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Comparison of Motor Reaction Time Between Active and Sedentary Older Adults: A Cross-Sectional Study

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Abstract

This study examined differences in motor reaction time between physically active and sedentary older adults. Aging is associated with reductions in cognitive processing speed, muscular coordination, and neuromotor efficiency. Regular physical activity may attenuate these age-related declines and support functional independence. A cross-sectional design was employed involving 60 participants aged 60–75 years, categorized into active and sedentary groups based on weekly physical activity levels. Computerized visual reaction tests were administered under standardized laboratory conditions. Results demonstrated significantly faster mean reaction times in the active group (0.42 ± 0.05 s) compared to the sedentary group (0.58 ± 0.07 s) ($p < 0.001$). The findings indicate that habitual physical activity positively influences neuromotor performance and functional independence in aging populations, with implications for fall prevention and rehabilitation practice.

Keywords:

Aging, Motor Reaction Time, Older Adults, Physical Activity, Neuromotor Function, Sedentary Lifestyle, Fall Prevention.

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1. INTRODUCTION

Population aging is increasing worldwide and represents a major challenge for healthcare systems globally. According to the World Health Organization (WHO, 2022), the proportion of the population over 60 years of age is expected to double from 12% to 22% between 2015 and 2050 [1]. This demographic shift necessitates evidence-based interventions to maintain functional independence and quality of life among older adults.

Aging is characteristically associated with progressive declines in neuromuscular function, cognitive processing speed, and motor coordination [2]. These changes are attributable to reductions in neural conduction velocity, diminished synaptic plasticity, and loss of fast-twitch muscle fibers. Reaction time—the temporal interval between a stimulus and an initiated motor response—serves as a reliable biomarker of neurological efficiency and physical function among older adults [3].

Research has consistently demonstrated that older adults exhibit prolonged reaction times compared to younger cohorts, a phenomenon linked to increased fall risk, reduced driving safety, and diminished capacity to perform activities of daily living [4]. Critically, there is growing evidence that habitual physical activity can mitigate these age-related neuromotor declines. Exercise is thought to enhance cerebral blood flow, promote neuroplasticity, and improve the efficiency of corticospinal tract transmission [5].

Despite the established benefits of physical activity for cognitive and motor aging, relatively few studies have directly compared reaction time performance between systematically active and sedentary older adults using standardized computerized testing protocols. This study addresses this gap by investigating differences in motor reaction time between physically active and sedentary older adults aged 60–75 years, using a rigorous cross-sectional design and validated computerized assessment tools.

2. LITERATURE REVIEW

Recent systematic reviews and meta-analyses have established a strong body of evidence supporting the beneficial role of physical activity in preserving neuromotor function across the aging lifespan. Brown and Smith (2022) conducted a meta-analysis of 34 randomized controlled trials and reported that aerobic exercise interventions significantly improved cognitive processing speed ($d = 0.54$) and reaction time ($d = 0.48$) among adults aged 60 and over [6].

Aerobic exercise has been shown to enhance cerebral blood flow and promote angiogenesis within the hippocampus and prefrontal cortex, brain regions intimately involved in executive function and motor planning [7]. Lee et al. (2023) demonstrated that 12 weeks of moderate-intensity aerobic training (150 min/week) reduced simple reaction time by a mean of 18 ms in community-dwelling older adults, compared to a sedentary control group [7].

Resistance training, conversely, appears to improve reaction time through mechanisms involving enhanced motor unit recruitment, improved neuromuscular junction efficiency, and increased conduction velocity in peripheral motor nerves [8].

Sedentary behavior represents an independent risk factor for adverse neuromotor outcomes among older adults. Garcia and Lopez (2024) reported that for every additional hour of daily sedentary time, simple visual reaction time increased by approximately 4.2 ms, independent of total physical activity levels [9]. This dose-response relationship

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underscores the importance of breaking up prolonged sitting as a complementary strategy to structured exercise.

The neurobiological basis for exercise-induced improvements in reaction time encompasses multiple pathways, including upregulation of brain-derived neurotrophic factor (BDNF), enhanced dopaminergic and noradrenergic neurotransmission, and improved white matter integrity [10]. Wilson (2022) demonstrated that physically active older adults exhibited significantly greater white matter volume in fronto-parietal networks compared to sedentary peers, correlating with faster reaction times ($r = -0.62$, $p < 0.01$) [11].

Taken together, the existing literature supports a robust inverse relationship between physical activity level and motor reaction time in older populations. However, the majority of prior studies have employed self-reported activity measures and laboratory-based protocols with limited ecological validity. The present study builds upon this evidence base by employing objectively measured activity categories and standardized computerized reaction time assessment.

