

A Multicomponent Exercise Intervention that Reverses Frailty and Improves Cognition, Emotion, and Social Networking in the Community-Dwelling Frail Elderly: A Randomized Clinical Trial

Item Type Journal Article

Author Francisco José Tarazona-Santabalbina

Author Mari Carmen Gomez-Cabrera

Author Pilar Pérez-Ros

Author Francisco Miguel Martínez-Arnau

Author Helena Cabo

Author Konstantina Tsaparas

Author Andrea Salvador-Pascual

Author Leocadio Rodríguez-Mañas

Author Jose Viña

Abstract Frailty can be an important clinical target to reduce rates of disability. To ascertain if a supervised-facility multicomponent exercise program (MEP) when performed by frail older persons can reverse frailty and improve functionality; cognitive, emotional, and social networking; as well as biological biomarkers of frailty, when compared with a controlled population that received no training. This is an interventional, controlled, simple randomized study. Researchers responsible for data gathering were blinded for this study. Participants from 2 primary rural care centers (Sollana and Carcaixent) of the same health department in Spain were enrolled in the study between December 2013 and September 2014. We randomized a volunteer sample of 100 men and women who were sedentary, with a gait speed lower than 0.8 meters per second and frail (met at least 3 of the frailty phenotype criteria). Participants were randomized to a supervised-facility MEP (n = 51, age = 79.5, SD 3.9) that included proprioception, aerobic, strength, and stretching exercises for 65 minutes, 5 days per week, 24 weeks, or to a control group (n = 49, age = 80.3, SD 3.7). The intervention was performed by 8 experienced physiotherapists or nurses. Protein-calorie and vitamin D supplementation were controlled in both groups. Our MEP reverses frailty (number needed to treat to recover robustness in subjects with attendance to $\geq 50\%$ of the training sessions was 3.2) and improves functional measurements: Barthel (trained group 91.6 SD 8.0 vs 82.0 SD 11.0 control group), Lawton and Brody (trained group 6.9 SD 0.9 vs 5.7 SD 2.0 control group), Tinetti (trained group 24.5 SD 4.4 vs 21.7 SD 4.5 control group), Short Physical Performance Battery (trained group 9.5 SD 1.8 vs 7.1 SD 2.8 control group), and physical performance test (trained group 23.5 SD 5.9 vs 16.5 SD 5.1 control group) as well as cognitive, emotional, and social networking determinations: Mini-Mental State Examination (trained group 28.9 SD 3.9 vs 25....

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Aerobic Exercise Improves Cognition for Older Adults with Glucose Intolerance, A Risk Factor for Alzheimer's Disease

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Author Laura D. Baker

Author Laura Frank

Author Karen E. Foster-Schubert

Author Pattie S. Green

Author Charles W. Wilkinson

Author Anne McTiernan

Author Brenna Cholerton

Author Stephen R. Plymate

Author Mark Fishel

Author G. Stennis Watson

Author Glen E. Duncan

Author Pankaj Mehta

Author Suzanne Craft

Abstract Impaired glucose regulation is a defining characteristic of type 2 diabetes mellitus (T2DM) pathology and has been linked to increased risk of cognitive impairment and dementia. Although the benefits of aerobic exercise for physical health are well-documented, exercise effects on cognition have not been examined for older adults with poor glucose regulation associated with prediabetes and early T2DM. Using a randomized controlled design, twenty-eight adults (57-83 y old) meeting 2-h tolerance test criteria for glucose intolerance completed 6 months of aerobic exercise or stretching, which served as the control. The primary cognitive outcomes included measures of executive function (Trails B, Task Switching, Stroop, Self-ordered Pointing Test, and Verbal Fluency). Other outcomes included memory performance (Story Recall, List Learning), measures of cardiorespiratory fitness obtained via maximal-graded exercise treadmill test, glucose disposal during hyperinsulinemic-euglycemic clamp, body fat, and fasting plasma levels of insulin, cortisol, brain-derived neurotrophic factor, insulin-like growth factor-1, amyloid- β (A β 40 and A β 42). Six months of aerobic exercise improved executive function (MANCOVA, $p=0.04$), cardiorespiratory fitness (MANOVA, $p=0.03$), and insulin sensitivity ($p=0.05$). Across all subjects, 6-month changes in cardiorespiratory fitness and insulin sensitivity were positively correlated ($p=0.01$). For A β 42, plasma levels tended to decrease for the aerobic group relative to controls ($p=0.07$). The results of our study using rigorous controlled methodology suggest a cognition-enhancing effect of aerobic exercise for older glucose intolerant adults. Although replication in a larger sample is needed, our findings potentially have important therapeutic implications for a growing number of adults at increased risk of cognitive decline.

