The Bioscan
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
21(1) S (1) 30-40, 2026 www.thebioscan.com

IMPACT OF DUAL-TASK AEROBIC TRAINING ON COGNITIVE FUNCTION AND FUNCTIONAL CAPACITY IN PATIENTS WITH STABLE CORONARY ARTERY DISEASE: A RANDOMIZED CONTROLLED TRIAL

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DOI: https://doi.org/10.63001/tbs.2026.v21.i02.S.I(2).pp30-40

KEYWORDS

Coronary artery disease,
dual-task training,
cognitive function,
cardiac rehabilitation,
aerobic exercise.

Received on: 11-02-2026

Accepted on: 08-03-2026

Published on: 4-04-2026

Abstract

Background: Coronary artery disease (CAD) is associated with reduced functional capacity and cognitive impairment, particularly affecting executive function and attention. Conventional cardiac rehabilitation primarily targets physical outcomes, with limited emphasis on cognitive function.
Objective: To evaluate the effectiveness of dual-task aerobic training on cognitive function and functional capacity in patients with stable CAD.
Methods: A randomized controlled trial was conducted on 40 patients with stable CAD, randomly allocated into dual-task aerobic training (DTAT, n=20) and conventional aerobic training (CAT, n=20) groups. Both groups underwent training for 8 weeks (3 sessions/week, 40–50 minutes/session at 60–75% HRmax). Outcome measures included the Montreal Cognitive Assessment for cognitive function, 6-Minute Walk Test for functional capacity, and Dual-Task Walking Test for cognitive-motor performance. Data were analyzed using paired and independent t-tests.
Results: Both groups showed significant improvements in all outcome measures ($p < 0.05$). However, the DTAT group demonstrated significantly greater improvements in cognitive function, 6MWT distance, and dual-task performance compared to the CAT group ($p < 0.05$). Large effect sizes were observed across outcomes in the DTAT group.
Conclusion: Dual-task aerobic training is more effective than conventional aerobic training in improving cognitive function, functional capacity, and dual-task performance in patients with stable CAD. Incorporating dual-task paradigms into cardiac rehabilitation may enhance overall patient outcomes.

INTRODUCTION

Coronary artery disease (CAD) continues to be a leading cause of morbidity and mortality worldwide, contributing significantly to the global burden of cardiovascular diseases.[1] In addition to its well-established cardiovascular manifestations, CAD is increasingly recognized as a systemic condition affecting multiple organ systems, including the brain. Emerging evidence highlights a strong association between CAD and cognitive impairment, particularly in domains such as attention, executive function, memory, and processing speed.[2]

The underlying mechanisms linking CAD and cognitive decline are multifactorial. Chronic cerebral hypoperfusion, endothelial dysfunction, systemic inflammation, and atherosclerotic vascular changes collectively contribute to impaired neuronal integrity and synaptic function.[3] These pathophysiological processes form the basis of the heart–brain axis, which explains how cardiovascular dysfunction can accelerate neurodegenerative changes and increase the risk of dementia.[4]

A growing body of literature indicates that individuals with CAD are at a significantly higher risk of developing cognitive impairment and dementia. Epidemiological evidence suggests that cardiovascular diseases may increase dementia risk by approximately 20–30%, emphasizing the importance of early identification and targeted interventions.[4] Cognitive dysfunction in CAD patients is clinically relevant, as it negatively affects treatment adherence, limits participation in rehabilitation programs, and reduces overall quality of life.[2]

Exercise-based cardiac rehabilitation is a cornerstone in the management of CAD and has been shown to improve functional capacity, cardiovascular fitness, and survival outcomes. However, conventional aerobic exercise programs primarily target physical performance, with limited direct influence on higher-order cognitive processes.[11] This limitation has led to increasing interest in combined cognitive-motor interventions that simultaneously target both physical and cognitive domains.

Extensive evidence supports the role of physical activity in enhancing cognitive function through mechanisms such as increased cerebral blood flow, neurogenesis, synaptic plasticity, and upregulation of neurotrophic factors.[10-13] Aerobic exercise has been shown to improve global cognition and executive function, particularly in older adults and clinical populations.[11,13] Furthermore, meta-analyses and systematic reviews have consistently demonstrated that regular physical activity is associated with improved cognitive outcomes and reduced risk of cognitive decline.[14-17]

In recent years, dual-task training (DTT), which involves the simultaneous performance of a motor and a cognitive task, has emerged as a promising and innovative rehabilitation strategy. Dual-task paradigms challenge attentional allocation, executive control, and neural efficiency by requiring individuals to manage competing cognitive and motor demands.[5] Such training is highly relevant to real-life functional activities, which often involve simultaneous cognitive and physical engagement, such as walking while talking or making decisions during ambulation.

