiple fitness components. On average, a 30-minute game burns significantly more calories than walking and provides a low-impact alternative to high-intensity sports, reducing the risk of injury while maintaining cardiovascular benefits (National Recreation and Park Association, 2022). Despite these advantages, empirical research on the effects of pickleball on junior high school students remains limited. Most studies have focused on adult or older populations, leaving a significant gap in understanding how the sport can be applied in school-based PE contexts.

In the Philippines, where schools face challenges in providing engaging physical activities due to resource constraints and limited PE time, exploring pickleball as an intervention may yield practical and scalable solutions for promoting youth fitness. Furthermore, investigating how pickleball affects students' motivation, participation, and enjoyment in PE can guide curriculum designers and educators in creating more inclusive and effective programs.

This study seeks to examine the effect of structured pickleball participation on the physical fitness skills of junior high school students, particularly muscular strength, muscular endurance, speed, agility, and reaction time. By addressing this research gap, the study aims to provide evidence-based recommendations for integrating pickleball into PE curricula, thereby contributing to holistic student development, improved physical activity levels, and lifelong healthy habits. In doing so, the research aligns with global health objectives, national educational priorities, and local efforts to create active, engaged, and well-rounded learners.

As a researcher, she was motivated to conduct this study by a personal desire to explore innovative and engaging ways to improve the physical fitness of junior high school students. Having observed how traditional sports can sometimes limit participation due to skill level or access to equipment, she became interested in pickleball because of its simplicity, inclusivity, and growing popularity. She believes that integrating alternative physical activities like pickleball into the school curriculum could provide students with a more enjoyable and accessible pathway to developing essential fitness skills, promoting lifelong health and active living.

Beyond physical metrics, her motivation is deeply rooted in contributing to a holistic and inclusive education. By introducing a sport that levels the playing field for students of

varying athletic backgrounds, she aims to foster a nurturing environment where every learner can grow into a confident and capable individual. Furthermore, she is driven by the belief that physical well-being is a cornerstone of social responsibility. By engaging students in a socially interactive and collaborative sport like pickleball, she hopes to inspire them to become responsible and compassionate citizens who value their health as a foundation for making meaningful contributions to society.

Through structured gameplay, peer mentoring, and team-based challenges, students develop not only motor skills and strategic thinking but also essential social competencies such as communication, respect, and conflict resolution in real time. The cooperative nature of doubles play fosters shared accountability, trust, and mutual encouragement—qualities that extend beyond the court into everyday interactions. This study aligns with Capiz State University's MAED-PE research agenda, which emphasizes high-quality instruction and community-centered research, and aims to produce client-responsive, sustainable, and relevant outcomes addressing current issues in physical education, sports management, and community development.

In addition, integrating reflective discussions and leadership roles within pickleball sessions allows students to connect physical activity with character development. Rotating responsibilities such as team captain, scorekeeper, or equipment manager fosters leadership, integrity, and organizational skills. By creating an inclusive environment where students of varying abilities can participate successfully, she reinforces the values of equity, empathy, and mutual support.

Ultimately, her approach positions physical education not merely as a space for exercise, but as a platform for holistic development. By linking physical well-being with social awareness and civic-mindedness, she aims to cultivate individuals who understand that caring for their bodies empowers them to serve others more effectively, collaborate within diverse communities, and contribute positively to society as active, healthy, and socially responsible citizens. Moreover, pickleball serves as a bridge between generations and communities, modeling how sport can unite individuals across age, background, and skill level. By highlighting its accessibility and lifelong nature, she promotes the idea that physical activity is not limited to youth but is a sustainable habit that strengthens communities over time.

Statement of the problem

This study aimed to investigate the effect of pickleball in the physical fitness skills of junior high school students, with particular emphasis on the following components: muscular strength, muscular endurance, speed, agility, and reaction time. Specifically, it seeks to attain the following:

1. Determine the level of physical fitness skills of junior high school students in the pretest in terms of muscular strength, muscular endurance, speed, agility, and reaction time.
2. Determine the level of physical fitness skills of junior high school students in the posttest in terms of muscular strength, muscular endurance, speed, agility, and reaction time.
3. Determine if there is a significant difference in the level of physical fitness skills of the junior high school students in the pretest and posttest.
4. Determine the effect size of the pickleball program in the physical fitness skills of junior high school students.

METHODOLOGY

This study employed a quasi-experimental one-group pretest-posttest design to examine the effect of pickleball on the physical fitness skills of Grade 10 junior high school students. Recent studies affirm that quasi-experimental designs are appropriate when random assignment is not feasible, allowing researchers to infer causal relationships through pretest-posttest comparisons (Cham et al., 2024; Capili & Anastasi, 2024). To answer the research questions, quantitative methods of data collection and analysis were utilized. The baseline physical fitness levels of the participants, encompassing muscular strength, muscular endurance, speed, agility, and reaction time, were measured using standardized physical fitness tests prior to the implementation of the intervention.

The study was conducted at Child's Academy, Inc., a school located at #2 St. Joseph Avenue, Pueblo De Panay, Lawaan, Roxas City, Capiz. The research was carried out during the second quarter of the academic year 2025-2026. The school setting was deemed ideal for the study, as it provides a controlled and structured environment where students could consistently participate in the intervention without significant disruption to their academic routines.

The study involved a total of 20 Grade 10 junior high school students, which was deemed sufficient to provide reliable results based on Cohen's guidelines and Lehr's rule guidelines for detecting a medium effect size in paired sample comparisons with an alpha level of 0.05 and statistical power of 0.80. This sample size is also consistent with educational research standards for pre-experimental designs using pretest and posttest methods. The sampling technique employed was purposive sampling, a non-probability method in which the researcher selected participants based on specific characteristics relevant to the study, specifically Grade 10 students enrolled at Child's Academy, Inc. The participants consisted of 12 male and 8 female students, aged 14 to 16 years old. Parental consent was obtained to ensure that permission for participation was properly granted, and all participants were confirmed to be physically able to engage in moderate physical activity. Furthermore, none of the participants were enrolled in any organized competitive sports programs during the period of the study, a precaution taken to minimize the influence of external variables on fitness outcomes.

To be eligible for participation in the study, students were required to meet several inclusion criteria. First, they must have been officially enrolled as Grade 10 junior high school students at Child's Academy, Inc. during the second quarter of the academic year 2025-2026. Participants were expected to be between 12 to 16 years old, corresponding to the typical age range for junior high school students in the Philippines. They must also have been physically fit to engage in moderate physical activity, as confirmed by a health clearance from the school clinic or a signed health declaration form from their parents or guardians. To ensure consistency in the effects of the intervention, students who were actively participating in other organized or competitive sports programs were excluded, as such involvement may have introduced external factors affecting physical fitness outcomes. Eligible participants were further required to be willing to complete the full eight-week pickleball program and commit to attending all scheduled pretests, training sessions, and posttests. Lastly, the study included only those students who had submitted a signed informed consent form from their parents or guardians, along with their own assent to participate.

Exclusion criteria were established to prevent compromising the integrity or safety of participation. Students with pre-existing medical conditions such as asthma, heart disease, joint injuries, or any other health risks that limit or prohibit physical activity were not permitted to join the program. Likewise, those undergoing physical therapy or rehabilitation for any injury or physical disability were excluded to avoid aggravating their condition. Students who regularly participated in competitive sports training were also excluded, as their advanced

fitness levels may have introduced confounding variables beyond the scope of the pickleball intervention. In addition, students with irregular school attendance or known scheduling conflicts that could hinder full participation in the program were deemed ineligible. Any student who failed or refused to provide the required informed consent from a parent or guardian, or who did not provide personal assent, was similarly excluded. These criteria ensured that all participants were both physically capable and available for the full duration of the program, allowing the researcher to more accurately evaluate the true effect of the pickleball intervention on physical fitness without interference from external variables.

