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Physical fitness characteristics of amateur badminton players: a comparative analysis of dynamic balance, agility, and ankle strength

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Abstract

Background and Study Aim Badminton is a high-intensity, multidirectional sport that requires optimal dynamic balance, agility, and lower-limb strength to support performance and reduce health risk. Amateur players often participate regularly in training and recreational matches that involve repeated directional changes, rapid movements, and substantial loading of the lower limbs. Such activity patterns make dynamic balance, agility, and ankle strength relevant functional characteristics in badminton participation. This study compared key physical fitness components between Malaysian amateur badminton players and healthy active controls.

Material and Methods A comparative cross-sectional study was conducted involving 246 participants (122 amateur badminton players and 124 healthy active controls) aged 18–40 years. Dynamic balance was assessed using the Y-Balance Test. Agility was assessed using the T-test. Ankle strength was measured using a handheld dynamometer. Independent samples t-tests were performed to examine between-group differences. Statistical significance was set at $p < 0.05$.

Results Amateur badminton players demonstrated significantly higher weekly playing frequency and duration than controls. No significant differences were observed in demographic or anthropometric characteristics. Between-group analyses revealed no statistically significant differences in dynamic balance across all Y-Balance Test directions, agility performance, or ankle dorsiflexor and plantar flexor strength (all $p > 0.05$). Trivial effect sizes were observed across outcomes (Cohen's d range −0.06 to 0.16). Overall, both groups exhibited comparable functional performance profiles despite differences in sport participation.

Conclusions Regular participation in amateur badminton was not associated with superior dynamic balance, agility, or ankle strength compared with generally physically active individuals. These findings suggest that recreational-level badminton participation alone may be insufficient to induce distinct sport-specific physical adaptations. Targeted structured conditioning programs may therefore be necessary to optimize performance and support injury prevention in amateur badminton populations.

Keywords: badminton, dynamic balance, strength, agility, physical fitness

Introduction

Badminton is widely practiced as a recreational and competitive sport that involves rapid movements, frequent changes of direction, and repeated unilateral actions of the lower limbs. Effective participation in such activities depends on the coordinated interaction of several physical fitness components, including dynamic balance, agility, and ankle strength. These characteristics contribute to movement control, rapid positioning on the court, and the ability to perform multidirectional actions during play. At the recreational level, players often engage in regular training and match play, which may influence functional performance profiles and physical fitness characteristics associated with badminton participation.

In this context, the game is characterized by rapid multidirectional movements, explosive actions, and continuous changes in speed and direction. Successful performance requires high levels of speed, power, coordination, and dynamic control, demanding efficient neuromuscular function and movement precision. With more than 200 million participants worldwide, badminton is among the most popular racket sports globally [1, 2]. In Malaysia, the sport has gained substantial popularity and is widely practiced at both competitive and recreational levels [3]. Due to the nature of gameplay, players repeatedly perform movements such as lunges, jumps, rapid accelerations, and directional

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changes, all of which impose considerable physical demands on balance control, agility, and lower-limb strength [4].

During play, athletes must respond to unpredictable shuttlecock trajectories that may exceed 250 km/h. This requires not only technical skill but also high levels of physical fitness, including dynamic balance and agility [2, 5]. Effective court movement depends on rapid footwork, postural control, and the ability to change direction quickly while maintaining stability [6]. These physical characteristics are essential for performance optimization and injury prevention [7]. However, training among amateur badminton players often emphasizes technical and tactical components rather than structured physical conditioning programs that target these fundamental abilities [8].

Amateur players represent a significant proportion of badminton participants and typically engage in the sport for recreational purposes rather than professional competition. Although physical fitness attributes such as strength, coordination, agility, and reaction speed are recognized as important components of badminton performance [9], amateur players may lack systematic training approaches. Evidence suggests that lower levels of fitness and playing experience are associated with increased injury risk. This highlights the vulnerability of amateur players compared with trained athletes [10]. Injury studies have consistently identified the lower extremities as the most commonly affected region among badminton players, with the knee, ankle, and foot showing high injury prevalence [4, 11, 12]. These injuries are likely related to the repetitive demands of lunging, jumping, landing, and rapid changes of direction required during gameplay. Poor conditioning, insufficient neuromuscular control, and deficits in physical fitness may contribute to increased injury risk among amateur players [13]. Consequently, evaluating physical fitness characteristics in this population is important for understanding potential performance limitations and injury susceptibility.

