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Individual-Specific Physical Activities on Cognitive Function among Older Adults

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Abstract

We evaluated the specific association between individual-specific physical activities and cognitive function among a national sample of the broader U. S. older adult population. Data from the 1999–2002 National Health and Nutrition Examination Survey (NHANES) were used to identify 1.902 adults, between 60–85 years, with complete data on selected study variables. The DSST (Digit Symbol Substitution Test) was used to assess participant executive cognitive functioning. Individual-specific physical activities were associated with higher cognitive performance. Weighted multivariable linear regressions showed bicycling (β=4.3; 95% CI:-0.2–9.0; P=0.06), walking (β=2.6; 95% CI: 0.3–4.9; P=0.02), yard work (β=4.1; 95% CI:-0.1–8.4; P=0.05) and golf (β=5.3; 95% CI: 1.3–9.3; P=0.01) were associated with higher cognitive functioning. However, when accounting for overall volume of physical activity, results showed the only activity that was statistically significantly associated with higher cognitive function was golf (β=4.7; 95% CI: 0.6–8.7; P=0.02). In this nationally representative sample of adults, there was a positive association between engagement in individual-specific physical activities and cognitive function.

Keywords: Epidemiology; exercise modality; health promotion; mental health; physical activity

Öz

Yaşlı Bireylerde Bireye Özgü Fiziksel Aktivitenin Bilişsel İşlevler Üzerine Etkisi

Amerika Birleşik Devletlerinde, oldukça kapsamlı yaşlı yetişkin popülasyondaki bireylerden oluşan bir örneklemde, bireye özgü fiziksel aktiviteler ile bilişsel işlevler arasındaki özgül bağlantıyı inceledik. 1999-2002 Ulusal Sağlık ve Beslenme İncelemesi Anketi kullanılarak elde edilen ve çalışma için seçilen değişkenler hakkında tamamlanmış veriler, 65-80 yaş aralığındaki 1902 yetişkinin tanımlanması için kullanıldı. Sayı Yerine Simge Koyma Testi, katılımcıların, yönetici bilişsel işlevlerini değerlendirmek için kullanıldı. Bireye özgü fiziksel aktiviteler, daha iyi bilişsel performans ile bağlantılı bulundu. Çok değişkenli ağırlıklı lineer regresyon; bisiklet sürme (β= 4.3; 95% CI: -0.2-9.0; P=0.06), yürüyüş (β= 2.6; 95% CI: 0.3-4.9; P=0.02), bahçe işi (β= 4.1; 95% CI: -0.1-8.4; P=0.05) ve golf (β= 5.3; 95% CI: 1.3-9.3; P=0.01) aktivitelerinin daha iyi bilişsel işlevler ile bağlantılı olduğunu gösterdi. Ancak, fiziksel aktivitenin genel hacmi hesaba katılınca, sonuçlar gösterdi ki bilişsel işlevler ile istatistiki açıdan anlamlı bağlantısı olan tek aktivide golfdü (β= 4.7; 95% CI: 0.6-8.7; P=0.02). Bu ulusal temsili yetişkin örnekleminde, bireye özgü fiziksel aktivitelerde bulunmakla bilişsel işlevler arasında pozitif bir bağlantı bulundu.

Anahtar Kelimeler: Epidemiyoloji, egzersiz tarzı, sağlık desteği, zihinsel sağlık, fiziksel aktivite

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INTRODUCTION

There exists an empirical nexus between the development of chronic diseases and advancing age (Epel, 2009). Lifestyle diseases have reached epidemic proportions in line with the increasing number of adults living well beyond the age of 65 (Wan, Sengupta, Velkoff

& DeBarros, 2005). Numerous cellular processes contribute to biological senescence, including the age-associated shortening of telomeres (Epel, 2009). Habitual physical activity behaviors have been shown to counteract development of such life-threatening health concerns via reductions in cortisol secretion, augmented anabolic hormonal action, improved vagal tone, in addition to a myriad of cellular-fortifying mechanisms (Epel, 2009; Kostka, Drai, Berthouze, Lacour, & Bonnefoy, 2000; Moller, Wallin, & Knudsen, 1996).