The instrument used in this study was the standardized Physical Fitness Test as prescribed by the Department of Education Revised Physical Fitness Test (PFT) Manual (DepEd Order No. 034, s. 2019) and the Department of Education Physical Education (PE) module titled Go For Fitness Goal, First Edition, 2020. The Physical Fitness Test is a set of measures designed to determine a learner's level of physical fitness and provides standardized scoring norms that are generally uniform across participants of the same sex, with the exception of the speed component, for which separate standards are applied for males and females. This distinction is grounded in biological and physiological differences, including variations in muscle mass, body composition, and skeletal structure, which are known to affect sprinting ability. By applying sex-specific norms for speed, the PFT ensures that each learner's performance is measured according to their own physical potential, allowing for a fair and accurate assessment of relative fitness. The five fitness tests employed in the study assessed the following components: the push-up test for muscular strength, the partial curl-up test for muscular endurance, the 40-meter sprint for speed, the hexagon agility test for agility, and the stick-drop test for reaction time.

The push-up test is a measure of muscular strength and endurance of the upper extremities and core muscles. Based on the DepEd PFT Manual, the procedure involves performing as many repetitions as possible while maintaining proper form. For boys, the standard push-up position is used, while girls perform modified push-ups with knees in contact with the floor. The scoring norms for this test are as follows: 33 repetitions and above is classified as Excellent; 25 to 32 as Very Good; 17 to 24 as Good; 9 to 16 as Fair; and 1 to 8 as Needs Improvement.

The partial curl-up test assesses the muscular endurance of the abdominal muscles. The test involves performing curl-ups at a specific cadence, with the score based on the duration in seconds for which the participant can maintain the repetitions. The interpretive norms are as follows: 51 seconds and above is Excellent; 46 to 50 seconds is Very Good; 31 to 45 seconds is Good; 16 to 30 seconds is Fair; and 1 to 15 seconds is Needs Improvement.

The 40-meter sprint measures speed, defined as the ability to move in one direction in the shortest period of time. Participants run a 40-meter distance and their time is recorded. The scoring standards differ for boys and girls. For male participants, the norms are as follows: less than 4.5 seconds is Excellent; 4.6 to 5.4 seconds is Very Good; 5.5 to 7.0 seconds is Good; 7.1 to 8.1 seconds is Fair; and greater than 8.2 seconds is Needs Improvement. For female participants, the corresponding norms are: less than 5.5 seconds is Excellent; 5.6 to 6.1 seconds is Very Good; 6.2 to 7.2 seconds is Good; 7.3 to 8.5 seconds is Fair; and greater than 8.6 seconds is Needs Improvement.

The hexagon agility test evaluates agility, defined as the ability to move in different directions quickly while maintaining balance, coordination, speed, and endurance. Participants jump in and out of a hexagon pattern, and the time taken to complete the sequence is recorded. The scoring norms are as follows: 5 seconds and below is Excellent; 6 to 10 seconds is Very

Good; 11 to 15 seconds is Good; 16 to 20 seconds is Fair; and 21 to 25 seconds is Needs Improvement.

The stick-drop test measures reaction time, defined as the amount of time it takes to respond to a stimulus. In this test, a ruler or stick is dropped and the participant attempts to catch it. The distance the stick falls before being caught indicates the participant's reaction time. The scoring norms based on the distance in centimeters are as follows: 0 to 2.4 cm is Excellent; 5.08 to 10.16 cm is Very Good; 12.70 to 17.78 cm is Good; 20.32 to 25.40 cm is Fair; and 27.94 to 30.48 cm is Needs Improvement.

The data gathering procedures for this study followed a structured and ethical process to ensure accurate, valid, and reliable results. Prior to actual data collection, the researcher secured the necessary permissions and approvals from the school administration. Informed consent forms for parents and guardians were distributed, explaining the purpose, process, risks, and benefits of the study, as well as the voluntary nature of participation. Once consent was obtained, the pretest and the intervention were conducted in sequence. The first phase involved a baseline physical fitness assessment of each participant using the standardized fitness test instruments. Additionally, each participant's sociodemographic data, including age, sex, and grade level, were collected using a structured questionnaire. A Physical Activity Readiness Questionnaire (PAR-Q) was administered as a diagnostic tool to assess baseline fitness and to identify any risks prior to engaging participants in physical activity such as pickleball.

Muscular strength was assessed during the pretest using the push-up test, requiring participants to perform as many push-ups as possible with proper form until fatigue. The assessment began with a one-minute targeted warm-up consisting of dynamic arm circles, in which participants rotated their arms in small to large circles to mobilize the shoulder joints. The researcher demonstrated the correct push-up technique, and an instructional video was shown to reinforce proper execution, ensuring that students understood the starting high plank position with hands slightly wider than shoulder-width and the body aligned straight from head to heels. Supervision was provided by the researcher and one member of the advisory committee to ensure fair guidance, safety, and adherence to proper form, specifically that elbows were bent to approximately 90 degrees during the lowering phase and that the body remained straight throughout each repetition. For boys, the standard push-up position was used, while girls performed modified push-ups with knees in contact with the floor. Each correctly performed push-up was counted, and the count was stopped if proper form was lost or the participant could no longer continue. The total number of push-ups was immediately recorded on prepared data sheets.

Muscular endurance was assessed using the partial curl-up test, which measured the number of abdominal curl-ups completed over a specified period. The assessment began with a warm-up consisting of five to eight mini-crunches, in which participants lifted only the shoulder blades slightly off the mat to familiarize themselves with the cadence and range of motion required for the test. Each participant was paired with a partner who held their feet firmly to prevent lifting during the exercise, thereby ensuring proper form and stability. The researcher demonstrated the correct technique, and an instructional video was shown to reinforce proper execution, emphasizing correct form including keeping feet flat on the floor, knees bent at approximately 90 degrees, hands positioned lightly behind the head, and lifting the torso only until the elbows approached the knees. Supervision was provided by the researcher and one member of the advisory committee. A stopwatch was used to measure the time in seconds, and each correctly performed curl-up was counted. The total repetitions completed were immediately recorded on prepared data sheets.

Speed was measured using the 40-meter sprint test, conducted on a marked straight track in an open oval field with a flat and even surface to ensure accurate and safe performance.

The warm-up began with one minute of light jogging to increase core body temperature, followed by one minute each of high knees and butt kicks. The 40-meter distance was verified using a meter stick, and the timing of each sprint was measured using phone stopwatches operated by the researcher, two teacher-facilitators, and an additional phone voluntarily provided by a student, thereby allowing more participants to be timed simultaneously and making the process more efficient. Before commencing, proper sprinting technique was demonstrated by the teacher, and an instructional video was shown to reinforce correct form, including a forward-leaning starting posture in either a crouched or standing position, with feet staggered and knees slightly bent to allow a powerful push-off. Participants were instructed to keep the head down initially, with body weight shifted forward for quick motion, and to work the arms in coordination with the opposite legs to maintain speed and balance. Three students ran at a time to facilitate efficient data collection and observation. Each student's sprint time was measured in seconds and recorded on prepared data sheets.

Agility was measured using the hexagon agility test, conducted on a flat open surface to ensure safety and accuracy. The warm-up involved line hops, in which participants jumped forward and backward over a straight line for one minute, then side-to-side for another minute. The testing area was prepared using a measuring tape to mark precise measurements and a mobile phone stopwatch to time each participant. A regular hexagon with sides of 24 inches (61 cm) was drawn by marking six points and connecting them with tape and chalk to form clear and visible lines. Participants stood at the center of the hexagon with feet together while the researcher prepared the stopwatch. On the "go" signal, the participant jumped forward over one side of the hexagon and immediately returned to the center, then continued jumping over each side in a clockwise direction, always returning to the center after each jump. The participant completed two continuous circuits around the hexagon as quickly as possible while keeping the feet together and maintaining balance. The total time taken to complete the two circuits was recorded, with faster times indicating better agility, coordination, and dynamic balance. Supervision was provided by the researcher and one member of the advisory committee. Prior to testing, proper technique was demonstrated by the researcher, and an instructional video was shown to reinforce correct posture, jumping technique, and landing.