Dynamic balance is a component of badminton performance due to frequent unilateral support and multidirectional movement patterns. Players must maintain postural stability during rapid transitions and landing tasks. This requires efficient neuromuscular control [4, 14]. Poor balance has been associated with increased injury risk and reduced movement efficiency. This emphasizes the relevance of assessing dynamic balance among recreational players [15]. Similarly, agility plays a role in badminton performance, enabling rapid directional changes and responses to unpredictable shuttle movement [16, 17]. Effective footwork is linked to agility performance and successful court coverage [18]. However, amateur players often demonstrate movement deficiencies that may compromise performance and increase injury risk.

Ankle strength is a factor supporting badminton-specific movement. The ankle joint contributes to force production, stability, and shock absorption during landing and directional changes. Adequate strength contributes to controlled footwork and reduces the risk of ankle sprains and joint instability, which are common in badminton [19, 20]. Despite the high physical demands of badminton, existing literature suggests that amateur players may not always demonstrate superior physical performance compared with healthy active individuals. Previous findings have shown minimal differences in certain fitness components between amateur players and physically active controls [21]. This raises questions regarding whether regular amateur participation alone is sufficient to produce sport-specific adaptations in dynamic balance, agility, and ankle strength.

Analysis of research findings has shown that badminton performance is associated with several physical fitness characteristics, particularly dynamic balance, agility, and lower-limb strength. Researchers emphasize that these factors contribute to movement control, court coverage, and the ability to perform rapid directional changes during gameplay. Authors also note that recreational badminton participation involves repeated high-demand movements that may influence functional performance characteristics and injury susceptibility among amateur players. At the same time, the relationship between regular amateur participation and the development of specific physical fitness characteristics remains a subject of practical interest in sports performance and injury prevention. Therefore, this study aimed to compare the level of physical fitness, specifically dynamic balance, agility, and ankle strength, between amateur badminton players and healthy active controls.

Materials and Methods

Participants

Participants were recruited from universities and badminton clubs located in and around Nilai, Malaysia. Recruitment was conducted through announcements and invitations to eligible individuals who regularly participated in badminton or recreational physical activity. Interested participants were screened according to predefined inclusion and exclusion criteria before enrolment in the study. The required sample size was determined using G*Power version 3.1 based on an independent two-group comparison for the primary outcome (dynamic balance assessed using the Y-Balance Test). The calculation assumed a medium effect size ($d = 0.5$), an alpha level of 0.05, and statistical power of 0.80 ($1 - \beta = 0.80$). The analysis indicated that the recruited sample size was sufficient to detect between-group differences in the study primary physical fitness outcomes, including dynamic balance, ankle strength, and agility performance.

Participants aged 18–40 years were included in the study. Amateur badminton players were required to have at least five years of singles or doubles playing experience and to participate in badminton activities for 2–4 hours per week. Healthy active controls consisted of individuals without formal badminton training [21, 22]. These participants engaged in regular physical activity totaling 150–300 minutes per week, including activities such as gym-based exercise, recreational running, fitness training, or other non-competitive physical activities. They did not participate in structured badminton training or amateur badminton activities. All participants were required to understand study instructions in English and to successfully complete the Exercise Preparticipation Health Screening Questionnaire for Exercise Professionals.

Exclusion criteria included any upper or lower limb injury within the previous six months, significant musculoskeletal, neurological, visual, vestibular, cardiorespiratory, or cognitive disorders, pregnancy, participation in sports other than badminton, or regular use of analgesic, muscle relaxant, or neuroleptic medication.