Evidence from randomized controlled trials and systematic reviews suggests that dual-task interventions are more effective than single-task training in improving both cognitive and functional outcomes.[6,9] Dual-task training has been shown to significantly enhance executive function, working memory, attention, and gait performance across various populations, including older adults and individuals with neurological and cardiovascular conditions.[6,8]

Neurophysiological studies further indicate that dual-task training enhances activation of the prefrontal cortex and improves neural connectivity, thereby facilitating better cognitive-motor integration.[10] These adaptations may explain the superior improvements observed in dual-task performance, particularly in complex functional activities requiring simultaneous processing.

Despite growing evidence supporting the benefits of dual-task interventions, research specifically investigating dual-task aerobic training in patients with CAD remains limited. Existing studies often involve heterogeneous populations or lack rigorous randomized controlled designs.[5] Therefore, there is a need for well-designed clinical trials to establish the effectiveness of dual-task aerobic training in improving both cognitive function and functional capacity in patients with stable CAD.

Hence, the present study aims to evaluate the impact of dual-task aerobic training on cognitive function and functional capacity in individuals with stable coronary artery disease.

METHODOLOGY:

- **Study Design**: Randomized controlled trial (RCT)
- **Participants:** Individuals with stable coronary artery disease.
- **Sample Size:** Total sample = 40
- **Sampling Method**

Participants were selected using purposive sampling and randomly allocated into 2 groups using a computer-generated randomization sequence:
Group A (Experimental): Dual-task aerobic training (DTAT)
Group B (Control) : Standard aerobic exercise

Inclusion Criteria

1. Adults aged 40–70 years
2. Both gender
3. Clinically diagnosed with stable coronary artery disease (CAD) (including history of myocardial infarction, angioplasty, or medically managed CAD).
4. Medically stable and cleared for participation in exercise by a cardiologist.
5. Able to ambulate independently with or without assistive devices.
6. Willingness to participate and provide written informed consent.

Exclusion Criteria

1. Unstable cardiovascular conditions, including unstable angina, recent myocardial infarction (<4 weeks), or uncontrolled arrhythmias.
2. History of neurological disorders (e.g., stroke, Parkinson's disease, dementia) that could affect cognitive or motor performance.
3. Severe musculoskeletal impairments limiting walking or exercise participation.
4. Diagnosed psychiatric disorders (e.g., major depression, schizophrenia) affecting cognitive assessment or compliance.
5. Severe visual or hearing impairments interfering with task performance.

INTERVENTION PROTOCOL

GROUP A (EXPERIMENTAL GROUP)
DUAL-TASK AEROBIC TRAINING (DTAT)

Participants allocated to the experimental group underwent a structured dual-task aerobic training program, integrating aerobic exercise with simultaneous cognitive tasks to target both physical and cognitive domains.

Training Parameters[11,13]
- **Frequency:** 3 sessions per week
- **Duration:** 40–50 minutes per session
- **Program Duration:** 8 weeks
- **Intensity:** 60–75% of maximum heart rate (HRmax)

Session Structure
1. Warm-up (5–10 minutes)
- Low-intensity walking or cycling
- Dynamic stretching exercises

2. Dual-Task Aerobic Phase (25–30 minutes)
During the main training phase, participants performed aerobic

exercise (treadmill walking or cycling) while simultaneously engaging in structured cognitive tasks.

Cognitive Tasks [6-9]

- **Attention:** backward counting, auditory cue response
- **Executive function:** Stroop tasks, task switching
- **Memory:** word recall, number sequencing
- **Processing speed:** rapid verbal responses

3. Cool-down (5–10 minutes)

- Slow walking
- Breathing and relaxation exercises

GROUP B (CONTROL GROUP) STANDARD AEROBIC EXERCISE

Participants in the control group performed standard aerobic exercises

Protocol

Training Parameters[11,13]

- **Frequency:** 3 sessions per week
- **Duration:** 40–50 minutes per session
- **Program Duration:** 8 weeks
- **Intensity:** 60–75% of maximum heart rate (HRmax)
- Activities included treadmill walking or cycling

OUTCOME MEASURES

- Montreal Cognitive Assessment (MoCA)
- 6-Minute Walk Test (6MWT)
- Dual-Task Walking Test (DTWT)

STATISTICAL ANALYSIS

All statistical analyses were performed using IBM SPSS Statistics version 26.0. The distribution of data was assessed using the Shapiro-Wilk test. For within-group comparisons, a paired t-test was used and for between-group comparisons, independent t-test was applied. The level of statistical significance was set at $p < 0.05$.

