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ORIGINAL ARTICLE

Effects of Recreational Badminton on Lipid Profiles in Older Adults

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KEYWORDS
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ABSTRACT

Background. Aging increases the risk of heart disease and metabolic disorders, making regular physical activity essential for maintaining good health. Recreational badminton is widely played, yet its effects on lipid profiles in older adults remain unclear. While previous research highlights the cardiovascular benefits of exercise, the role of intermittent sports, such as badminton, in lipid metabolism remains underexplored. **Objectives.** This study investigated whether the duration of weekly badminton play influences key lipid markers in older adults. **Methods.** This cross-sectional study involved 54 participants aged 55 years or older, stratified into high-playtime (HPT; 9.72 ± 2.16 hours/week), low-playtime (LPT; 3.34 ± 1.53 hours/week), and non-player (CON; n = 18 each) groups. Participants fasted for 8–12 hours before blood sampling and anthropometric assessments. Triglycerides (TG), total cholesterol (T-Cho), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) were analyzed. Badminton duration was assessed using weekly logs and a modified PASE questionnaire. **Results.** No significant differences were observed in TG (HPT: 59.2 ± 13.8; LPT: 63.0 ± 16.1 mg/dL), T-Cho (HPT: 203 ± 7.8; LPT: 201 ± 14 mg/dL), HDL (HPT: 67.8 ± 4.94; LPT: 64.0 ± 7.79 mg/dL), or LDL (HPT: 120 ± 3.49; LPT: 122 ± 7.17 mg/dL); p>0.05. Effect sizes (η^2 = 0.02–0.05) indicated minimal group differences. **Conclusion.** Given the study's cross-sectional design, causality cannot be inferred. Future longitudinal studies should control for diet and genetics and explore combined training strategies.

INTRODUCTION

Aging and chronic degeneration present considerable challenges to lipid and cardiovascular health, particularly in older adults. As individuals age, physiological changes such as increased arterial stiffness, chronic low-grade inflammation, and reduced lipid metabolism elevate the risk for cardiovascular disease and dyslipidemia (1, 2). Maintaining a healthy lipid profile through regular physical activity is crucial for reducing these risks. Recreational exercise, including sport-based activity, has been proposed as a sustainable method for improving health markers among older populations. Compared to structured endurance training, recreational sports may increase adherence due to their enjoyable and social nature (3). Badminton, classified as a vigorous intermittent sport, combines aerobic and anaerobic components with high movement variability (4). It has shown potential cardiovascular benefits, but its effects on lipid profiles remain underexplored.

Intermittent sports, such as badminton, may engage the cardiovascular system differently than steady-state aerobic training. However, most exercise-lipid research focuses on continuous training modes, such as walking, cycling, and jogging (5-7). This creates a gap in understanding whether intermittent sports can induce similar changes in lipid metabolism, particularly in older individuals. In addition to traditional lipid markers, such as total cholesterol, HDL, and LDL, clinicians and researchers are increasingly using lipid ratios, specifically the total cholesterol to HDL (TC: HDL) and LDL to HDL (LDL: HDL) ratios, as sensitive predictors of cardiovascular risk. These ratios provide a more integrated reflection of lipid balance and are often more strongly associated with atherosclerotic risk than single lipid markers alone. However, limited evidence exists on how intermittent sport-based activities, such as badminton, influence these atherogenic ratios, especially among aging populations. Unlike walking or cycling, which maintain consistent submaximal aerobic effort, badminton consists of short, high-intensity efforts interspersed with recovery periods. This fluctuating intensity profile results in a lower cumulative aerobic load and may fail to maintain the prolonged heart rate elevation required to enhance lipid oxidation pathways. Moreover, intermittent sports often rely more heavily on anaerobic metabolism and phosphocreatine resynthesis, rather than sustained beta-oxidation of lipids, which is more characteristic of steady-state activities. These physiological distinctions raise questions about whether sports like badminton can elicit comparable effects on lipoprotein regulation and cholesterol clearance (8, 9).

Recent studies have begun to investigate the impact of games like tennis, futsal, or badminton on metabolic health. For example, improved aerobic fitness and quality of life have been observed in elderly badminton players, but results on lipid-specific outcomes are inconclusive (10, 11). Moreover, badminton's short burst and rest format may not meet the continuous intensity thresholds needed to stimulate lipid oxidation or lipoprotein regulation (12). In addition to conventional lipid parameters, such as total cholesterol, HDL, and LDL, atherogenic lipid ratios, particularly the ratio of total cholesterol to HDL (TC: HDL) and the ratio of LDL to HDL (LDL: HDL), are increasingly used to assess cardiovascular risk. These ratios offer a more comprehensive view of lipid balance and have been shown to predict outcomes more accurately than absolute lipid values alone in aging populations (13, 14). However, few studies have investigated how recreational badminton participation might influence these clinically relevant lipid ratios.