Participants were recruited and screened according to predefined eligibility criteria. Baseline demographic and anthropometric data, including age, height, weight, playing experience, and weekly training duration, were recorded prior to testing. All physical fitness assessments were conducted during a single testing session in a controlled environment to ensure procedural consistency. Participants were provided with a familiarization session for each assessment to ensure proper understanding of the procedures. During testing, three trials were performed for each measure. The recorded values were used for analysis. Tests were conducted in a standardized order (dynamic balance, ankle strength, and agility) with adequate rest intervals between assessments. Participants were informed that participation was voluntary and that they could withdraw at any stage without consequence. All collected data were treated confidentially.

Ethical approval for the study was obtained from the University Research Ethics Committee (Reference No: INTI-IU/FHLS-RC/BPHTI/7NY12022/020). The study adhered to institutional research integrity policies and complied with the ethical principles outlined in the Declaration of Helsinki (2013). Written informed consent was obtained from all participants prior to data collection.

Research Design

The observational cross-sectional design was utilized to examine associations between group (amateur badminton players vs. physically active controls) and physical fitness outcomes. The primary outcome of the study was dynamic balance assessed using the Y-Balance Test (YBT), while secondary outcomes included agility measured by the T-test and ankle muscle strength measured using a handheld dynamometer. All measurements were obtained at a single time point under standardized testing conditions. Secondary adjusted analyses were performed to account for potential confounding variables, including age, sex, BMI, weekly physical activity, and hours of badminton participation per week. The overall study procedure and sequence of assessments are presented in Figure 1.

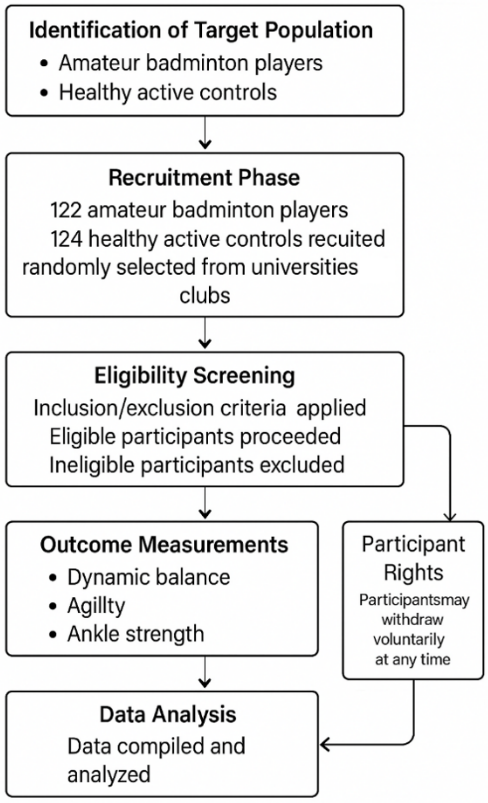

Figure 1. Flowchart of cross-sectional comparative study

Dynamic balance was assessed using the Y-Balance Test (YBT), a validated and reliable field-based assessment tool for dynamic postural control [23]. Participants were required to maintain a single-leg stance while reaching maximally in three directions: anterior, posteromedial, and posterolateral. Interrater test–retest reliability for the YBT has been demonstrated to be excellent (ICC = 0.80–0.85) [24].

Agility was evaluated using the T-test, a standardized assessment designed to measure multidirectional movement ability including forward, lateral, and backward running while maintaining speed and body control. The T-test has shown high reliability (R = 0.98) and acceptable validity, with significant correlations with sprint and jumping performance measures [25].

Ankle strength was measured using a handheld dynamometer (J Tech Medical Commander Echo Wireless Muscle Tester 3). This device provides objective measurement of isometric muscle strength and has demonstrated strong reliability and validity in lower limb assessments. Reported intraclass correlation coefficients range from 0.83 to 0.92. Intra- and inter-tester reliability values exceed ICC > 0.75 [26].