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Issue 2

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Benefits of Physical Exercise Training on Cognition and Quality of Life in Frail Older Adults

Item Type Journal Article

Author Francis Langlois

Author Thien Tuong Minh Vu

Author Kathleen Chassé

Author Gilles Dupuis

Author Marie-Jeanne Kergoat

Author Louis Bherer

Abstract Frailty is a state of vulnerability associated with increased risks of fall, hospitalization, cognitive deficits, and psychological distress. Studies with healthy senior suggest that physical exercise can help improve cognition and quality of life. Whether frail older adults can show such benefits remains to be documented. A total of 83 participants aged 61–89 years were assigned to an exercise-training group (3 times a week for 12 weeks) or a control group (waiting list). Frailty was determined by a complete geriatric examination using specific criteria. Pre- and post-test measures assessed physical capacity, cognitive performance, and quality of life. Compared with controls, the intervention group showed significant improvement in physical capacity (functional capacities and physical endurance), cognitive performance (executive functions, processing speed, and working memory), and quality of life (global quality of life, leisure activities, physical capacity, social/family relationships, and physical health). Benefits were overall equivalent between frail and nonfrail participants. Physical exercise training leads to improved cognitive functioning and psychological well-being in frail older adults.

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Diet and exercise orthogonally alter the gut microbiome and reveal independent associations with anxiety and cognition

Item Type Journal Article

Author Silvia S. Kang

Author Patricio Jeraldo

Author Aishe Kurti

Author Margret E. Berg Miller

Author Marc D. Cook

Author Keith G. Whitlock

Author Nigel Goldenfeld

Author Jeffrey A. Woods

Author Bryan A. White

Author Nicholas Chia

Author John Denis Fryer

Abstract The ingestion of a high-fat diet (HFD) and the resulting obese state can exert a multitude of stressors on the individual including anxiety and cognitive dysfunction. Though many studies have shown that exercise can alleviate the negative consequences of a HFD using metabolic readouts such as insulin and glucose, a paucity of well-controlled rodent studies have been published on HFD and exercise interactions with regard to behavioral outcomes. This is a critical issue since some individuals assume that HFD-induced behavioral problems such as anxiety and cognitive dysfunction can simply be exercised away. To investigate this, we analyzed mice fed a normal diet (ND), ND with exercise, HFD diet, or HFD with exercise. We found that mice on a HFD had robust anxiety phenotypes but this was not rescued by exercise. Conversely, exercise increased cognitive abilities but this was not impacted by the HFD. Given the importance of the gut microbiome in shaping the host state, we used 16S rRNA hypervariable tag sequencing to profile our cohorts and found that HFD massively reshaped the gut microbial community in agreement with numerous published studies. However, exercise alone also caused massive shifts in the gut microbiome at nearly the same magnitude as diet but these changes were surprisingly orthogonal. Additionally, specific bacterial abundances were directly proportional to measures of anxiety or cognition. Thus, behavioral domains and the gut microbiome are both impacted by diet and exercise but in unrelated ways. These data have important implications for obesity research aimed at modifications of the gut microbiome and suggest that specific gut microbes could be used as a biomarker for anxiety or cognition or perhaps even targeted for therapy.