Table 1: Baseline Characteristics of Participants

Variable	Experimental Group (n=20)	Control Group (n=20)	p-value
Age (years)	56.2 ± 6.5	55.8 ± 6.8	0.78
Gender (M/F)	14/6	16/4	0.79
BMI (kg/m²)	26.4 ± 2.3	26.1 ± 2.5	0.65
MoCA Score	22.4 ± 2.1	22.6 ± 2.3	0.71
6MWT (m)	418 ± 45	420 ± 48	0.84
DTWT Speed (m/s)	0.85 ± 0.10	0.86 ± 0.09	0.77

Interpretation: No significant difference ($p > 0.05$) → groups are comparable

TABLE 2: Pre and Post intervention Comparison in Experimental Group

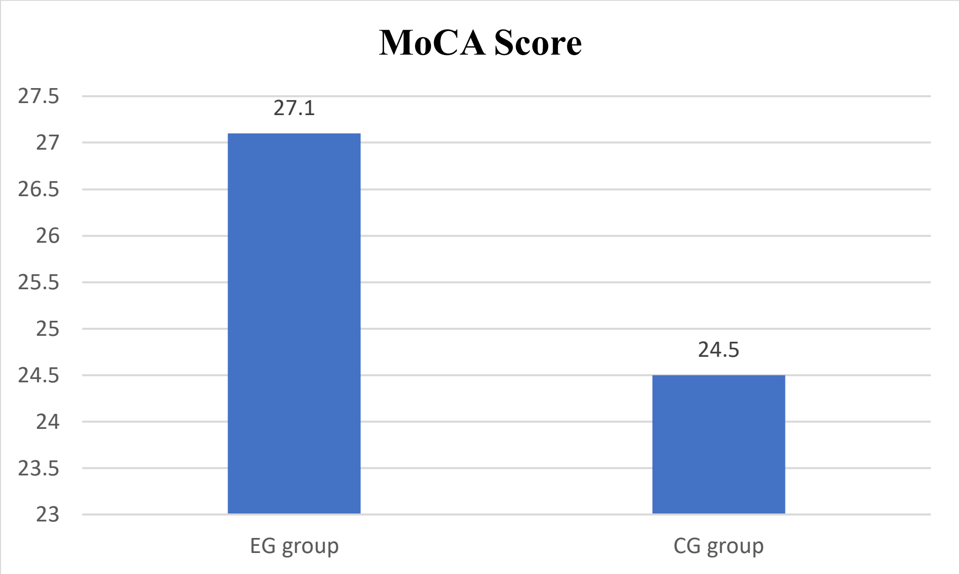
Outcome	Pre (Mean ± SD)	Post (Mean ± SD)	t-value	p-value
MoCA Score	22.4 ± 2.1	27.1 ± 1.8	10.52	<0.001
6MWT (m)	418 ± 45	525 ± 50	11.34	<0.001
DTWT Speed (m/s)	0.85 ± 0.10	1.12 ± 0.12	9.45	<0.001
DTWT Cognitive Score	8.2 ± 1.5	12.5 ± 1.8	10.01	<0.001
Dual-task Cost (%)	28 ± 5	15 ± 4	8.76	<0.001

