The Effects of an Intensity Coaching Intervention in Pickleball on the Fitness and Well-Being of Older Adults

by

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Abstract

Introduction:

Pickleball is one of the fastest-growing sports among older adults and has demonstrated potential physical, psychological, and social health benefits. However, despite its increasing popularity, limited research has examined the effects of structured pickleball coaching interventions on functional fitness and psychological well-being in older adults. Therefore, the purpose of this study was to examine the effects of a four-week pickleball intensity coaching intervention on functional fitness and psychological well-being in older adults.

Methods:

Adults aged 50 years and older who were new to pickleball or played no more than one hour per week participated in a four-week pickleball intervention. Participants were assigned to either a coaching pickleball group or a no-coaching group and completed eight one-hour pickleball sessions over four weeks. Functional fitness and psychological well-being were assessed before and after the intervention using the Fullerton Functional Fitness Test, the Satisfaction with Life Scale, and the Scales of Psychological Well-Being, respectively.

Results:

There were no significant group by time interactions, indicating that the coaching and no coaching pickleball groups improved similarly across all outcomes. Regardless of group assignment, participants demonstrated significant improvements in upper- and lower-body strength, dominant and non-dominant upper-body flexibility, agility, aerobic endurance, and psychological well-being following the intervention. No significant changes were observed in lower-body flexibility or life satisfaction.

Conclusion:

These findings suggest that a four-week pickleball intervention can improve functional fitness and psychological well-being in older adults, regardless of whether participants receive intensity coaching. Recreational pickleball, practiced without a coach, may therefore represent an effective, enjoyable, and accessible strategy for promoting healthy aging and supporting physical and psychological health in older adults.

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When I began this journey two years ago, I could not have imagined the amount of support, encouragement, and patience it would take to reach this point. This project would not have been possible without the many people who gave their time and listened to countless conversations about pickleball.

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List of Abbreviations

ADLs – Activities of Daily Living

BPM – Beats per minute

CI – Confidence Interval

cm – Centimetres

ECG – Electrocardiogram

FFFT – Fullerton Functional Fitness Test

GAQ – Get Active Questionnaire

HR – Heart Rate

ICC – Intraclass Correlation Coefficient

kg – Kilograms

m – Meters

MVPA – Moderate to Vigorous Physical Activity

NPHS – National Population Health Survey

PWB – Psychological Well-Being

s – Seconds

SPSS – Statistical Package for the Social Sciences

SPWB – Scales of Psychological Well-Being

SWLS – Satisfaction With Life Scale

VO_2peak – Peak Oxygen Uptake

WHO – World Health Organization

W_{max} – Maximal Workload

1RM – One Repetition Maximum

Chapter 1: Review of The Literature

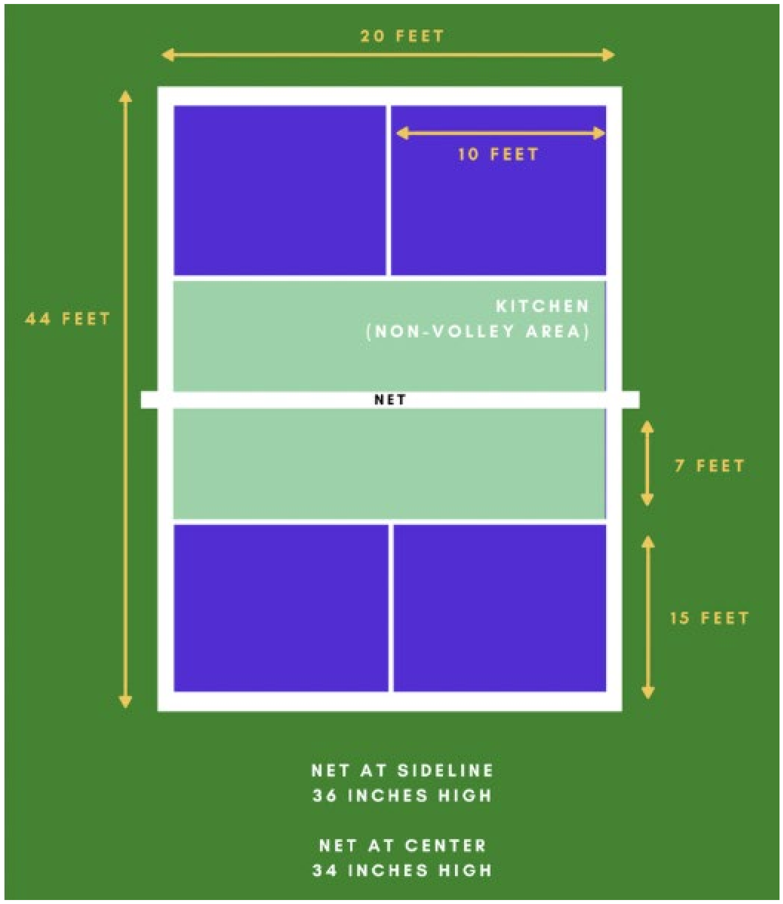
Pickleball

Pickleball has rapidly transformed into one of the fastest-growing sports in North America (Webber et al., 2023). There are an estimated 4.8 million pickleball players in the United States, reflecting a 39% increase from 2020 to 2022 (USA Pickleball, 2022). In Canada, participation has nearly tripled in the same two years, reaching one million players (Pickleball Canada, 2022). Invented in 1965, the game uniquely blends elements of badminton, tennis, and ping pong, creating a fun and accessible activity for people of all ages (Buzzelli & Draper, 2020). Played with lightweight paddles, a perforated plastic ball, and on a smaller court, pickleball offers a low-impact alternative to traditional racquet sports, reducing stress on joints while still providing meaningful physical activity (Changstrom et al., 2021). It is the game's simple rules and easy learning curve that make it especially popular among older adults (Heo & Ryu, 2024).

Pickleball is played on a court that is 6 meters wide and 13.4 meters long, with a net standing 36 inches high at the sidelines and 34 inches at the center (Pickleball Canada, 2025). The game can be played as singles or doubles and can be played coed or same gender. Play begins with an underhand serve, which must be made diagonally into the opponent's service court. A key feature is the non-volley zone, or *kitchen* (see Figure 1) a 7-foot area on either side of the net where players cannot volley the ball; this encourages longer rallies and reduces aggressive net play. Points are scored only by the serving team, games are typically played to 11 points, and won by 2 points, keeping matches short and manageable (Pickleball Canada, 2025).

Figure 1

Pickleball Court



Note. From Pickleball Canada (2025) "Basic Rules"

Playing Intensity

Research has shown that playing pickleball, both singles and doubles, provides sufficient intensity to promote cardiovascular health in older adults. Webber and colleagues (2023) categorized the physical activity levels of pickleball players based on heart rate (HR) and accelerometer data, finding that both singles and doubles games predominantly fell within the moderate-intensity activity range, with mean HR's reaching 64–76% of the predicted maximum. The study also noted that 72% of active time during pickleball resulted in moderate-to-vigorous intensity levels (Webber et al., 2023). Singles pickleball elicited slightly higher activity levels than doubles, with participants averaging more steps per hour and achieving greater cadence during play. Although both singles and doubles pickleball have been shown to elicit moderate-to-vigorous physical activity, the doubles format in this study was played outdoors during the summer months, with an average temperature (including humidex) of 26.9°C. These environmental temperatures may have increased players' heart rates, potentially overestimating the true physiological intensity of doubles play. This limits the generalizability of these findings to cooler climates or indoor settings, such as those commonly found in northern Ontario. Therefore, examining the intensity of doubles pickleball in a more controlled and thermally regulated environment is necessary to understand its physiological demands.

Since achieving 150 minutes of moderate-to-vigorous physical activity (MVPA) per week is critical for increasing and maintaining cardiovascular health (Health Canada, 2002), engaging in approximately three hours of pickleball weekly has the potential to allow older adults to meet these recommendations.

Physiological Benefits

Few studies have examined the physiological benefits of playing pickleball. Denning and colleagues (2022) examined the energy expenditure between pickleball and walking, a leading leisure activity among older adults. Denning found that playing doubles pickleball has been shown to elicit greater physical activity demands than walking at a self-paced speed. According to this study, 30 minutes of doubles pickleball led to a significantly higher mean HR of 118.8 beats per minute (bpm) and peak HR (152.8 bpm) compared to walking (104.5 bpm mean and 128.6 bpm peak). Additionally, caloric expenditure was 36% greater during doubles pickleball than during walking, with participants burning an average of 242.3 calories compared to 178.6

calories during walking (Denning et al., 2022). These findings suggest that pickleball has more cardiovascular benefits than walking.

To date, only one study examined and measured the effects of a structured pickleball intervention on older adults. In their 2021 study, Wray and colleagues implemented a 6-week pickleball program with 20 older adults between the ages of 50 and 75 years old. The players participated in doubles pickleball 3 times a week, for one hour per session. The researchers observed improvements in the participants' vertical jump performance, cardiovascular health, cognitive function, and a decrease in self-reported pain. These results suggest enhancements in both physical and mental health across the sample. Participants reported high satisfaction with the program and demonstrated good adherence throughout the intervention. However, the study's small sample size limits its ability to draw definitive conclusions (Wray et al., 2021). Furthermore, 85% of the participants were female, preventing the researchers from exploring potential sex differences in outcomes. These limitations highlight the need for an increased number of participants with equal numbers between sexes (Wray et al., 2021).

Casper and colleagues (2023) examined the health benefits of pickleball for older adults by objectively measuring physical activity levels over two weeks in adults who already play at least twice a week. The results demonstrated that playing pickleball significantly increased steps and time spent in moderate-to-vigorous physical activity. Participants averaged nearly 3,000 additional steps and over 42 minutes (m) in the cardiovascular zone (70–85% maximum HR) on pickleball play days compared to non-play days. This suggests that the sport is a valuable source of aerobic exercise, however, the study had several limitations. First, it relied on activity tracking devices (Fitbit©), which may not accurately measure steps or MVPA and can introduce reactivity bias, where participants increase activity because they know they are being monitored.

Another limitation was that only pickleball-specific activity was examined, without comparing its effects to those of other sports or activities that participants may engage in. Despite these limitations, the study provides preliminary evidence that pickleball is an effective physical activity for older adults, with potential benefits for cardiovascular health and increased physical activity levels. Further research is needed to confirm these findings and explore additional health outcomes (Casper et al., 2023).

Psychological Benefits

Previous research highlights the significant psychological benefits of pickleball for older adults, including its capacity to enhance individual well-being and happiness (Buzzelli & Draper, 2020; Ryu et al., 2020). Hoe and colleagues (2018) recruited 153 older adults over the age of 50 years who participated in pickleball competitions. The researchers were interested in examining pickleball as a form of serious leisure, meaning a leisure pursuit in which individuals invest significant time, develop specialized skills, and form a strong identity around the activity. They tested how serious leisure involvement, financial status, and loneliness predicted subjective well-being (SWB). Results showed that serious leisure, measured through participants' commitment, identity, and perseverance in pickleball, was a significant predictor of both life satisfaction and positive aging, whereas financial status and loneliness were not significant predictors. They found that playing pickleball as a serious leisure activity was associated with increased SWB, using a regression analysis. However, the study only used the Satisfaction With Life Scale (SWLS), a short 5 item scale, to assess SWB. Therefore, incorporating additional measures of well-being would provide a more comprehensive understanding in future research (Heo et al., 2018).

Ryu and colleagues (2019) explored the psychological impacts of pickleball on adults over the age of 50 years by examining how authentic individuals felt while playing the sport. The researchers defined authenticity as the extent to which individuals act in ways that are true to their inner values, emotions, and desires while feeling a strong sense of choice. Using surveys from 208 participants at the U.S. Open Pickleball Championship, they investigated the relationship between authenticity (self-determination and autonomy) and positive psychological functioning (lower perceived stress and greater happiness). Their findings showed that pickleball may serve as a vehicle in which older adults experience a sense of authenticity, and that authenticity is negatively associated with stress and positively associated with happiness. However, because all participants were competing at a major tournament, they were likely highly engaged players who may feel more authentic than recreational or less involved players. Future research should therefore include pickleball players across all skill and involvement levels to improve generalizability (Ryu et al., 2019).

Casper and Jeon (2019) further noted that pickleball facilitates the creation of new social connections, providing opportunities for older adults to expand their social networks and reduce feelings of isolation. These findings align with Heo et al. (2018), who classified pickleball as a serious leisure activity and a key contributor to eudaimonic well-being, offering older adults a sense of fulfillment and meaning through regular participation. This body of research suggests that pickleball’s combination of physical activity, social interaction, and enjoyment can promote a positive well-being in older populations.

Aging

Population aging is a growing global phenomenon, and Canada is no exception. In 2020, 18% of the Canadian population was over the age of 65 years, amounting to approximately 6.8

million individuals (Statistics Canada, 2020; Visconti & Neiterman, 2021). This demographic is expected to rise significantly, with older adults projected to make up 23% of the population by 2030, increasing life expectancy from 84.2 to 86.2 years of age (Visconti & Neiterman, 2021). The growing number of older adults will place substantial demands on healthcare systems and caregiving resources. Promoting healthy behaviours, such as regular physical activity, is essential to enhance functional independence and reduce the burden of chronic conditions, ensuring older adults maintain a high quality of life as they age. The next sections will review the physical effects of aging and how exercise can be used to combat these effects.

Physical Aging and Exercise

Aging is a common risk factor for many different diseases and disabilities; however, most of them can be prevented or delayed through lifestyle behaviours (Garber et al., 2011). The disorders that are of most concern are cognitive decline (Sophie et al., 2011), fragility (osteoporosis), which increases the risk of falls (Carter., 2002), and cardio-metabolic factors such as heart attack and obesity (O'Donnell et al., 2010). Exercise is recognized as one of the most important lifestyle factors that can help mitigate these diseases (Havighurst, 1961). Physical activity improves physical health, enhances mental well-being, preserves functional independence, and contributes to a higher quality of life as individuals age (Gómez-Campos et al., 2023). Consequently, incorporating regular exercise into daily routines is important for maintaining health and reducing the burden of age-related diseases.

Fall Risk

According to the World Health Organization (WHO), falls are the second leading cause of accidental injury and deaths worldwide (WHO, 2008) in older adult populations, with approximately one in three adults aged 65 years and older experiencing a fall each year due to fragility (Zhao & Chung, 2016). Falls and fall-related injuries, such as fractures, sprains, and tears, are major contributors to morbidity and loss of mobility in older adults (Cesari et al., 2002). The consequences of falls often extend beyond physical injury, leading to the loss of independence, social isolation, reduced quality of life, and increased hospitalization rates (Roe et al., 2009). These outcomes place a substantial burden on health care systems and result in significant economic costs globally. The personal, caregiver, and societal impacts of fall-related injuries suggest the urgent need for effective interventions aimed at reducing fall risk among older adults (WHO, 2008).

Functional fitness, defined as the physical capacity to perform everyday tasks safely and independently without excessive fatigue, serves as a key indicator of fall risk in older adults (Ho et al., 2021). Declines in functional fitness, particularly in balance, muscular strength, flexibility, and endurance, are closely associated with increased frailty and a higher likelihood of falls (Zhao & Chung, 2016). Improving these components through targeted physical activity or exercise interventions has been shown to mitigate fall risk by enhancing stability, coordination, and confidence during movement (Gómez-Campos et al., 2023). Therefore, promoting functional fitness, like in sports such as pickleball, among older adults represents an essential strategy in fall prevention efforts, supporting both longevity and quality of life, in this growing population.