In addition to age-related physiological cell destruction, psychological stress may intensify the risk for developing early-onset, late-life diseases (Bosma, Stansfeld, & Marmot, 1998; Chrousos & Gold, 1992; McEwen, 1998; Musselman, Evans, & Nemeroff, 1998; Stansfeld, Fuhrer, Shipley, & Marmot, 2002). A synchronous, negative relationship has been observed between poor health habits, such as overeating, and mental stress (Epel, 2009). Amplified cortisol and insulin responses may render abdominal fat deposition, along with inflammatory cascades (Epel, 2009). Further, cell lysis associated with diminished telomere length may act on immune cells, inducing rapid proliferation of free radicals (Beckman & Ames, 1998; Finkel & Holbrook, 2000) known to profoundly alter the functionality of cardiac cells and brain tissue (McEwen, 2002). Cardiovascular and brain structures are especially prone to the litany of oxidative risks associated with prolonged sedentary behavior (McEwen, 2002; Moller, Wallin, & Knudsen, 1996). However, healthy seniors who engage in regular physical activity may achieve an oxidative capacity comparable to their younger counterparts (Cals et al., 1997). In addition, long-term exercise has been linked to attenuated cortisol reactivity (Traustadottir, Bosch, & Matt, 2005) and regulation of acute cardiovascular response to stressors (Georgiades et al., 2000) among geriatric populations.

Dai et al. has described the need for an individual analysis of preferred physical activity modalities to promote a deeper understanding of the best strategies to promote well-being and plan effective programs to encourage adoption of healthy behaviors (Dai et al., 2015). Previous research has also provided important insight into the individual physical activity patterns of special populations, including those diagnosed with cancer or expressing weight control concerns (Blanchard et al., 2003; DiPietro, Williamson, Caspersen, & Eaker, 1993; Services, 1996; Spees, Scott, & Taylor, 2012). Further, Loprinzi demonstrated the rationale for running specific activities to aid cardiovascular disease prevention efforts and counteract early mortality (Loprinzi, 2015). Although, to our knowledge, no study has examined the relationship between individual-specific physical activities or examined the impact of these activities on cognition. Therefore, we aim to address a gap in the existing literature. Specifically, the purpose of our study was to examine the association of physical activity on health and cognition by specifically evaluating the association between individual-specific physical activities, including aerobics, bicycling, walking, yard work and golf on mental performance within a large sample of older U. S. citizens.

METHODS

Study Design and Participants

Data were extracted from the 1999–2002 National Health and Nutrition Examination Survey (NHANES). Analyses are based on data from 1902 older adults (60–85 yrs) who provided complete data for the study variables; these 1902 adults were free of congestive heart failure, coronary artery disease, heart attack, and stroke, as individuals with these self-reported physician-diagnosed conditions were excluded from our analyses.

Procedures were approved by the National Center for Health Statistics review board. Consent was obtained from all participants prior to data collection. Further information on NHANES methodology and data collection is available on the NHANES website (http://www. cdc. gov/nchs/nhanes. htm).

Cognitive Function

The Digit Symbol Substitution Test (DSST) (Wechsler, 1958) was used to assess cognitive function among older adults 60+ years of age. The DSST, a component of the Wechsler Adult Intelligence Test and a test of visuospatial and motor speed-of-processing, has a considerable executive function component and is frequently used as a sensitive measure of frontal lobe executive functions (Parkin & Java, 1999; Vilkki & Holst, 1991). The DSST was used to assess participant cognitive function tasks of pairing (each digit 1–9 has a symbol it is associated with) and free recall (allowing participants to draw more figures in the limited time due to remembering pairs). Participants were asked to draw as many symbols as possible that were paired with

numbers within 2 min. Following the standard scoring method, one point is given for each correctly drawn and matched symbol, and one point is subtracted for each incorrectly drawn and matched symbol, with a maximum score of 133.

Physical Activity

As described elsewhere (Loprinzi, 2015), participants were asked open-ended questions about participation in leisure-time physical activity over the past 30 days. This self-report physical activity item has demonstrated evidence of convergent validity by associating with accelerometer-assessed physical activity (Loprinzi, 2015). Data was coded into 48 activities, including 16 sports-related activities, 14 exercise-related activities, and 18 recreational-related activities; these individual physical activities are published elsewhere (*National Health and Nutrition Examination Survey*, 2007).

For each of the 48 activities where participants reported moderate or vigorous-intensity for the respective activity, they were asked to report the number of times they engaged in that activity over the past 30 days and the average duration they engaged in that activity. For each of the 48 physical activities, Metabolic Equivalent of Task (MET)-min-month was calculated by multiplying the number of days, by the mean duration, by the respective MET level (MET-min-month=days*duration*MET level). The MET levels for each activity are provided elsewhere (Ainsworth et al., 2000). For example, the MET level for moderate-intensity walking is 3.5 and 5.0 for vigorous-intensity walking; for swimming, the MET level for moderate and vigorous intensity, respectively, is 6.0 and 8.0.

Among the individual physical activities, we examined the association between meeting moderate-to-vigorous physical activity (MVPA) guidelines (2000+ MET-min-month) and cognitive function among 5 individual physical activities, due to cell size concerns. These 5 physical activities were evaluated because they had the highest prevalence of meeting MVPA guidelines, and included *aerobics* (weighted percent meeting guidelines: 2.7% ; n=45), *bicycling* (2.7% ; n=48), *golf* (4.8% ; n=72), *walking* (17.6% ; n=308), and *yard work* (5.5% ; n=100). Notably, and as stated earlier, only time spent in moderate or vigorous intensity activity were evaluated for these individual activities; the self-report physical activity questionnaire, unfortunately, did not query regarding time spent in light-intensity physical activity.