Emerging evidence suggests the aerobic threshold, rather than maximal effort, is critical for modifying lipid profiles (15). However, few studies have examined the effects of recreational badminton on cholesterol subfractions, triglyceride concentrations, or atherogenic lipid ratios in older adults. Given the limited but growing interest in intermittent sports and lipid modulation, this study addresses a timely and relevant gap in the literature by investigating how weekly badminton play duration affects lipid outcomes in aging populations. Therefore, this study aims to determine whether weekly duration of recreational badminton play is associated with differences in lipid profiles, including TG, T-Cho, HDL, LDL, and the atherogenic ratios TC: HDL and LDL: HDL among healthy older adults. We hypothesized that individuals with greater weekly participation in badminton would demonstrate more favorable lipid profiles and lower lipid risk ratios than those with lower or no engagement.

MATERIALS AND METHODS

Study Design. This population-based, analytical cross-sectional study was conducted among older adults in Negeri Sembilan, Malaysia. The study was approved by the Research Ethics Committee (REC/06/2022-PG/MR/127) and conducted in accordance with the principles of the Declaration of Helsinki. Before commencement, it was registered in the UMIN Clinical Trials Registry (UMIN000047240). While this design allows for group comparisons, it does not permit causal inference regarding the effects of badminton on lipid metabolism. Additionally, this study did not assess or control for dietary intake and genetic predisposition.

Participants. The sample size was estimated using the statistical formula by Charan & Biswas

(8), considering a 95% confidence interval, a 5% level of precision, and an estimated population of 1% elderly badminton players based on data from badminton clubs and the Department of Statistics Malaysia (DOSM). A total of 98 individuals were screened, and 54 eligible participants (aged ≥55 years) were stratified into three groups: high-playing time (HPT; n=18, 9.72 ± 2.16 hr/week), low-playing time (LPT; n=18, 3.34 ± 1.53 hr/week), and a control group (CON; n=18, non-players). Inclusion Criteria: Participants were included if they were recreational badminton players (HPT/LPT groups) and free of diagnosed metabolic, cardiovascular, or pulmonary diseases. Exclusion Criteria: Participants were excluded if they had chronic metabolic disorders, participated in structured exercise programs (e.g., running, cycling, swimming), used dietary supplements or hormone therapy, or had alcohol or drug dependence. Figure 1 illustrates the process, including the number of participants, from selection to data completion.