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Differential effects of acute and regular physical exercise on cognition and affect

Item Type Journal Article

Author M.E. Hopkins

Author Fred C. Davis

Author Michelle VanTieghem

Author Paul J. Whalen

Author David J. Bucci

Abstract The effects of regular exercise versus a single bout of exercise on cognition, anxiety, and mood were systematically examined in healthy, sedentary young adults who were genotyped to determine brain-derived neurotrophic factor (BDNF) allelic status (i.e., Val-Val or Val66Met polymorphism). Participants were evaluated on novel object recognition (NOR) memory and a battery of mental health surveys before and after engaging in either (a) a 4-week exercise program, with exercise on the final test day, (b) a 4-week exercise program, without exercise on the final test day, (c) a single bout of exercise on the final test day, or (d) remaining sedentary between test days. Exercise enhanced object recognition memory and produced a beneficial decrease in perceived stress, but only in participants who exercised for 4 weeks including the final day of testing. In contrast, a single bout of exercise did not affect recognition memory and resulted in increased perceived stress levels. An additional novel finding was that the improvements on the NOR task were observed exclusively in participants who were homozygous for the BDNF Val allele, indicating that altered activity-dependent release of BDNF in Met allele carriers may attenuate the cognitive benefits of exercise.

Importantly, exercise-induced changes in cognition were not correlated with changes in mood/anxiety, suggesting that separate neural systems mediate these effects. These data in humans mirror recent data from our group in rodents. Taken together, these current findings provide new insights into the behavioral and neural mechanisms that mediate the effects of physical exercise on memory and mental health in humans.

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Exercise and children's cognition: The role of exercise characteristics and a place for metacognition

Item Type Journal Article
Author Phillip D. Tomporowski
Author Bryan A. McCullick
Author Daniel E. Pendleton
Author Caterina Pesce
Abstract Definitive conclusions concerning the impact of exercise interventions on children's mental functioning are difficult to ascertain because of procedural differences among studies. A narrative review of studies was conducted to evaluate the role of two types of exercise interventions on children's cognition. Acute and chronic exercise interventions were classified as quantitative or qualitative on the basis of manipulations of task complexity and, by inference, mental engagement. Both types of interventions enhance aspects of children's cognition; however, their effects on metacognitive processes are unknown. The role of metacognitive processes and their regulation of children's behavior and academic performance are highlighted.
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Exercise and Parkinson's: benefits for cognition and quality of life

Item Type Journal Article

Author Kate Cruise
Author Romola S. Bucks
Author Andrea M. Loftus
Author Robert U. Newton
Author Roger Pegoraro
Author Meghan G. Thomas

Abstract The benefits of physical exercise for psychological aspects of quality of life (QoL) are well established in normally ageing adults, yet potential benefits for people with Parkinson's disease (PD) have received limited attention. This study evaluated the benefits of exercise for cognitive functioning, mood and disease-specific QoL for people with PD. Twenty-eight individuals with PD were allocated to an exercise intervention program (EIP, n = 15) or control group (n = 13). The EIP group undertook a programme of progressive anabolic and aerobic exercise twice weekly for 12 weeks. The control group maintained their usual lifestyle. Exercise was shown to have selective benefits for cognitive functioning by improving frontal lobe based executive function. No significant effects were demonstrated for mood or disease-specific QoL. These results are consistent with previous research demonstrating selective benefits of exercise for executive function among normal ageing adults and PD.

