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Impact of a Six-Month Walking Program on Cognitive and Functional Abilities in Older Tunisian Adults: A Quasi-Experimental Study

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Abstract: Regular physical activity is a key modulator of healthy aging, yet its multidomain effects on cognition, functional independence, and physical capacity remain understudied in North African populations. This study investigated the effects of a six-month structured walking program on cognitive performance, functional independence, and cardiorespira-tory endurance in older Tunisian adults. A quasi-experimental study with a matched pairs design was conducted. Fifty two adults (mean age: 70.98 ± 4.55 years; 26 per group) participated in a six-month walking program held three sessions per week. Cognitive function was assessed with the Digit Symbol Substitution Test (DSST), functional independence with the Lawton Instru-mental Activities of Daily Living Scale (IADL), cardiorespiratory endurance with the Six Minute Walk Test (6MWT), and perceived exertion with the Borg Scale. Assessments were conducted at baseline (T1), three months (T2), and six-month (T3). The exercise group showed significant improvements in DSST scores ($p < 0.001$; $\eta^2p = 0.561$), IADL scores ($p < 0.001$; $\eta^2p = 0.816$), and 6MWT distance ($p < 0.0001$; $\eta^2p = 0.927$). Perceived exertion decreased significantly ($p < 0.001$; $\eta^2p = 0.126$), reflecting cadiovascular adaptation. The control group showed no significant changes. Strong positive correlations emerged between DSST, IADL, and 6MWT scores at T2 and T3 (all $p < 0.001$). A structured six-month walking program significantly improves cognitive function, functional independence, and physical endurance in older Tunisian adults. These findings support the integration of walking-based interventions into routine health strategies for aging populations.

Keywords: walking program; cognitive function; functional independence; physical endurance; aging; older adults; quasi-experimental

1. Introduction

Regular physical activity, particularly walking, produces well-documented benefits for physical and mental health. It is an accessible, low-cost intervention that improves well-being and quality of life across the lifespan, and especially for older adults.

The World Health Organization (WHO) classifies physical inactivity as a leading risk factor for global morbidity and mortality, linking it to cardiovascular diseases, type 2 diabetes, and certain cancers **[1]**. Conversely, moderate activities such as walking reduce the risk of chronic diseases and increase lifespan **[2]**. WHO guidelines recommend at least 150 minutes of moderate intensity physical activity per week, or 75 minutes of vigorous activity **[3]**. The relationship between exercise and cardiovascular risk follows a curvilinear dose response pattern, with vascular benefits that depend on training frequency, intensity, volume, and modality [4].

Walking offers practical advantages over other exercise forms. It requires no specialized equipment or prior knowledge, making it easy to incorporate into daily routines **[5]**. Even 30 minutes of walking at a steady pace each day can produce meaningful health improvements **[6]**. Physiologically, regular walking enhances cardiovascular capacity, increases oxygen efficiency, reduces resting heart rate, strengthens muscles, improves bone density, and supports healthy body weight [7], [8]. These gains extend to mental health, with consistent evidence that regular physical activity alleviates anxiety, depression, and stress **[9]**.

The relationship between walking and cognitive function in aging populations has received substantial research attention. Epidemiological data suggest that regular physical activity slows cognitive decline and improves performance across cognitive domains in healthy older adults **[10]**. Proposed biological mechanisms include increased cerebral blood flow, neurogenesis, and the release of neurotrophic factors supporting synaptic plasticity and neuronal health **[11]**.

A key concern in aging research is the ability to perform activities of daily living (ADL). Maintaining these tasks is vital for independence and quality of life. With aging, the performance of activities such as dressing, cooking, and managing finances may decline, increasing the risk of dependency **[12]**. Walking based interventions have shown positive effects on ADL performance, helping older adults maintain mobility and independence **[13]**. Despite a growing body of evidence, older Tunisian adults have not been examined in this context. We hypothesized that participation in a structured six-month walking program would improve cognitive performance, functional independence, and cardiorespiratory endurance compared with usual activity. Both objective and subjective measures were included to provide a comprehensive assessment of the health benefits of regular walking. We hypothesized in this study that participation in a structured six-month walking program would improve cognitive performance, functional independence, and cardiorespiratory endurance compared with usual activity.

2. Materials and Methods

2.1. Ethical Approval

This study was conducted in accordance with the Declaration of Helsinki and received ethical approval from the South Tunisian Committee for the Protection of Individuals (CPP SUD N° 0477/2023). Written informed consent was obtained from all participants prior to enrollment. This quasiexperimental study is reported following the TREND (Transparent Reporting of Evaluations with Nonrandomized Designs) statement **[14]**.