Statistical Analysis

Statistical analyses were performed using IBM SPSS version 25. Normality of data distribution was assessed using the Shapiro–Wilk test. Homogeneity of variance was evaluated using Levene's test prior to conducting independent-samples t-tests. Descriptive statistics were calculated for demographic and baseline characteristics. Independent samples t-tests were used to compare differences in dynamic balance, agility, and ankle strength between amateur badminton players and healthy active controls. Statistical significance was set at $p < 0.05$. To address potential confounding variables, an additional analysis of covariance (ANCOVA) was conducted adjusting for relevant covariates, including age, sex, BMI, weekly physical activity, and hours played per week.

Results

The results are presented according to the main study variables and are supported by appropriate statistical analyses. Descriptive statistics were calculated for participant characteristics, and independent samples t-tests were used to compare physical fitness variables between groups. The baseline demographic and anthropometric characteristics of the participants are presented in Table 1.

As shown in Table 1, a total of 246 individuals were included in the study, comprising 124 healthy active controls and 122 amateur badminton players. The mean age was comparable between the control group (23.51 ± 1.82 years) and the badminton group (23.12 ± 1.86 years). Both groups demonstrated similar anthropometric profiles. The mean height was 1.68 ± 0.09 m in the control group and 1.69 ± 0.09 m in the badminton group. The mean body weight was 63.89 ± 11.13 kg and 60.97 ± 9.87 kg for the control and badminton groups, respectively.

Baseline comparisons of selected participant characteristics between healthy active controls and amateur badminton players are presented in Table 2. No significant differences were observed between

Table 1. Descriptive characteristics of healthy active controls and amateur badminton players

Parameter	Healthy Active Controls (n = 124)	Amateur Badminton Players (n = 122)
Age (years)	23.51 ± 1.82	23.12 ± 1.86
Gender, n		
Male	66	82
Female	58	40
Height (m)	1.68 ± 0.09	1.69 ± 0.09
Weight (kg)	63.89 ± 11.13	60.97 ± 9.87
BMI (kg/m^2)	22.82 ± 4.68	21.51 ± 3.89
Right leg length (cm)	87.58 ± 5.59	86.86 ± 5.25
Left leg length (cm)	87.42 ± 5.91	86.85 ± 5.25
Limb dominance, n		
Right	121	121
Left	3	1
Playing sessions per week	1.12 ± 0.33	3.52 ± 1.09
Hours played per week	1.45 ± 0.50	4.45 ± 1.27

Table 2. Baseline comparison of selected characteristics between healthy active controls and amateur badminton players

Parameter	Mean difference (95% CI)	p-value
Age (years)	0.39 (−0.08, 0.85)	0.102
Height (m)	−0.01 (−0.03, 0.02)	0.523
Right leg length (cm)	0.72 (−0.64, 2.08)	0.298
Left leg length (cm)	0.56 (−0.84, 1.97)	0.429
Playing sessions per week	−2.40 (−2.60, −2.19)	< 0.001
Hours played per week	−3.00 (−3.24, −2.76)	< 0.001

groups for age, height, or limb length ($p > 0.05$). However, amateur badminton players reported higher playing frequency and greater weekly playing duration than controls (mean differences = −2.40 sessions/week and −3.00 hours/week, respectively; $p < 0.001$).

Baseline comparisons are presented in Table 2. No significant differences were observed between groups for age, height, or limb length ($p > 0.05$). However, amateur badminton players reported higher playing frequency and greater weekly playing duration than controls (mean differences = −2.40 sessions/week and −3.00 hours/week, respectively; $p < 0.001$).

Y-Balance Test results comparing dynamic balance performance between healthy active controls and amateur badminton players are presented in Table 3.

As shown in Table 3, no significant differences were observed between healthy active controls and amateur badminton players across all measured parameters, including RA, RPM, RPL, LA, LPM, and LPL ($p > 0.05$), indicating comparable dynamic balance performance between the groups.

Independent samples t-test results for ankle strength variables comparing healthy active controls and amateur badminton players are presented in Table 4.

As shown in Table 4, no significant differences were observed between groups in dorsiflexion or plantar flexion strength for either limb ($p > 0.05$), indicating similar ankle strength profiles between healthy active controls and amateur badminton players.