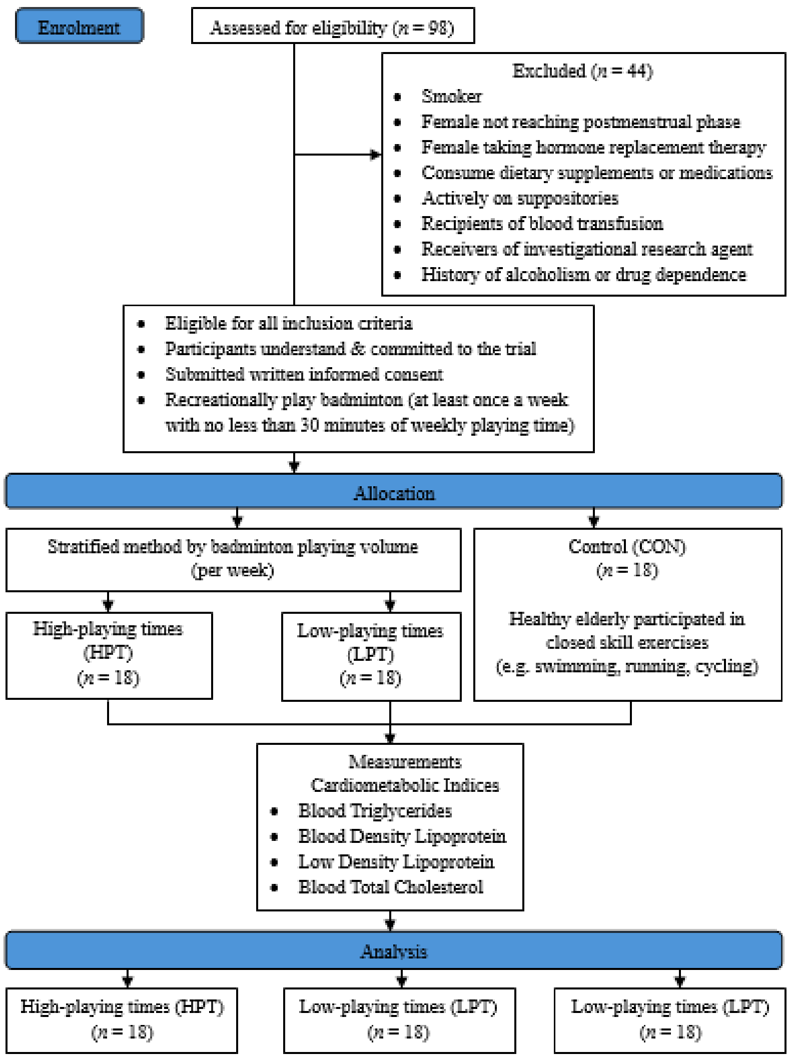

Figure 1. Study participant flow diagram illustrating eligibility screening, exclusion criteria, group allocation based on weekly badminton playtime, and the outcome measurements assessed. Participants were stratified into three groups: high-playtime (HPT), low-playtime (LPT), and control (CON). Cardiometabolic indices included triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and total cholesterol.

Study Protocol. Participants arrived at the laboratory at 8:00 AM in a fasting state (having fasted for 8–12 hours) and were instructed to abstain from all caloric intake except for plain water. Upon arrival, they received an explanation of study procedures and potential risks before providing written informed consent. After 10 minutes of seated rest, anthropometric and blood biomarker assessments were conducted. After testing, participants completed weekly badminton participation logs and the modified Physical Activity Scale for the Elderly (PASE) questionnaire.

A modified version of the Physical Activity Scale for the Elderly (PASE) was used to estimate total weekly activity and to validate the amount of time spent playing badminton. The original PASE, which quantifies physical activity in older adults based on leisure, household, and occupational tasks, was adapted to reflect badminton-specific frequency and duration in more detail. Questions related to household and work activities were excluded, while new items specifying "number of badminton sessions per week" and "average duration per session" were added. The modified PASE for badminton showed acceptable internal consistency ($\alpha = 0.79$) in a small pilot sample prior to study implementation.

Although sessions were not directly observed, badminton participation logs were complemented by qualitative data on session characteristics. Recreational badminton typically involves high-movement variability and intermittent bursts of effort lasting 4–10 seconds per rally, followed by brief rest intervals. Heart rate responses during play can reach 75–85% of HRmax, suggesting vigorous-intensity exertion (6). Players in the HPT group reported playing 4–5 days/week, averaging 2 hours/day, typically in a doubles format. No structured monitoring of rally duration or intensity was performed, which limits physiological precision.

Measurements.

Anthropometric Characteristics. Anthropometric measurements were taken following standardized guidelines. Height and weight were assessed using a validated stadiometer (Seca 220, Hamburg, Germany), and BMI (kg/m²) was calculated using standard formulas.

Blood Biomarker Analysis. A certified medical technologist collected Venous blood samples using 2 mL Vacuette tubes (without additives) and 6 mL Vacutainer tubes (containing EDTA). A 10 µL aliquot of whole blood from no-additive Vacuette® tubes was analyzed for triglycerides (TG), total cholesterol (T-Cho), and high-density lipoprotein cholesterol (HDL) using the PTS Panels® Lipid Panel (CardioChek PA, PTS Diagnostics, USA). In contrast, low-density lipoprotein cholesterol (LDL) was calculated using Friedewald's formula. Whole blood from EDTA-containing tubes was left at room temperature for 20 minutes before being centrifuged at 4,000 rpm for 8 minutes using a Hettich EBA 20 centrifuge (Germany). The extracted serum was analyzed for fasting glucose, uric acid (UA), and C-reactive protein (CRP), with CRP samples diluted 21-fold according to the manufacturer's guidelines.

Badminton Playing Time and Group Stratification. Participants were ranked by weekly badminton playtime. The median cutoff (7.05 hrs/week) was used to divide the sample into HPT and LPT groups, based on the 18th and 19th-ranked individuals (6.6 and 7.5 hrs/week, respectively).