2.2. Study Design and Participants

A quasiexperimental design with two matched groups (exercise and control) was used. Data collection commenced in June 2022 at the Department of Sports and Technology, University of Sfax, Tunisia.

Participants were recruited from a retirement home in Gafsa, Tunisia. A total of 52 older adults were enrolled in the study (15 men and 11 women per group; n = 26 per group; mean age: 70.98 ± 4.55 years). A matched pairs allocation procedure was used to ensure baseline comparability between groups. Participants were first stratified by sex and then matched according to the closest values of age ,body weight, height, and body mass index (BMI). Matching was performed by the research team prior to group allocation. Within each matched pair, one participant was assigned to the exercise group and the other to the control group. Baseline equivalence was confirmed statistically (all $p > 0.05$; Table 1). Outcome assessors responsible for 6MWT, IADL, and DSST measurements were blinded to participants group allocation. A priori power analysis, based on expected effect sizes from comparable walking interventions (Cohen's $d \approx 0.8$ for cognitive outcomes), indicated that 24 participants per group were sufficient to achieve 80% statistical power at $\alpha = 0.05$. The final allocation of 26 per group provided a buffer against attrition.

Inclusion criteria: age 60–80 years; physically inactive (< 30 min moderate activity/week over the preceding 6 months); non-smoker; non-drinker; educational attainment below high school level. Exclusion criteria: disability; severe osteoarthritis; cognitive impairment (MMSE < 24); metal implants; hypertension; prior cardiac surgery; poorly controlled diabetes; use of antihyperlipidemic, antihypertensive, or antihyperglycemic medications. Of 70 candidates screened, 18 were excluded. Participants were instructed to avoid additional physical activity throughout the study period **(Figure 1)**.

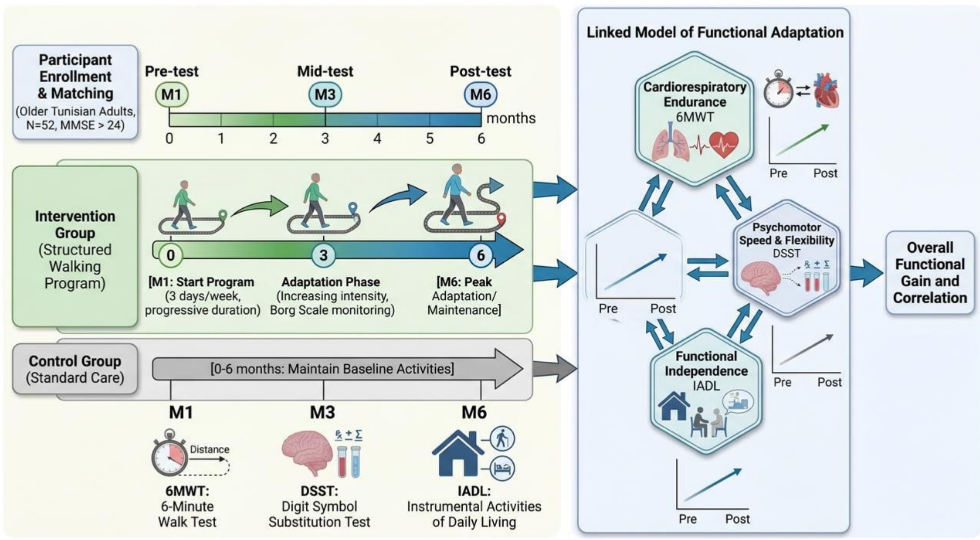

Figure 1. Study design and linked model of functional adaptation. Fifty two older Tunisian adults (N = 52, MMSE > 24) were enrolled and matched into the Intervention Group (structured walking program, three sessions per week, progressive duration) and the Control Group (standard care, baseline activities maintained). Outcome assessments were conducted at three time points: pre test (M1), mid test (M3), and post test (M6). Primary outcomes included cardiorespiratory endurance (6MWT), psychomotor speed and cognitive flexibility (DSST), and functional independence (IADL). The linked model illustrates the anticipated interconnected improvements across all three domains following the six-month intervention.

2.3. Exercise Protocol The exercise group completed a six-month walking program, three sessions per week, conducted outdoors in the mornings. Attendance was recorded at each training session. All the participants were present at every session throughout the intervention period, with no missed sessions or dropouts reported.