Social Aspects of Aging

Human beings are inherently social and rely on stable, supportive relationships to maintain overall well-being. Trustworthy social connections are essential for both mental and physical health, whereas impaired or diminished social relationships can contribute to social isolation and loneliness (Tragantzopoulou & Giannouli, 2021). Although related, social isolation and loneliness are distinct concepts that have each been identified as risk factors for poor health, reduced well-being, and functional decline in older adults (Tragantzopoulou & Giannouli, 2021). As individuals age, social connectedness tends to decrease due to retirement, reduced income, functional limitations, bereavement, and changes in family structure and mobility (Courtin & Knapp, 2017). Given the vital role that deep social relationships play in supporting quality of life and health, it is critical to identify strategies that increase social engagement and connectedness in older populations.

Physical Activity Guidelines

Canadian 24-Hour Movement Guidelines

The Canadian Society for Exercise Physiology (2020) developed the Canadian 24-Hour Movement Guidelines for Older Adults to highlight the importance of incorporating physical activity and reducing sedentary behaviour in promoting overall health and well-being. These guidelines recommend that older adults participate in at least 150 minutes of moderate-to-vigorous aerobic physical activity per week, along with activities that enhance muscular strength and balance at least twice a week. Additionally, older adults are encouraged to break up long periods of sedentary behaviour to minimize associated health risks (Canadian Society for Exercise Physiology, 2020).

Although these guidelines are recommended, physical inactivity is still highly prevalent among older adults in Canada, making them the most sedentary segment of the population (Public Health Agency of Canada, 2014). According to Health Canada (2002), inactivity levels increase significantly with age, with participation in vigorous activities declining substantially among older age groups. Data from the National Population Health Survey showed that only 14% of seniors are sufficiently active, while 65% are considered inactive (Health Canada, 2002). Statistics Canada reports that 32% of seniors have a low level of physical activity (Health

Canada, 2002). These statistics highlight the need for targeted interventions to reduce physical inactivity and promote active aging in Canada's senior population.

Sport-Based Physical Activity

Sport-based activities are shown to positively impact increasing adherence to exercise participation (Wray et al., 2021). They are advantageous due to their strong social engagement, cognitive demand, and high intrinsic enjoyment (Kolt et al., 2014). Sports that are group-based have also been shown to increase participation, accountability, consistency, and enjoyment, leading to better adherence to exercise programs (Farrance et al., 2016).

Although sports, in general, are advantageous, it is important to consider the intensity and difficulty of the sport based on the population. Some sports may be too physically demanding (e.g., basketball) and have a risk factor for injury. This is important to consider as older adults claim that perceived injury risk is one of the main barriers to sports and exercise participation (Newson & Kemps, 2007). Other sports do not require a high enough intensity to see health benefits (e.g., cornhole, shuffleboard), where much of the time is spent inactive. Racquet and paddle sports provide a good balance between high and low-intensity activities and are associated with a significant reduction in all-cause mortality compared to other sports (Oja et al., 2017).

Coaching Interventions in Older Adults

Coaching interventions have been shown to enhance engagement in physical activity among older adults by improving exercise adherence, motivation, and participation (Nicolson et al., 2017). A systematic review by Oliveira et al. (2017), which included 27 randomized controlled trials involving adults aged 60 years and older, found that health coaching produced significant improvements in physical activity participation compared to usual care or minimal intervention. Similarly, Room et al. (2017) reported that behavioural strategies commonly incorporated into coaching interventions, including individualized feedback, goal setting, and supervision, were effective in improving adherence to exercise programs among older adults. These findings suggest that coaching may encourage individuals to exercise more consistently and at an appropriate intensity. Although pickleball is most commonly played recreationally, it can also be delivered in a structured coaching environment where participants receive instruction, feedback, and guidance to maintain target exercise intensities. Despite the widespread popularity of both recreational and coached pickleball, little research has examined whether participating in a structured coaching intervention provides greater physical or psychological benefits than recreational play alone.

Functional Fitness

Many older adults prioritize the ability to perform activities of daily living (ADLs) and maintain functional independence over disease prevention (Blackwell & Clarke, 2018; Whitfield et al., 2009). Functional fitness refers to the physical capacity to perform everyday tasks safely and efficiently, encompassing essential abilities such as strength, endurance, balance, flexibility, and mobility (Jones & Rikli, 2000). These components are critical for tasks like standing, walking, bending, and lifting, all of which contribute to an individual's autonomy and quality of life.

As individuals age, declines in functional fitness are associated with an increased risk of falls, frailty, and difficulty performing ADLs, which can lead to a loss of independence and a higher reliance on caregivers or assisted living (Tornero-Quinones et al., 2020). For example, lower body strength is essential for standing up from a seated position or climbing stairs, while balance and agility help prevent falls. Cardiovascular endurance is needed to support stamina for sustained physical activities, such as grocery shopping or walking, and flexibility enables safe bending and reaching motions (Jones & Rikli, 2000). Programs focusing on functional fitness can empower older adults to retain their independence, engage in meaningful activities, and enjoy a higher quality of life well into their later years.

Parameters

Parameters refer to the characteristics of a measurement tool that determine its quality and usefulness in assessing a specific concept or skill. The two most fundamental parameters are validity and reliability (Ahmed & Ishtiaq, 2021). Validity refers to the degree to which a test or assessment tool measures what it is intended to measure (Weir & Vincent, 2021). There are several types of validity, including content validity (how well the items represent the construct), construct validity (how well the test aligns with theoretical concepts), and criterion-related validity (how well the test correlates with a gold-standard measure; Weir & Vincent, 2021). Validity is crucial because it determines the meaningfulness and accuracy of the inferences made from the test scores, particularly when applying the results to real-world settings (Weir & Vincent, 2021).

Reliability refers to the consistency of a measurement tool over time, across raters, or within the test itself (Weir & Vincent, 2021). A reliable test yields similar results under consistent conditions, thereby reducing the likelihood of measurement error. Reliability is often assessed using test-retest methods (measuring the same participants at two points in time), inter-rater reliability (consistency between different assessors), and internal consistency (how well multiple items within a measurement instrument assess the same underlying construct; Weir & Vincent, 2021). Together, validity and reliability help researchers determine whether a test provides accurate and dependable data. The parameters of the measurement tools used in this study will be discussed below.

Fullerton Functional Senior Fitness Test

The Fullerton Functional Fitness Test (FFFT; see Appendix 9) is a tool designed to assess the key physical components necessary for maintaining independence in older adults (Jones & Rikli, 2000). The test battery includes six items including the 30-Second Chair Sit to Stand Test for the assessment of lower body strength, the 30-Second Arm Curl Test for upper body strength, the 6-Minute Walk Test or 2 Minute Step Test for aerobic endurance, the 8-Foot Up-and-Go Test for dynamic balance, the Back Scratch Test for upper body flexibility, and the Sit and Reach Test for lower body flexibility (Jones & Rikli, 2000).

30-Second Chair Sit-to-Stand Test

The 30-Second Sit-to-Stand Test assesses lower-body strength and endurance, particularly of the quadriceps femoris muscle (Rikli & Jones, 1999). The test requires participants to sit in a standard chair (approximately 43–45 cm seat height) with their arms crossed over their chest and perform as many full stands as possible within 30 s. The tester counts the total number of correct stands, with only full extensions and controlled returns to the seated position being counted (Rikli & Jones, 1999).

Rikli and Jones (1991) examined the validity and reliability of the FFFT by recruiting 82 older adults (48 women and 34 men; mean age in years=71.8, SD=6.9). To establish test-retest reliability, they administered the 30-Second Chair Sit-to-Stand Test twice, with 2-5 days between retests. Different technicians were used to conduct the test on each of the two test days. The technicians on the second test day were not aware of the score obtained on the first test day. Test-retest reliability was established by calculating the interclass correlation coefficient (ICC), using a one-way analysis of variance (ANOVA) model that is appropriate for estimating reliability for a single test. The one-way ANOVA also detects any change in score from the first day to the second day. A lack of significant changes indicated scoring stability across trials. The test showed high reliability between test one and two (ICC=.89, 95% Confidence Interval (CI)=[.79, .93]; Rikli & Jones, 1999).

To test convergent criterion validity, Rikli and Jones compared the scores of the 30-Second Chair Sit-to-Stand Test in 76 adults with those obtained from the 1 repetition maximum (RM) leg press strength test. The 1 RM leg press is a multi-joint exercise that involves hip extension, knee extension, and ankle plantarflexion and is considered a valid measure of lower body strength (Verdijk et al., 2009). The study found a high correlation between the chair to stand performance and maximum leg press performance for both men and women (r=.78 and .71, respectively). This suggests good criterion validity for the 30 Second Chair-to-Stand Test (Rikli & Jones, 1999).

Boneth and colleagues (2012) assessed the test-retest reliability and level of agreement of the 30-Second Chair Stand Test in a sample of older adults. The test was administered by the same evaluator to 111 adults over the age of 59 years on two occasions, with an interval of 4 to 8 days between measurements. Test-retest reliability was evaluated using the ICC along with the corresponding 95% CI. The level of agreement was determined using the Bland and Altman Method. The test-retest reliability of the 30-Second Chair Stand Test was found to be good, with an ICC of .78. The agreement level was considered very good. The 95% CI for the difference between the number of repetitions of standing for test sessions ranged from -3.8 to 3.2. The study concluded that the 30-Second Chair Stand Test demonstrates good reliability and agreement for assessing lower body muscular endurance in functionally independent older adults.

30-Second Arm Curl Test

The 30-Second Arm Curl Test assesses upper body strength and muscular endurance, primarily targeting the biceps brachii and forearm flexor muscles (Rikli & Jones, 1999). It is measured by recording the number of biceps curls completed in 30 s using a 2.5 kg for women, 3.6 kg for men (Rikli & Jones, 1999).

Rikli and Jones (1999) tested the reliability and validity of the 30-Second Arm Curl Test. To establish test-retest reliability, the test was administered twice to 83 older adults, with a 2-5 days interval between retests. Different technicians conducted the test on each of the two test days. The technicians on the second test day were not aware of the score obtained on the first test day. Test-retest reliability was established by calculating the ICC, using a one-way ANOVA model. The test showed good reliability between tests one and two (ICC=.81, 95% CI= [0.72, 0.88]; Rikli & Jones, 1999).

To assess the criterion validity of the 30-Second Arm Curl Test, Rikli and Jones (1999) examined its correlation with established measures of upper body strength. Specifically, they compared arm curl performance with 1RM biceps brachii muscle strength measured on a Keiser pneumatic biceps machine. The results showed moderate correlations of r=.62 for men and r=.68 for women. However, stronger correlations were observed when comparing the arm curl performance to overall upper body strength, calculated using a combination of 1RM biceps, 1RM chest press, and 1RM seated row measurements. These composite correlations were r=.81, n=20 for men and r=.78, n=24 for women, indicating that the 30-Second Arm Curl Test is a moderately to highly valid measure of overall upper body strength in older adults (Rikli & Jones, 1999).

The same study as mentioned in the previous section also aimed to assess the test-retest reliability and level of agreement of the 30-Second Arm Curl test in a sample of older adults (Boneth et al., 2012). The test was administered by the same evaluator to 111 adults over the age of 59 years on two occasions, with a time interval of 4 to 8 days between measures. Test-retest reliability was determined using the ICC, along with its 95% CI. The level of agreement was assessed using the Bland and Altman Method. The test-retest reliability of the 30-Second Arm Curl Test was found to be very good, with an ICC of .88. The level of agreement was also considered very good. The 95% CI ranged between -3.1 and 2.8 arm curls. The study concluded that the 30-Second Arm Curl Test demonstrated good reliability and agreement for assessing upper body muscle endurance in functionally independent older adults (Boneth et al., 2012).

Back Scratch Test

The Back Scratch Test requires a combination of shoulder abduction, adduction, and internal and external rotation movements (Rikli & Jones, 1999). It involves raising one arm over the shoulder and behind the back, while the other hand reaches down around the back. The distance measured between the tips of the two middle fingers is the score (Rikli & Jones, 1999).

Rikli and Jones (1999) tested the reliability and validity of the Back Scratch Test. To establish test-retest reliability, the test was administered twice to 83 older adults, with a 2-5 day interval between retests. Different technicians were used to conduct the test on each of the two test days and were not aware of each other's scores. Test-retest reliability was established by calculating the ICC, using a one-way ANOVA model. The test showed excellent reliability between tests one and two (ICC=.96, 95% CI=[0.94, 0.98]; Rikli & Jones, 1999).

Although there is no single criterion measure for the Back Scratch Test, it has been widely recognized by experts as a valid tool for assessing overall shoulder range of motion

(Gross et al., 1996; Hoppenfeld, 1986; Line-Seiler, 2016; Rikli & Jones, 1999; Starkey & Ryan, 1996). However, the test has shown correlations with self-reported functional ability, supporting its role as a meaningful indicator of upper-body flexibility using concurrent validity testing (Keith et al., 2014). Keith and colleagues (2014) assessed the Self-Reported Physical Fitness (SRFit) survey, which included the Back Scratch Test performed bilaterally and examined its correlation with upper-body flexibility as reported by participants. The researchers collected both objective performance data from the Back Scratch Test and subjective data from the SRFit survey, which asked participants to rate their ability to complete flexibility-related movements. The sample consisted of older adults, and both tests were administered in a controlled environment following standardized protocols. Findings showed moderate to strong correlations, with r=.77 for the left side and r=.75 for the right side, corresponding to the SRFit upper-body flexibility summary scores that aggregated multiple self-reported movement items (e.g., reaching across the back). These results provided evidence that the Back Scratch Test is a valid indicator of functional upper-body flexibility, meaning those who performed better on the test also reported greater ease with flexibility-related tasks (Keith et al., 2014).

Chair Sit and Reach Test

The Chair Sit and Reach Test is a modified version of the Floor Sit and Reach Test designed to measure lower body flexibility (primarily hamstring muscles; Rikli & Jones, 1999). The participants are asked to sit on the edge of a chair with one leg straight in front of them, with their heel resting on the ground. The objective is to reach as far as they can with straight arms as close to or past the toes as possible. The distance measured between the fingertips and toes is the recorded score (Rikli & Jones, 1999).

Rikli and Jones (1999) aimed to test the reliability and validity of the Chair Sit and Reach Test. To establish test-retest reliability, the test was administered twice to 83 older adults, with a 2–5 days interval between retests. The study calculated the ICC by using a one-way ANOVA to detect changes from one test to the next. The test showed excellent reliability between tests one and two (ICC=.95, 95% CI=[0.92, 0.97]; Rikli & Jones, 1999).

To evaluate the criterion validity of the Chair Sit and Reach Test, Rikli and Jones (1999) compared scores to a gold standard measurement of hamstring flexibility, goniometer-measured hamstring flexibility (American Academy of Orthopaedic Surgeons, 1966). They also compared the scores to those of other established flexibility assessments, such as the Two Leg Floor Sit and Reach and the One Leg Back Saver Sit and Reach (American Academy of Orthopaedic Surgeons, 1966; Jones et al., 1998). The results showed strong correlations between Chair Sit-and-Reach scores and goniometer-measured hamstring flexibility, with correlations of r=.81 for women and r=.76 for men. Notably, the Chair Sit-and-Reach Test demonstrated slightly stronger correlations with the goniometric criterion than either of the floor-based flexibility tests, indicating that it may be a more effective measure of hamstring flexibility in older adults (Jones et al., 1998).