Reaction time was evaluated using the stick-drop test to assess how quickly students could respond to an unexpected stimulus. The warm-up involved practice drops with a ruler to help participants synchronize their visual tracking with their grasping reflex. During the test, each participant sat comfortably on a chair with their forearm resting on a table and their hand positioned over the edge, with the thumb and index finger slightly open. The researcher held a ruler vertically above the participant's hand, with the zero-mark aligned at the top of the participant's fingers. Without providing a warning, the researcher released the ruler, and the participant attempted to catch it as quickly as possible using the thumb and index finger. The distance the ruler fell before being caught was recorded in centimeters. The test was performed over three trials, and the average score was computed by adding the three recorded distances and dividing the total by the number of trials conducted. Supervision was provided by the researcher and one member of the advisory committee. Prior to testing, proper technique was demonstrated by the researcher, and an instructional video was also shown to reinforce correct procedure.

Prior to the implementation of the pickleball intervention, a short orientation was conducted to familiarize participants with the nature of pickleball, its equipment, and the general structure of the program. The intervention consisted of a structured pickleball program conducted over eight weeks, with sessions held three times per week, each lasting 60 minutes. Each session followed a five-phase structure designed to comprehensively address the physical

fitness components being assessed. The first phase was an eight-minute warm-up consisting of jogging, arm and leg swings, and walking lunges. Participants commenced the warm-up with jogging at a light and comfortable pace, estimated at 40% to 50% of maximum effort, to gradually elevate their heart rate. They maintained an upright torso with relaxed shoulders and allowed their arms to swing naturally, with a mid-foot strike encouraged to minimize joint impact. The pace was incrementally increased approximately every two minutes. Following jogging, dynamic flexibility exercises were performed through arm and leg swings designed to enhance speed and range of motion. For arm swings, participants stood with feet shoulder-width apart and swung both arms forward and backward, followed by horizontal movements crossing the arms in front of the chest. For leg swings, participants used a wall or pole for balance and swung each leg forward and backward in a pendulum-like motion for 10 to 15 repetitions per leg, then laterally across the front of the body and out to the side for an equal number of repetitions. Walking lunges were incorporated to develop lower body muscular endurance, with participants stepping forward into deep lunges, bending both knees to approximately a 90-degree angle, and pushing through the front heel to step into the next lunge in a continuous walking motion.

The warm-up was followed by a 15-minute skill acquisition phase aimed at building coordination and developing speed, agility, and reaction time through three specific skills: serving, dinking, and volleying. Serving practice was conducted to improve participants' reaction time and precision. Participants stood behind the baseline in a balanced athletic stance and executed an underhand motion ensuring contact with the pickleball below the waist, with the objective of directing the serve diagonally into the opponent's service court. A Target Practice drill was implemented in which boxes were placed in the corners of the service box and participants attempted to hit them consistently. Dinking drills focused on developing hand-eye coordination and speed at the net. Participants positioned themselves at the Non-Volley Zone (NVZ) line and executed the dink shot using a controlled lifting motion with minimal backswing, emphasizing shoulder guidance rather than wrist action. A Cross-Court Dinking drill was performed with a partner, involving soft low shots hit diagonally across the net with the primary focus of maintaining a low ball trajectory to prevent opponents from initiating an attack. Volleying drills were designed to develop agility and quick reflexes. Participants adopted a ready position at the NVZ line with the paddle held up in front of the chest and knees slightly bent, meeting the ball out in front of the body using a short compact punching motion. A Volley-to-Volley drill with a partner required participants to keep the ball in the air continuously without allowing it to bounce, necessitating quick lateral footwork and rapid paddle adjustments.

The third phase consisted of a 15-minute movement and conditioning segment designed to develop agility, speed, and muscular endurance through two activities: zigzag cone sprints and sit-ups. The zigzag cone sprint drill was set up by placing five cones in a zigzag pattern with approximately three to five meters between each cone. Participants sprinted aggressively to the first cone, planted the outside foot firmly into the ground, and quickly cut toward the next cone, maintaining a low center of gravity during turns to facilitate maximum acceleration. After completing the course, participants walked back to the starting line to recover before repeating. Sit-ups were utilized to build both speed and muscular endurance in the core musculature. Participants lay on their backs with knees bent and feet planted flat on the floor, engaged their abdominal muscles, and lifted the upper body toward the knees while keeping hands lightly touching the ears or crossed over the chest. For speed training, participants performed as many controlled repetitions as possible within a 30-second interval, while muscular endurance was addressed through a steady, slower pace maintained for a longer duration of one minute.

The fourth phase consisted of a 17-minute game-based cardio segment that combined fitness with engaging gameplay to simultaneously develop muscular strength, muscular endurance, speed, agility, and reaction time through singles and doubles game play. Singles play placed emphasis on cardiovascular endurance and speed, as one player was responsible for covering the entire court, while doubles play highlighted reaction time and agility due to the rapid exchanges that typically occurred at the net. During this phase, participants engaged in full-speed competitive points, actively incorporating the shots and kitchen battles practiced earlier in the session. To maintain fresh physical and mental stimulus, partners were rotated or court sides were switched approximately after 11 points. The final phase consisted of a five-minute cool-down comprising walking laps and static stretching. Participants walked around the court at a slow and relaxed pace for two minutes, focusing on deep diaphragmatic breathing, inhaling through the nose and exhaling slowly through the mouth, to signal the body to transition into a state of recovery. Static stretching followed, targeting the muscle groups most heavily used during the session, specifically the legs, core, and dominant hitting arm. Each stretch was held for 20 to 30 seconds without bouncing or forcing the muscle beyond comfortable tension, including a quadriceps stretch, a hamstring stretch, a calf stretch, and a shoulder stretch.

The intervention flow was designed to be both necessary and effective, providing a structured and comprehensive approach to improving health-related and skill-related physical fitness components in junior high school students through pickleball. The eight-minute warm-up prepared the body and prevented injury; the 15-minute skill acquisition phase built coordination and developed speed, agility, and reaction time; the 15-minute movement and conditioning phase developed agility, speed, and muscular endurance; the 17-minute game-based cardio phase combined fitness with engaging gameplay to address muscular strength, muscular endurance, speed, agility, and reaction time; and the five-minute cool-down supported flexibility and recovery. The flow ensured safety, balanced physical development, and student engagement, making it suitable for school-based physical education.

After the intervention period, participants underwent the same battery of fitness tests during the posttest phase. The post-intervention results were collected using the same procedures, locations, and equipment as the pretest to maintain uniformity and comparability of data. All data were carefully recorded, encoded, and checked for accuracy. The posttest procedures for each fitness component followed the same warm-up protocols, technical demonstrations, instructional video presentations, and supervisory arrangements as described for the pretest phase, with no deviation in test conditions or measurement methods.