Agility performance comparisons between healthy active controls and amateur badminton players are presented in Table 5.

As shown in Table 5, no significant difference was observed in Agility T-test performance between healthy active controls and amateur badminton players (mean difference = 0.13 s, 95% CI: −0.28 to 0.54; $p = 0.526$), indicating comparable agility levels between the groups.

Adjusted ANCOVA results controlling for potential covariates are presented in Table 6.

Table 3. Independent samples t-test results for Y-Balance Test scores between healthy active controls and amateur badminton players

Variable	Healthy Active Controls (n = 124)	Amateur Badminton Players (n = 122)	Mean difference (95% CI)	p-value	Cohen's d
RA	61.71 ± 10.36	61.95 ± 10.04	−0.23 (−2.80, 2.33)	0.858	0.03
RPM	96.56 ± 12.42	98.27 ± 12.70	−1.70 (−4.86, 1.45)	0.289	0.11
RPL	99.06 ± 16.02	100.28 ± 16.82	−1.22 (−5.34, 2.91)	0.561	0.05
LA	58.30 ± 7.34	57.88 ± 7.15	0.43 (−1.39, 2.25)	0.646	−0.06
LPM	95.24 ± 10.59	95.17 ± 10.55	0.07 (−2.59, 2.72)	0.960	−0.02
LPL	99.50 ± 15.64	99.93 ± 16.90	−0.43 (−4.52, 3.66)	0.836	0.03

Note. RA (right anterior), RPM (right posteromedial), RPL (right posterolateral), LA (left anterior), LPM (left posteromedial), LPL (left posterolateral).

Table 4. Independent samples t-test results for ankle strength variables between healthy active controls and amateur badminton players

Variable	Healthy Active Controls (n = 124)	Amateur Badminton Players (n = 122)	Mean difference (95% CI)	p-value	Cohen's d
RDF	118.98 ± 11.20	120.48 ± 7.83	−1.50 (−3.93, 0.93)	0.225	0.16
LDF	110.39 ± 11.86	110.34 ± 8.17	0.04 (−2.52, 2.60)	0.975	0.01
RPF	150.55 ± 16.78	149.97 ± 12.37	0.58 (−3.13, 4.29)	0.758	−0.04
LPF	138.87 ± 15.04	139.03 ± 10.51	−0.16 (−3.43, 3.10)	0.922	0.02

Note. RDF (right dorsiflexors), LDF (left dorsiflexors), RPF (right plantar flexors), LPF (left plantar flexors).

Table 5. Independent samples t-test results for Agility T-test scores between healthy active controls and amateur badminton players

Variable	Healthy Active Controls (n = 124)	Amateur Badminton Players (n = 122)	Mean difference (95% CI)	p-value	Cohen's d
Agility T-test (s)	16.05 ± 1.68	15.92 ± 1.56	0.13 (−0.28, 0.54)	0.526	−0.06

Table 6. Adjusted ANCOVA results controlling for age and sex

Variables	F	p
RA	2.104	0.148
RPM	0.623	0.431
RPL	0.386	0.535
LA	0.355	0.552
LPM	0.633	0.427
LPL	0.005	0.945
RDF	1.650	0.200
LDF	0.175	0.676
RPF	0.031	0.861
LPF	1.671	0.197
Agility	1.062	0.304

Note. RA (right anterior), RPM (right posteromedial), RPL (right posterolateral), LA (left anterior), LPM (left posteromedial), LPL (left posterolateral), RDF (right dorsiflexors), LDF (left dorsiflexors), RPF (right plantar flexors), LPF (left plantar flexors).

As shown in Table 6, ANCOVA analyses were conducted adjusting for age, sex, BMI, weekly physical activity, and hours played per week. After controlling for these covariates, no significant group differences were observed for dynamic balance, ankle strength, or agility outcomes (all $p > 0.05$). These results indicate that the absence of differences between amateur badminton players and healthy active controls remained unchanged after adjustment.