In a pilot study on older adults with intellectual disabilities, Hilgenkamp et al. (2012) assessed the reliability and feasibility of several physical fitness tests, including the Extended Modified Back-Saver Sit-and-Reach Test (EMBSSR), a variation of the Chair Sit and Reach Test. To determine test–retest reliability, participants completed the test on two separate days: an initial test (Session 1) and a follow-up session two weeks later (Session 2). To evaluate short-term reliability, the test was also repeated twice on the same day (Sessions 2 and 3). The study involved 36 older adults aged 50 to 89 years of age, with varying levels of intellectual disability and mobility. Intraclass correlation coefficients were calculated for both the short-term and long-term intervals.

The test–retest reliability of the EMBSSR was found to be acceptable to excellent. For the left leg, the ICC was .96 (95% CI=[.91, 0.98]) for the short-term interval and .63 (95% CI=[0.29, 0.83]) for the long-term interval. For the right leg, the ICC was .95 (95% CI=[0.89, 0.98]) for the short-term interval and .71 (95% CI=[0.43, 0.87]) for the long-term interval (Hilgenkamp et al., 2012). These results suggested that the Chair Sit-and-Reach Test, in its extended form, demonstrates strong short-term reliability and moderate to good long-term reliability in older adults with intellectual disabilities.

8-Foot Up and Go Test

The 8-Foot Up and Go Test is designed to measure power, agility, and dynamic balance, which is meant to integrate neuromuscular system parameters (Rikli & Jones, 1999). The test involves standing up out of a chair, walking 8 feet around a cone, and returning to the chair as quickly as possible. The time measured in seconds is the recorded score, and participants get two attempts at their fastest score (Rikli & Jones, 1999).

Rilki and Jones (1999), assessed the psychometric properties of the 8-Foot Up and Go test by recruiting 82 older adults over the age of 59 years. Tests were administered by graduate students or trained technicians. To test reliability, they had two different technicians complete the test on two separate days, with 2-5 days between tests. Test-retest reliability was established by calculating the ICC using a one-way ANOVA that detects reliability for a single test and changes between scores from one day to the next. The test showed excellent reliability between tests one and two (ICC=.95, 95% CI=[0.92, 0.97]; Rikli & Jones, 1999).

To establish the content relevance (convergent construct validity) of the 8-Foot Up and Go Test, Rikli and Jones (1999) examined how well this test correlated with other established measures of agility, balance, and mobility in older adults. The test was designed to reflect real-world functional abilities, such as quick directional changes. To validate this, the researchers compared 8-Foot Up and Go Test scores with measures such as the Berg Balance Scale and a timed walking test. They also compared the scores to the Barthel Index of ADL's, which is a measure of walking, stair climbing, and transfer actions (e.g., getting out of a bath; Liu et al., 2015). The 8-Foot Up-and-Go Test showed a moderate negative correlation with the Berg Balance Scale (r=—.81), indicating that higher agility was associated with better balance. Additionally, there were moderate to high positive correlations with the Barthel Index of ADLs (r=.77) and walking speed (r=.61), further demonstrating that the 8-Foot Up-and-Go Test is a strong indicator of dynamic balance and agility. These findings confirm that the test is content-relevant and effectively captures essential aspects of mobility and fall risk in older adults (Rikli & Jones, 1999).

6-Minute Walk Test

The 6-Minute Walk Test (6MWT) is designed to measure aerobic endurance in people of varying physical fitness (Rikli & Jones, 1999). The test involves walking as quickly as possible for 6 minutes along a 50-yard rectangular course. The distance measured in meters is the score (Rikli & Jones, 1999).

Rilki and Jones (1999) aimed to provide evidence of the reliability and validity of the 6MWT. They recruited 82 older adults over the age of 60 years. To test the reliability of the 6MWT, they administered the test three times to each participant with 2-5 days between retests. The first trial was treated as a practice trial to account for the practice effect, which refers to the improvement in performance that occurs simply because a participant becomes more familiar with a test or task after doing it once (Liu et al., 2008). Test-retest reliability was calculated using the ICC by using a one-way ANOVA. The ICC between trials 1 and 2 were .88 for women and .91 for men, which is slightly lower than the correlations between trials 2 and 3, which were .91 for women and .97 for men. This suggests that a practice error may be occurring between trials 1 and 2, although it is not statistically significant. Overall, these results showed that the test has reliability across trials (Rikli & Jones, 1999).

Meys and colleagues measured test–retest reliability by having participants complete the same assessment tools on two separate occasions within a 7-14 days interval. The ICC was used to measure the consistency of scores between the two testing sessions. ICC values greater than .70 were considered acceptable, while values above .90 indicated excellent reliability. The results demonstrated that the ICCs for the test was .91, excellent test-retest reliability. These findings support that the instruments consistently measure performance over time when no true change is expected (Meys et al., 2023).

Convergent construct validity was assessed by Meys and colleagues by analyzing how well the 6MWT correlated with other established physiological and clinical measures. Depending on the distribution of the data, either Pearson's or Spearman's Correlation Coefficients were used. The best 6MWT performance had a mean of 418 meters (95% CI [402–435 m]), which represented 68% of the predicted value (95% CI [65–70%]). A strong positive correlation was found with peak oxygen uptake (VO_2peak=.61), and a strong negative correlation was observed with the modified Medical Research Council dyspnea scale (mMRC, r=–.64), indicating that higher walking distances were associated with better aerobic capacity and lower breathlessness. As functional impairment (mMRC) increased, mean 6MWT scores decreased, supporting known group validity (Meys et al., 2023). Maximal workload (W_{max}) showed a moderate correlation (r=.50). The pattern of results supports the construct validity of the 6MWD as a meaningful measure of functional capacity (Meys et al., 2023).

Taken together, the FFFT provides a valid and reliable battery of tests that measure older adult mobility, flexibility and balance. Functional fitness tests assess objective changes in physical performance, however a comprehensive evaluation also requires patient-reported outcome measures to assess subjective experiences.

Measures of Well-Being

Satisfaction with Life Scale

The SWLS (see Appendix 3) is a five-item self-report questionnaire designed to assess an individual's global judgment of life satisfaction (Hinz et al., 2018). Each item is rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), resulting in total scores ranging from 5 to 35. Higher scores reflect greater life satisfaction, with scores above 30 indicating high satisfaction and scores below 9 suggesting extreme dissatisfaction (Aishvarya et al., 2014). The scale focuses on the cognitive component of SWB, specifically measuring how individuals evaluate their own lives based on personal standards and criteria (Aishvarya et al., 2014).

López-Ortega and colleagues (2016) tested the psychometric properties of the SWLS. In this study, 13,220 participants with complete SWLS responses were included. The mean age was 64.7 years (SD = 9.4), and 56.9% of the sample were women. Statistical analyses included internal consistency (Cronbach’s alpha), exploratory factor analysis (EFA), known-groups validity, and criterion-related validity using Spearman’s Correlations (López-Ortega et al., 2016).

Construct validity was assessed through EFA. The analysis showed that the SWLS had a one-factor structure, with all five items loading onto a single dimension. Meaning the scale effectively measures one main concept, overall life satisfaction, rather than multiple separate ideas. The Kaiser–Meyer–Olkin Index was 0.80, and Bartlett's Test of Sphericity was statistically significant (X^2=13,046.76, p<.001), confirming that it was appropriate to complete a factor analysis. The factor explained 54.25% of the total variance, with item factor weights ranging from .61 to .83. Lastly, López-Ortega and colleagues analyzed a scree plot, determining that a one-factor model accurately represents the data (López-Ortega et al., 2016).

López-Ortega and colleagues tested the known-groups validity by comparing life satisfaction scores between participants with good health and those with poor health. As hypothesized, participants in the bad-health group reported significantly lower life satisfaction scores (M=7.0, SD=2.3) compared to the good-health group (M=6.0, SD=1.6). The differences between the groups were statistically significant (p<.01). This means that the scale can reliably distinguish between people who are expected to have higher or lower life satisfaction (in this case, based on their health status; López-Ortega et al., 2016).

Convergent construct validity was further supported through correlations between the SWLS and related variables. Life satisfaction has a weak correlation with depressive symptoms (r=.29, p<.01), pain (r=.15, p<.01), and poor self-reported health (r=.19, p<.01), meaning that people had less depressive symptoms, pain, and poor health had greater life satisfaction scores. Additionally, life satisfaction was positively correlated with perceived financial situation (r=.23, p<.01) and social support from spouses (r=.23, p<.01), children (r=.21, p<.01), and friends (r=.13, p<.01; López-Ortega et al., 2016). This means that people who had more social support and greater financial status had higher life satisfaction scores. These correlation coefficients supported what would be expected based on the definition of the scales (López-Ortega et al., 2016).

López-Ortega and colleagues measured the reliability of the SWLS by using internal consistency analysis. The Cronbach's alpha coefficient for the scale was .74, indicating acceptable reliability for use in large-scale surveys with older adults. Inter-item correlations ranged from .27 to .48, and item-total correlations ranged from .64 to .74, suggesting that the items were moderately to strongly related to the overall scale score. These findings supported the internal consistency of the SWLS (López-Ortega et al., 2016).

Lorenzo-Seva and colleagues (2019) evaluated the psychometric properties of the SWLS in a clinical population of cancer patients. A total of 713 patients with non-advanced cancers who had undergone surgery and were beginning follow-up chemotherapy participated (Lorenzo-Seva et al., 2019).

Internal consistency of the SWLS was assessed using Cronbach's alpha and McDonald's omega. Both coefficients were .91, indicating excellent reliability. Corrected item-total correlations ranged from .66 to .75, confirming strong item discrimination. This confirms that all five items consistently measured the same underlying idea of life satisfaction, and each item contributed strongly to the overall score (Lorenzo-Seva et al., 2019).

Lorenzo-Seva and colleagues tested construct validity by analyzing whether all five items of the SWLS measured a single concept, life satisfaction, using confirmatory factor analysis (CFA). The results showed that the scale fits a one-factor model very well. Key indicators included comparative fit index (CFI=.99), which indicated that the model fits very well, and root mean square error of approximation (RMSEA; RMSEA=.05), which indicated low error between the SWLS and reality. Together, these values showed a very good fit. Additionally, the explained common variance (ECV) was tested (ECV=.947), indicating 94.7% of the shared variance in the items was explained by one factor, and the factor was considered strong and likely to be consistent across studies (H=.953; Lorenzo-Seva et al., 2019).

The authors tested whether the SWLS measured life satisfaction the same way across different groups, such as men and women, different age groups, and types of cancer. This is called measurement invariance. The results showed that the scale was consistent across all groups. This means that comparisons between these groups are fair and valid. Gender invariance showed good model fit (χ^2=37.07, degrees of freedom=18, CFI=0.98, RMSEA=0.05), meaning men and women interpreted and responded to the scale similarly (Lorenzo-Seva et al., 2019).

Lorenzo-Seva and colleagues analyzed convergent construct validity by testing if the SWLS was related to similar concepts, which they expected it to be. Life satisfaction scores were lower in people with more anxiety ($r=-.33$), depression ($r=-.42$), and somatic symptoms ($r=-.26$). It was also related to physical health: people with better functioning had higher life satisfaction ($r=-.29$), while those with more symptoms or lower quality of life had lower satisfaction ($r=.25$ and $r=-.32$, respectively). All of these correlations were statistically significant ($p<.001$), showing that the SWLS is meaningfully connected to both emotional and physical well-being (Lorenzo-Seva et al., 2019).

Scales of Psychological Well-Being

The concept of psychological well-being has been widely studied and is recognized as a vital component of living a fulfilling and meaningful life (Wiklund et al., 2019). To assess this construct, Ryff (1989) developed the Scales of Psychological Well-Being (SPWB; see Appendix 2), one of the most comprehensive and empirically supported measures of eudaimonic well-being (Manchiraju, 2020). This study defined eudaimonic well being as finding meaning, purpose, personal growth, and self-actualization for long-term fulfillment, instead of short-term happiness. The SPWB conceptualizes well-being as a multidimensional construct encompassing six interrelated dimensions, 7 items each, including autonomy (the ability to function independently and resist social pressures), environmental mastery (the capacity to manage one's environment effectively), personal growth (the continual development of one's potential), positive relations with others (the ability to form warm and trusting relationships), purpose in life (having direction and meaning in one's existence), and self-acceptance (holding a positive attitude toward oneself, including both strengths and limitations; Ryff, 1989; Ryff & Keyes, 1995). Together, these dimensions provide a holistic framework for understanding psychological functioning beyond just the absence of distress (Manchiraju, 2020).

Kallay and Rus (2014) tested reliability of the SPWB by using the weighted-omega (Ωw) reliability coefficient, which estimates internal consistency based on standardized parameters from the CFA (Bacon et al., 1995). The Ωw values for all six subscales exceeded .70, meeting the commonly accepted cutoff for adequate reliability (Lance et al., 2006). These findings suggest that each subscale of the SPWB demonstrates a high degree of internal consistency and measures its intended aspect (Kallay & Rus, 2014).

Manchiraju (2020) examined the reliability of the scales by having 332 participants complete the 42-item SPWB. They completed a reliability analysis by calculating Cronbach's alpha for each subscale of the SPWB. The lowest coefficient was Purpose in Life with a value of .70 and the highest being Self-Acceptance with a value of .85. This indicates that each subscale consistently measures its intended aspect of psychological well-being (Manchiraju, 2020).

Shryock and Meeks (2018) examined the reliability of the SPWB across three age groups within a multi-generational sample of 581 participants. Internal consistency, measured using

Cronbach's alpha, demonstrated acceptable reliability across all groups, with coefficients of .71 for younger adults, .78 for middle-aged adults, and .77 for older adults. These values exceeded the commonly accepted cutoff of .70, indicating that the items within each subscale consistently measure the same underlying dimensions of well-being. Although reliability was slightly lower in the youngest group, the results overall suggested that the 42-item SPWB provides stable and dependable scores across different age populations (Shryock & Meeks, 2018).

Kallay and Rus (2014) examined if the SPWB accurately measured the six areas of well-being it was designed to assess using factorial validity. Using confirmatory factor analysis, they tested the original six-factor model of psychological well-being and compared it with three other possible models; one with all items combined into a single factor, one with six unconnected factors, and a hierarchical model combining the six factors under a broader overall factor. They evaluated how well each model fit the data using several statistical indicators, including the chi-square test (χ^2), the CFI, the root mean square error of approximation, and the standardized root mean square residual, following the model-fit guidelines recommended by Hu and Bentler (1999). The results showed that the six-factor model fit the data well ($\chi^2[887]=2922.85$, $p<.001$, RMSEA=.059, SRMR=.048, CFI=.973), meaning that the SPWB effectively captures six distinct but related aspects of psychological well-being.

Shryock and Meeks (2018) examined factorial validity of the 42-item SPWB through CFA to assess whether the data supported the original six-factor model of psychological well-being. The CFA results indicated moderate model fit, with fit indices of NFI=.77, CFI=.84, RMSEA=.06, and CMIN/DF=3.09. While these values fall slightly below the recommended cutoffs for a well-fitting model (CFI $\geq$.90–.95, NFI $\geq$ .90), they still reflect a reasonable approximation of the expected factor structure. Overall, these findings indicated that the 42-item

SPWB demonstrates adequate construct validity, though alternative factor solutions may further optimize its structure (Shryock & Meeks, 2018).

Purpose

Although Canadian health guidelines recommend that adults participate in at least 150 minutes of moderate-to-vigorous physical activity per week, only 14% of older adults meet these recommendations. While numerous studies have examined the psychological benefits of pickleball, only one study has explored its physical benefits through an intervention. To date, no studies have investigated the functional fitness outcomes of pickleball for older adults. Therefore, the purpose of this study is to examine the effects of a four-week pickleball intensity coaching intervention on muscular strength, aerobic endurance, dynamic balance, flexibility, and psychological well-being in adults.