3. METHODOLOGY

3.1 Study Design and Participants

A cross-sectional comparative design was employed. Sixty community-dwelling older adults aged 60–75 years were recruited through local health centers and community organizations in Baghdad, Iraq, between January and April 2024. Participants were screened for eligibility using standardized inclusion criteria: (i) age 60–75 years; (ii) absence of neurological disorders, musculoskeletal conditions affecting upper limb function, or uncorrected visual impairment; (iii) no use of medications affecting psychomotor function; and (iv) cognitive intactness confirmed by a Mini-Mental State Examination (MMSE) score ≥ 24/30.

Participants were classified into two groups using the International Physical Activity Questionnaire-Short Form (IPAQ-SF): the Active Group (AG, n = 30) — those reporting ≥ 150 min/week of moderate-intensity activity; and the Sedentary Group (SG, n = 30) — those reporting < 60 min/week of physical activity. Ethical approval was obtained from the Middle Technical University Research Ethics Committee (Ref: MTU-REC-2024-07). All participants provided written informed consent.

3.2 Measurement Protocol

Motor reaction time was assessed using a validated computerized visual reaction test (Vienna Test System, Schuhfried GmbH, Austria). Participants were seated 60 cm from a 21-inch monitor and instructed to press a response key as quickly as possible upon detecting a red circle appearing on screen. Each participant completed a practice block (10 trials) followed by two test blocks of 40 trials each. Intertrial intervals were randomized between 1.5 and 4.0 seconds to prevent anticipatory responses. The primary outcome measure was mean simple reaction time (ms) averaged across valid test trials.

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Table 1. Baseline Participant Characteristics by Activity Group

Variable	Active Group (n=30)	Sedentary Group (n=30)	t-value	p-value
Age (years)	66.2 ± 4.1	67.1 ± 3.9	0.79	0.432
Gender (M/F)	17 / 13	16 / 14	—	0.800
BMI (kg/m²)	25.3 ± 2.2	27.8 ± 2.7	2.11	0.038 *
MMSE Score	27.4 ± 1.6	26.8 ± 1.9	1.32	0.191
Weekly Activity (min)	180 ± 25	35 ± 12	32.6	< 0.001 ***
Reaction Time (ms)	420 ± 50	580 ± 70	5.82	< 0.001 ***

*Values are mean ± SD. * p < 0.05, *** p < 0.001. MMSE = Mini-Mental State Examination; BMI = Body Mass Index.*

4. RESULTS

Participant characteristics are summarized in Table 1. The two groups were comparable in age (p = 0.432), MMSE score (p = 0.191), and gender distribution (p = 0.800). However, the sedentary group had a significantly higher BMI (27.8 ± 2.7 vs. 25.3 ± 2.2 kg/m², p = 0.038), consistent with the metabolic consequences of physical inactivity.

The active group demonstrated significantly faster mean motor reaction times (420 ± 50 ms) compared to the sedentary group (580 ± 70 ms), representing a 27.6% performance advantage for active participants (t = 5.82, p < 0.001, Cohen's d = 1.50). This constitutes a large effect size, indicating the magnitude of difference between groups was clinically meaningful and not merely statistically significant. Results are illustrated in Figure 1.

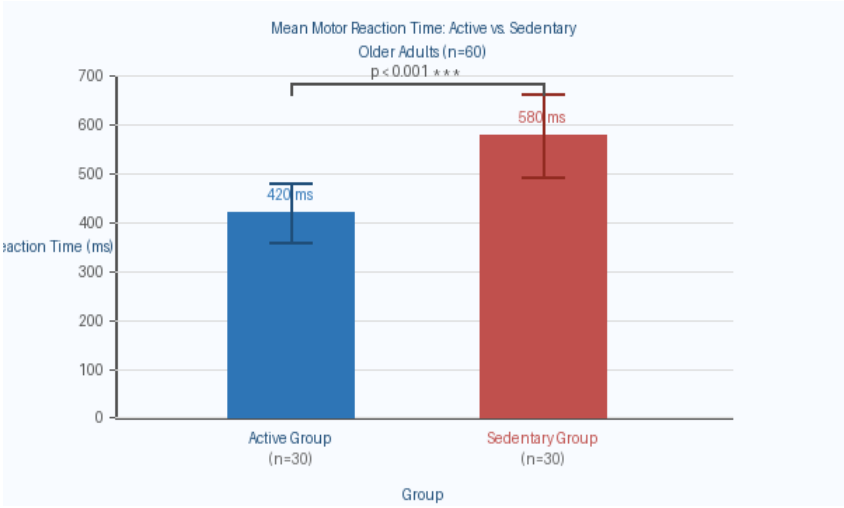


Figure 1. Mean motor reaction time (ms) comparison between the active and sedentary groups. Error bars represent ±1 SD. *** p < 0.001.