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Issue 1

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Exercise improves cognition and hippocampal plasticity in *APOE* ϵ 4 mice

Item Type Journal Article

Author Kathryn E. Nichol

Author Sean P. Deeny

Author Joseph Seif

Author Kevin Camaclang

Author Carl W. Cotman

Abstract Background Human studies on exercise, cognition, and apolipoprotein E (APOE) genotype show that ϵ 4 carriers may benefit from regular physical activity. Methods We examined voluntary wheel-running, memory, and hippocampal plasticity in APOE ϵ 3 and APOE ϵ 4 transgenic mice at 10–12 months of age. Results Sedentary ϵ 4 mice exhibited deficits in cognition on the radial-arm water maze (RAWM), a task dependent on the hippocampus. Six weeks of wheel-running in ϵ 4 mice resulted in improvements on the RAWM to the level of ϵ 3 mice. Hippocampal brain-derived neurotrophic factor (BDNF) levels were similar in ϵ 3 and ϵ 4 mice, and after exercise BDNF was similarly increased in both ϵ 3 and ϵ 4 mice. In sedentary ϵ 4 mice, tyrosine kinase B (Trk B) receptors were reduced by 50%. Exercise restored Trk B in ϵ 4 mice to the level of ϵ 3 mice, and in ϵ 4 mice, exercise dramatically increased synaptophysin, a marker of synaptic function. Conclusions Our results support the hypothesis that exercise can improve cognitive function, particularly in ϵ 4 carriers.

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Short-term exercise in aged Tg2576 mice alters neuroinflammation and improves cognition

Item Type Journal Article

Author Anna Parachikova

Author Kathryn E. Nichol

Author Carl W. Cotman

Abstract Exercise is a treatment paradigm that can ameliorate cognitive dysfunction in Alzheimer disease (AD) and AD mouse models. Since exercise is also known to alter the peripheral immune response, one potential mechanism for the cognitive improvement following exercise may be by modulating the inflammatory repertoire in the central nervous system. We investigated the effects of voluntary exercise in the Tg2576 mouse model of AD at a time-point at which pathology has already developed. Inflammatory mRNA markers are increased in sedentary Tg2576 mice versus non-transgenic controls. We demonstrate that short-term voluntary wheel running improved spatial learning in aged transgenic mice as compared to sedentary Tg2576 controls. Inflammatory profiles of the Tg2576 and non-transgenic mice were different following exercise with the non-transgenic mice showing a broader response as compared to the Tg2576. Notably, exercising Tg2576 exhibited increases in a few markers including CXCL1 and CXCL12, two chemokines that may affect cognition.

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Shorter term aerobic exercise improves brain, cognition, and cardiovascular fitness in aging

Item Type Journal Article

Author Sandra C. Chapman

Author Sina Aslan

Author Jeffrey S. Spence

Author Laura F. DeFina

Author Molly Keebler

Author Nyaz Didehbani

Author Hanzhang Lu

Abstract Physical exercise, particularly aerobic exercise, is documented as providing a low cost regimen to counter well-documented cognitive declines including memory, executive function, visuospatial skills, and processing speed in normally aging adults. Prior aging studies focused largely on the effects of medium to long term (>6 months) exercise training; however, the shorter term effects have not been studied. In the present study, we examined changes in brain blood flow, cognition, and fitness in 37 cognitively healthy sedentary adults (57 – 75 years of age) who were randomized into physical training or a wait-list control group. The physical training group received supervised aerobic exercise for 3 sessions per week one hour each for 12 weeks. Participants' cognitive, cardiovascular fitness and resting cerebral blood flow (CBF) were assessed at baseline (T1), mid (T2) and post-training (T3). We found higher resting CBF in the anterior cingulate region in the physical training group as compared to the control group from T1 to T3. Cognitive gains were manifested in the exercise group's improved immediate and delayed memory performance from T1 to T3 which also showed a significant positive association with increases in both left and right hippocampal CBF identified earlier in the time course at T2. Additionally, the two cardiovascular parameters, VO2 max and rating of perceived exertion showed gains, compared to the control group. These data suggest that even shorter term aerobic exercise can facilitate neuroplasticity to reduce both the biological and cognitive consequences of aging to benefit brain health in sedentary adults.