Guiding Questions

(1) What is the effect of a four-week pickleball intervention on functional fitness measured using the FFFT?

(a) What is the effect of a four-week pickleball intervention on upper body strength between those who play recreationally versus intensity coached (30-second Arm Curl Test)?

(b) What is the effect of a four-week pickleball intervention on lower body strength between those who play recreationally versus intensity coached (30-Second Chair Sit to Stand Test)?

(c) What is the effect of a four-week pickleball intervention on upper body flexibility between those who play recreationally versus intensity coached (Back Scratch Test)?

(d) What is the effect of a four-week pickleball intervention on lower body flexibility between those who play recreationally versus intensity coached (Chair Sit and Reach Test)?

(e) What is the effect of a four-week pickleball intervention on agility in older adults between those who play recreationally versus intensity coached (8-Foot Up and Go Test)?

(f) What is the effect of a four-week pickleball intervention on aerobic fitness in older adults between those who play recreationally versus intensity coached (6MWT)?

(2) What is the effect of a four-week pickleball intervention on well-being (SWLS and SPWB)?

(a) What is the effect of a four-week pickleball intervention on overall satisfaction with life between those who play recreationally versus intensity coached (SWLS)?

(b) What is the effect of a four-week pickleball intervention on overall psychological well-being between those who play recreationally versus intensity coached (SPWB)?

Chapter 2: Method

Participants

Participants were recruited to take part in the pickleball intervention delivered in three separate cohorts. Each cohort consisted of eight participants, for a total target sample size of 22 participants. Due to space constraints, a maximum of eight participants could complete the intervention at one time. Therefore, participants were divided into three sequential cohorts. The first cohort completed the four-week intervention, then the second cohort, followed by the third cohort. All three cohorts completed the same four-week intervention protocol and study procedures; however, the cohorts participated at different time points.

Within each cohort, participants were randomly assigned to one of two groups: a recreational pickleball group (n = 4) and an intensity-coached pickleball group (n = 4). A priori power analysis was conducted using G*Power, assuming a medium effect size (f = 0.35), an alpha level of 0.05, and a power of 0.95, which indicated a required total sample size of 24 participants. There was a total of 22 participants, as 2 participants dropped out before the first pickleball session. There were 10 participants in the recreational group and 12 in the intensity coached group.

Recruitment

After receiving ethical approval from the Lakehead University Research Ethics Board, participants were recruited through purposive and convenience sampling. Prospective male and female participants were included in this study if they:

(1) Were above the age of 50 years.

(2) Were new to the sport of pickleball or currently playing no more than one hour per week.

(3) Had no contraindications to exercise indicated on the Physical Activity Readiness Questionnaire (PAR-Q).

(4) Had no bone, joint, or soft tissue problem within the past 6 months that could be made worse by becoming more physically active.

(5) Have not had any previous heart conditions (e.g., aneurysm, angina, cardiac bypass).

(6) Not currently on beta-blockers.

Potential participants were recruited through posters displayed at the Moose Hall and Lakehead University Wolf Den, with prior permission obtained from each organization. The posters included a brief description of the study, the eligibility criteria for participation, and the researcher's contact information for individuals who are interested in participating. Interested individuals will be instructed to contact the researcher directly via phone or email to obtain further information, confirm eligibility, and schedule a testing session.

Instrumentation and Equipment

Polar® H10 Heart Rate Straps

The instrumentation used to measure HR was the Polar® H10 HR straps (see Figure 1) that connect to the Polar® Flow app. The strap used electrical electrocardiogram (ECG) sensing technology to measure cardiac activity. It features Bluetooth® and ANT+ connectivity, built-in memory for a training session, and water resistance up to 30 m (Polar®, 2025). The straps were secured around the participant's chest, immediately below the pectoral muscles, with the sensor positioned over the sternum.

Vermunicht and colleagues (2023) assessed the accuracy of 2 HR monitors (Polar® H10 chest strap and Fitbit Inspire 2 tracker) compared to Holter, the gold standard for ECG monitoring. They had 15 participants wear the Polar® H10 HR strap, Fitbit Inspire 2 tracker, and the Holter for 24 hours. Polar® H10 HR data showed a strong correlation (*r*=.93), a mean absolute error of 3.43 beats per minute (bpm) and a mean absolute percent error of 4.86%. The *r*-value indicates a very strong positive relationship, meaning the Polar® H10 readings closely follow the same pattern as the Holter HR measurements. The MAE represents the average difference between the Polar® H10 readings and the reference device's readings. On average, the Polar® H10 was off by about 3.43 bpm, which is a small and acceptable error. The MAPE expresses that same error as a percentage of the Holter HR. A 4.86% error means that the Polar® H10's HR estimates were, on average, less than 5% different from the gold-standard measurement, indicating excellent accuracy. Compared to gold standard Holter monitoring, Polar® H10 is very accurate at assessing HR over a 24 h time window (Vermunicht et al., 2023).

Figure 2

Polar® H10 Heart Rate Strap

Standard Chair

The study required a standard, hard chair for the 30 Second Sit to Stand Test, and the 8 Foot up and Go Test. The chair has a sturdy surface to provide stable support and reduce variability caused by cushioning or uneven surfaces (see Figure 3). It has a straight backrest to promote proper upright posture but no armrests, as these could interfere with functional movements during testing. The seat height is between 43 and 45 cm (Rikli & Jones, 1999).

Figure 3

Standard Chair

Dumbbell

Two YORK Rubber Hex Dumbbells were used to assess upper body muscular endurance during the 30 Second Arm Curl Test. The study requires two dumbbells, one weighing 2.5 kg and one weighing 3.6 kg, for females and males, respectively. If the participant was unable to lift the required weight for their sex, then they were allowed to lift a lower weight, and the researcher ensured they used the same weight for all testing sessions. However, all participants were able to use the standard weight for their sex. Rubber hex dumbbells were selected for their stability, as the hexagonal shape prevents rolling.

Figure 4

YORK Rubber Hex Dumbbells

Measuring Tape and Wheel

An Ultra Steal Tape Measure was used to record reach distances in inches for the Chair Sit and Reach Test and the Back Scratch Test. A standard measuring wheel, calibrated in meters, was used to measure the walking path for the 6MWT.

Figure 5

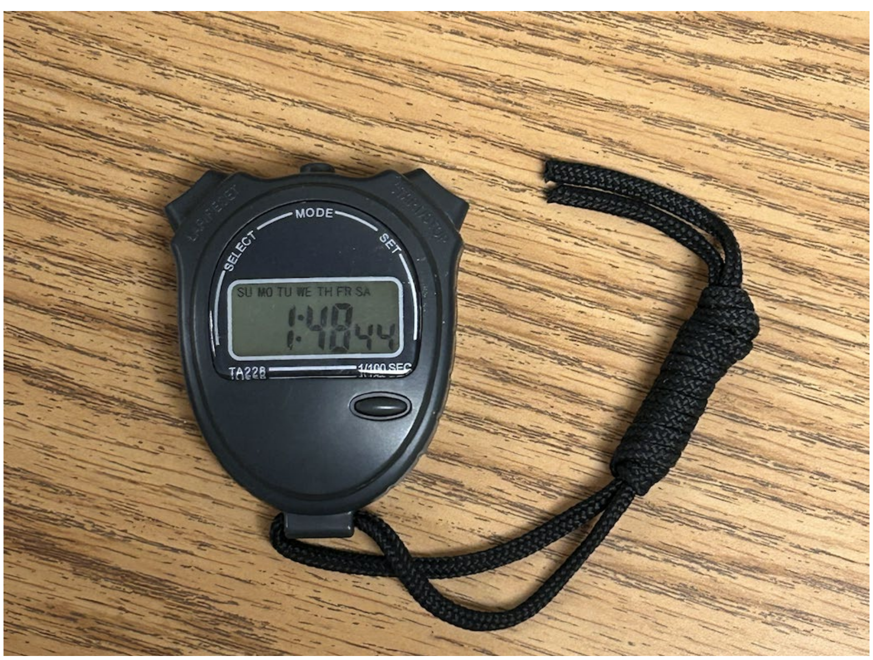
Ultra Steal Tape Measure

Stopwatch

To measure time for the 8 Foot Up and Go test and the 6MWT, the study required one standard, handheld stopwatch.

Figure 6

Stopwatch



Cones

One standard orange sport cone (approximately 12 inches in height) was used to mark the turning point for the 8 Foot Up and Go Test. Cones will also be placed every 10 m around the Lakehead University Hangar track for the 6MWT.

Figure 7

Standard Orange Cone

Pickleball Paddles

Eight Babolat XPLR Pickleball Paddles was required to ensure participants have consistent, standardized equipment during the intervention.

Figure 8

Babolat XPLR Pickleball Paddle

Pickleball Net

Two Selkirk Prime Portable Wheeled Pickleball Nets were needed for this study. Each net met standard pickleball dimensions, with a height of 36 inches at the sidelines, 34 inches at the center, and a width of 21 feet 9 inches (Pickleball Canada, 2025).

Figure 9

Selkirk Prime Portable Wheeled Pickleball Net

Pickleball Ball

Two Selkirk Pro S1 Pickleball Balls were required for the study. They are plastic perforated balls, meaning they are made from a lightweight, durable polymer and contain multiple evenly spaced holes throughout the surface appropriate for indoor play.

Figure 10

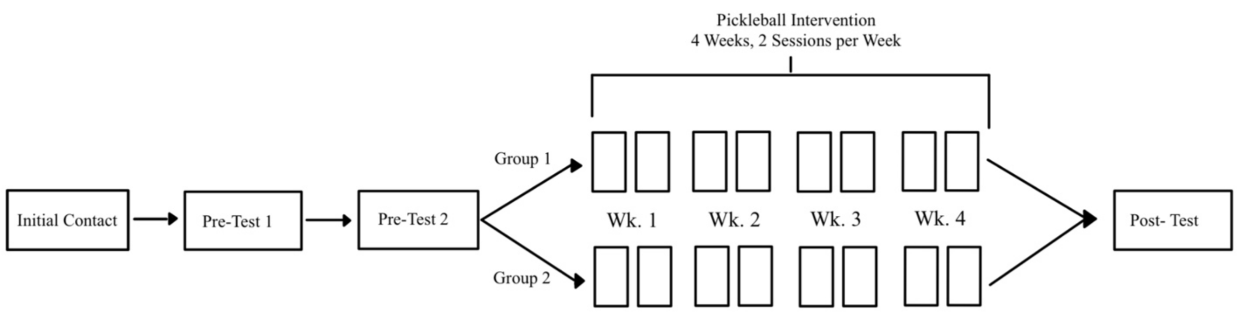
Selkirk Pro S1 Pickleball Ball

Procedures

Participants in this study were required to commit to a total of three laboratory testing sessions, two before and one after the pickleball intervention (see Figure 11). Each laboratory session lasted approximately 1.5 h. Participants also participated in a four-week pickleball intervention. The intervention consisted of a four-week pickleball program, with participants attending two 1-hour sessions per week (totalling 8 sessions).

Figure 11

Overview of Study Design



Note. Wk. = week

Fitness Test Sessions

Before each fitness testing session, the researcher prepared the designated testing room (SB-1028) to ensure all necessary equipment and materials were organized and ready for use. The researcher verified that all functional fitness testing equipment was available and in proper working order, including a stable chair, a 2.5 kg dumbbell for female participants, a 3.6 kg dumbbell for male participants, a cone, a measuring tape, and a stopwatch. The testing area was arranged to allow for safe movement and consistent test administration across participants. Additionally, all participant paperwork was prepared in advance. This included the information and consent form, the GAQ (see Appendix 1), the SPWB, the SWLS, and the Data Collection Sheet (Fitness Test session; see Appendix 5).

Each fitness test session lasted approximately 1 h and was conducted at approximately the same time of day for each participant to control potential effects of circadian rhythm on physical performance. Upon arrival at the Sanders Building, room 1028, participants were welcomed and greeted by the researcher. They were then provided with a detailed explanation of the study. Any questions that they had regarding the study and their participation were answered at this time. They then completed the informed consent form, followed by the GAQ, to ensure they met the eligibility criteria for safe participation in physical activity and were included in the study. The participants were then asked to complete the SWLS and the SPWB, two questionnaires designed to assess SWB. The researcher also collected personal information, including sex, age (years), height (cm), and body mass (kg).

The researcher then explained and demonstrated all testing protocols before beginning the assessments. The researcher then guided the participants through a standardized 10-minute warm-up consisting of light dynamic stretching (see Appendix 7).

After the warm-up was completed, the participant first performed the Senior Fitness Test, starting with the Chair Stand Test, where they were instructed to sit in a standard chair (approximately 43–45 cm seat height) with arms crossed over the chest, their feet flat on the ground, and their back flat against the back of the chair. The participants then stood up out of the chair and sat back down in a controlled manner as many times as possible within 30 s without using their arms. The last full stand with controlled return to sitting was counted. The researcher then recorded the total number of repetitions completed on the Data Collection Sheet.

Next, they performed the Arm Curl Test. The participant stood with their back straight, holding the weight in their hand, palm facing forward, with their arm in a vertical down position beside their body. They were instructed to brace their upper arm against their body so that only the lower arm was moving. With one arm at a time, they performed as many arm curls as possible within 30 seconds using a standardized dumbbell (2.5 kg for women, 3.6 kg for men). The researcher then recorded the number of completed curls on each side on the Data Collection Sheet.

Next, the participant performed the Chair Sit and Reach Test, where they sat at the edge of a chair (secured against a wall for safety) with their dominant foot flat on the floor and the other leg extended forward with the knee straight and ankle positioned at 90°. With the dominant hand placed on top of the other and fingers aligned, the participant was asked to reach forward toward their toes while exhaling. The researcher measured and recorded the distance (cm) between the fingertips and toes, with the distance between their fingers resulting in a negative score and overlap being a positive score. Results were recorded on the Data Collection Sheet.

Next, the participant was asked to perform the Back Scratch Test, where they would place their dominant hand behind their head and back over the shoulder, reaching downward, and the other hand behind their back, reaching upward. The goal was to touch or overlap the middle fingers of both hands. The researcher assisted in aligning the fingers and measured the distance (cm) between them, recording either the gap or the overlap on the Data Collection Sheet.

Next, the participant performed the 8 Foot Up and Go Test, where they started fully seated with feet flat on the floor and hands on knees. The participant was asked to stand up on the verbal command “Go,” walk (not run) as quickly and safely as possible around a cone placed 2.4 meters (8 feet) away and return to sit down. Timing began on the verbal command “Go” and stopped when the participant was fully seated again. The participant was asked to perform the test twice, with both times being recorded. The researcher recorded the total time in seconds on the Data Collection Sheet.

The participant then performed the 6MWT in the Lakehead University Hangar around the track. The track was clearly marked every 10 m with cones. Participants were instructed to walk as far as possible in six minutes at a brisk but safe pace without running or jogging. Participants were encouraged to maintain a steady pace and were informed that they may slow down or rest if needed. The researcher started a stopwatch at the beginning of the test and walked alongside the participant to monitor safety. At the end of the 6 minutes, the participant was instructed to stop, and the researcher measured the distance to the closest meter. The total number of meters walked was scored, and the researcher recorded the number on the Data Collection Sheet.

Participants completed the same testing session on three occasions: twice before the intervention and once following the intervention. The two pre-tests were completed within one week of starting the intervention, and the post-test was completed within one week of finishing the intervention. Each session included the functional fitness tests and the two well-being surveys. All testing sessions were conducted using the same format to ensure consistency of results.