Each session began with warm up stretching followed by 30 minutes of walking at moderate intensity. Intensity was regulated using the Borg Perceived Exertion Scale **[15]**, targeting a rating of 11–13 ("light" to "somewhat hard"). This ensured the program remained safe and appropriately challenging for each participant. The control group maintained their usual daily routines. Full adherence was observed across both groups.

2.4. Outcome Measures

All assessments were conducted by trained staff using standardized protocols at T1, T2, and T3.

Six Minute Walk Test (6MWT). The 6MWT assessed functional cardiorespiratory capacity by measuring the distance walked in six minutes on a flat 30-metre course, following ATS guidelines **[16]**. It is a validated measure of endurance in older adult populations.

Digit Symbol Substitution Test (DSST). The DSST evaluated psychomotor speed, sustained attention, visuospatial skills, and cognitive flexibility **[17]**. A printed key pairs nine symbols with digits 1–9. Participants filled 140 blanks with corresponding symbols within 120 seconds. The score is the number of correct responses.

Instrumental Activities of Daily Living (IADL). The Lawton IADL scale assessed the ability to perform tasks necessary for independent living, including managing finances, meal preparation, and household maintenance **[18]**. It is widely used in geriatric and functional assessment contexts.

Borg Perceived Exertion Scale. The Borg Scale (range: 6–20) was used during sessions to regulate training intensity **[18]**. It was also administered at each testing time point as a secondary outcome to track perceived effort adaptation across the program.

2.5. Statistical Analysis

Data are presented as mean ± standard deviation. The Shapiro Wilk test verified normality of the distribution. Repeated measures ANOVA compared 6MWT, DSST, IADL, and Borg scores across time points and between groups. Effect sizes are reported as partial etasquared (η^2p): values of ≥ 0.01, ≥ 0.06, and ≥ 0.14 reflect small, medium, and large effects, respectively. Significant time by group interactions were followed by Bonferroni corrected post hoc comparisons. Spearman rank correlations assessed assocations between DSST, IADL, and 6MWT at each time point, reported for the pooled sample (N = 52). The significance threshold was $p < 0.05$. All analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA).

3. Results

Baseline characteristics of both groups are presented in **Table 1**. No significant between group differences were found for any variable, including MMSE scores (exercise: 24.38 ± 0.50; control: 24.55 ± 1.10; p = 0.45).

Table 1. Baseline characteristics of study participants (mean ± SD or n). No significant between group differences were observed at baseline (p > 0.05 for all variables).

Variable	All (N = 52)	Exercise (n = 26)	Control (n = 26)	p value
Age (years)	70.98 ± 4.55	70.73 ± 4.96	71.23 ± 4.19	0.69
Weight (kg)	71.07 ± 9.66	70.65 ± 11.93	71.50 ± 6.88	0.75
Height (m)	1.72 ± 0.12	1.72 ± 0.13	1.72 ± 0.11	0.98
BMI (kg/m²)	23.86 ± 2.18	23.67 ± 2.75	24.04 ± 1.75	0.55
MMSE score	24.46 ± 0.82	24.38 ± 0.50	24.55 ± 1.10	0.45
Female, n	22	11	11	1.00
Male, n	30	15	15	1.00

Six Minute Walk Test (6MWT). As shown in **Figure 2A**, the control group's 6MWT distance remained stable (T1: 402.57 ± 4.36 m; T2: 402.30 ± 4.29 m; T3: 402.38 ± 4.45 m; p = 0.87). The exercise group showed a progressive and significant increase (T1: 401.53 ± 3.60 m; T2: 447.50 ± 8.10 m; T3: 495.30 ± 11.03 m; $p < 0.0001$; $\eta^2p = 0.927$). At T3, the exercise group walked significantly further than controls (495.30 ± 11.03 m vs. 402.38 ± 4.45 m; $p < 0.001$).

Instrumental Activities of Daily Living (IADL). IADL scores in the control group showed no significant change (T1: 22.07 ± 0.39; T2: 21.96 ± 0.44; T3: 21.88 ± 0.32; $p = 0.78$; **Figure 2B**). The exercise group demonstrated a significant progressive improvement (T1: 22.07 ± 0.39; T2: 24.38 ± 0.85; T3: 26.53 ± 0.64; $p < 0.001$; $\eta^2p = 0.816$). At T3, the exercise group scored significantly higher than controls (26.53 ± 0.64 vs. 21.88 ± 0.32; $p < 0.001$).