Discussion

This study compared key physical fitness components between Malaysian amateur badminton players and healthy active controls. The findings indicate that both groups demonstrated comparable functional performance at the time of measurement. The absence of between-group differences suggests that regular recreational badminton participation may not produce measurable advantages in dynamic balance, agility, or ankle strength compared with generally physically active individuals. This pattern may reflect a ceiling effect, where performance variables plateau because baseline capacities are already near physiological limits [27].

No statistically significant differences were identified between amateur badminton players and healthy active controls across all six YBT directions ($p > 0.05$). This result contrasts with expectations that badminton participation, which involves rapid acceleration, deceleration, unilateral loading, and multidirectional movements, may promote enhanced proprioception and dynamic stability [28]. One explanation is that although amateur players trained more frequently than controls (3.52 ± 1.09 vs. 1.12 ± 0.33 sessions per week), their training exposure may not have included sufficient balance-specific or high-intensity stimuli to induce measurable neuromuscular adaptations beyond those gained through general physical activity. The healthy active control group, meeting recommended activity guidelines, may already have developed adequate balance capacity through varied recreational activities. Similar findings have been reported in studies where moderately trained athletes demonstrated minimal differences in dynamic balance compared with physically active individuals [29].

Supporting this interpretation, the study [30] reported that moderately trained athletes did not demonstrate substantially superior postural control compared with active individuals. This suggests that improvements beyond baseline levels require greater training specificity or intensity. Likewise, the study [31] concluded that differences in dynamic balance between recreational athletes and physically active non-athletes are generally small and often statistically non-significant, with clearer distinctions emerging mainly among elite athletes.

Comparable observations have been reported in team sports. The study [32] found no significant differences in YBT performance between amateur volleyball and basketball players, suggesting that shared physical demands across sports may produce similar baseline balance capabilities. This indicates that overall athletic exposure and habitual activity levels may exert greater influence on dynamic balance than sport-specific participation at recreational levels. Conversely, research involving elite badminton players demonstrates that combined balance and plyometric training can produce improvements in dynamic balance beyond those achieved through regular training alone [33]. Such interventions impose greater neuromuscular and proprioceptive demands that may be necessary to generate measurable performance changes. Overall, the findings suggest that although badminton inherently challenges balance, these demands alone may not produce measurable dynamic balance advantages in amateur players compared with other physically active individuals. General physical activity appears capable of maintaining a high baseline level of dynamic stability, potentially masking sport-specific differences. Therefore, targeted balance-oriented training with greater intensity may be required to elicit measurable improvements.

In this study, no significant differences were observed in ankle dorsiflexor or plantar flexor strength between amateur badminton players and healthy active controls ($p > 0.05$). This result contrasts with findings from elite badminton populations, where repeated explosive lunges, jumps, and rapid directional changes have been shown to contribute to greater lower-limb strength through sustained overload and neuromuscular adaptation [19]. The absence of differences in the present study may reflect insufficient training volume or intensity among amateur players to induce adaptations beyond those maintained through general physical activity. Controls engaging in activities such as running, gym-based exercise, or recreational sports may have developed comparable ankle strength, thereby reducing between-group differences [34]. This overlap in physical demands may have resulted in similar neuromuscular conditioning across both groups.

Research indicates that untrained individuals exhibit lower dorsiflexor and plantar flexor endurance compared with trained populations, highlighting the role of habitual physical activity in maintaining functional muscle capacity [35]. Recreational activities may provide sufficient mechanical loading to preserve baseline strength and joint stability, narrowing performance differences between active individuals and moderately trained athletes. Training modality also appears to influence outcomes. Resistance-trained individuals demonstrate greater plantar flexion strength compared with those engaging primarily in endurance activities, emphasizing the role of progressive overload in muscular development [36]. Similarly, high-intensity unilateral dorsiflexor training can increase strength through neural adaptations, including cross-education effects [37]. Combined eccentric–concentric training has also been shown to enhance strength and proprioception, supporting the role of training specificity [38].