Weekly Activity Tracking

Participants were asked to record any physical activity they engage in outside of the pickleball program. They were encouraged to maintain their usual routines and avoid adding any new forms of physical activity throughout the study period. The researcher explained that this requirement is important to ensure the results reflect the impact of the pickleball intervention itself, rather than changes in additional exercise habits. Each week, participants submitted a completed activity log (see Appendix 6) documenting their physical activity. If these logs indicated that a participant had substantially increased their activity level beyond what is typical for them, their data may have needed to be excluded, as it would no longer accurately represent the effects of the intervention.

Pickleball Sessions

Each session was supervised and conducted in the Lakehead University Wolf Den. Upon arrival at the first session, participants were given a brief orientation that included an overview of the rules of pickleball, an explanation of the structure of each session, and their playing partners, which were assigned randomly. Each session began with a standardized 10-minute warm-up, guided and supervised by the researcher, consisting of dynamic stretches and light aerobic movement. The main portion of the session involved 40 minutes of doubles pickleball. Following gameplay, participants completed a 10-minute cool-down guided and supervised by the researcher (see Appendix 9), consisting of static stretching to gradually lower their HR. Attendance was recorded at each session to monitor participants' adherence to the program. Because consistent participation was necessary to accurately assess the effects of the pickleball intervention, participants who missed more than three sessions would not have their data included in the final analysis. However, they were still asked to participate to keep playing pairing consistent. If a participant missed a session, an alternate player (such as a student volunteer) was on standby to fill their spot. This ensures that all games were played as doubles.

Participants were randomly assigned to one of two groups using an online random group generator. This process ensured that group assignments were conducted in an objective and unbiased manner. Both groups wore Polar® HR straps that connect to the Polar® Flow app on the researchers' iPad to track their HR. The researcher calculated the maximum heart rate for all participants using the formula : (208 x 0.7 - age).

The first group played pickleball at a self-directed, self-paced recreational intensity without any coaching. The purpose of this group was to assess whether recreational pickleball alone is sufficient to produce meaningful improvements in functional fitness and well-being under real-world conditions. The unstructured format reflected how older adults typically engage in the sport during informal, leisure play with friends.

Coaching Intensity Intervention

The second group was intensity-coached, with individualized coaching based on their HR. Prior to the intervention, the researcher calculated the participants' maximum heart rate using the formula: (208 x 0.7 - age). From this, their target HR zone (60-80% of HRmax) was identified to ensure they are exercising at a moderate-to-vigorous intensity (Tanaka et al., 2001). During each 40-minute game, every 10 minutes, the researcher checked the current HR of participants in group two in the Polar® Flow app. Based on these readings, the researcher recorded the current HR in the Data Collection Sheet (Pickleball Session; see Appendix 4) and provided feedback (pick up the pace, slow down the pace, or continue as you are) to adjust their playing pace as needed to maintain a moderate-to-vigorous intensity range. After each session, the researcher checked the participants' HR using the Polar® Flow app. Participants then disconnected their devices from the HR monitors and returned them to the researcher.

After the eight sessions were completed, the researcher scheduled the final laboratory session with each participant within one week of finishing the program. At the end of the final laboratory session, participants were thanked for their time and commitment. Participants were notified via email when the data were analyzed, and the results were ready to be released. At this time, participants stated if they would like a copy of their results. Results from this project were shared with participants in an accessible and meaningful way. Participants were provided with a summary report written in clear, plain language that outlines the main findings of the study.

Data Processing

Data from the functional fitness tests were collected and recorded manually by the researcher into the Data Collection Sheet during each testing session. For the 6MWT, the total distance (m) covered within six minutes was measured using a measuring wheel, and the distance was measured to the closest meter by cones and manually recorded. The number of repetitions completed within 30 seconds during the Chair Stand and Arm Curl tests was counted aloud by the researcher and manually recorded. For the 8 Foot Up-and-Go Test, the time to complete the course was measured with a stopwatch, and the time (s) was manually recorded. For the Sit and Reach Test and the Back Scratch Test, the researcher used a measuring tape to measure the distance (cm) between the fingertips and the toes and recorded the number manually. All data were transferred to Microsoft® Excel® after each testing session to organize and compile the data.

Self-report data from the SPWB and the SWLS were collected via pen-and-paper questionnaires. Each completed form was scored manually according to the respective scoring guidelines for each scale. Data were transferred to Microsoft® Excel® after each testing session.

The dependent variables are performance factors, including upper body strength (reps), lower body strength (reps), upper body flexibility (cm), lower body flexibility (cm), agility (s), endurance (m), and scores for psychological well-being. The two independent variables are coaching condition (coaching versus no coaching) and time (pre- and post-intervention).

Statistical Analysis

This study used a quasi-experimental, two-group pretest-posttest design. The average of pretest one and pretest two was used as the pretest to create a more stable baseline measure. Statistical analysis was conducted for this using IBM© SPSS 28. Each of the previously stated research questions was used to guide the statistical analysis, and descriptive statistics were conducted for the variables of interest.

A two-way mixed factorial ANOVA was conducted to address research questions 1 (a-f) and 2 (a,b), examining the interaction between group (coaching versus no coaching) and time (pre-test versus post-test) for each outcome measure. The outcomes include upper-body strength (30-Second Arm Curl Test), lower-body strength (30-Second Chair Sit to Stand Test), upper-body flexibility (Back Scratch Test), lower-body flexibility (Chair Sit and Reach Test), agility (8 Foot Up and-Go Test), aerobic fitness (6MWT), life satisfaction (SWLS), and psychological well-being (SPWB). For all analyses, the alpha level was set at $p < .05$.

If a statistical test revealed a statistically significant interaction effect between variables, post hoc testing was done to examine the simple main effects of each independent variable. To examine the simple main effects of group, a *t*-test for independent measures was used to examine differences between coaching versus no coaching at the pre- and post-tests, respectively. To examine the simple main effects of time, a *t*-test for dependent measures will be used to examine differences between pre- and post-intervention, for each group separately. If no statistically significant interaction is found, then the main effects of time, regardless of group, were analyzed.

Chapter 3: Results

The results of this study provide insight into the effect pickleball may have on the functional fitness and subjective well-being of older adults. Functional fitness was measured by testing upper-body strength (30-Second Arm Curl Test), lower-body strength (30-Second Chair Sit to Stand Test), upper-body flexibility (Back Scratch Test), lower-body flexibility (Chair Sit and Reach Test), agility (8 Foot Up and Go Test), and endurance (6MWT). Subjective well-being was assessed by measuring life satisfaction (SWLS) and psychological well-being (SPWB). Results are organized within each of the study's research questions.

Demographic Information

A total of 22 (8 male and 14 female) people participated in this study. Demographic information for all participants is presented in Table 1. Independent-samples t tests were conducted to compare baseline scores between the coached and no-coached groups. No significant differences were observed at baseline for any outcome measure, indicating that the groups were comparable before the intervention (see Table 2).

Table 1

Participant Demographic Information

Variable	Male (n=8)	Female (n=14)	Total 9 (n=22)
		Mean ± SD	
Age (yrs)	60.0 ± 4.2	60.4 ± 6.2	60.2 ± 5.5
Height (cm)	180.5 ± 4.0	162.7 ± 6.9	169.2 ± 10.5
Weight (kg)	89.5 ± 8.9	68.0 ± 11.6	75.8 ± 14.8

Note. SD = standard deviation, n = number, yrs = years, cm = centimetres, and kg = kilograms.

Table 2

Baseline Comparisons Between the Groups

Variable	Intensity Coached (Mean ± SD)	Recreational (Mean ± SD)	t(df)	p
Upper Body Strength Dominant (reps)	26.08 ± 5.72	26.30 ± 3.87	0.102(20)	.920
Upper Body Strength Non-Dominant (reps)	25.91± 6.08	26.90± 4.04	0.436(20)	.667
Lower Body Strength	20.66 ± 3.46	21.50 ± 5.79	0.417(20)	.681
Upper Body Flexibility Dominant (cm)	-6.37± 11.48	-5.96± 12.52	0.080(20)	.937
Upper Body Flexibility Non-Dominant (cm)	-14.31± 14.61	-9.81± 9.65	0.833(20)	.415
Lower Body Flexibility Right (cm)	1.92±16.97	0.87±10.63	-0.169(20)	.867
Lower Body Flexibility Left (cm)	2.38± 16.80	1.23± 10.86	-0.185(20)	.855
Agility (s)	4.22±0.26	4.38±0.58	0.836(20)	.413
Endurance (m)	706.70±73.93	669.60±74.87	-1.166(20)	.258
Satisfaction With Life	26.95±5.02	28.95±3,80	1.267(20)	.220
Psychological Well Being	233.00±23.09	239.50±16.14	0.749(20)	.463

Note. cm = centimeters, m = meters, reps = repetitions, and s = seconds.

Research Question 1 (a)

What is the effect of a four-week pickleball intervention on upper body strength between those who play recreationally versus intensity coached (30-second Arm Curl Test)?

Upper Body Strength: Dominant Arm. Boxplot inspection identified two mild outliers in the recreational group. However, no studentized residuals exceeded the commonly accepted threshold of ±3.0, indicating that no cases were considered statistically significant outliers. A Levene's Test was conducted to assess the equality of variances in the data between the groups. It was determined that there was no violation in the equality of variance between the groups for the 30 Second Arm Curl Test on the dominant arm pre ($F_{(1,20)}$=1.612, p=.219) or post ($F_{(1,20)}$=0.224, p=.626) intervention.

A two-way mixed factorial ANOVA was conducted to compare the interaction effect between time and group on dominant arm upper body strength. There was no statistically significant interaction effect between time and group on dominant arm upper body strength ($F_{(1,20)}$=0.046, p=.832, η^2=.002) with a small effect size. There was a statistically significant main effect of time on right arm upper body strength ($F_{(1,20)}$=28.842, p=.001, η^2=.591) with a large effect size. A Bonferroni correction was applied to account for multiple comparisons between the dominant and non-dominant hands, resulting in an adjusted significance level of $p<0.025$. This outcome represents a statistically significant increase in arm curls with the dominant arm from the pre-intervention, with an average of 26.18 reps (SD=4.32) to the post-intervention with an average of 28.27 reps (SD=4.50; see Figure 12). The main effect of group showed that there was not a statistically significant difference in dominant hand upper body strength between groups ($F_{(1,20)}$=0.004, p=.948, η^2=0.000) with a small effect size.

Figure 12

Descriptive Statistics for Dominant Arm Upper Body Strength

Note. * denotes statistical significance

Upper Body Strength: Non-Dominant Arm. Boxplot inspection identified one mild outlier in the recreational group. However, no studentized residuals exceeded the commonly accepted threshold of ±3.0, indicating that no cases were considered statistically significant outliers. A Levene's Test was conducted to assess the equality of variances in the data between the groups. It was determined that there was no violation in the equality of variance between the groups for the 30 Second Arm Curl Test on the non-dominant arm pre ($F_{(1,20)}$ =1.968, p=.176) or post ($F_{(1,20)}$ =0.003, p=.956) intervention.

A two-way mixed factorial ANOVA was conducted to compare the interaction effect between time and group on non-dominant arm upper body strength. There was no statistically significant interaction effect between time and group on non-dominant arm upper body strength ($F_{(1,20)}$ =0.268, p=.611, η^2=.013) with a small effect size. There was a statistically significant main effect of time on right arm upper body strength ($F_{(1,20)}$=25.534, p=.001, η^2=.561) with a large effect size. A Bonferroni correction was applied to account for multiple comparisons between the dominant and non-dominant hands, resulting in an adjusted significance level of $p<0.025$. This outcome represents a statistically significant increase in arm curls with the dominant arm from the pre-intervention, with an average of 26.36 reps (SD=5.15) to the post-intervention with an average of 28.50 reps (SD=4.71; see Figure 13). The main effect of group showed that there was not a statistically significant difference in dominant hand upper body strength between groups ($F_{(1,20)}$=0.131, p=.721, η^2=0.007) with a small effect size.

Figure 13

Descriptive Statistics for Non-Dominant Arm Upper Body Strength

Note. * denotes statistical significance

Research Question 1 (b)

What is the effect of a four-week pickleball intervention on lower body strength between those who play recreationally versus intensity coached (30-Second Chair Sit to Stand Test)?

Lower Body Strength. There were no outliers in the data, as assessed by inspection of a boxplot. Levene's Test was conducted to assess the equality of variances between groups. Levene's Test indicated that the assumption of homogeneity of variance was met at pre-test ($F_{(1,20)}$ =2.427, p=0.135), but was violated at post-test ($F_{(1,20)}$ =4.63, p=0.044). A two-way mixed factorial ANOVA was conducted to examine the interaction between time and group on lower-body strength. There was no statistically significant interaction effect between time and group on lower body strength ($F_{(1,20)}$ =.042, *p*=.840, η2 =0.002) with a small effect size. There was a statistically significant main effect of time on left arm upper body strength ($F_{(1,20)}$ =44.728, *p*=.001, η2 =0.691) with a large effect size. Descriptive statistics showed that participants completed an average of 21.04 reps (SD=4.56) at pre-intervention and 24.04 reps (SD=4.06) at post-intervention, representing an increase in the number of squats completed (see Figure 14).

Before examining the main effect of group, a Levene's test was conducted to assess the assumption of homogeneity of variances for the between-subjects factor (Group) regardless of time. Levene's test indicated that the assumption of homogeneity of variances was met, $F_{(1,20)}$ =4.208, *p*=0.054. The main effect of group showed that there was not a statistically significant difference in dominant hand lower body strength between groups ($F_{(1,20)}$ =0.163, *p*=.691, η=0.008) with a small effect size.

Figure 14

Descriptive Statistics for Lower Body Strength

Note. * denotes statistical significance

Research Question 1 (c)

What is the effect of a four-week pickleball intervention on upper body flexibility between those who play recreationally versus intensity coached (Back Scratch Test)?

Upper Body Flexibility: Dominant Hand. Boxplots identified one mild outlier and one extreme outlier. To determine whether these cases exerted undue influence on the analyses, studentized residuals were examined. No studentized residuals exceeded the commonly accepted threshold of ±3.0, indicating that no cases were considered statistically significant outliers. Therefore, all participants were retained for subsequent analyses. Levene's Test was conducted to assess the equality of variances between groups. It was determined that there was no violation in the equality of variance between the groups for the Back Scratch Test on the dominant arm pre ($F_{(1,20)}$ =0.096, p=.719) or post ($F_{(1,20)}$ =0.035, p=.854) intervention.

A two-way mixed factorial ANOVA was conducted to compare the interaction effect between time and group on right dominant upper body flexibility. There was no statistically significant interaction effect between time and group on dominant arm upper body flexibility ($F_{(1,20)}$ =2.126, p=.160, η2 =0.096) with a medium effect size. There was a statistically significant main effect of time on left arm upper body strength ($F_{(1,20)}$ =8.846, p=.007, η2=0.307) with a large effect size. A Bonferroni correction was applied to account for multiple comparisons between the dominant and non-dominant hands, resulting in an adjusted significance level of p<0.025. Descriptive statistics indicated that participants reached an average of -6.19 cm (SD=11.68) at pre-intervention and -4.38 cm (SD=10.39) at post-intervention, representing an improvement in the distance they reached (see Figure 15). Negative values represent the distance between the participants' fingertips, meaning they are less flexible, whereas positive values indicate the distance the fingertips overlap, meaning they are more flexible. The main effect of group showed that there was not a statistically significant difference in dominant hand upper body flexibility between groups ($F_{(1,20)}$ =0.78, p=.783, η=0.004) with a small effect size.