Digit Symbol Substitution Test (DSST). DSST scores in the control group remained stable (T1: 46.38 ± 2.97; T2: 46.03 ± 3.14; T3: 46.26 ± 3.00; $p = 0.96$; **Figure 2C**). The exercise group showed a significant and progressive improvement (T1: 45.00 ± 3.00; T2: 50.26 ± 2.86; T3: 58.92 ± 4.25; $p <0.001$; $\eta^2p = 0.561$). At T3, the exercise group significantly outperformed controls (58.92 ± 4.25 vs. 46.26 ± 3.00; $p < 0.001$).

Borg Perceived Exertion. Control group Borg scores showed no significant change (T1: 12.98 ± 1.76; T2: 12.85 ± 2.04; T3: 12.77 ± 1.99; $p = 0.449$). The exercise group showed a significant progressive decrease (T1: 12.88 ± 0.32; T2: 11.23 ± 0.43; T3: 10.69 ± 0.61; $p < 0.001$; $\eta^2p = 0.126$; **Figure 2D**), indicating progressive cardiovascular adaptation to training load.

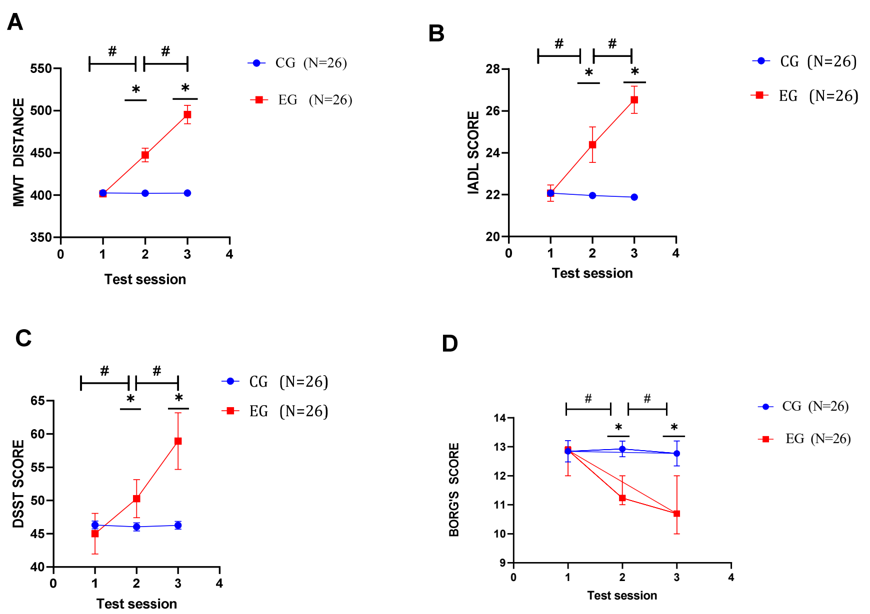

Figure 2. Effects of the six-month walking program on performance outcomes at T1 (baseline), T2 (3 months), and T3 (6 months) in the exercise group (EG, n = 26) and control group (CG, n = 26). (A) Six Minute Walk Test (6MWT) distance in metres; (B) Instrumental Activities of Daily Living (IADL) scores; (C) Digit Symbol Substitution Test (DSST) scores; (D) Borg Perceived Exertion ratings. * $p < 0.05$, significant difference between EG and CG at the same time point; # significant difference between consecutive measurement times within EG. Error bars represent standard deviation. Changes in functional and cognitive outcomes from baseline (T1) to post intervention (T3). Significant time × group interactions were observed for all outcomes in 52 participants (EG: n = 26, CG: n = 26). IADL scores: $F(1,50) = 580.65$, $p < .001$, $\eta^2p = .921$, mean difference = 4.62, 95% CI [4.23, 5.00]. 6MWT scores: $F(1,50) = 973.03$, $p < .001$, $\eta^2p = .951$, mean difference = 94.04, 95% CI [87.98, 100.09]. Borg Scale scores: $F(1,50) = 201.03$, $p < .001$, $\eta^2p = .801$, mean difference = -2.15, 95% CI [-2.46, -1.85]. DSST scores: $F(1,50) = 238.09$, $p < .001$, $\eta^2p = .826$, mean difference = 13.81, 95% CI [12.01, 15.61]. Mean differences represent EG minus CG change scores (T3–T1).

3.1. Correlation Analysis

Correlation results for all time points are presented in **Table 2** and summarized in **Table 3**. At T1, a moderate positive correlation was found between IADL and 6MWT scores ($r = 0.379$, $p = 0.006$). This association strengthened markedly by T2 ($r = 0.831$, $p < 0.001$) and remained robust at T3 ($r = 0.835$, $p < 0.001$). DSST scores showed a moderate correlation with 6MWT at T2 ($r = 0.468$, $p = 0.001$), which intensified at T3 ($r = 0.765$, $p < 0.001$). IADL and DSST scores correlated moderately at T2 ($r = 0.564$, $p < 0.001$), strengthening to $r = 0.822$ at T3 ($p < 0.001$). A visual summary is provided in **Figure 3**.