This study employed a quantitative data analysis procedure grounded in the quasi-experimental one-group pretest-posttest design. All raw scores obtained from the pretest and posttest, specifically from the push-up test for muscular strength, the partial curl-up test for muscular endurance, the 40-meter sprint for speed, the hexagon agility test for agility, and the stick-drop test for reaction time, were collected, organized, and tabulated. Each participant's performance was then evaluated using the standardized scoring norms provided in the Department of Education Revised Physical Fitness Test (PFT) Manual (DepEd Order No. 034, s. 2019) and the Go For Fitness Goal Physical Education module (2020), which classify results into qualitative descriptors of Excellent, Very Good, Good, Fair, and Needs Improvement. Specifically, the push-up test was interpreted based on repetitions (33 and above as Excellent, 25-32 as Very Good, 17-24 as Good, 9-16 as Fair, and 1-8 as Needs Improvement), while the partial curl-up test was assessed according to duration in seconds (51 and above as Excellent, 46-50 as Very Good, 31-45 as Good, 16-30 as Fair, and 1-15 as Needs Improvement). The 40-meter sprint was evaluated using sex-specific standards in which lower completion times

indicated better performance, with separate ranges for boys and girls to ensure fair assessment. The hexagon agility test was interpreted based on completion time, with 5 seconds and below classified as Excellent and 21-25 seconds as Needs Improvement. For the stick-drop test, performance was measured in centimeters, with a shorter distance indicating faster reaction time and better performance based on DepEd norms.

Descriptive statistics, including the mean and standard deviation, were computed to summarize the participants' performance in each fitness component during both the pretest and posttest phases. To determine whether there was a statistically significant difference between the pretest and posttest scores, a paired sample t-test was employed, as the same group of participants was measured before and after the intervention. The level of significance was set at 0.05, and a p-value less than 0.05 was taken to indicate a significant improvement in physical fitness following the pickleball program. Furthermore, the magnitude of the intervention's effect was determined using Cohen's d effect size, calculated as the difference between the posttest and pretest means divided by the pooled standard deviation. The resulting values were interpreted according to the following classifications: small (0.20-0.49), medium (0.50-0.79), large (0.80-1.19), very large (1.20-1.99), and huge (2.0 and above). Separate analysis was conducted for male and female participants, particularly for the 40-meter sprint, to account for sex-specific scoring standards. The analyzed data were presented through tables supported by narrative explanations to clearly illustrate the changes in physical fitness levels and to determine the overall effectiveness of pickleball as an intervention for improving the physical fitness skills of junior high school students.

RESULTS AND DISCUSSION

Physical fitness of junior high school students in the pretest and posttest in terms of muscular strength, muscular endurance, speed, agility, and reaction time

This section presents, analyzes, and interprets the data gathered on the physical fitness of junior high school students before and after participation in the Pickleball program. The discussion is grounded on the results obtained from the pretest and posttest assessments conducted among the respondents using standardized physical fitness measures focusing on muscular strength, muscular endurance, speed, agility, and reaction time. The findings are interpreted directly in relation to the objectives of the study and are supported by relevant scholarly literature and theoretical perspectives concerning youth physical fitness development, sports participation, and structured physical activity interventions. The analysis specifically examines the changes in the students' fitness levels from pretest to posttest and explores the implications of these findings for physical education and athletic readiness among junior high school students.

The pretest results revealed that the students demonstrated a "fair" level of muscular strength with a mean score of 10.80 prior to participation in the Pickleball program. Based on the legend, the score range of 9–16 corresponds to a "fair" level of muscular strength, indicating that the students initially possessed only moderate upper and lower body force production capabilities. In terms of muscular endurance, the students obtained a mean score of 29.65, which also falls within the "fair" category based on the range of 16–30 sec. This result suggests that the students had a moderate ability to sustain muscular activity over time before exposure to the intervention. Meanwhile, the speed component showed relatively stronger baseline performance, as the male students obtained a mean score of 6.98 and the female students recorded a mean score of 6.94, both verbally interpreted as "good." According to the established criteria, male speed scores between 5.5–7.0 sec. and female scores between 6.2–7.2 sec. correspond to a "good" level, indicating that the students already demonstrated acceptable

levels of quickness and movement acceleration prior to the program implementation. The agility component yielded a mean score of 16.54, verbally interpreted as “fair,” based on the range of 16–20 sec., implying moderate movement efficiency and directional control. However, reaction time produced a mean score of 27.00, which falls under the “Needs Improvement” category based on the range of 27.94–30.48 cm., indicating deficiencies in rapid perceptual processing and neuromuscular responsiveness before the intervention.

The overall pretest findings indicate that the students generally possessed fair to good levels of physical fitness before participating in the Pickleball program. The results suggest that although the students demonstrated acceptable baseline capacities in certain fitness domains, particularly speed, there remained substantial room for improvement in muscular strength, muscular endurance, agility, and especially reaction time. These findings align with the study of Pinho et al. (2024), who reported that supervised and structured physical exercise can produce substantial improvements in muscular strength ranging from 15–35% and muscular power ranging from 5.6–11.8% among adolescents. Their findings emphasize that moderate baseline fitness levels among adolescents are often associated with limited participation in organized and structured exercise programs. Similarly, Faigenbaum (2017) emphasized that pre-training strength levels among youth are generally limited but can significantly improve through progressive sport-based exercise interventions. These perspectives support the present findings by suggesting that the students’ “fair” levels of muscular strength and endurance prior to the intervention may reflect insufficient exposure to sustained and structured physical activity.

However, the findings contradict the study of Kim et al. (2020), which reported significantly higher baseline muscular strength among students actively involved in organized school sports compared to their non-athletic peers. According to the authors, regular participation in organized athletic activities contributes to better general physical conditioning, including muscular endurance and muscular strength, due to continuous training, structured exercise routines, professional coaching, and peer motivation. The discrepancy between the findings may indicate that the participants in the present study had limited prior involvement in organized sports activities, thereby explaining their relatively lower pretest fitness levels.

The students’ “good” level of speed prior to the intervention reflects acceptable levels of explosive movement and linear acceleration despite the moderate performance observed in other fitness domains. This observation aligns with Johnson et al. (2019), who noted that adolescent growth spurts may naturally contribute to enhanced speed performance even in the absence of targeted training interventions. The findings imply that developmental and physiological maturation processes may have contributed to the students’ baseline speed capabilities. Nevertheless, the “fair” level of agility suggests that although the students possessed acceptable movement speed, they still experienced limitations in efficient directional changes, balance, and body control. This indicates that speed alone may not sufficiently support functional athletic performance without corresponding agility development.

The most concerning pretest finding involved the students’ reaction time, which was verbally interpreted as “Needs Improvement” with a mean score of 27.00. This result suggests deficiencies in sensorimotor integration, visual tracking, and immediate physical response to external stimuli. Such limitations may negatively affect athletic performance, particularly in sports requiring rapid decision-making and reflexive movement execution. This finding supports the study of Bozkurt et al. (2017), which revealed a significant relationship between sports participation and improved anticipation time and reaction speed among children aged 10–12 years. The study emphasized that children without prior sports experience often demonstrate weaker perceptual-motor coordination and slower response execution. The present

findings therefore imply that the students lacked sufficient exposure to activities that stimulate neuromuscular responsiveness and perceptual speed prior to the Pickleball intervention.

The pretest findings carry important implications regarding the athletic readiness and developmental needs of the students. The “fair” levels of muscular strength and muscular endurance indicate that while the students possessed basic functional capacities, they may not yet have developed sufficient muscular stability and stamina necessary for prolonged physical exertion and repetitive sport-related movements. Such limitations may increase susceptibility to fatigue and movement inefficiency during sustained gameplay. On the other hand, the “good” level of speed observed among both male and female students indicates a strong foundation for court movement and rapid offensive play. However, the concurrent “fair” level of agility suggests that the students’ movement speed was not yet fully supported by coordinated directional control and body balance. This gap between raw speed and functional movement efficiency highlights the importance of interventions that simultaneously develop coordination, balance, and multidirectional mobility.