Figure 15

Descriptive Statistics for Dominant Arm Upper Body Flexibility

Note. * denotes statistical significance

Upper Body Flexibility: Non-Dominant Arm. There were no outliers in the data, as assessed by inspection of a boxplot. Levene's Test was conducted to assess the equality of variances between groups. Levene's Test indicated that the assumption of homogeneity of variance was met at pre-test ($F_{(1,20)}$ =1.813, p=0.193), and post-test ($F_{(1,20)}$ =2.128, p=.160).

A two-way mixed factorial ANOVA was conducted to compare the interaction effect between time and group on non-dominant arm upper body flexibility. There was no statistically significant interaction effect between time and group on left arm upper body flexibility ($F_{(1,20)}$ =0.703, p=.412, η2 =0.034) with a medium effect size. There was a statistically significant main effect of time on non-dominant arm upper body flexibility ($F_{(1,20)}$=6.829, p=.017, η2 =0.255) with a large effect size. A Bonferroni correction was applied to account for multiple comparisons between the dominant and non-dominant hands, resulting in an adjusted significance level of $p<0.025$. Descriptive statistics indicated that participants reached an average of -12.27 cm (SD=12.53) at pre-intervention and -11.17 cm (SD=12.25) at post-intervention, representing an improvement in the distance they reached (see Figure 16). Negative values represent the distance between the participants' fingertips, meaning they are less flexible, whereas positive values indicate the distance the fingertips overlap, meaning they are more flexible. The main effect of group showed that there was no statistically significant difference in non-dominant arm flexibility between intervention groups $F_{(1,20)}$ =0.840, p=.370, η2=0.40.

Figure 16

Descriptive Statistics for Non-Dominant Arm Upper Body Flexibility

Note. * denotes statistical significance

Research Question 1 (d)

What is the effect of a four-week pickleball intervention on lower body flexibility between those who play recreationally versus intensity coached (Chair Sit and Reach Test)?

Lower Body Flexibility: Right Leg. There were no outliers in the data, as assessed by inspection of a boxplot. Levene's Test was conducted to assess the equality of variances between groups. It was determined that there was no violation in the equality of variance between the groups for the Chair Sit and Reach Test on the right leg, pre ($F_{(1,20)}$ =2.621, p=.121) or post ($F_{(1,20)}$ =.312, p=.583) intervention.

A two-way mixed factorial ANOVA was conducted to compare the interaction effect between time and group on right leg lower body flexibility. There was no statistically significant interaction effect between time and group on right leg lower body flexibility ($F_{(1,20)}$ =1.811, p=.193, η2 =0.083) with a medium effect size. There was no statistically significant main effect of time on right leg lower body flexibility ($F_{(1,20)}$ =3.968, p=.060, η2 =0.166) with a small effect size. The main effect of group showed that there was no statistically significant difference in right leg flexibility between intervention groups $F_{(1,20)}$ =0.240, p=.630, η2=0.012 with a small effect size. Descriptive statistics indicated that participants reached an average of 1.44 cm (SD=14.12) at pre-intervention and 3.96 cm (SD=11.27) at post-intervention (see Figure 17). Negative values represent the distance between the participants' fingertips and toes, suggesting they are less flexible, whereas positive values indicate the distance the fingertips extend beyond the toes, suggesting they are more flexible.

Figure 17

Descriptive Statistics for Right Leg Lower Body Flexibility

Lower Body Flexibility: Left Leg. There were no outliers in the data, as assessed by inspection of a boxplot. Levene's Test was conducted to assess the equality of variances between groups. It was determined that there was no violation in the equality of variance between the groups for the Sit and Reach Test on the left leg, pre ($F_{(1,20)}$ =2.029, p=.170) or post ($F_{(1,20)}$ =.785, p=.386) intervention.

A two-way mixed factorial ANOVA was conducted to compare the interaction effect between time and group on left leg lower body flexibility. There was no statistically significant interaction effect between time and group on left leg lower body flexibility ($F_{(1,20)}$ =.720, p=.406, η2 =.035) with a small effect size. There was no statistically significant main effect of time on left leg lower body flexibility ($F_{(1,20)}$ =3.595, p=.072, η2 =.152) with a small effect size. Descriptive statistics indicated that participants reached an average of 1.85 cm (SD=14.09) at pre-intervention and 3.94 cm (SD=11.09) at post-intervention (see Figure 18). The main effect of group showed that there was no statistically significant difference in left leg flexibility between intervention groups $F_{(1,20)}$ =0.141, p=.712, η2=0.007 with a small effect size. Negative values represent the distance between the participants' fingertips and toes, suggesting they are less flexible, whereas positive values indicate the distance the fingertips extend beyond the toes, meaning they are more flexible.

Figure 18

Descriptive Statistics for Left Leg Lower Body Flexibility

Research Question 1 (e)

What is the effect of a four-week pickleball intervention on agility in older adults between those who play recreationally versus intensity coached (8-Foot Up and Go Test)?

Agility. Visual inspection of boxplots identified one mild outlier. Further examination of studentized residuals found that the outlier had a value of +3.25. Therefore, the data point was removed from the data set. Levene’s Test was conducted to assess the equality of variances between groups.

Levene's Test indicated that the assumption of homogeneity of variance was met at pretest ($F_{(1,19)}$ =0.602, p=.447) but was violated at post-test ($F_{(1,19)}$ 4.658, p=.044). A two-way mixed factorial ANOVA was conducted to compare the interaction effect between time and group on agility. There was no statistically significant interaction effect between time and group on agility ($F_{(1,19)}$ =2.648, p=0.120, $\eta 2$ =0.122) with a medium effect size. There was a statistically significant main effect of time on agility ($F_{(1,19)}$ =43.573, p=.001, $\eta 2$ =0.738) with a large effect size. Descriptive statistics show that participants completed the agility test at an average of 4.23 s (SD=0.31) at pre-intervention and 3.85 s (SD=0.29) at post-intervention, representing an improvement in time to complete the course (see Figure 19). The shorter completion time at post-intervention indicates that participants completed the agility course more quickly, demonstrating improved walking speed post-intervention. Before examining the main effect of group, a Levene's test was conducted to assess the assumption of homogeneity of variances for the between-subjects factor (Group) regardless of time. Levene's test indicated that the assumption of homogeneity of variances was met, $F_{(1,20)}$=0.82, p=.371. The main effect of group showed that there was no statistically significant difference in endurance between intervention groups $F_{(1,19)}$ =0.559, p=.464, $\eta 2$=0.029 with a small effect size

Figure 19

Descriptive Statistics for Agility

Note. * denotes statistical significance

Research Question 1 (f)

What is the effect of a four-week pickleball intervention on aerobic fitness in older adults between those who play recreationally versus intensity coached (6MWT)?

Endurance. Visual inspection of boxplots identified three mild outliers. Further examination of studentized residuals found that the outliers did not have a value of ±3. Therefore, the data points were not removed from the data set. Levene’s Test was conducted to assess the equality of variances between groups. Levene's test indicated that the assumption of homogeneity of variance was met at pre-test ($F_{(1,20)}$ =0.131, p=.721), and post-test ($F_{(1,20)}$ =0,104, p=.751).

A two-way mixed factorial ANOVA was conducted to compare the interaction effect between time and group on endurance. There was no statistically significant interaction effect between time and group on endurance ($F_{(1,20)}$ =.134, p=.718, $\eta2$ =.007) with a small effect size. There was a statistically significant main effect of time on endurance ($F_{(1,20)}$ =16.590, p=.001, $\eta2$ =.453) with a large effect size. Descriptive statistics indicated that participants walked an average of 689.84 m (SD=74.99) at pre-intervention and 712.50 m (SD=69.99) at post-intervention, representing an improvement in aerobic endurance, meaning they walked further in six minutes post-intervention (see Figure 20). The main effect of group showed that there was no statistically significant difference in endurance between intervention groups, $F_{(1,20)}$ 1,336, p=.261, $\eta2$=0.063 with a small effect size

Figure 20

Descriptive Statistics for Endurance

Note. * denotes statistical significance

Research Question 2 (a)

What is the effect of a four-week pickleball intervention on overall satisfaction with life between those who play recreationally versus intensity coached (SWLS)?

Satisfaction With Life. Visual inspection of boxplots identified one outlier; the outlier was removed from the data set. Levene's Test of equality of error variances was statistically significant, indicating that the assumption of homogeneity of variances was violated at pre-test ($F_{(1,19)}$ 8.46, p=.009), and at post-test ($F_{(1,19)}$ =9.600, p=.006).

A two-way mixed factorial ANOVA was conducted to compare the interaction effect between time and group on satisfaction with life. There was no statistically significant interaction effect between time and group on satisfaction with life ($F_{(1,19)}$ =2.714, p=.116, $\eta 2$ =0.125) with a medium effect size. There was no statistically significant main effect of time on satisfaction with life ($F_{(1,19)}$ =0.679, p=.420, $\eta 2$ =0.034) with a small effect size. Descriptive statistics showed that participants scored an average of 28.02 (SD=4.26) on the SWLS at pre-intervention and 28.66 (SD=4.42) at post-intervention (see Figure 21). This means that participants reported slightly higher levels of life satisfaction at post-intervention.

Before examining the main effect of group, a Levene's test was conducted to assess the assumption of homogeneity of variances for the between-subjects factor (Group) regardless of time. Levene's test indicated that the assumption of homogeneity of variances was violated, $F_{(1,19)}$=5.711, p=.027. Therefore, a Welch's ANOVA was conducted to account for the unequal variances. Welch's ANOVA indicated that there was no statistically significant difference in satisfaction with life between the groups, Welch's F(1,17.72)=1.06, p=.316.

Figure 21

Descriptive Statistics for Satisfaction with Life

Research Question 2 (b)

What is the effect of a four-week pickleball intervention on overall psychological well-being between those who play recreationally versus intensity coached (SPWB)?

Psychological Well-Being. There were no outliers in the data, as assessed by inspection of a boxplot. Levene's Test was conducted to assess the equality of variances between groups. Levene's Test indicated that the assumption of homogeneity of variance was met at pre-test ($F_{(1,20)}$ =0.780, p=.388), and at post-test ($F_{(1,20)}$ =0.013, p=0.910).

A two-way mixed ANOVA was conducted to compare the interaction effect between time and group on psychological well-being. There was no statistically significant interaction effect between time and group on psychological well-being ($F_{(1,20)}$ =0.038, p=.848, $\eta 2$ =0.002) with a small effect size. There was a statistically significant main effect of time on psychological well-being ($F_{(1,20)}$ =4.194, p=.054, $\eta 2$

=0.173) with a large effect size. Descriptive statistics indicated that participants scored an average of 235.95 (SD=24.28) on the SPWB at pre-intervention and 242.86 (SD=25.36) at post-intervention, representing an improvement in their score (see Figure 22). This means that participants reported higher levels of psychological well-being at post-intervention. The main effect of group showed that there was no statistically significant difference in psychological well-being between groups $F_{(1,20)}=0.390$, $p=0.539$, $\eta 2=0.019$ with a small effect size.

Figure 22

Descriptive Statistics for Psychological Well-Being

Note. * denotes statistical significance

Chapter 5: Discussion

The purpose of this study was to examine the effects of a four-week pickleball intervention on strength, flexibility, agility, endurance, and psychological well-being in older adults who play recreationally versus those who are intensity coached. Previous literature examining the effect of pickleball on functional fitness and well-being is relatively unexplored. Existing studies have primarily demonstrated that doubles pickleball provided a moderate-to-vigorous physical activity level in hot and humid conditions (Webber et al., 2023), improved cardiovascular health (Wray et al., 2021), increased physical activity levels compared to walking (Denning et al., 2022), and reduced feelings of loneliness (Casper and Jeon, 2019). However, much of this research has focused on participants who were already regular players, and only one study evaluated the effects of a structured pickleball intervention. The following section will discuss the results and implications of this study in greater detail.

Main Effects of Intervention

The intensity coaching intervention did not produce greater improvements than recreational pickleball participation for any of the physical or psychological outcome measures. Participants in the coaching group received individualized feedback throughout each session to increase or decrease their pace in order to maintain a moderate-to-vigorous physical activity intensity. However, heart rate data demonstrated that participants in both the intensity coached and recreational groups exercised within the moderate-to-vigorous intensity zone. Because both groups achieved an exercise intensity sufficient to promote physiological adaptations, the coaching intervention may not have provided an additional training stimulus beyond that experienced through recreational pickleball participation. These findings suggest that the health benefits associated with pickleball may be attributable to the intensity of participation rather than the presence of structured coaching. From a practical perspective, it may indicate that older adults can achieve meaningful improvements in physical function and psychological well-being through regular recreational pickleball participation without requiring a formal coaching program.

Research Question 1 (a)

What is the effect of a four-week pickleball intervention on upper body strength between those who play recreationally versus intensity coached (30-second Arm Curl Test)?

All participants showed a statistically significant increase in the number of arm curls post-intervention compared with pre-intervention; however, there was no difference between groups.

These findings are consistent with those of Zeng and colleagues (2026), who also reported significant improvements in upper-body strength using the same outcome measure following an eight-week pickleball intervention. Together, these findings suggest that regular participation in pickleball may improve upper-body muscular endurance in older adults. Upper-body strength is important for maintaining independence as we age, as it is necessary for activities of daily living such as carrying groceries, doing laundry, pushing open doors, and rising from a chair using the arms (Wang et al., 2020).

Another previous study assessed grip strength following a six-week pickleball intervention and reported no significant improvements (Wray et al., 2021). Although both measures assess upper-extremity function, grip strength primarily reflects maximal isometric force of the hand and forearm musculature (Carson, 2018), whereas the 30-Second Arm Curl Test measures dynamic muscular endurance of the upper extremities (Rikli & Jones, 1999). The improvement in arm curl performance observed in the present study may, therefore, indicate that regular pickleball participation is more effective at enhancing muscular endurance through repeated paddle strokes rather than isometric force.

Research Question 1 (b)

What is the effect of a four-week pickleball intervention on lower body strength between those who play recreationally versus intensity coached (30-Second Chair Sit to Stand Test)?

All participants showed an increase in the number of squats post-intervention compared with pre-intervention. These findings are consistent with those of Zeng and colleagues (2026), who also reported significant improvements in lower body strength and endurance using the 30 Second Sit to Stand Test following an eight-week pickleball intervention. Together, these findings suggest that regular participation in pickleball can improve lower-extremity strength in older adults.

These findings are also consistent with Wray and colleagues (2021), who examined jump height and lower body power output. They found that after a six-week pickleball intervention, lower body power output increased by 11% (Wray et al., 2021). Lower-body power and lower-body strength are distinct components of physical function. Lower-body strength refers to the maximal force that the lower extremity muscles can produce, whereas lower-body power reflects the ability to generate that force rapidly (Regterschot et al., 2021). However, they both contribute to functional performance of the lower body (Regterschot et al., 2021). Therefore, the improvements in lower-body muscular endurance observed in the present study are consistent with the findings of Wray and colleagues (2021), as both studies demonstrated enhanced lower-extremity function following participation in pickleball.

The improvements observed across these studies are likely attributable to the repeated squatting, lunging, rapid accelerations, decelerations, and changes in direction required during pickleball play. These movements place repeated demands on the lower-extremity musculature and provide a functional training stimulus that may improve strength and overall lower-limb performance. This is important for older adults because maintaining lower-body function is essential for the ability to perform activities of daily living such as rising from a chair, climbing stairs, and reducing fall risk (Wang et al., 2020).