The negative correlations between DSST at T1 and 6MWT at T2 ($r = -0.324$, $p = 0.021$) and T3 ($r = -0.302$, $p = 0.031$) in the pooled sample represent a between group artifact. The control group entered with marginally higher mean DSST scores (46.38 vs. 45.00) but showed no 6MWT improvement, while the exercise group produced the largest 6MWT gains. Pooling both groups creates a spurious inverse pattern that does not reflect a true within group negative association.

Table 2. Spearman correlation matrix for 6MWT, IADL, and DSST scores at T1, T2, and T3 (pooled sample, N = 52). Bold values indicate statistical significance. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Variable	6MWT.T1	6MWT.T2	6MWT.T3	IADL.T1	IADL.T2	IADL.T3	DSST.T1	DSST.T2	DSST.T3
6MWT.T1	1.000								
6MWT.T2	-0.122 (0.390)	1.000							
6MWT.T3	-0.174 (0.218)	**0.958*** **	1.000						
IADL.T1	**0.379** **	-0.020 (0.888)	0.045 (0.752)	1.000					
IADL.T2	-0.097 (0.493)	**0.831*** **	**0.830*** **	-0.052 (0.714)	1.000				
IADL.T3	-0.167 (0.237)	**0.835*** **	**0.835*** **	-0.044 (0.757)	**0.915*** **	1.000			
DSST.T1	0.047 (0.744)	**-0.324***	**-0.302***	-0.097 (0.498)	-0.154 (0.282)	-0.104 (0.467)	1.000		
DSST.T2	-0.115 (0.421)	**0.468*** **	**0.489*** **	0.008 (0.957)	**0.564*** **	**0.601*** **	**0.484*** **	1.000	
DSST.T3	-0.078 (0.588)	**0.753*** **	**0.765*** **	-0.055 (0.700)	**0.785*** **	**0.822*** **	0.095 (0.508)	**0.788*** **	1.000

Table 3. Summary of key Spearman correlations between DSST, IADL, and 6MWT by time point. Bold values indicate statistically significant associations. ** $p < 0.01$; *** $p < 0.001$; ns = not significant.

Variable	6MWT.T1	6MWT.T2	6MWT.T3	IADL.T1	IADL.T2/T3
IADL.T1	**0.379****				
IADL.T2		**0.831*****			
IADL.T3			**0.835*****		
DSST.T1	ns			-0.097 (ns)	
DSST.T2		**0.468*****			**0.564*****
DSST.T3			**0.765*****		**0.822*****