Statistical Analysis. Differences in badminton playing history were analyzed using an independent samples t-test. A one-way repeated measures analysis was conducted using the Brown-Forsythe and Welch ANOVA to examine differences in physical attributes (height, weight, BMI, and age), total weekly badminton playtime, and blood lipid biomarkers (TG, T-Cho, HDL, and LDL). Post hoc comparisons were performed using Dunnett's T3 multiple comparison test. Statistical analyses were conducted using GraphPad Prism (version 9.0, GraphPad Software, Inc., La Jolla, USA), with statistical significance set at $p < 0.05$.

RESULTS

A total of 54 participants were included in the study, comprising HPT (n = 18), LPT (n = 18), and CON (n = 18). Table 1 presents the physical and anthropometric characteristics of the participants. No significant differences were observed across the three groups for age ($p = 0.326$), BMI ($p = 0.390$), or other baseline anthropometric characteristics, indicating comparability at baseline. However, as expected, the frequency, session duration, and total playtime of badminton were significantly greater in the HPT group than in the LPT group, confirming successful group stratification. Participants in the HPT group had significantly greater playing experience (28.6 ± 1.33 years) compared to the LPT group (24.3 ± 3.03 years), although this difference was not statistically significant ($p > 0.05$). The HPT group played more frequently per week (4.72 ± 1.13 days) and spent more hours per day (2.14 ± 0.56 hours/day) compared to the LPT group (2.28 ± 1.02 days; 1.51 ± 0.50 hours/day), with statistically significant differences ($p < 0.05$).

Blood Lipid Profile. Table 2 summarizes the comparisons of lipid biomarkers among the three groups. Analysis of variance (ANOVA) revealed no statistically significant differences in triglycerides (TG), total cholesterol (T-Cho), high-density lipoprotein (HDL), or low-density lipoprotein (LDL) levels between the HPT, LPT, and CON groups ($p>0.05$). Specifically, the HPT group demonstrated TG levels of 59.2 ± 13.8 mg/dL, T-Cho of 203 ± 7.8 mg/dL, HDL of 67.8 ± 4.94 mg/dL, and LDL of 120 ± 3.49 mg/dL, which were not significantly different from values in the LPT or CON groups.

In addition to traditional lipid biomarkers, TC:HDL and LDL:HDL ratios were also calculated to provide further insight into cardiovascular risk. The TC: HDL ratio averaged 2.99 ± 0.45 in the HPT group, 3.14 ± 0.52 in the LPT group, and 3.13 ± 0.49 in the CON group. The LDL: HDL ratio was 1.77 ± 0.29, 1.91 ± 0.41, and 1.90 ± 0.37 for the respective groups. These ratios did not differ significantly between groups ($p > 0.05$), indicating that recreational badminton playtime did not substantially influence atherogenic lipid ratios among older adults.

In addition to standard lipid parameters, atherogenic lipid ratios (TC:HDL and LDL:HDL) were also calculated (Table 3). No significant group differences were observed, though slightly lower average ratios were noted in the HPT group.

Group Comparison and Statistical Findings. Post hoc analyses confirmed no significant differences in lipid biomarkers between the HPT, LPT, and CON groups. The null hypothesis, which states that there are no differences in lipid profiles among elderly recreational badminton players based on play duration, was accepted.

Table 1. Physical and Anthropometric Characteristics of the participants.

Parameter	HPT (*n*=18)	LPT (*n*=18)	CON (*n*=18)	*p*-value
Age (years)	64.2 ± 2.81	63.3 ± 2.59	64.9 ± 2.89	0.326
Weight (kg)	64.8 ± 4.52	67.2 ± 4.58	66.3 ± 6.39	0.287
Height (cm)	165 ± 3.95	165 ± 3.58	164 ± 3.48	0.478
BMI (kg/m²)	23.9 ± 1.46	24.8 ± 2.34	24.6 ± 2.31	0.390
Playing experience (years)	28.6 ± 1.33	24.3 ± 3.03	-	
Badminton playing frequency (day/week)	4.72 ± 1.13	2.28 ± 1.02	-	
Badminton playing hours (hrs/day)	2.14 ± 0.56	1.51 ± 0.50	-	
Total badminton playing time (hrs/week)	9.72 ± 2.16	3.34 ± 1.53	-	

Values are expressed as mean ± standard deviation (SD). HPT: High badminton playtime group; LPT: Low playtime group; CON: Control group. P-values refer to one-way ANOVA comparisons among HPT, LPT, and CON groups for age, weight, height, and BMI only. No statistical comparisons were conducted for badminton-related variables, as CON participants did not engage in badminton activity.