The “Needs Improvement” level in reaction time further emphasizes the necessity for activities that enhance neuro-motor efficiency, perceptual awareness, and rapid response execution. In the context of Pickleball, where players must quickly react to incoming shots, changing ball trajectories, and opponent positioning, deficiencies in reaction time may significantly hinder defensive and offensive performance. The findings therefore suggest that the Pickleball program was particularly well suited to address these developmental gaps through repeated exposure to fast-paced visual tracking, reflexive racket movement, and coordinated body responses. Overall, the baseline results reveal a clear readiness gap among the students, characterized by moderate physical conditioning and limited neuro-motor responsiveness, which the Pickleball program was expected to improve through consistent and skill-oriented participation.

The posttest results demonstrated substantial improvements across all measured physical fitness components following participation in the Pickleball program. The students achieved a mean score of 17.65 in muscular strength, verbally interpreted as “good.” Based on the legend, scores ranging from 17–24 correspond to the “good” category, indicating that the students developed stronger muscular force production capabilities after the intervention. Similarly, muscular endurance improved to a mean score of 36.85, which also falls within the “good” category based on the range of 31–45 sec. These findings indicate enhanced muscular stamina and greater resistance to fatigue during sustained physical activity.

Significant improvements were also observed in the speed component. Male students obtained a mean score of 4.86, verbally interpreted as “very good,” while female students recorded a mean score of 5.56, verbally interpreted as “excellent.” According to the legend, male speed scores between 4.6–5.4 sec. correspond to “Very Good,” while female scores below 5.5 sec. correspond to “Excellent.” These findings suggest substantial enhancement in movement acceleration, sprinting ability, and court coverage efficiency following participation in the Pickleball program. Agility likewise improved considerably, as reflected by a mean score of 11.85, verbally interpreted as “good” based on the range of 11–15 sec. This indicates improved body coordination, balance, multidirectional movement efficiency, and rapid directional transition. Reaction time also improved to a mean score of 16.15, which falls under the “good” category, suggesting enhanced perceptual processing speed and neuromuscular responsiveness after the intervention.

The posttest findings clearly indicate that the Pickleball program positively influenced the physical fitness of junior high school students across all measured domains. The students progressed from “fair” or “Needs Improvement” levels during the pretest to “good,” “very good,” and “excellent” levels during the posttest assessment. These results demonstrate measurable enhancement in muscular strength, muscular endurance, speed, agility, and

reaction time following participation in the Pickleball activities. The findings align with Lesinski et al. (2016), who reported that resistance training produced small-to-moderate effects across various physical performance categories, with the most substantial improvements observed in muscular strength. The authors further noted significant improvements in jump performance and athletic performance, emphasizing that structured resistance and sport-based training are essential for stimulating athletic development and preparing adolescents for long-term physical demands. The present findings support this perspective, as the repetitive dynamic movements involved in Pickleball appear to have contributed significantly to muscular development and physical conditioning.

The results also align with Pinho et al. (2024), who found that different forms of supervised and structured physical exercise produce varying degrees of improvement in children's and adolescents' physical fitness. According to the researchers, strength and resistance training generated the greatest gains in muscular power and endurance, while aerobic activities and organized sports contributed to moderate but meaningful improvements in overall fitness levels. The findings of the present study support these conclusions, as the Pickleball program, which combines aerobic movement, coordination drills, repetitive muscular engagement, and multidirectional activity, produced improvements across multiple fitness components. Additional support is provided by findings published in BMC Pediatrics (2024), which reported statistically significant improvements in muscle strength ($p < 0.001$), power ($p < 0.001$), cardiorespiratory fitness ($p < 0.001$), flexibility ($p = 0.005$), and overall health-related physical fitness scores ($p = 0.001$) among adolescents participating in school-based physical activity programs. These findings reinforce the effectiveness of structured physical activity interventions in improving youth fitness outcomes.

The posttest findings further indicate that Pickleball effectively enhanced not only physical conditioning but also motor coordination and neuromuscular functioning. The "good" level of muscular strength suggests that the repetitive serving, swinging, volleying, and court movement patterns inherent in Pickleball contributed to improved muscular development in both the upper and lower extremities. Similarly, the improvement in muscular endurance reflects enhanced ability to sustain prolonged muscular activity and resist fatigue during continuous movement. The "very good" and "excellent" levels achieved in speed among male and female students respectively suggest that the rapid sprinting, quick positioning, and explosive directional changes required in Pickleball effectively developed acceleration and movement quickness.

The improvement in agility further demonstrates the program's effectiveness in enhancing movement coordination, balance, and efficient body control during multidirectional activity. Likewise, the "good" level of reaction time indicates enhanced neuro-motor responsiveness and faster perceptual processing among the students. These findings suggest that repeated exposure to visual tracking, anticipatory movement, and immediate physical response during Pickleball gameplay contributed to significant improvements in cognitive-motor integration and sensorimotor efficiency.

The findings are further supported by Agostino (2022), who reported that participation in Pickleball significantly increased overall physical activity levels and improved motor coordination among participants. According to the study, the sport's dynamic nature requiring coordinated hand-eye movements, rapid reactions, and continuous repositioning contributed to enhanced movement timing, spatial awareness, and body control. Similarly, findings published in the Journal of Physical Activity and Health in 2024 by Stroesser et al. indicated that Pickleball participation promotes moderate-to-vigorous physical activity (MVPA), which contributes to improved cardiovascular endurance, muscular function, and overall physical

fitness. The authors also emphasized that the continuous rallies, lateral movements, and rapid transitions characteristic of Pickleball support improvements in muscular endurance and agility over time.

Overall, the findings of the study provide strong evidence that participation in the Pickleball program positively influenced the physical fitness of junior high school students across all assessed domains. The transition from “fair” and “Needs Improvement” levels during the pretest to “good,” “very good,” and “excellent” levels during the posttest demonstrates the effectiveness of structured, sport-based interventions in promoting holistic physical development among adolescents. The findings highlight the potential of Pickleball as an effective physical education activity capable of enhancing muscular strength, muscular endurance, speed, agility, reaction time, and neuro-motor coordination simultaneously. These results contribute to the growing body of literature supporting the integration of dynamic recreational sports into school-based physical education programs and provide a strong empirical foundation for the succeeding analyses concerning the effectiveness and implications of the Pickleball intervention among junior high school students.

Difference in the physical fitness skills of the junior high school students in the pretest and posttest

The difference in the physical fitness skills of the 20 junior high school students was analyzed in terms of muscular strength, muscular endurance, speed, agility, and reaction time using SPSS statistical software. Descriptive statistics, specifically the mean and standard deviation, were used to summarize the pretest and posttest results, while the paired sample t-test was employed to determine whether the observed differences were statistically significant at the 0.05 significance level. The interpretation of the findings is grounded in the data gathered and directly aligned with the objective of determining whether the Pickleball intervention program produced measurable improvements in the students' physical fitness skills.

The results revealed a significant improvement in muscular strength from pretest to posttest. The pretest mean of the 20 students was 10.80, while the posttest mean increased to 17.65, with a mean difference of -6.85, S.E.D. $\times$ of 1.221, t-value of -5.610, and p-value of 0.000. Since the p-value of 0.000 is less than the 0.05 alpha level, the result is significant at the 5% level, leading to the rejection of the null hypothesis. This indicates that the Pickleball intervention program significantly improved the muscular strength of the junior high school students. This finding supports Bailey et al. (2024), who found that strength exercises yielded an effect size of 1.073 for muscular strength with 95% CI: 0.612–1.533 and $P < 0.001$, while sports and aerobic based interventions also improved strength, power, speed, and agility among youth. The result also aligns with Zago et al. (2020), who reported in a school-based trial of 672 children aged approximately 10 years that a 14 week “Enriched Sport Activity” program significantly improved ball throw distance, standing broad jump, 30 m sprint time, and Illinois agility test performance.