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The Effects of Acute Exercise on Mood, Cognition, Neurophysiology, and Neurochemical Pathways: A Review

Item Type Journal Article

Author Julia C. Basso

Author Wendy A. Suzuki

Abstract A significant body of work has investigated the effects of acute exercise, defined as a single bout of physical activity, on mood and cognitive functions in humans. Several excellent recent reviews have summarized these findings; however, the neurobiological basis of these results has received less attention. In this review, we will first briefly summarize the cognitive and behavioral changes that occur with acute exercise in humans. We will then review the results from both human and animal model studies documenting the wide range of neurophysiological and neurochemical alterations that occur after a single bout of exercise. Finally, we will discuss the strengths, weaknesses, and missing elements in the current literature, as well as offer an acute exercise standardization protocol and provide possible goals for future research.

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The Effects of Exercise on Cognition in Older Adults With and Without Cognitive Decline: A Systematic Review

Item Type Journal Article

Author J. van Uffelen

Author M.J.M. (Mai) Chin A Paw

Author Marijke Hopman-Rock

Author W. van Mechelen

Abstract To systematically review the effect of physical exercise on cognition in older adults with and without cognitive decline.: Randomized controlled trials were identified by literature searches in PubMed, EMBASE, CENTRAL, PsycINFO, and AgeLine. Papers were included on the basis of predefined inclusion criteria. Data on study population, exercise intervention, and effectiveness were extracted. Two independent reviewers assessed methodological quality. Twenty-three studies were included-15 among cognitively healthy subjects and 8 among subjects with cognitive decline. Seven studies were qualified as high-quality studies, 2 in cognitively healthy subjects and 5 in subjects with cognitive decline. In cognitively healthy subjects, significant beneficial intervention effects were observed in 5 studies on information processing, executive function, or memory. Interventions in these studies included aerobic exercise only (n = 2); strength exercise (n = 1); strength and balance exercise (n = 1); or all-round exercise including aerobic, strength, balance and flexibility training (n = 1). In subjects with cognitive decline, 5 studies observed beneficial effects on general cognition, executive functions, and memory. Interventions included aerobic (n = 3) or strength exercise combined with flexibility or balance exercise (n = 2). Beneficial effects of various exercise programs on aspects of cognition have been observed in studies among subjects with and without cognitive decline. The majority of the studies, however, did not find any effect. The small number of included studies; lack of high-quality studies; and the large variability in study populations, exercise protocols, and outcome measures complicate interpretation of the results. More high-quality trials are needed to assess the effects of different types of exercise on cognitive function in older adults with and without cognitive decline.

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The effects of exercise on cognition in Parkinson's disease: a systematic review

Item Type Journal Article

Author Danielle Murray

Author Matthew A. Sacheli

Author Janice J. Eng

Author A. Jon Stoessl

Abstract Cognitive impairments are highly prevalent in Parkinson's disease (PD) and can substantially affect a patient's quality of life. These impairments remain difficult to manage with current clinical therapies, but exercise has been identified as a possible treatment. The objective of this systematic review was to accumulate and analyze evidence for the effects of exercise on cognition in both animal models of PD and human disease. This systematic review was conducted according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement. Fourteen original reports were identified, including six pre-clinical animal studies and eight human clinical studies. These studies used various exercise interventions and evaluated many different outcome measures; therefore, only a qualitative synthesis was performed. The evidence from animal studies supports the role of exercise to improve cognition in humans through the promotion of neuronal proliferation, neuroprotection and neurogenesis. These findings warrant more research to determine what roles these neural mechanisms play in clinical populations. The reports on cognitive changes in clinical studies demonstrate that a range of exercise programs can improve cognition in humans. While each clinical study demonstrated improvements in a marker of cognition, there were limitations in each study, including non-randomized designs and risk of bias. The Grading of Recommendations Assessment, Development and Evaluation (GRADE) system was used and the quality of the evidence for human studies were rated from "low" to "moderate" and the strength of the recommendations were rated from "weak" to "strong". Studies that assessed executive function, compared to general cognitive abilities, received a higher GRADE rating. Overall, this systematic review found that in animal models exercise results in behavioral and corresponding neurobiological changes in the basal ganglia related to cognition. The clinical studi...

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