Table 2. Comparison Between Groups on Blood Metabolic Biomarkers.

Parameter (mg/dL)	HPT (*n*=18)	LPT (*n*=18)	CON (*n*=18)	HPT vs. LPT *t (p)*	HPT vs. CON *t (p)*	LPT vs. CON *t (p)*
Triglycerides	59.2 ± 13.8	63.0 ± 16.1	71.4 ± 18.4	0.76 (0.45)	2.20 (0.07)	1.43 (0.16)
HDL	67.8 ± 4.94	64.0 ± 7.79	61.9 ± 8.65	1.74 (0.09)	2.50 (0.06)	0.76 (0.45)
LDL	120 ± 3.49	122 ± 7.17	126 ± 10.2	1.09 (0.31)	2.45 (0.06)	1.42 (0.17)
T-Cho	203 ± 7.8	201 ± 14	205 ± 15	0.40 (0.69)	0.53 (0.59)	0.75 (0.46)

Values are expressed as mean ± standard deviation (SD). HPT: High-playtime group; LPT: Low-playtime group; CON: Control group. T-Cho: Total cholesterol; HDL: High-density lipoprotein; LDL: Low-density lipoprotein. *t*: Welch's independent sample t-test value; p: Significance level from between-group comparison. No comparisons reached statistical significance ($p>0.05$ for all contrasts). Data reflect fasting lipid profiles collected at a single time point.

Table 3. Atherogenic Lipid Ratios Among High-Playtime, Low-Playtime, and Control Groups.

Lipid Ratio	HPT (*n*=18)	LPT (*n*=18)	CON (*n*=18)	*p*-value
TC: HDL Ratio	2.99 ± 0.45	3.14 ± 0.52	3.13 ± 0.49	0.481
LDL:HDL Ratio	1.77 ± 0.29	1.91 ± 0.41	1.90 ± 0.37	0.525

Values are expressed as mean ± standard deviation (SD). TC: Total cholesterol; HDL: High-density lipoprotein; LDL: Low-density lipoprotein. P-values refer to one-way ANOVA comparisons among high-playtime (HPT), low-playtime (LPT), and control (CON) groups.

DISCUSSION

The present study investigated the impact of recreational badminton playtime on lipid profiles among older adults. Results showed no statistically significant differences in triglycerides (TG), total cholesterol (T-Cho), high-density lipoprotein (HDL), or low-density lipoprotein (LDL) levels across groups stratified by playtime. These findings suggest that although badminton promotes physical activity, its typical duration and intermittent structure may not provide the aerobic stimulus required for enhancing lipid metabolism. Physiologically, the stop-and-go nature of badminton, with its short rallies and recovery periods, contrasts with the sustained effort required in continuous aerobic exercises like walking or cycling. Moderate-intensity activity is better documented to improve lipid transport, lipoprotein lipase activity, and HDL-C efflux capacity (9, 13). This may explain why steady-state modalities produce more consistent lipid benefits, while badminton's intermittent load may be insufficient to achieve the same benefits. These findings align with emerging evidence that the lipid response to exercise varies depending on modality, duration, and intensity. Yun et al. found that continuous aerobic training was more effective than resistance training or intermittent activity in improving lipid profiles among older populations (9). Similarly, Braga et al. (13) emphasized that regular physical activity enhances HDL cholesterol metabolism, particularly through improved cholesterol efflux and reverse transport mechanisms. Fan et al. (15) further demonstrated that combining aerobic and resistance training resulted in greater improvements in LDL and total cholesterol levels than either modality alone in older adults. These findings suggest that while recreational badminton supports physical activity engagement, its intermittent format may lack the volume or intensity required to elicit favorable lipid changes without complementary interventions.

In addition to standard lipid biomarkers, this study evaluated atherogenic ratios TC: HDL and LDL: HDL as surrogate indicators of cardiovascular risk. Although these ratios are sensitive predictors, no significant differences were found between groups. These results align with prior findings that sport-based physical activity, when unstructured or performed at variable intensity, may not meaningfully alter blood lipoproteins unless combined with greater volume or dietary changes (12, 14). Despite these observations, several limitations must be acknowledged. As a cross-sectional design, this study does not permit causal inference; results reflect associations only. Importantly, the study did not control for dietary intake, a major determinant of lipid levels. Participants' macronutrient composition, caloric intake, and use of cholesterol-lowering medications or supplements were not assessed. No food frequency questionnaire (FFQ) or dietary recall was used, making it impossible to account for the confounding role of diet.