In terms of muscular endurance, the 20 students obtained a pretest mean of 29.65 and a posttest mean of 36.85, producing a mean difference of -7.20, S.E.D. $\times$ of 1.546, t-value of -4.655, and p-value of 0.000. Since the p-value of 0.000 is below the 0.05 alpha level, the result is statistically significant at the 5% level, which indicates that the null hypothesis is rejected. This means that the Pickleball intervention program led to a significant improvement in muscular endurance. The finding suggests that the sustained rallies and repeated movements involved in Pickleball allowed students to strengthen their ability to maintain muscular activity over time and resist fatigue. This result is consistent with Martin et al. (2024), whose study titled “Lack of Neuromuscular Fatigue Due to Recreational Doubles Pickleball” found that participants demonstrated significant improvements in countermovement jump (CMJ)

performance after playing pickleball, indicating enhanced lower body power output rather than fatigue. Their findings suggest that recreational pickleball can promote acute performance enhancement while maintaining low levels of fatigue.

For the speed component among male students, the 20 students obtained a pretest mean of 6.98 and a posttest mean of 4.86, with a mean difference of 2.11, S.E.D. $\times$ of 0.324, t-value of 6.52, and p-value of 0.000. Since the p-value of 0.000 is less than the 0.05 alpha level, the result is significant at the 5% level, leading to the rejection of the null hypothesis. This indicates a significant improvement in male students' speed, as the mean time decreased from 6.98 to 4.86, moving from "good" to "very good." For female students, the 20 students obtained a pretest mean of 6.94 and a posttest mean of 5.56, with a mean difference of 1.37, S.E.D. $\times$ of 0.506, t-value of 2.71, and p-value of 0.030. Since the p-value of 0.030 is below the 0.05 alpha level, the result is also significant at the 5% level, leading to the rejection of the null hypothesis. This indicates a significant improvement in female students' speed, as the mean time decreased from 6.94 to 5.56 seconds, moving from "good" to "excellent." These findings imply that Pickleball contributed to improved quickness and acceleration among both male and female students. This result aligns with Farrow et al. (2006), who concluded that structured, sport specific drills significantly enhance speed, agility, and reaction time through repeated exposure to movement-based and decision-making tasks that improve acceleration, directional changes, neuromuscular adaptation, and motor learning.

For agility, the 20 students obtained a pretest mean of 16.54 and a posttest mean of 11.85, with a mean difference of 4.69, S.E.D. $\times$ of 0.653, t-value of 7.176, and p-value of 0.000. Since the p-value of 0.000 is less than the 0.05 alpha level, the result is statistically significant at the 5% level, resulting in the rejection of the null hypothesis. This indicates that the Pickleball intervention program significantly improved the agility of the students, as their performance moved from a pretest mean of 16.54 seconds, verbally interpreted as "fair," to a posttest mean of 11.85 seconds, verbally interpreted as "good." This improvement reflects enhanced coordination, balance, body control, and ability to change direction efficiently. The result is supported by Sekulic et al. (2013), who concluded that repeated exposure to dynamic movement tasks significantly enhances agility performance, particularly when activities involve rapid changes in direction and speed. Their findings emphasized that neuromuscular adaptations, lower body power, and faster reaction speed contribute to improved agility outcomes.

For reaction time, the 20 students obtained a pretest mean of 27.00 and a posttest mean of 16.15, with a mean difference of 10.85, S.E.D. $\times$ of 1.723, t-value of 6.296, and p-value of 0.000. Since the p-value of 0.000 is below the 0.05 alpha level, the result is statistically significant at the 5% level, leading to the rejection of the null hypothesis. This indicates that the Pickleball intervention program significantly improved students' reaction time, as the mean score decreased from 27.00 cm, verbally interpreted as "needs improvement," to 16.15 cm, verbally interpreted as "good." This finding suggests that the program strengthened students' ability to respond quickly to visual stimuli and improved their neuromuscular coordination, attention, and cognitive motor responses. The result aligns with Kojić et al. (2024), whose randomized controlled study involving six-year-old children demonstrated that a six-month structured movement activities program produced significant improvements in standing long jump, plate tapping times, and shuttle run times compared with unstructured free play. These findings support the value of guided and purposeful physical activity in developing motor skills, agility, coordination, and overall physical fitness.

Overall, the paired sample t-test results revealed that the Pickleball intervention program significantly improved all measured physical fitness components among the junior

high school students. Muscular strength, muscular endurance, speed for male, speed for female, agility, and reaction time all obtained p-values below the 0.05 alpha level, specifically 0.000, 0.000, 0.000, 0.030, 0.000, and 0.000 respectively, indicating statistical significance at the 5% level. These results show that the intervention enhanced both health related fitness components, such as muscular strength and muscular endurance, and skill related fitness components, such as speed, agility, and reaction time. The significant improvements suggest that Pickleball is an effective, engaging, and developmentally appropriate physical education activity that promotes holistic physical fitness and motor skill development among junior high school students.

Effect size of the Pickleball program in the physical fitness skills of junior high school students

The effect size of the Pickleball program on the physical fitness skills of junior high school students was determined across five key components, namely muscular strength, muscular endurance, speed, agility, and reaction time. Data analysis was conducted using SPSS statistical software, and the pretest and posttest means and standard deviations were used to calculate Cohen's *d* values. The results were interpreted using Cohen's (1988) standard thresholds, where 0.20–0.49 indicates a small effect, 0.50–0.79 indicates a medium effect, 0.80–1.19 indicates a large effect, 1.20–1.99 indicates a very large effect, and 2.0 or greater indicates a huge effect. These effect sizes provide further evidence of the magnitude of the Pickleball program's influence on the students' physical fitness development.

The results revealed a large effect of Pickleball on muscular strength, with a Cohen's *d* of 1.04. This indicates that the average student performed better in the posttest than in the pretest, suggesting that the intervention produced a meaningful improvement in muscular strength. The improvement may be attributed to the repetitive and force producing movements required in Pickleball, such as lunging for low shots, executing smashes, serving, and maintaining ball control. This finding aligns with Dennis (2019), who highlighted that Pickleball participation positively affects lower body muscle parameters, including strength and power, because of the constant engagement of the legs and core during play. Yu et al. (2026) similarly noted that racket sports require substantial core and lower body strength to maintain balance and generate force during multidirectional movements. The large effect on muscular strength implies that Pickleball can serve as an effective functional alternative to traditional resistance training among adolescents, particularly in building foundational strength necessary for injury prevention and long-term musculoskeletal health.

For muscular endurance, the results showed a large effect, with a Cohen's *d* of 0.93. This indicates that students meaningfully improved their ability to sustain muscle contractions over time. Pickleball matches involve continuous movement, repeated rallies, and frequent engagement of the legs, arms, and core, making the sport a form of interval activity that challenges muscular endurance. This finding aligns with Turan (2024), who reported that students participating in structured Pickleball programs showed significant improvements in overall physical performance due to the sustained activity levels required during gameplay. Stroesser et al. (2024) also suggested that the aerobic and anaerobic demands of Pickleball contribute to improved cardiovascular and muscular endurance across age groups. The large effect on muscular endurance implies that Pickleball may be used in Physical Education (PE) curricula to improve stamina while reducing the monotony often associated with traditional endurance activities such as long-distance running.

For speed, the results revealed a huge effect among male students, with a Cohen's *d* of -2.01, and a very large effect among female students, with a Cohen's *d* of -1.27. In timed tests, the negative value represents a reduction in time, which indicates improved performance rather than decline. Therefore, the negative Cohen's *d* values show that students became significantly faster after the Pickleball intervention. This finding aligns with Cerezuela et al. (2023), who

noted that the fast-paced nature of Pickleball, characterized by quick bursts of movement to reach the ball, trains the anaerobic systems responsible for speed. The smaller court size compared with tennis also requires players to execute rapid accelerations and decelerations repeatedly. The huge effect for male students and very large effect for female students suggest that Pickleball develops game speed, or the ability to accelerate quickly from a stationary position, which can improve performance in other sports and physical activities requiring quickness and rapid movement transitions.