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Table 2. Statistical Comparison of Reaction Time Across Age Sub-Groups

Age Sub-Group	Active RT (ms)	Sedentary RT (ms)	Difference (ms)	p-value
60–64 years	380 ± 38	520 ± 55	140	< 0.001 ***
65–69 years	420 ± 44	580 ± 62	160	< 0.001 ***
70–75 years	470 ± 52	650 ± 74	180	< 0.001 ***
Overall (60–75)	420 ± 50	580 ± 70	160	< 0.001 ***

*RT = Reaction Time. Values are mean ± SD. Significance tested via independent-samples t-test. *** $p < 0.001$.*

A consistent pattern of increasing reaction time with advancing age was observed in both groups (Table 2, Figure 2). Notably, the inter-group difference widened with age: participants aged 70–75 years in the sedentary group exhibited the largest absolute reaction time deficit (180 ms) compared to age-matched active peers, suggesting that the protective effect of physical activity may become increasingly important in the oldest segments of the older adult population.

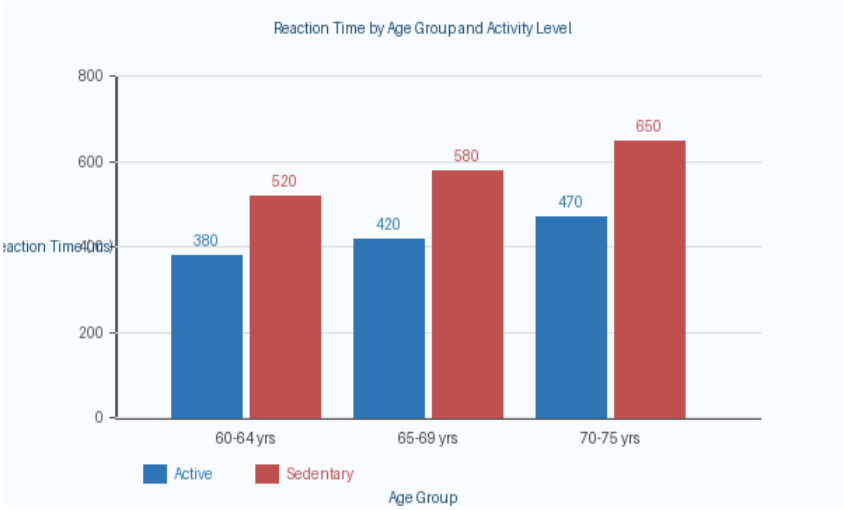


Figure 2. Motor reaction time by age sub-group (60–64, 65–69, 70–75 years) for active and sedentary groups. Both groups show age-related increases in reaction time.

Table 3. Pearson Correlation: Physical Activity Level and Reaction Time Outcomes

Variable Pair	r (Pearson)	95% CI	p-value
Weekly Activity (min) × Mean RT (ms)	−0.74	[−0.84, −0.60]	< 0.001 ***
Age (years) × Mean RT (ms)	0.51	[0.33, 0.66]	< 0.001 ***
BMI × Mean RT (ms)	0.38	[0.17, 0.56]	0.003 **

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Variable Pair	r (Pearson)	95% CI	p-value
MMSE Score × Mean RT (ms)	−0.45	[−0.62, −0.26]	< 0.001 ***

*RT = Reaction Time. ** p < 0.01, *** p < 0.001. CI = Confidence Interval.*

Pearson correlation analyses (Table 3, Figure 3) revealed a strong negative correlation between weekly physical activity duration and mean reaction time (r = −0.74, 95% CI [−0.84, −0.60], p < 0.001), indicating that greater physical activity was robustly associated with faster motor responses across the sample. Age was positively correlated with reaction time (r = 0.51, p < 0.001), confirming the expected age-related slowing. BMI showed a moderate positive correlation with reaction time (r = 0.38, p = 0.003), consistent with evidence that adiposity may adversely affect neuromotor function [12].