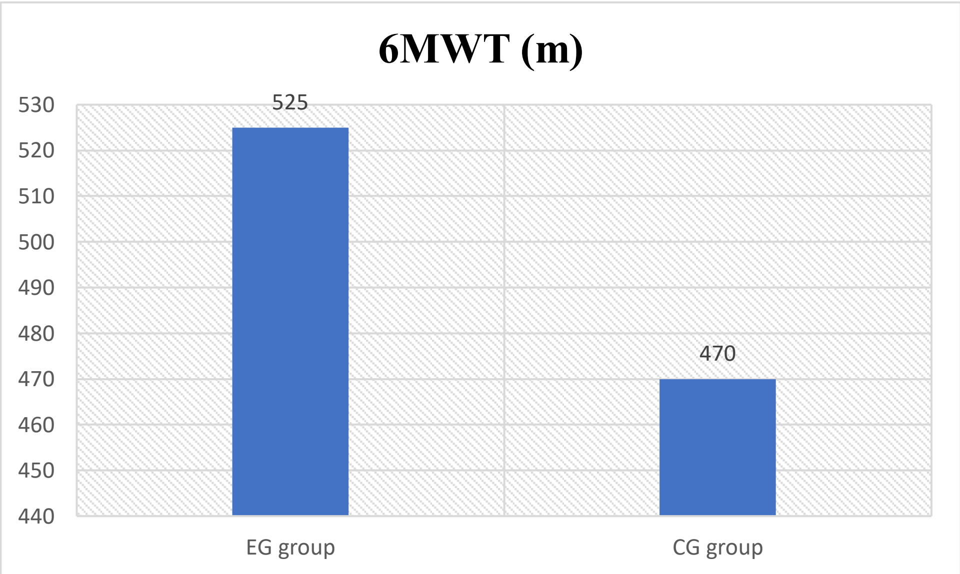
TABLE 3: Pre and Post intervention Comparison in control Group

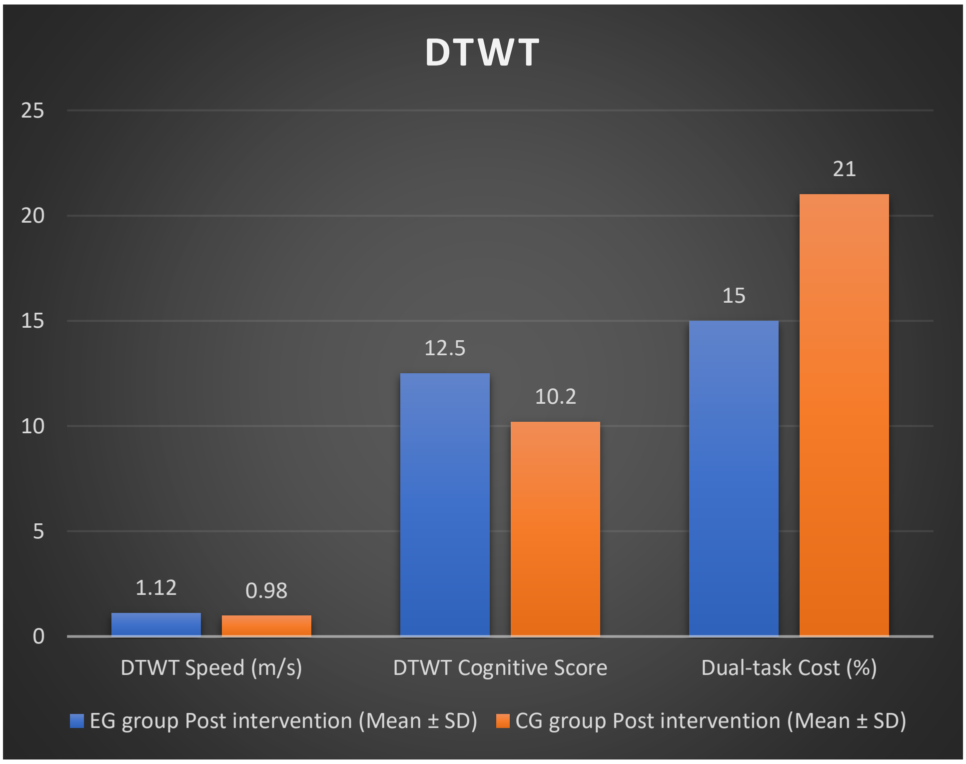
Outcome Measure	Pre (Mean ± SD)	Post (Mean ± SD)	t-value	p-value
MoCA Score	22.6 ± 2.3	24.5 ± 2.0	4.32	<0.01
6MWT (m)	420 ± 48	470 ± 46	5.28	<0.001
DTWT Speed (m/s)	0.86 ± 0.09	0.98 ± 0.11	4.11	<0.01
DTWT Cognitive Score	8.4 ± 1.6	10.2 ± 1.7	4.56	<0.01
Dual-task Cost (%)	27 ± 6	21 ± 5	3.98	<0.01

Table 4: Between-Group Comparison of Post-Intervention Scores Using Independent t-Test