Agility showed a very large effect, with a Cohen's d of -1.37. Since agility was measured through time, the negative value indicates that students became faster in changing direction and completing agility tasks. This improvement is consistent with the nature of Pickleball, which requires constant quick movements, lateral shifts, pivots, and rapid responses to opponents' shots. The finding aligns with McBroom et al. (2025), who emphasized that racket sports such as Pickleball require high levels of agility and coordination to respond to game constraints, including ball trajectory and opponent positioning. Steff et al. (2024) also highlighted that sports involving reactive movements significantly improve agility in young athletes compared with static drills. The very large effect on agility implies that Pickleball is highly effective in developing multidirectional movement skills, general motor coordination, and body awareness, which are especially important during the rapid growth and development phase of junior high school students.

The results also revealed a very large effect on reaction time, with a Cohen's d of -1.95. Since reaction time was measured in distance, the negative Cohen's d value indicates a substantial reduction in the distance required to respond to a stimulus, reflecting a significant improvement in performance. This finding suggests that the Pickleball program effectively sharpened students' neuromuscular responses and enhanced their reactive capabilities. The result aligns with Lee et al. (2025), who indicated that the high-speed exchanges in Pickleball, particularly at the "kitchen" line or non-volley zone, require split second decision-making and rapid hand eye coordination. Stroesser et al. (2024) further supported this by identifying improved cognitive motor responses as a key benefit of regular Pickleball participation. The very large improvement in reaction time indicates that Pickleball has a strong influence on the central nervous system's ability to process visual information and initiate motor actions efficiently.

Taken together, the effect size results demonstrate that the Pickleball program produced meaningful and substantial improvements in the physical fitness skills of junior high school students. Muscular strength showed a large effect with a Cohen's d of 1.04, muscular endurance showed a large effect with a Cohen's d of 0.93, speed for male showed a huge effect with a Cohen's d of -2.01, speed for female showed a very large effect with a Cohen's d of -1.27, agility showed a very large effect with a Cohen's d of -1.37, and reaction time showed a very large effect with a Cohen's d of -1.95. For speed, agility, and reaction time, the negative Cohen's d values represent improvement because these variables were measured in time and distance, where lower scores indicate better performance. Thus, the negative effect sizes reflect faster movement and quicker response rather than decreased performance. Overall, the findings confirm that Pickleball enhances both health related fitness, particularly strength and endurance, and skill related fitness, particularly speed, agility, and reaction time. These results strengthen the conclusion that Pickleball is an effective, engaging, and developmentally appropriate intervention for improving multiple components of physical fitness among junior high school students and may therefore be considered a valuable addition to Physical Education programs.

Table 5 presents the effect size of the Pickleball program on the physical fitness skills of junior high school students across the identified fitness components, namely muscular strength, muscular endurance, speed, agility, and reaction time. The effect sizes were determined using Cohen's *d* values based on the pretest and posttest means and standard deviations computed through SPSS statistical software. The interpretation of the effect sizes followed Cohen's established criteria, wherein 0.20–0.49 indicates a small effect, 0.50–0.79 indicates a medium effect, 0.80–1.19 indicates a large effect, 1.20–1.99 indicates a very large effect, and 2.0 or greater indicates a huge effect. These effect size measures provide a deeper understanding of the magnitude and practical significance of the Pickleball intervention beyond statistical significance alone.

The results revealed that muscular strength obtained a Cohen's *d* value of 1.04, verbally interpreted as a "Large Effect." This finding indicates that the Pickleball program produced a substantial improvement in the muscular strength of the junior high school students. The magnitude of the effect suggests that the repetitive physical movements involved in Pickleball, including lunging, swinging, serving, volleying, and maintaining body balance during gameplay, contributed significantly to the enhancement of muscular force production. The large effect size further implies that the intervention did not merely produce minimal or moderate gains, but instead generated practically meaningful improvements in muscular fitness. This finding supports Dennis (2019), who emphasized that Pickleball participation positively affects lower body muscle parameters and muscular power due to the continuous activation of the legs and core during gameplay. Similarly, Yu et al. (2026) noted that racket sports require significant lower body and core engagement to stabilize the body and generate force during multidirectional movements, thereby enhancing muscular strength development.

Muscular endurance obtained a Cohen's *d* value of 0.93, verbally interpreted as a "Large Effect." This result demonstrates that the Pickleball intervention substantially improved the students' ability to sustain repeated muscular contractions and prolonged physical activity. The continuous rallies, repetitive movements, and sustained court positioning required during gameplay likely contributed to the enhancement of muscular stamina and fatigue resistance. The large effect size indicates that the Pickleball program effectively strengthened the students' endurance capacities in a practically meaningful manner. This finding aligns with Turan (2024), who reported that students participating in structured Pickleball programs demonstrated significant improvements in overall physical performance due to the sustained physical demands of gameplay. Stroesser et al. (2024) further explained that the aerobic and anaerobic demands of Pickleball contribute to enhanced cardiovascular and muscular endurance among participants across different age groups.

For the speed component among male students, the results revealed a Cohen's *d* value of -2.01, verbally interpreted as a "Huge Effect." Meanwhile, female students obtained a Cohen's *d* value of -1.27, verbally interpreted as a "Very Large Effect." Since speed was measured in terms of time, the negative Cohen's *d* values indicate reductions in sprint time, which reflect improved performance rather than decline. The huge effect among male students and the very large effect among female students indicate that the Pickleball program produced exceptionally strong improvements in movement acceleration, quickness, and sprinting ability. These findings imply that the repetitive rapid accelerations, decelerations, and quick directional transitions required during Pickleball gameplay effectively enhanced the students' speed performance. This observation is consistent with Cerezuela et al. (2023), who emphasized that the fast-paced nature of Pickleball trains the anaerobic systems responsible for explosive movement and rapid acceleration. The relatively smaller court size compared with tennis also requires players to react and move quickly, thereby improving functional game speed and movement efficiency.

Agility obtained a Cohen's d value of -1.37, verbally interpreted as a "Very Large Effect." Since agility was measured through completion time, the negative value indicates substantial improvement in the students' ability to rapidly change direction and execute coordinated movements efficiently. The very large effect size suggests that the Pickleball program strongly enhanced body coordination, balance, movement control, and multidirectional mobility. The dynamic nature of Pickleball, which requires frequent pivots, lateral shifts, and reactive positioning, likely contributed to these improvements. This finding supports McBroom et al. (2025), who explained that racket sports require high levels of agility and coordination due to the need to continuously respond to ball trajectory and opponent positioning. Likewise, Steff et al. (2024) found that sports involving reactive movement patterns significantly improve agility among young athletes compared with static conditioning drills.

Reaction time yielded a Cohen's d value of -1.95, verbally interpreted as a "Very Large Effect." Since reaction time was measured in terms of distance, the negative Cohen's d value indicates a substantial reduction in the response distance required to react to a stimulus, signifying enhanced performance. The very large effect size demonstrates that the Pickleball program produced major improvements in neuromuscular responsiveness, perceptual processing, and cognitive motor coordination. These findings imply that the repeated visual tracking, rapid hand eye coordination, and split-second decision-making required during gameplay effectively sharpened the students' reactive capabilities. This result aligns with Lee et al. (2025), who reported that high-speed exchanges in Pickleball demand rapid visual processing, immediate motor responses, and precise hand eye coordination. Stroesser et al. (2024) similarly identified improved cognitive motor responses as a major benefit associated with regular Pickleball participation.