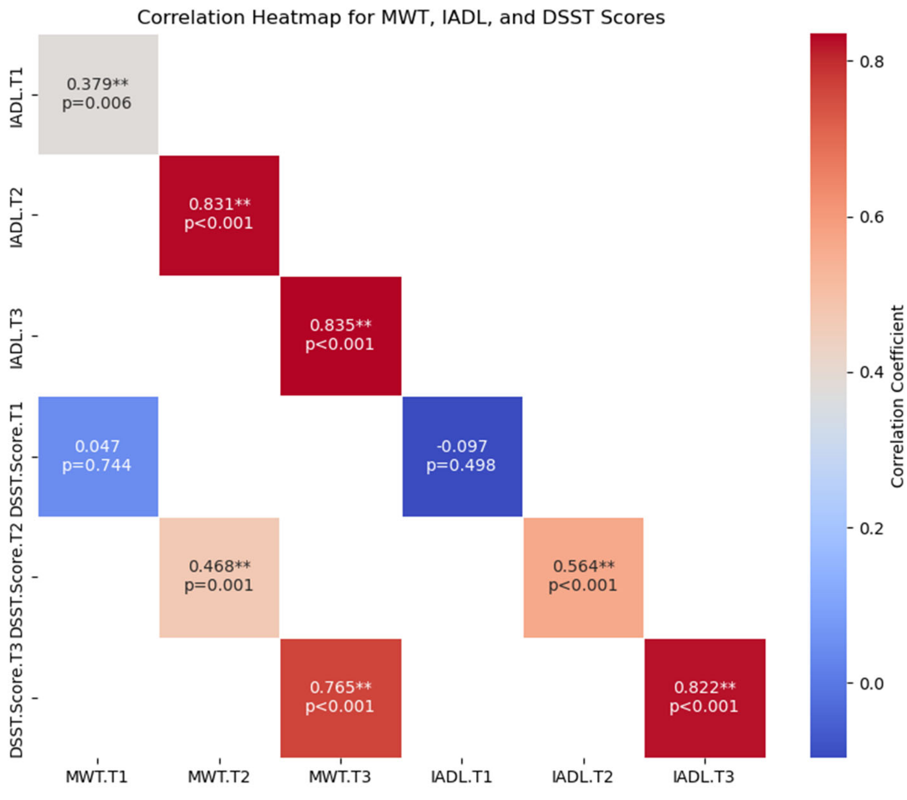

Figure 3. Correlation heatmap of Spearman coefficients between 6MWT, IADL, and DSST scores at T1, T2, and T3 (pooled sample, N = 52). Colour intensity reflects the magnitude and diretion of each association. ** $p < 0.01$; *** $p < 0.001$.

4. Discussion

This study provides compelling evidence that a six-month walking program, evaluated within a quasiexperimental design, significantly benefits older Tunisian adults across physical, cognitive, and functional domains. The 6MWT improvement in the exercise group ($\eta^2p = 0.927$) is consistent with prior work by Sawada et al. **[19]** and Pucci et al. **[20]**, both demonstrating that structured walking programs improve endurance, mobility, and cardiovascular function in older adults. Normative 6MWT data for communitydwelling adults aged 61–70 years report mean distances of 387–487 m **[21, 29]**. The exercise group's T3 performance (495.30 m) exceeded this upper bound, indicating a clinically meaningful gain.

The improvement in IADL scores (η^2p = 0.816) aligns with findings from Verstraeten et al. **[22]** and Baltasar Fernandez et al. **[23]** , who demonstrated the value of regular exercise in preserving daily functioning and reducing frailty. These results reinforce walking's practical role for maintaining autonomy in aging populations.

Cognitive gains in the exercise group (η^2p = 0.561) are consistent with results from Firth et al. **[24]** , who found that regular aerobic exercise increases hippocampal volume and improves memory and executive function. Elkhooly et al. **[25]** confirmed in a meta analysis that aerobic activity produces significant improvements in processing speed and memory. These studies suggest that physical activity supports neuroplasticity and stimulates brain derived neurotrophic factor (BDNF) secretion, contributing to cognitive health in aging populations.These findings align with preventive rehabilitation principles, highlighting walking as a low-cost strategy for preservation of functional independence and prevention of functional decline in older adults. The intervention supports rehabilitation-oriented ageing strategies aimed at maintaining autonomy and reducing disability burden.

The progressive decrease in Borg scores (η^2p = 0.126) in the exercise group (12.88 at T1 to 10.69 at T3) is consistent with observations by D'Onofrio et al. **[8]** and the foundational work of Borg **[18]**. As cardiorespiratory fitness improves, perceived effort at the same absolute workload decreases. This confirms genuine physiological conditioning rather than a motivational or placebo effect.

The correlation data provide mechanistic insight. The IADL 6MWT correlation rose from 0.379 at baseline to 0.835 at T3, visualized in **Figure 3**. Chavoix et al. **[26]** reported analogous associations between walking capacity and cognitive function, supporting a shared neuromotor substrate. The IADL DSST relationship (r = 0.822 at T3) indicates that gains in daily living skills and cognitive function coevolved during the program. Li et al. **[27]** demonstrated parallel gains in cognitive and functional performance following high intensity interval walking, further supporting this finding.

Taken together, these results support the use of moderate intensity walking for improving both physical and cognitive health in older adults. The findings align with broader evidence for combined physical and cognitive training to optimize outcomes in aging **[28]**. This study provides the first multi domain exercise evidence from older Tunisian adults.

Limitations

The sample was relatively small (n = 52), constraining generalizability to larger or more diverse populations. Future studies should target larger samples with greater demographic variation.

The study used matched pair allocation rather than computer generated randomization. Although this produced well balanced groups at baseline (Table 1), it does not fully eliminate selection bias. A fully randomized design would provide stronger causal inference.

Potential confounders, including diet, sleep quality, psychological stress, and informal physical activity outside the structured program, were not controlled.

Perceived exertion was measured with the Borg Scale, a validated but inherently subjective instrument. Objective measures such as heart rate monitoring or VO_2 peak assessment would provide a more precise index of cardiorespiratory adaptation.