Outcome	EG group Post intervention (Mean ± SD)	CG group Post intervention (Mean ± SD)	Mean Difference	t-value	p-value
MoCA Score	27.1 ± 1.8	24.5 ± 2.0	2.6	5.12	<0.001
6MWT (m)	525 ± 50	470 ± 46	55	4.89	<0.001
DTWT Speed (m/s)	1.12 ± 0.12	0.98 ± 0.11	0.14	4.21	<0.01
DTWT Cognitive Score	12.5 ± 1.8	10.2 ± 1.7	2.3	4.67	<0.01
Dual-task Cost (%)	15 ± 4	21 ± 5	6	5.01	<0.001


MoCA Score
27.5
27
26.5
26
25.5
25
24.5
24
23.5
23
27.1
24.5
EG group
CG group


6MWT (m)
530
520
510
500
490
480
470
460
450
440
525
470
EG group
CG group



RESULTS

A total of 40 participants completed the study with no significant differences observed at baseline between the groups ($p > 0.05$). Within-group analysis demonstrated statistically significant improvements in cognitive function, functional capacity, and dual-task performance in both the dual-task aerobic training (DTAT) and conventional aerobic training (CAT) groups ($p < 0.05$). However, between-group comparison revealed that the DTAT group showed significantly greater improvements in Montreal Cognitive Assessment scores (27.1 ± 1.8 vs 24.5 ± 2.0), 6-Minute Walk Test distance (525 ± 50 m vs 470 ± 46 m), and Dual-Task Walking Test parameters, including walking speed, cognitive accuracy, and reduced dual-task cost ($p < 0.05$).

DISCUSSION:

The present randomized controlled trial investigated the effects of dual-task aerobic training on cognitive function and functional capacity in patients with stable coronary artery disease (CAD). The findings demonstrate that while both interventions were effective, dual-task aerobic training resulted in significantly greater improvements in cognitive performance, functional capacity, and dual-task ability compared to conventional aerobic training.

Cognitive impairment is increasingly recognized in patients with CAD and is attributed to multiple mechanisms, including reduced cerebral perfusion, endothelial dysfunction, and systemic inflammation.[2,3] These factors contribute to deficits in executive function, attention, and memory, which are critical for daily functioning. The significant improvement in Montreal Cognitive Assessment scores observed in the dual-task group suggests that combining cognitive and motor activities provides enhanced stimulation to neural networks involved in higher-order cognitive processing. This finding is consistent with previous studies demonstrating that aerobic exercise can improve cognitive function through increased cerebral blood flow, neurogenesis, and synaptic plasticity.[10-13] However, conventional aerobic training alone may not sufficiently challenge executive control mechanisms. Dual-task training, by contrast, requires simultaneous allocation of attentional resources, thereby engaging the prefrontal cortex more effectively. Neuroimaging studies have shown increased activation in frontal brain regions during dual-task performance, supporting the hypothesis that such interventions enhance neural efficiency and cognitive reserve.[10]

The improvement in functional capacity, as measured by the 6-Minute Walk Test, was significantly greater in the dual-task group. This suggests that the addition of cognitive tasks does not hinder physical performance but may instead enhance motor learning and adaptability. Similar findings have been reported in previous studies, where combined cognitive-motor training improved both gait performance and cardiovascular fitness.[6,7]

A key finding of this study is the significant improvement in dual-task performance, assessed using the Dual-Task Walking Test. The reduction in dual-task cost indicates improved cognitive-motor integration and more efficient allocation of attentional resources. Dual-task deficits are known to increase the risk of falls and functional limitations, particularly in clinical populations.[6] Therefore, improving dual-task ability has important implications for real-world functional independence.

The superiority of dual-task training observed in this study is supported by systematic reviews and meta-analyses demonstrating that combined cognitive and physical interventions yield greater improvements in executive function, attention, and mobility compared to single-task interventions.[8,9] Furthermore, dual-task paradigms closely mimic real-life situations, where individuals are required to perform multiple tasks simultaneously, thereby enhancing ecological validity and transfer of training effects.[6]

Previous meta-analyses have consistently shown that physical activity has a moderate to large effect on cognitive function, particularly when interventions are structured and progressive.[11,14,17] The present study extends these findings by demonstrating that integrating cognitive challenges within aerobic exercise amplifies these benefits.