Overall, the effect size analysis demonstrates that the Pickleball program produced substantial and practically meaningful improvements across all measured physical fitness components among the junior high school students. Muscular strength and muscular endurance both demonstrated "Large Effect" sizes with Cohen's d values of 1.04 and 0.93 respectively, while speed among male students demonstrated a "Huge Effect" with a Cohen's d value of -2.01. Speed among female students, agility, and reaction time all demonstrated "Very Large Effect" sizes with Cohen's d values of -1.27, -1.37, and -1.95 respectively. The findings indicate that Pickleball effectively enhances both health related fitness components, such as muscular strength and muscular endurance, and skill related fitness components, such as speed, agility, and reaction time. The consistently large to huge effect sizes further confirm that Pickleball is an effective and engaging intervention capable of promoting holistic physical development among junior high school students. These findings provide strong empirical support for the integration of Pickleball into Physical Education curricula as a developmentally appropriate activity that simultaneously improves physical conditioning, neuromuscular coordination, and motor skill performance.

CONCLUSION

The study investigated the effects of a Pickleball program on the physical fitness of junior high school students of Child's Academy, Inc., focusing on muscular strength, muscular endurance, speed, agility, and reaction time. The findings revealed that prior to participation in the intervention, the students generally demonstrated fair to good levels of physical fitness. Specifically, muscular strength and muscular endurance were verbally interpreted as "fair," while speed for both male and female students was already at a "good" level. Agility also fell

within the “fair” category, whereas reaction time indicated a “needs improvement” level. These baseline findings suggest that although the students possessed average physical fitness abilities before the intervention, several components still required further development, particularly muscular endurance, agility, and neuromuscular responsiveness. The pretest results therefore established the need for a structured and engaging physical activity program capable of improving multiple domains of fitness simultaneously.

Following participation in the Pickleball intervention program, the posttest results demonstrated notable improvements across all measured fitness components. Muscular strength and muscular endurance both improved to “good” levels, indicating enhanced muscular force production and increased capacity to sustain physical activity over time. Speed improved considerably, reaching a “very good” level for male students and an “excellent” level for female students, reflecting faster acceleration, improved movement efficiency, and enhanced sprinting performance. Agility and reaction time also progressed to “good” levels, signifying better coordination, balance, directional control, and quicker responses to visual stimuli. The transition from fair and needs improvement ratings during the pretest to good, very good, and excellent ratings during the posttest clearly demonstrated that the Pickleball program positively influenced the students’ physical fitness and motor performance. These findings indicate that the sport’s repetitive, dynamic, and movement-oriented activities effectively enhanced both health related and skill related fitness components among junior high school students.

The statistical analysis further confirmed that there was a significant difference between the pretest and posttest scores across all physical fitness components following the implementation of the Pickleball program. Muscular strength significantly improved as evidenced by a mean difference of -6.85, t-value of -5.610, and p-value of 0.000, while muscular endurance significantly improved with a mean difference of -7.20, t-value of -4.655, and p-value of 0.000. Speed also demonstrated statistically significant improvements for both male and female students. Male students obtained a mean difference of 2.11, t-value of 6.52, and p-value of 0.000, whereas female students obtained a mean difference of 1.37, t-value of 2.71, and p-value of 0.030. Agility significantly improved with a mean difference of 4.69, t-value of 7.176, and p-value of 0.000, while reaction time significantly improved with a mean difference of 10.85, t-value of 6.296, and p-value of 0.000. Since all p-values were below the 0.05 alpha level, the null hypothesis was rejected for all fitness variables, confirming that the Pickleball intervention program produced statistically significant improvements in muscular strength, muscular endurance, speed, agility, and reaction time. These findings demonstrate that the physical demands of Pickleball, including rapid directional movements, sustained rallies, quick accelerations, and reactive gameplay, effectively enhanced the students’ physical conditioning, neuromuscular coordination, and movement efficiency.

The effect size analysis further revealed that the Pickleball program produced substantial and practically meaningful effects on the physical fitness skills of the students. Muscular strength obtained a Cohen’s d value of 1.04, verbally interpreted as a “Large Effect,” while muscular endurance obtained a Cohen’s d value of 0.93, also interpreted as a “Large Effect.” These findings indicate that the repetitive and dynamic movements involved in Pickleball significantly enhanced the students’ muscular fitness and endurance capacities. Speed demonstrated particularly strong effects, with male students obtaining a Cohen’s d value of -2.01, interpreted as a “Huge Effect,” and female students obtaining a Cohen’s d value of -1.27, interpreted as a “Very Large Effect.” Agility also showed a “Very Large Effect” with a Cohen’s d value of -1.37, while reaction time demonstrated a “Very Large Effect” with a Cohen’s d value of -1.95. Since speed, agility, and reaction time were measured using time and distance variables where lower scores indicate improved performance, the negative Cohen’s d values reflect meaningful enhancement rather than decline. The findings therefore confirm that

the Pickleball program effectively improved not only muscular fitness but also sprinting ability, movement coordination, directional control, and neuromuscular responsiveness. Overall, the consistently large to huge effect sizes demonstrate that Pickleball is a highly effective intervention for promoting holistic physical fitness development among junior high school students.

The findings of the study therefore lead to the conclusion that Pickleball is an effective and engaging physical activity capable of significantly improving multiple components of physical fitness among junior high school students. The results demonstrate that the sport effectively enhances muscular strength, muscular endurance, speed, agility, and reaction time through its dynamic and repetitive movement patterns. Moreover, the study confirms that Pickleball contributes to both health related fitness and skill related fitness, making it a valuable and developmentally appropriate activity for adolescent learners. The significant improvements observed in speed, agility, and reaction time also suggest that Pickleball positively influences neuromuscular coordination, cognitive motor responsiveness, and movement efficiency, all of which are essential for physical performance and injury prevention during adolescence. Beyond physical fitness enhancement, the engaging and game-based nature of Pickleball may also increase students' motivation, participation, and long-term interest in physical activity compared with traditional conditioning exercises.

In light of these findings, it is recommended that students actively participate in Pickleball and similar structured physical activities to continuously improve their physical fitness and establish lifelong healthy habits. Regular engagement in movement-based sports can contribute not only to improved muscular fitness and motor coordination but also to better physical, mental, and social well-being. Schools are likewise encouraged to integrate Pickleball into Physical Education programs as an enjoyable and accessible activity capable of simultaneously developing multiple fitness components while maintaining student engagement and motivation. School administrators may further support the institutionalization of Pickleball by allocating adequate resources, equipment, facilities, and scheduling opportunities necessary for sustainable program implementation. Creating supportive school environments that promote active participation in physical activities can help reduce sedentary behaviors and reinforce the importance of maintaining an active lifestyle among students.

Furthermore, professional development opportunities for teachers should be strengthened to equip educators with innovative and effective strategies for implementing engaging, skill oriented, and inclusive physical activity programs. Training programs, seminars, and workshops may help teachers remain updated regarding contemporary instructional approaches, safety practices, and movement-based learning strategies that address diverse student needs and abilities. Schools and community organizations may also collaborate to promote extracurricular Pickleball activities that provide students with continued opportunities to enhance their skills and maintain the fitness gains achieved through school-based interventions. Such collaboration may foster supportive environments that reinforce the value of physical activity beyond the classroom setting.

Finally, further studies and long-term initiatives examining the sustained effects of Pickleball participation on various dimensions of physical fitness are encouraged. Future research may explore the long-term influence of consistent participation in Pickleball on endurance, agility, muscular strength, coordination, and overall health outcomes among adolescents. Additional investigations may also examine the sport's effects on psychological well-being, academic performance, social interaction, and lifestyle behaviors. Overall, the findings of this study strongly support the integration of Pickleball into school-based Physical Education programs as an effective, enjoyable, and sustainable intervention for promoting

holistic physical fitness, neuromuscular development, and lifelong wellness among junior high school students.

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