Furthermore, the badminton exposure was self-reported using a modified PASE questionnaire, which, although practical, may be vulnerable to recall and social desirability bias. No objective measures of session intensity, heart rate, or duration per rally were recorded, limiting the ability to interpret the actual training load or cardiovascular stress imposed by the sport. Recent systematic reviews emphasize that lipid responsiveness to exercise is highly individual and dependent on exercise mode, frequency, and baseline cholesterol status (9, 11, 13). These studies suggest that while moderate-to-vigorous activity is beneficial, structured protocols with dietary control are most likely to yield measurable changes in lipid levels.

Future studies should adopt longitudinal or randomized controlled trial (RCT) designs with stricter monitoring of exercise dosage, dietary intake, and biochemical markers. Interventions combining badminton with endurance or resistance training, as well as nutritional education, may better clarify the role of sport-based activities in managing lipid profiles among older adults. Although lipid outcomes remained unchanged, the physical, cognitive, and social benefits of badminton participation for healthy aging are still important. These findings contribute to the growing dialogue on how different exercise modalities can support cardiovascular health and wellness in aging populations.

CONCLUSION

This study examined the effects of recreational badminton play duration on lipid profiles in older adults. No significant differences were found among high-playtime, low-playtime, and non-playing control groups in triglycerides (TG), total cholesterol

(T-Cho), high-density lipoprotein (HDL), low-density lipoprotein (LDL), or lipid ratios (TC:HDL and LDL:HDL). These findings suggest that while badminton promotes physical activity and functional engagement, it may not have a sufficient impact on lipid outcomes when performed in an unstructured and intermittent format.

The intermittent nature of badminton may result in variable cardiovascular engagement, which could limit its effectiveness in modulating lipid metabolism compared to continuous aerobic exercise. However, as this study did not include physiological measures such as heart rate or oxygen consumption, further research is needed to clarify these mechanisms. Additionally, individual variability in lipid response may be influenced by broader factors, such as genetic predisposition, as suggested by prior literature; however, such variables were not assessed in the current study.

Future studies should adopt longitudinal or randomized controlled trial designs, incorporate objective monitoring of exercise intensity, and better control for dietary intake and genetic factors to understand the relationship between recreational sports and lipid health. Nonetheless, badminton's broader physical and psychosocial benefits for aging populations remain valuable, and it may serve as a complementary component of a more comprehensive lifestyle approach to cardiovascular health.

APPLICABLE REMARKS

- Recreational badminton benefits cardiovascular fitness and mobility, but may not be sufficient for significant improvements in lipid profile.
- To optimize cholesterol management, older adults should incorporate aerobic endurance training, such as playing badminton.
- Sports and fitness programs for older adults should include both intermittent and continuous aerobic exercises to maximize metabolic health benefits.
- Healthcare professionals and fitness trainers should encourage holistic lifestyle modifications, integrating exercise with dietary counselling to enhance lipid metabolism.
- Future studies should investigate the long-term effects of combining badminton with endurance training and the role of genetic predisposition in lipid metabolism responses.

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AUTHORS' CONTRIBUTIONS

Study concept and design: Raja Nurul Jannat Raja Hussain. Acquisition of data: Syed Murshid Syed Zubir. Analysis and interpretation of data: Syed Murshid Syed Zubir, Raja Nurul Jannat Raja Hussain, Maisarah Shari, Adam Linoby. Drafting the manuscript: Raja Nurul Jannat Raja Hussain, Maisarah Shari. Critical revision of the manuscript for important intellectual content: Adam Linoby, Maisarah Shari, Raja Nurul Jannat Raja Hussain. Statistical analysis: Syed Murshid Syed Zubir. Administrative, technical, and material support: Maisarah Shari, Adam Linoby. Study supervision: Raja Nurul Jannat Raja Hussain.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

FINANCIAL DISCLOSURE

This study has no financial interests related to the material in the manuscript.

FUNDING/SUPPORT

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ETHICAL CONSIDERATION

The Research Ethics Committee approved the study (REC/06/2022-PG/MR/127) and adhered to the principles outlined in the Declaration of Helsinki. Before its commencement, the study was registered in the UMIN Clinical Trials Registry (UMIN000047240).

ROLE OF THE SPONSOR

The funding organizations are public institutions and have no role in the design and conduct of the study, collection, management, and analysis of the data, or preparation, review, and approval of the manuscript.

ARTIFICIAL INTELLIGENCE (AI) USE

This study agrees with the Journal's policy in this section.

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