The MMSE inclusion criterion (≥ 24) restricted the sample to cognitively intact individuals. The findings may not extend to older adults with mild cognitive impairment or dementia, who may require adapted exercise protocols.

Finally, the six-month observation window captured short term gains. Long term follow up is required to determine whether benefits persist and translate into clinically meaningful endpoints such as reduced hospitalization or delayed cognitive decline.

5. Conclusions

This quasiexperimental study demonstrates that a structured six-month walking program significantly improves cognitive function, functional independence, and cardiorespiratory endurance in older Tunisian adults. The large effect sizes for 6MWT (η^2p = 0.927) and IADL (η^2p = 0.816), alongside the moderate effect for DSST (η^2p = 0.561), confirm the clinical and practical relevance of these gains. The progressive strengthening of correlations between DSST, IADL, and 6MWT underscores the interconnected nature of cognitive and physical adaptation during sustained exercise training. These findings contribute the first multi domain exercise data from older Tunisian adults and support the wider evidence base for walking based interventions. Future research should examine the long term durability of these effects and explore combined physical cognitive training protocols in larger, more diverse cohorts.

Author Contributions: Conceptualization: K.S., N.L.B. and M.S.Z.; Methodology: K.S. and W.D.; Data Collection and Curation: K.S. and A.M.; Formal Analysis: W.D. and A.A.; Writing – Original Draft: R.I.M. and K.S.; Writing – Review and Editing: W.D., A.M., I.D., A.A., H.I.C., N.L.B. and M.S.Z.; Supervision: N.L.B., A.A., R.I.M. and M.S.Z.; Project Administration: M.S.Z. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the South Tunisian Committee for the Protection of Individuals (Protocol Code: CPP SUD N° 0477/2023).

Informed Consent Statement: Written informed consent was obtained from all participants prior to enrollment.

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Bull, F.C.; Al Ansari, S.S.; Biddle, S.; Borodulin, K.; Buman, M.P.; Cardon, G.; Carty, C.; Chaput, J.P.; Chastin, S.; Chou, R.; et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br. J. Sports Med. 2020, 54, 1451–1458.
2. Rozanski, A. New principles, benefits, and practices for fostering a physically active lifestyle. Prog. Cardiovasc. Dis. 2023, 77, 37–49.
3. Königstein, K.; Dipla, K.; Zafeiridis, A. Training the vessels: Molecular and clinical effects of exercise on vascular health—a narrative review. Cells 2023, 12, 2544.
4. Konigstein, K.; Wagner, J.; Infanger, D.; Knaier, R.; Nève, G.; Klenk, C.; Carrard, J.; Hinrichs, T.; Schmidt Trucksass, A. Car-diorespiratory fitness and endothelial function in aging healthy subjects and patients with cardiovascular disease. Front. Cardiovasc. Med. 2022, 9, 870847.
5. Maresova, P.; Krejcar, O.; Maskuriy, R.; Bakar, N.A.A.; Selamat, A.; Truhlarova, Z.; Sourkova, M.; Penhaker, M.; Fend, M.; Kuca, K. Challenges and opportunity in mobility among older adults—key determinant identification. BMC Geriatr. 2023, 23, 447.
6. Shakoor, H.; Platat, C.; Ali, H.I.; Ismail, L.C.; Al Dhaheri, A.S.; Bosevski, M.; Apostolopoulos, V.; Stojanovska, L. The benefits of physical activity in middle aged individuals for cardiovascular disease outcomes. Maturitas 2023, 168, 49–52.
7. Garg, R.K.; Sharma, B. Walking transmutes the individual health system: Diseases. Int. J. Contemp. Pediatr. 2022, 10, 122–129.
8. D'Onofrio, G.; Kirschner, J.; Prather, H.; Goldman, D.; Rozanski, A. Musculoskeletal exercise: Its role in promoting health and longevity. Prog. Cardiovasc. Dis. 2023, 77, 25–36.
9. Mahindru, A.; Patil, P.; Agrawal, V. Role of physical activity on mental health and well being: A review. Cureus 2023, 15, e33475.
10. Imanol, R.E.; Mikel, I.; Heike, A.B.; Martínez, L.; Mikel, L.; Sáez, A. Effect of long term physical exercise and multidomain interventions on cognitive function and the risk of mild cognitive impairment and dementia in older adults: A systematic review with meta analysis. Ageing Res. Rev. 2024, 100, 102407.