However, increases in isolated ankle strength do not necessarily translate into proportional improvements in functional performance or balance [39], reflecting the multifactorial nature of athletic performance. Strength development should therefore be integrated with broader neuromuscular and sport-specific training components. In summary, the absence of strength differences suggests that general physical activity may be sufficient to maintain baseline ankle strength in non-elite populations. To achieve measurable sport-specific advantages, amateur players may require targeted high-load resistance and proprioceptive training integrated with agility and sport-specific movement practice.

The results showed that T-test agility performance did not differ significantly between groups ($p = 0.526$), with amateur players completing the assessment only 0.13 s faster on average. This minimal difference suggests that the agility demands of amateur-level badminton may not be sufficient to produce measurable advantages beyond those obtained through general physical activity [40].

A key consideration is the nature of the T-test, which assesses pre-planned agility involving predictable movement patterns. Because directional changes are known in advance, the test reduces reliance on perceptual processing and decision-making. In contrast, agility demands in badminton are predominantly reactive, requiring rapid responses to unpredictable shuttle trajectories and opponent actions [41]. Consequently, sport-specific agility differences may not be fully captured by pre-planned assessments. Previous research indicates that cognitive components contribute to performance in open-skill sports [42]. Similarly, studies involving rugby league athletes demonstrate that reactive agility tests better differentiate skill levels compared with traditional change-of-direction assessments [43].

Further evidence suggests that pre-planned agility tests may underestimate real-game agility demands in court-based sports due to the absence of perceptual and anticipatory components [44]. A systematic review confirmed that reactive agility tests demonstrate reliability and discriminatory validity when cognitive load is incorporated [45]. In badminton-specific contexts, reactive initiation training has been shown to produce greater improvements in movement initiation speed than traditional shuttle run drills, indicating the role of perceptual–motor integration [46]. Sport-specific reactive tests employing live opponent stimuli may enhance ecological validity by replicating competitive demands more closely [47]. Although some studies in younger athletes suggest comparable reliability between test types [48], evidence indicates that reactive assessments are more effective in distinguishing performance levels among experienced athletes [49]. Taken together, the absence of differences in T-test performance observed in the present study is more likely attributable to limitations of the assessment tool rather than a genuine absence of sport-specific agility adaptations. Future research should employ reactive and sport-specific agility assessments capable of capturing both cognitive and physical components of agility performance.

Across dynamic balance, ankle strength, and agility outcomes, a consistent pattern emerged: general physical activity appeared sufficient to maintain baseline neuromuscular performance among non-elite individuals, thereby reducing measurable differences between amateur badminton players and active controls. These findings suggest that training intensity, specificity, and assessment sensitivity influence the detection of sport-specific adaptations. From an applied perspective, the results support the inclusion of targeted sport-specific training strategies that exceed general activity thresholds to elicit measurable improvements. From a methodological standpoint, the findings indicate the need to select outcome measures that reflect the ecological and cognitive demands of the sport to capture performance differences more accurately.

Limitations of the Study and Future Research Directions

This study has several limitations that should be acknowledged. First, the cross-sectional design limits the ability to establish causal relationships between badminton participation and physical fitness outcomes. The study did not control for differences in training intensity or specific conditioning practices. These factors may have influenced the observed physical fitness outcomes. Additionally, the control group consisted of physically active individuals who participated in different types of exercise. This may have reduced the contrast in physical conditioning between groups and potentially influenced between-group comparisons.

Future research should adopt longitudinal or intervention-based study designs to examine training effects over time. Future studies should investigate structured conditioning programs targeting balance, agility, and ankle strength to improve performance and reduce injury risk among amateur badminton players.

Conclusions

Amateur badminton players did not demonstrate greater dynamic balance, agility, or ankle strength compared with healthy active controls despite higher participation frequency. These findings indicate that recreational badminton participation alone may be insufficient to produce sport-specific physical adaptations. General physical activity appears adequate to maintain baseline performance levels. This suggests the need for structured sport-specific conditioning programs to improve physical performance and reduce potential injury risk among amateur players.

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Conflict of Interest

The authors declare no conflict of interest.

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