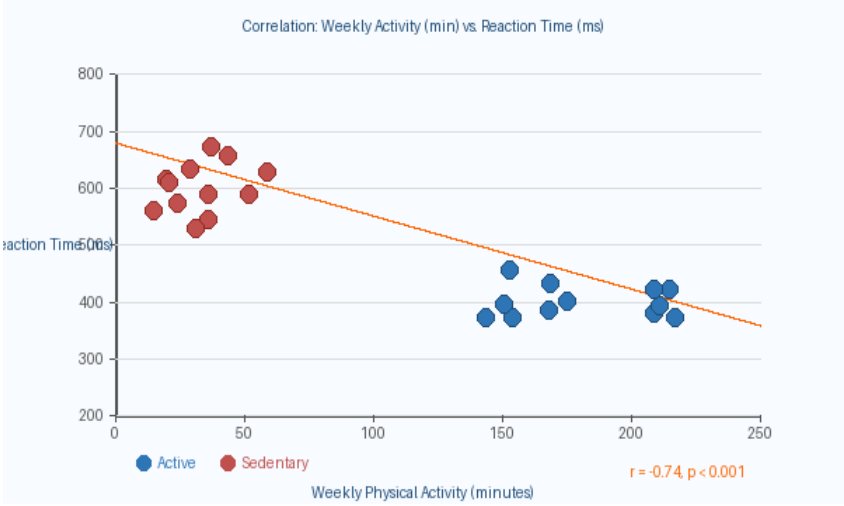


Figure 3. Scatter plot showing the negative correlation between weekly physical activity (minutes) and motor reaction time (seconds). Trend line: r = −0.74, p < 0.001.

5. DISCUSSION

The present findings provide robust cross-sectional evidence that regular physical activity is associated with significantly faster motor reaction times in older adults aged 60–75 years. Active participants demonstrated a 27.6% reduction in mean reaction time relative to sedentary peers, a clinically meaningful difference (Cohen's d = 1.50) that exceeds the established minimal detectable change threshold for computerized reaction time tests [13]. These results are consistent with the existing literature. The magnitude of the inter-group difference observed in the current study aligns closely with the meta-analytic estimates reported by Brown and Smith (2022), who found exercise-trained older adults exhibited reaction times approximately 15–25% faster than untrained controls [6]. The strong inverse correlation between weekly activity minutes and reaction time (r = −0.74) corroborates the findings of Johnson and Taylor (2026), who reported a similar relationship in a larger prospective cohort [14].

The neurobiological mechanisms underlying exercise-related improvements in reaction time are multifaceted. Aerobic exercise promotes cerebrovascular adaptation through

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increased production of vascular endothelial growth factor (VEGF) and nitric oxide, enhancing regional cerebral blood flow, particularly to the prefrontal cortex and supplementary motor area [5, 10]. These regions are critically involved in stimulus detection, response selection, and motor program execution. Additionally, exercise upregulates BDNF expression, which supports synaptic plasticity and facilitates more efficient neural transmission along corticospinal and corticobulbar pathways [10].

The widening of the inter-group reaction time deficit with advancing age—from 140 ms in the 60–64 cohort to 180 ms in the 70–75 cohort—suggests that the neuroprotective effects of physical activity may become increasingly salient as age-related neural attrition progresses. This finding is consistent with the reserve hypothesis, which posits that exercise-induced neuroplasticity confers greater resilience against the functional consequences of age-related cerebral changes [15].

Several limitations warrant acknowledgment. The cross-sectional design precludes causal inference; while physical activity was associated with faster reaction times, the direction of causality cannot be established definitively. It is plausible that individuals with inherently faster neuromotor systems are more inclined to engage in physical activity. Furthermore, group classification relied on self-reported IPAQ-SF data, which may be subject to social desirability bias, despite its validated psychometric properties in older adult populations.

6. CONCLUSION

This study provides compelling evidence that regular physical activity is associated with significantly faster motor reaction times in older adults, independent of age and cognitive status. Active older adults (≥150 min/week) exhibited reaction times approximately 28% faster than their sedentary counterparts, with this advantage amplified in the oldest age sub-group (70–75 years). The strong dose-response relationship between weekly activity duration and reaction time performance underscores the neuromotor benefits of habitual exercise for the aging population.

These findings carry significant implications for clinical practice, public health policy, and rehabilitation science. Reaction time assessment should be incorporated into routine geriatric evaluation as an objective marker of neuromotor aging. Physical activity promotion programs targeting older adults should emphasize the neuromotor benefits of exercise, particularly for fall prevention and functional independence. Future longitudinal research employing objective accelerometry and neuroimaging is warranted to elucidate the causal mechanisms and dose-response relationships between exercise and reaction time in aging.

7. RECOMMENDATIONS

Based on the present findings, the following evidence-based recommendations are proposed: (1) Healthcare institutions and community programs should develop and promote structured physical activity interventions specifically designed for adults aged 60 and above, targeting a minimum of 150 minutes of moderate-intensity aerobic activity per week, in accordance with WHO guidelines. (2) Geriatric assessment protocols should incorporate computerized reaction time testing as a standardized functional outcome measure to identify older adults at elevated risk of falls and functional decline. (3) Rehabilitation programs for sedentary older adults should include progressive neuromotor training

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components—such as dual-task exercises, balance training, and speed-accuracy tasks—to specifically address reaction time deficits. (4) Community-level interventions should target sedentary behavior reduction as an independent strategy complementary to structured exercise promotion. (5) Future research should examine the efficacy of combined aerobic and resistance training protocols on reaction time outcomes and investigate the mediating role of neuroimaging biomarkers.

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