11. Lee, M.J.; Ro, H.J.; Choi, J.K.; Kim, S.Y. Effects of walking exercise on cognitive and physical functions: Meta analysis of older adults. For. Sci. Technol. 2024, 20, 201–212.
12. Miri, S.; Farhadi, B.; Takasi, P.; Ghorbani Vajargah, P.; Karkhah, S. Physical independence and related factors among older adults: A systematic review and meta analysis. Ann. Med. Surg. 2024, 86, 3400–3408.
13. Venturelli, M.; Scarsini, R.; Schena, F. Six-month walking program changes cognitive and ADL performance in patients with Alzheimer. Am. J. Alzheimers Dis. Other Demen. 2011, 26, 381–388.
14. Des Jarlais, D.C.; Lyles, C.; Crepaz, N.; TREND Group. Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: The TREND statement. Am. J. Public Health 2004, 94, 361–366.
15. Borg, G.A.V. Psychophysical bases of perceived exertion. Med. Sci. Sports Exerc. 1982, 14, 377–381.
16. ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories. ATS statement: Guidelines for the six minute walk test. Am. J. Respir. Crit. Care Med. 2002, 166, 111–117.
17. Jaeger, J. Digit Symbol Substitution Test: The case for sensitivity over specificity in neuropsychological testing. J. Clin. Psy-chopharmacol. 2018, 38, 513–519.
18. Portela, D.; Almada, M.; Midão, L.; Costa, E. Instrumental Activities of Daily Living (iADL) limitations in Europe: An assesment of SHARE data. Int. J. Environ. Res. Public Health 2020, 17, 7387.
19. Sawada, Y.; Tanaka, E.; Tomisaki, E.; Watanabe, T.; Okumura, R.; Kinoshita, H.; Ozaki, S.; Hirano, K.; Ikeda, M. Active use of local exercise facilities can improve physical performance of community dwelling older adults. J. Phys. Ther. Sci. 2024, 36, 325–329.
20. Pucci, V.; Guerra, C.; Barsi, A.; Nucci, M.; Mondini, S. How long have you exercised in your life? The effect of motor reserve and current physical activity on cognitive performance. J. Int. Neuropsychol. Soc. 2024, 30, 11–17.
21. Enright, P.L.; McBurnie, M.A.; Bittner, V.; Tracy, R.P.; McNamara, R.; Arnold, A.; Newman, A.B. The 6 min walk test: A quick measure of functional status in elderly adults. Chest 2003, 123, 387–398.
22. Verstraeten, L.M.G.; Reijnierse, E.M.; Spoelstra, T.; Meskers, C.G.M.; Maier, A.B. The impact of mobility limitations on geri-atric rehabilitation outcomes: Positive effects of resistance exercise training (RESORT). J. Cachexia Sarcopenia Muscle 2024, 15, 2094–2103.
23. Baltasar Fernandez, I.; Soto Paniagua, H.; Alcazar, J.; Uceta Espinosa, M.I.; Alegre, L.M.; Gracia Garcia, F.J.; Casas Herrero, A. Long term effects of a 6 week power based resistance training and fast walking interval training program on physical func-tion in pre frail and frail older adults. Gerontology 2024, 70, 701–714.
24. Firth, J.; Stubbs, B.; Vancampfort, D.; Schuch, F.; Lagopoulos, J.; Rosenbaum, S.; Ward, P.B. Effect of aerobic exercise on hip-pocampal volume in humans: A systematic review and meta analysis. NeuroImage 2018, 166, 230–238.
25. Elkhooly, M.; Di Stadio, A.; Bernitsas, E. Effect of aerobic exercise versus non invasive brain stimulation on cognitive func-tion in multiple sclerosis: A systematic review and meta analysis. Brain Sci. 2024, 14, 771.
26. Chavoix, C.; Paire Ficout, L.; Lafont, S. Relationship between walking and driving, and cognitive functioning common to both modes of mobility, in healthy older adults. Gerontology 2024, 70, 184–192.
27. Li, X.; Seo, J.W.; Bae, J.H.; Jiang, S.; Sung, Y.; Jamrasi, P.; Ahn, S.Y.; Han, S.; Kim, S.; Kim, C.; et al. Effects of high intensity interval walking on cognitive and physical functions in older adults: A randomized pilot study. Cureus 2024, 16, e68165.
28. Chen, C.; Nakagawa, S. Physical activity for cognitive health promotion: An overview of the underlying neurobiological mechanisms. Ageing Res. Rev. 2023, 86, 101868.
29. Vizitiu, E., Costea, A. I., Silişteanu, S. C., & Constantinescu, M. (2023). Study on the assessment of cognitive and functional status for a segment of the population during the ageing process. Balneo and PRM Research Journal 2023, 14, 624.