From a physiological perspective, the combined intervention likely enhances both central and peripheral adaptations. Aerobic exercise improves cardiovascular efficiency and cerebral perfusion, while cognitive engagement promotes neural plasticity and strengthens synaptic connections.[10-13] This synergistic effect may explain the superior outcomes observed in the dual-task group.In addition, dual-task training may improve attentional flexibility and processing speed, which are essential for safe ambulation and complex motor tasks. Previous randomized trials have reported similar improvements in dual-task gait speed and cognitive accuracy following combined training programs.[6-8] These improvements are particularly relevant for CAD patients, who often exhibit reduced exercise tolerance and cognitive deficits.

The findings of this study also align with broader evidence indicating that lifestyle interventions, including physical activity, play a crucial role in preventing cognitive decline and reducing the risk of dementia.[15,16] Given the increased risk of cognitive impairment in individuals with cardiovascular disease, incorporating cognitive elements into rehabilitation programs may offer additional protective benefits.[4]

In summary, dual-task aerobic training appears to be a superior rehabilitation strategy compared to conventional aerobic exercise, as it effectively enhances cognitive function, functional capacity, and cognitive-motor integration in patients with stable coronary artery disease. Integrating dual-task paradigms into cardiac rehabilitation programs may optimize patient outcomes and improve real-world functional performance.

CONCLUSION

Dual-task aerobic training is more effective than conventional aerobic exercise in improving cognitive function, functional capacity, and dual-task performance in patients with stable coronary artery disease. Significant gains in Montreal Cognitive Assessment, 6-Minute Walk Test, and Dual-Task Walking Test indicate that integrating cognitive tasks with aerobic training provides superior and functionally relevant rehabilitation outcomes.

CONFLICT OF INTEREST:

None

FUNDING:

None

REFERENCES:

1. Bhat R et al. Oral Sphere J. Dent. Health Sci. 2025;1(1):19-28.
2. van Nieuwkerk AC, et al. Cognitive impairment in cardiac disease. Stroke. 2023.
3. Abete P, et al. Heart–brain continuum hypothesis. Ageing Res Rev. 2014.
4. Wolters FJ, et al. Coronary heart disease and dementia risk: systematic review. Alzheimers Dement. 2018.
5. Cezareti TC, et al. Dual-task training and cognitive performance in CAD: systematic review. Front Cardiovasc Med. 2025.
6. Gregory MA, Boa Sorte Silva NC, Gill DP, McGowan CL, Liu-Ambrose T, Shoemaker JK, et al. Combined dual-task gait training and aerobic exercise to improve cognition and mobility in older adults. *J Alzheimers Dis.* 2017;57(3):747–763.
7. Maeneja R, Silva CR, Ferreira IS, Abreu AM. Aerobic exercise versus dual-task cognitive walking in cognitive rehabilitation: randomized clinical trial. *Front Psychol.* 2023;14:1258262.
8. Feng QM, Chen JW. Effects of exercise combined with cognitive dual-task training on cognitive function: systematic review and meta-analysis. *Disabil Rehabil.* 2025;47(14):3538–3547.
9. Mundada PH, Dadgal RM. Comparison of dual-task training versus aerobic training in improving cognition in elderly. *Cureus.* 2022;14(9):e29027.
10. Erickson KI, Hillman C, Kramer AF. Physical activity, brain, and cognition. *Nat Rev Neurosci.* 2015;16(9):552–565.
11. Smith PJ, Blumenthal JA, Hoffman BM, et al. Aerobic exercise and neurocognitive performance: meta-analysis. *Psychosom Med.* 2010;72(3):239–252.
12. Voss MW, Nagamatsu LS, Liu-Ambrose T, Kramer AF. Exercise, brain, and cognition across lifespan. *J Appl Physiol.* 2011;111(5):1505–1513.
13. Baker LD, Frank LL, Foster-Schubert K, et al. Effects of aerobic exercise on mild cognitive impairment. *Arch Neurol.* 2010;67(1):71–79.
14. Colcombe S, Kramer AF. Fitness effects on cognitive function of older adults: meta-analysis. *Psychol Sci.* 2003;14(2):125–130.
15. Lautenschlager NT, Cox KL, Flicker L, et al. Effect of physical activity on cognitive function in older adults at risk. *JAMA.* 2008;300(9):1027–1037.
16. Angevaren M, Aufdemkampe G, Verhaar HJ, Aleman A, Vanhees L. Physical activity and enhanced fitness improve cognitive function. *Cochrane Database Syst Rev.* 2008;(3):CD005381.
17. Best JR. Effects of physical activity on executive function: meta-analysis. *Br J Sports Med.* 2010;44(14):1008–1013.