Research Question 1 (c)

What is the effect of a four-week pickleball intervention on upper body flexibility between those who play recreationally versus intensity coached (Back Scratch Test)?

All participants showed an increase in the distance they could reach post-intervention compared with pre-intervention. These findings are consistent with those of Zeng and colleagues (2026) who also reported significant improvements in upper-body flexibility following an eight-week pickleball intervention. The authors suggested that the repetitive overhead serves, forehand and backhand strokes, and swinging motions performed during pickleball require movement through a large range of motion at the shoulder, which may contribute to improvements in upper-body flexibility. Similar mechanisms may explain the improvements observed in the present study.

Another possible explanation for this difference is that participants completed standardized warm-up and cool-down routines that included upper-body stretching exercises before and after each session. Because both the recreational and intensity-coached groups performed the same stretching protocol for the same duration throughout the intervention, the stretching component may have contributed to the observed improvements in upper-body flexibility and may also explain why no significant differences were found between the two groups. Consequently, it is difficult to determine whether the improvements in flexibility resulted from pickleball participation, the stretching protocol, or the combination of both.

Research Question 1 (d)

What is the effect of a four-week pickleball intervention on lower body flexibility between those who play recreationally versus intensity coached (Chair Sit and Reach Test)?

Results of this analysis revealed no statistically significant interaction effect between group and time on lower-body flexibility during completion of the Chair Sit and Reach Test. There was also no statistically significant main effect of time on lower-body flexibility for both the right and left leg when comparing before and after the intervention. Participants did not show a statistically significant increase in the distance they could reach post-intervention compared with pre-intervention.

These findings are consistent with a recent randomized controlled trial by Zeng and colleagues (2026) that also reported no significant changes in Chair Sit-and-Reach performance following an eight-week pickleball intervention, despite improvements in other components of functional fitness. This may suggest that participation in physical activity alone is not always sufficient to improve lower-body flexibility, particularly over a relatively short intervention period. While pickleball requires movements such as lunging, bending, and reaching for the ball, these movements may not provide a sufficient stretching stimulus to produce measurable improvements in hamstring and lower-back flexibility as assessed by the Chair Sit-and-Reach Test. Additionally, the standardized warm-up and cool-down stretching protocol may not have been of sufficient intensity or duration to elicit significant changes in flexibility.

Research Question 1 (e)

What is the effect of a four-week pickleball intervention on agility in older adults between those who play recreationally versus intensity coached (8-Foot Up and Go Test)?

All participants showed an increase in the speed at which they could complete the 6 Minute Walk Test course post-intervention compared with pre-intervention. There were no differences found between the groups.

Previous research examining the relationship between pickleball participation and agility is limited. Ahrndt and colleagues (2026) compared older adults who participated in pickleball with those participating in other Senior Games sports and found that pickleball players demonstrated marginally better agility scores; however, these differences were not statistically significant. The discrepancy between the findings may be explained by differences in study design and outcome measures. Whereas Ahrndt and colleagues conducted a cross-sectional comparison using the Four-Square Agility Test, the present study evaluated changes over time using the 8-Foot Up-and-Go Test following a structured pickleball intervention. Despite the lack of statistically significant findings reported by Ahrndt and colleagues, both studies suggest that pickleball has the potential to positively influence agility.

The improvements observed in the present study may be attributed to the frequent accelerations, decelerations, lateral movements, and rapid changes in direction required during pickleball play, which closely resemble the movement demands assessed by the 8-Foot Up-and-Go Test. Maintaining agility is important for older adults because it supports safe and efficient movement during everyday activities, such as changing direction while walking, avoiding obstacles, and recovering balance, thereby helping to maintain independence and reduce fall risk (Gómez-Campos et al., 2023).

Research Question 1 (f)

What is the effect of a four-week pickleball intervention on aerobic fitness in older adults between those who play recreationally versus intensity coached (6MWT)?

All participants showed a statistically significant increase in the distance they could walk in six minutes post-intervention compared with pre-intervention. There were no differences found between the groups.

The significant improvement in the 6-Minute Walk Test observed in the present study is supported by previous research demonstrating improvements in functional mobility following pickleball participation. For example, Ahrndt and colleagues (2026) reported that older adults who participated in pickleball demonstrated significantly faster gait speeds than those in other Senior Games sports. Although fast gait speed and the 6-Minute Walk Test assess different aspects of mobility, both outcomes reflect improvements in walking performance and functional mobility among older adults.

These findings are also supported by previous research demonstrating that pickleball elicits exercise intensities sufficient to promote cardiovascular adaptations. Casper et al. (2023) reported that participants spent an average of 42 minutes within the recommended cardiovascular training zone (70–85% of maximum heart rate) while playing pickleball for an hour, indicating that the sport provides an adequate aerobic stimulus. Together, these findings suggest that regular participation in pickleball may improve cardiorespiratory endurance in older adults by providing sustained moderate-to-vigorous physical activity. The improvement observed in the present study may, therefore, reflect physiological adaptations resulting from repeated participation in cardiovascular exercise over the course of the intervention.

Cardiorespiratory endurance is important for older adults because it enables sustained participation in activities of daily living, such as walking, shopping, and completing household tasks, thereby supporting functional independence (Tornero-Quinones et al., 2020). Maintaining cardiorespiratory endurance is also important for cardiovascular health, as higher levels of aerobic fitness are associated with a reduced risk of cardiovascular disease, chronic illness, and premature mortality in older adults (O'Donnell et al., 2010).

Research Question 2 (a)

What is the effect of a four-week pickleball intervention on overall satisfaction with life between those who play recreationally versus intensity coached (SWLS)?

Results of this analysis revealed no statistically significant interaction effect between group and time on satisfaction with life during completion of the SWLS. There was also no statistically significant main effect of time on satisfaction with life when comparing before and after the intervention. Participants did not show a statistically significant increase in their score post-intervention compared with pre-intervention.

These findings differ from those of Hoe and colleagues (2018), who reported that older adults who identified pickleball as a serious leisure activity demonstrated greater psychological well-being, as measured using the SWLS. However, an important distinction between the two studies is that Hoe and colleagues examined individuals who had already developed a strong commitment to pickleball as a meaningful leisure activity. Serious leisure is characterized by sustained participation, personal commitment, skill development, and the formation of an identity around the activity (Hoe et al., 2018). In contrast, participants in the present study were novice pickleball players who participated in the sport for only four weeks. As a result, they may not have had sufficient time to develop the personal investment and social connections associated with serious leisure that may contribute to greater life satisfaction. Therefore, the relatively short duration of the intervention and participants' limited experience with the sport may help explain why no significant improvements in satisfaction with life were observed.

The absence of a significant improvement in satisfaction with life may also be attributable to a ceiling effect. Many participants reported relatively high satisfaction with life at baseline, with scores approaching the maximum possible score of 35 on the Satisfaction with Life Scale, leaving limited opportunity for measurable improvement following the intervention.

Research Question 2 (b)

What is the effect of a four-week pickleball intervention on overall psychological well-being between those who play recreationally versus intensity coached (SPWB)?

Results of this analysis revealed no statistically significant interaction effect between group and time on psychological well-being during completion of the SPWB. There was, however, a statistically significant main effect of time on psychological well-being when comparing before and after the intervention. All participants showed a statistically significant increase in their score post-intervention compared with pre-intervention.

Although intervention studies examining the effects of pickleball on psychological well-being are limited, previous cross-sectional research has reported positive associations between participation in pickleball and psychological functioning. Ryu and colleagues (2019) found that greater authenticity while playing pickleball was associated with lower perceived stress and greater happiness among older adult pickleball players. Although the cross-sectional design does not establish a causal relationship and psychological functioning was measured differently than in the present study, these findings suggest that the psychological experiences associated with pickleball participation may contribute to positive mental health outcomes. It is possible that participating in an enjoyable and socially engaging activity promoted feelings of autonomy and social connection, which may have contributed to the improvements in psychological well-being observed in the present study.

This finding is important because psychological well-being is associated with healthy aging, greater resilience, and improved quality of life in older adults (Bragina & Voelcker-Rehage, 2018). Higher levels of psychological well-being have also been linked to greater functional independence, stronger social relationships, and a reduced risk of depression and anxiety (Ryff, 1989).

Limitations

One limitation of the present study was the relatively small sample size. An a priori power analysis conducted using G*Power indicated that a minimum sample of 24 participants was required to achieve adequate statistical power; however, only 22 participants completed the study. Although sufficient participants were initially recruited, two participants withdrew at the beginning of the study before completing any pickleball session and, therefore, their data could not be included in the analyses. Consequently, the study was slightly underpowered, which may have reduced the ability to detect statistically significant effects. In addition, the groups were not evenly distributed, with 10 participants in the recreational group and 12 participants in the intensity-coached group. Although this imbalance was small, unequal group sizes can further reduce statistical power and may have limited the precision of between-group comparisons.

Another limitation of the present study was the modification of the pickleball court dimensions. To accommodate the size of the gymnasium and ensure participant safety, the length of the playing court was reduced by approximately one foot on each side to provide additional clearance between the court boundaries and the surrounding walls. Although this modification was necessary to minimize the risk of participants backing into the walls while playing, it may have altered the movement demands of the game compared with regulation-sized pickleball courts. Specifically, the smaller playing area may have reduced the distance participants were required to cover during rallies, potentially influencing the intensity of play and limiting the generalizability of the findings to standard pickleball settings.

Another limitation of the present study was that participants required a substantial portion of the first intervention session to become familiar with playing pickleball. Although the rules and basic gameplay were reviewed verbally with participants before the intervention began, many participants had little or no prior experience with the sport and required hands-on practice before they were able to play independently. As a result, much of the first session was devoted to skill development and learning the flow of the game rather than actual gameplay. Because the intervention lasted only four weeks, this reduced the amount of time participants spent engaged in the intended exercise, which may have limited the magnitude of the observed training adaptations.

Another limitation of the present study relates to the ecological validity of the recreational group. This group was designed to replicate the pace and intensity of older adults playing pickleball recreationally with friends. However, because most participants did not know one another before the study, the social environment may not have reflected typical recreational play. Participants may have been less comfortable with one another and, consequently, may have played with greater effort or competitiveness than they would have with familiar playing partners. As a result, the intensity of the recreational condition may have been higher than intended, potentially reducing the distinction between the recreational and intensity-coached groups. This may have contributed to the lack of significant differences observed between groups.

Delimitations

One delimitation of the present study was the selection of a four-week intervention period. This duration was intentionally chosen to maximize participant recruitment and retention while remaining feasible for older adults to complete. Although longer interventions may produce greater physiological adaptations, the four-week timeframe allowed the study to be conducted within practical recruitment and scheduling constraints. Consequently, the present study was designed to evaluate the short-term effects of pickleball participation rather than the effects of a longer-term training program.

Another delimitation of the present study was the inclusion of participants aged 50 years and older. Although older adulthood is commonly defined as beginning at 65 years of age, the minimum age of 50 years was intentionally selected to increase the pool of eligible participants and support successful recruitment. This decision also allowed the study to include middle-aged and older adults who may be beginning to experience age-related changes in physical function and could benefit from participating in physical activity interventions such as pickleball. Consequently, the findings apply to adults aged 50 years and older and should not be generalized exclusively to adults aged 65 years and older.

Future Directions

Future research should examine the effects of a longer pickleball intervention, such as eight weeks or longer, to determine whether greater improvements in functional fitness and psychological well-being can be achieved over time. A longer intervention would provide participants with more opportunities to engage in consistent gameplay after becoming familiar with the sport and may allow sufficient time for larger physiological and psychological adaptations to occur. Extending the intervention duration may also increase the likelihood of detecting differences between intensity-coached and recreational play, should such differences exist.

Future research should evaluate recreational pickleball participation in a more realistic setting to better reflect how older adults typically engage in the sport. For example, researchers could assess participants while they play with their regular playing partners or friends on outdoor community courts rather than in a structured research environment. This approach may provide a more accurate representation of the intensity, social interactions, and overall experience of recreational pickleball, therefore, improving the ecological validity of the findings and allowing for a more meaningful comparison with structured, coached interventions.

Chapter 6: Conclusion

The purpose of the present study was to examine the effects of a four-week pickleball intervention on functional fitness and psychological well-being in older adults by comparing an intensity-coached group with a recreational group. The findings indicated that there were no significant differences between the two groups, suggesting that participating in pickleball recreationally provides similar benefits to participating in a structured, intensity-coached program over a four-week period. Significant improvements were observed in upper-body strength, lower-body strength, cardiorespiratory endurance, agility, upper-body flexibility, and psychological well-being following the intervention. In contrast, no significant changes were found in lower-body flexibility or satisfaction with life. These findings suggest that regular participation in pickleball, regardless of coaching intensity, may be an effective strategy for improving several components of functional fitness and psychological well-being in older adults. From a theoretical perspective, these results contribute to the limited literature examining pickleball as a physical activity intervention for older adults and provide further evidence that regular participation may support multiple components of functional fitness and psychological well-being. The absence of an intervention effect suggests that structured intensity coaching may not be necessary to produce these benefits when recreational play naturally elicits moderate-to-vigorous physical activity intensities. This finding suggests that the physical demands of pickleball itself may be sufficient to promote meaningful adaptations among older adults. From a practical perspective, these findings support recreational pickleball as an accessible approach for promoting physical activity among older adults without requiring continuous intensity monitoring or specialized coaching. This may make pickleball easier and less costly to implement within community and recreation settings, where older adults can participate socially and recreationally while still engaging at an intensity associated with health benefits.

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Appendix 1

Get Active Questionnaire

CSEP | SCPE
THE GOLD STANDARD IN EXERCISE SCIENCE AND PERSONAL TRAINING

Get Active Questionnaire

CANADIAN SOCIETY FOR EXERCISE PHYSIOLOGY –
PHYSICAL ACTIVITY TRAINING FOR HEALTH (CSEP-PATH®)

Physical activity improves your physical and mental health. Even small amounts of physical activity are good, and more is better.

For almost everyone, the benefits of physical activity far outweigh any risks. For some individuals, specific advice from a Qualified Exercise Professional (QEP – has post-secondary education in exercise sciences and an advanced certification in the area – see csep.ca/certifications) or health care provider is advisable. **This questionnaire is intended for all ages – to help move you along the path to becoming more physically active.**

☐ I am completing this questionnaire for myself.

☐ I am completing this questionnaire for my child/dependent as parent/guardian.

PREPARE TO BECOME MORE ACTIVE

The following questions will help to ensure that you have a safe physical activity experience. Please answer **YES** or **NO** to each question before you become more physically active. If you are unsure about any question, answer **YES**.

YES	NO	
		1 Have you experienced **ANY** of the following (A to F) **within the past six months**?
○	○	**A** A diagnosis of/treatment for heart disease or stroke, or pain/discomfort/pressure in your chest during activities of daily living or during physical activity?
○	○	**B** A diagnosis of/treatment for high blood pressure (BP), or a resting BP of 160/90 mmHg or higher?
○	○	**C** Dizziness or lightheadedness during physical activity?
○	○	**D** Shortness of breath at rest?
○	○	**E** Loss of consciousness/fainting for any reason?
○	○	**F** Concussion?
○	○	**2** Do you currently have pain or swelling in any part of your body (such as from an injury, acute flare-up of arthritis, or back pain) that affects your ability to be physically active?
○	○	**3** Has a health care provider told you that you should avoid or modify certain types of physical activity?
○	○	**4** Do you have any other medical or physical condition (such as diabetes, cancer, osteoporosis, asthma, spinal cord injury) that may affect your ability to be physically active?

NO to all questions: go to Page 2 – ASSESS YOUR CURRENT PHYSICAL ACTIVITY

YES to any question: go to Reference Document – ADVICE ON WHAT TO DO IF YOU HAVE A YES RESPONSE

CSEP | SCPE
THE GOLD STANDARD IN EXERCISE SCIENCE AND PERSONAL TRAINING

Get Active Questionnaire

ASSESS YOUR CURRENT PHYSICAL ACTIVITY

Answer the following questions to assess how active you are now.

1 During a typical week, on how many days do you do moderate- to vigorous-intensity aerobic physical activity (such as brisk walking, cycling or jogging)? ____ DAYS/WEEK

2 On days that you do at least moderate-intensity aerobic physical activity (e.g., brisk walking), for how many minutes do you do this activity? ____ MINUTES/DAY

For adults, please multiply your average number of days/week by the average number of minutes/day: ____ MINUTES/WEEK

Canadian 24-Hour Movement Guidelines recommend that adults accumulate at least 150 minutes of moderate- to vigorous-intensity physical activity per week. For children and youth, at least 60 minutes daily is recommended. Strengthening muscles and bones at least two times per week for adults, and three times per week for children and youth, is also recommended (see csep.ca/guidelines).

GENERAL ADVICE FOR BECOMING MORE ACTIVE

Increase your physical activity gradually so that you have a positive experience. Build physical activities that you enjoy into your day (e.g., take a walk with a friend, ride your bike to school or work) and reduce your sedentary behaviour (e.g., prolonged sitting).

If you want to do **vigorous-intensity physical activity** (i.e., physical activity at an intensity that makes it hard to carry on a conversation), and you do not meet minimum physical activity recommendations noted above, consult a Qualified Exercise Professional (QEP) beforehand. This can help ensure that your physical activity is safe and suitable for your circumstances.

Physical activity is also an important part of a healthy pregnancy.

Delay becoming more active if you are not feeling well because of a temporary illness.

DECLARATION

To the best of my knowledge, all of the information I have supplied on this questionnaire is correct.
If my health changes, I will complete this questionnaire again.

I answered NO to all questions on Page 1

Sign and date the Declaration below

I answered YES to any question on Page 1

Check the box below that applies to you:

- ☐ I have consulted a health care provider or Qualified Exercise Professional (QEP) who has recommended that I become more physically active.
- ☐ I am comfortable with becoming more physically active on my own without consulting a health care provider or QEP.

Name (+ Name of Parent/Guardian if applicable) [Please print] | Signature (or Signature of Parent/Guardian if applicable) | Date of Birth

Date | Email (optional) | Telephone (optional)

With planning and support you can enjoy the benefits of becoming more physically active. A QEP can help.

☐ Check this box if you would like to consult a QEP about becoming more physically active.
(This completed questionnaire will help the QEP get to know you and understand your needs.)

Appendix 2

Scales of Psychological Well-Being

Psychological Wellbeing (42 items)

This survey accompanies a measure in the SPARQTools.org Measuring Mobility toolkit, which provides practitioners curated instruments for assessing mobility from poverty and tools for selecting the most appropriate measures for their programs.

Age: Adult
Duration: 6-8 minutes
Reading Level: 6th to 8th grade
Number of items: 42
Answer Format: 1 = strongly agree; 2 = somewhat agree; 3 = a little agree; 4 = neither agree or disagree; 5 = a little disagree; 6 = somewhat disagree; 7 = strongly disagree.

Scoring:
The Autonomy subscale items are Q1, Q13, Q24, Q35, Q41, Q10, and Q21.The Environmental Mastery subscale items are Q3, Q15, Q26, Q36, Q42, Q12, and Q23. The Personal Growth subscale items are Q5, Q17, Q28, Q37, Q2, Q14, and Q25. The Positive Relations with Others subscale items are Q7, Q18, Q30, Q38, Q4, Q16, and Q27. The Purpose in Life subscale items are Q9, Q20, Q32, Q39, Q6, Q29, and Q33. The Self-Acceptance subscale items are Q11, Q22, Q34, Q40, Q8, Q19, and Q31.

Q1, Q2, Q3, Q4, Q6, Q7, Q11, Q13, Q17, Q20, Q21, Q22, Q23, Q27, Q29, Q31, Q35, Q36, Q37, Q38, and Q40 should be reverse-scored. Reverse-scored items are worded in the opposite direction of what the scale is measuring. The formula for reverse-scoring an item is:

((Number of scale points) + 1) - (Respondent's answer)

For example, Q7 is a 7-point scale. If a respondent answered *3* on Q7, you would re-code their answer as: (7 + 1) - 3 = 5.

In other words, you would enter a *5* for this respondents' answer to Q7.

To calculate subscale scores for each participant, sum respondents' answers to each subscale's items.

Sources:
Ryff, C., Almeida, D. M., Ayanian, J. S., Carr, D. S., Cleary, P. D., Coe, C., … Williams, D. (2010). *National Survey of Midlife Development in the United States (MIDUS II), 2004-2006: Documentation of psychosocial constructs and composite variables in*

Appendix 3

Satisfaction with Life Scale

NovoPsych

Satisfaction with Life Scale (SWLS)

Instructions:

Below are five statements that you may agree or disagree with. Indicate your agreement with each item by tapping the appropriate box, from strongly agree, to strongly disagree. Please be open and honest in your responding.

		Strongly agree	Agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Disagree	Strongly disagree
1	In most ways my life is close to my ideal.	**7**	**6**	**5**	**4**	**3**	**2**	**1**
2	The conditions of my life are excellent.	**7**	**6**	**5**	**4**	**3**	**2**	**1**
3	I am satisfied with my life.	**7**	**6**	**5**	**4**	**3**	**2**	**1**
4	So far I have gotten the important things I want in life.	**7**	**6**	**5**	**4**	**3**	**2**	**1**
5	If I could live my life over, I would change almost nothing.	**7**	**6**	**5**	**4**	**3**	**2**	**1**

Developer Reference:

Diener, E., Emmons, R.A., Larsen, R.J., & Griffin, S. (1985). Development of the Satisfaction with Life Scale. Journal of Personality Assessment, 49(1), 71–75.

Administer Now

Appendix 4

Data Collection Sheet 1 (Pickleball Sessions)

Date: ______________________ **Notes:** ______________________

Group: ______________________

Session: ______________________

Heart Rate:

Interval:	Time:	P1	P2	P3	P4	P5	P6	P7	P8
Pre Game									
10 min									
20 min									
30 min									
40 min									

Appendix 5

Data Collection Sheet 2 (Fitness Tests)

Date: ____________________ Particpant #: ____________________

Session: Pre1 Pre2 Post

Age (yrs):	Sex:	Height (cm):	Weight (kg):

Test:	Sit to Stand	Arm Curl	Sit and Reach	Back Scratch	Up and Go	6 Min Walk
Score:						

Notes: ____________________

Appendix 6

Weekly Activity Log

Weekly Activity Log

Start Date:

Name:

Day	**Physical Activity**
Monday	
Tuesday	
Wednesday	
Thursday	
Friday	
Saturday	
Sunday	

Appendix 7

Warm Up Sheet

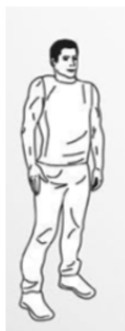
Pickleball Warm Up

10 Repetitions Each

(1) Neck Tilts
While looking forward, tilt your head towards one shoulder then back to neutral and towards the other shoulder.

(2) Neck Rotations
While keeping your head horizontal turn your head towards the left then towards the right.

(3) Shoulder Shrug
Keeping your arms in a neutral positions shrug shoulders up towards ears and then bring down back to relaxed position.



(4) Arm Circles
Raise your arms straight out to the side, making small, controlled circles, rotate arms forward 10 times and backwards 10 times.

(5) Wrist Rotations
Position your hand into a loose fist, rotate wrist one direction 10 times and the other direction 10 times.

(6) Single Hip Rotations
While holding onto the wall, rotate one leg up, outwards, and back down 10 times. Then reverse the action 10 times. Switch between both legs.

(7) Ankle Rotations
While holding onto the wall, pick one foot up a few cm off the ground. Move the foot in small circles 10 times one way and 10 times the other directions. Complete on both feet.

(8) March on the Spot
March on the spot by raising one knee then raising your other knee consecutively. Continue for 90 seconds.

Appendix 8

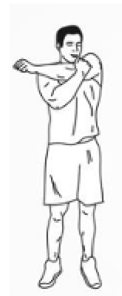
Cool Down Sheet

Pickleball Cool Down

Hold 30 Seconds Each

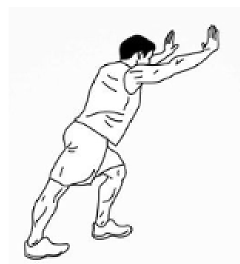
(1) Triceps Stretch
Raise one arm overhead and bend your elbow so that the hand reaches down the back. Use the opposite hand to gently press on the bent elbow. Hold, then repeat on the other side.

(2) Shoulder Stretch
Bring one arm across your chest and hold it with your opposite arm, gently pulling it closer. Keep your back straight and avoid twisting your body. Hold, then repeat on the other side.



(3) Side Stretch
Stand with feet shoulder-width apart and place one hand on your hip. Reach the other arm overhead and gently lean to the side. Hold, then repeat on the other side.

(4) Calf Stretch
Stand facing a wall with your hands pressed against it. Step one leg back, keeping the heel on the ground and the leg straight. Gently lean forward into the wall until you feel a stretch in the calf of the back leg. Hold, then repeat on the other side.

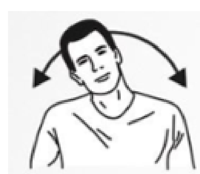


(5) Quad Stretch
Stand tall and hold onto a wall for balance. Bend one knee and bring your heel toward your glutes, holding your ankle with your hand. Keep your knees close together and gently press your hips forward until you feel a stretch in the front of your thigh.

(6) Glute Stretch
Stand tall and hold onto a wall for balance. Lift one knee toward your chest and gently hug it with one or both hands. Hold, then repeat on the other side.

(7) Hamstring Stretch
Stand with your feet hip-width apart and slowly bend forward at the hips, letting your arms reach toward the floor. Keep your knees slightly bent to avoid strain.

(8) Neck Stretch
Slowly tilt your head to one side, bringing your ear toward your shoulder without raising the shoulder. Hold briefly, then repeat on the other side.



Safety Note: Use a wall or chair for balance when needed, breathe deeply and avoid bouncing.

Appendix 9

Functional Fitness Tests

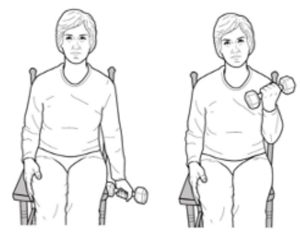
Functional Fitness Tests

(1) 30-Second Chair Sit-to-Stand Test

Participants sit in a standard chair (approximately 43–45 cm seat height) with arms crossed over the chest and perform as many full stands as possible within 30 seconds. The tester counts the total number of correct stands, with only full extensions and controlled returns to the seated position being counted.

(2) 30 Second Arm Curl Test (upper body muscle strength and endurance)

The participants will sit or stand with their back straight. They will complete as many full bicep curls as possible in 30 seconds. The participants will use a 5-lb (women) or 8-lb (men) weight. The total number of full curls in 30 seconds is the score.



(3) Back Scratch Test (shoulder flexibility)

The participant will sit or stand with their back straight. One hand will reach over the shoulder with the palm facing down, the second hand reached down around the back with the palm facing out. The distance between the tips of the middle fingers is measured in cm. If the fingertips touch, then the score is zero. If they do not touch, measure the distance between the fingertips (a negative score), if they overlap, measure by how much (a positive score).

(4) Chair Sit and each Test (lower body flexibility)

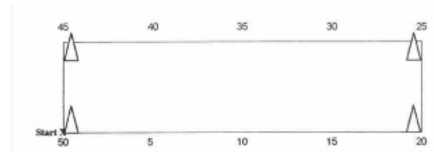
The participants sit on the edge of a chair with one leg straight in front of them, with their heel resting on the ground. The objective is to reach with straight arms as close to or past the toes. If the fingertips touch the toes, then the score is zero. If they do not touch, measure the distance between the fingers and the toes (a negative score), if they overlap, measure by how much (a positive score).

(5) 8 Foot Up and Go Test (speed, agility and, dynamic balance)

The test involves the participants to start seated in a chair with their feet flat on the ground. On the command they must stand up out of a chair, walk 8 feet around a cone, and return to the chair in a seated position as quickly as possible (without running). The time measured in seconds is the score

(6) 6 Minute Walk Test (aerobic endurance)

The test involves the participants to walk as quickly as possible for 6 minutes along a 50-yard rectangular course. The distance measured to the closet yard is the score. With longer distances equaling better aerobic endurance.



Appendix 10

Research Ethics Board Approval

Thunder Bay Regional Health Sciences Centre | Thunder Bay Regional Health Research Institute

Research Ethics & Authorization Office
Room 2167 – Level 2
980 Oliver Road
Thunder Bay, ON P7B 6V4
(807) 684-6422
TBRHSC.REO@tbh.net

December 12, 2025

Dr. Paolo Sanzo
Lakehead University

File No: 100346
Project Title: The Effects of Pickleball on the Fitness and Well-Being of Adults
Approval Date: December 11, 2025
Expiry Date: December 11, 2026

Dear Dr. Paolo Sanzo,

Thank you for your submission to the Thunder Bay Regional Health Sciences Centre Research Ethics Board (TBRHSC REB). The above noted application has been reviewed and approved through the delegated review process for the TBRHSC REB. This REB approval is granted until the expiry date noted above. The delegated approval for this study will be reported to the full REB at their next meeting. TBRHSC REB approval is granted based on the following documentation:

- Project Protocol dated 21-Nov-2025
- Participant Information Sheet and Consent dated 05-Nov-2025
- Recruitment Poster v2 dated 04-Dec-2025
- Function Fitness Tests
- Pickleball Warm Up
- Pickleball Cool Down
- Weekly Activity Log
- PB Activity Log
- PB Data Collection Sheet
- FT Data Collection Sheet
- Satisfaction With Life Scale
- Psychological Well Being
- Get Active Questionnaire

Continuing ethics review is the responsibility of the Principal Investigator. During the course of this research, all requests for modifications, re-approvals, and serious adverse event reports are submitted via the Research Portal. To continue your proposed research beyond December 11, 2026, you must submit an Annual Re-approval Form within the 30 days prior to your expiry date.

Upon completion of the project, you are required to submit a Research Completion Report.

Thunder Bay Regional Health Sciences Centre | Thunder Bay Regional Health Research Institute

Research Ethics & Authorization Office
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TBRHSC.REO@tbh.net

The ROMEO Research Portal is available at: https://tbrhsc-tbrhri.researchservicesoffice.com/Romeo.Researcher.Admin

Sincerely,

Dr. Andrea Raynak
Chair, TBRHSC REB

The TBRHSC Research Ethics Board operates in compliance with and is constituted in accordance with the requirements of:

- TCPS 2 - 2022 Tri-Council Policy Statement: Ethical conduct for Research Involving Humans,
- ICH Good Clinical Practice: Consolidated Guideline (ICH E6)
- Part C division 5 of the *Food and Drug Regulations* of Health Canada
- The provisions of the Personal Health Information Protection Act, 2004 and its applicable regulations
- TBRHSC REB is registered with the US department of Health and Human services under IRB registration #00004396