Statistical Analysis

All statistical analyses were computed in Stata (v. 12) and accounted for the multistage, complex probability design employed in NHANES. A multivariable weighted linear regression analysis was computed, with cognition as the outcome variable. Two models were computed: Model 1) the 5 binary meeting MVPA guidelines variables (aerobics, bicycling, golf, walking and yard work) serving as independent variables; and Model 2) same as Model 1, but an overall physical activity variable (MVPA MET-min-month) was also included in this model. In both models, covariates included age, gender, race-ethnicity, mean arterial pressure (average of 4 manually assessed blood pressures), C-reactive protein, self-reported smoking status, measured body mass index, and physician-diagnosed diabetes status. Notably, in Model 2 there was no evidence of multicollinearity, based on the highest observed variance inflation factor being 1.04. Statistical significance was established as a nominal alpha of 0.05.

RESULTS

Weighted characteristics of the analyzed sample is shown in Table 1. Participants, on average, were 69.9 years, the sample was equally distributed across gender, and the activity with the highest proportion of participants meeting MVPA guidelines was walking-based activities. However, the highest mean MVPA among those meeting MVPA guidelines for the select activities was for those meeting guidelines via yard work and bicycling. That is, those most active individuals were those who met MVPA guidelines via yard work and bicycling.

Table 2 displays the weighted multivariable linear regressions evaluating the association between select physical activities and cognitive function. In model 1, which did not account for overall volume of MVPA, nearly all of the select physical activities (with the exception of aerobics) was associated with higher cognitive function. In model 2, which accounted for overall volume of physical activity, the only activity that was statistically significantly associated with higher cognitive function was golf (β=4.7; 95% CI: 0.6, 8.7; P=0.02).

DISCUSSION

The significant, beneficial relationship between regular physical activity engagement and improved cognitive

function has been well documented (Loprinzi, Herod, Cardinal, & Noakes, 2013; Loprinzi & Kane, 2015). Less investigated is the potential for select modalities of physical activity to exert differential effects on cognition. The purpose of our study was to broaden the scope of the impact of physical activity on cognition by specifically evaluating the association between individual-specific physical activities, including aerobics, bicycling, walking, yard work and golf on mental performance within a large sample of older U. S. citizens. The main finding our study was that among elderly individuals, bicycling, walking, yard work and golf were modalities associated with higher performance on a test of executive cognitive functioning. After controlling for cumulative volume of physical activity participation, only golf was statistically significantly associated with higher scores on the DSST.

Table 1: Weighted characteristics of the analyzed sample

Variable	*Point Estimate*	*SE*
Age, mean years	69.9	0.2
% Female	58.6	
% White	83.3	
% Smoker	11.6	
% Diabetes	11.6	
DSST, mean	48.7	0.6
MAP, mean mmHG	93.3	0.4
CRP, mean mg/dL	0.49	0.02
BMI, mean kg/m^2	28.0	0.1
MVPA, mean MET-min-month	3635.9	322
% Meeting Guidelines in Aerobic Activities	2.7	
Mean MVPA in this group	8853.0	816
% Meeting Guidelines in Yard Work	5.5	
Mean MVPA in this group	18209.3	1903
% Meeting Guidelines in Bicycling	2.5	
Mean MVPA in this group	16008.5	1993
% Meeting Guidelines in Golf	4.8	
Mean MVPA in this group	13037.6	1081
% Meeting Guidelines in Walking	17.5	
Mean MVPA in this group	9204.3	774

BMI: Body mass index, **CRP**: C-reactive protein, **DSST:** Digit Symbol Substitution Test, **MAP:** Mean Arterial Pressure, **MET:** Metabolic Equivalent of Task, **MVPA:** Moderate-to-Vigorous Physical Activity

This is a noteworthy finding, as emerging work suggests that there might be a unique effect of different activities on cardiometabolic biomarkers and telomere length (Loprinzi, 2015; Loprinzi & Sng, 2016). Thus, it is plausible to suggest that there may be a mode-specific effect on cognition. That is, perhaps all activities are not equal with regard to their effects on cognition. Our results may reflect the reported tendency for vigorous physical activity to decline with age, with walking often the highest reported modality of physical activity (Dai et al., 2015; Services, 1996). Aerobics is typically a higher intensity exercise, meaning that the lack of statistical significance could possibly be a function of the limited capacity for many older adults to safely participate in vigorous exercise programs (Services, 1996). Bicycling, walking, yard work, and golf are all activities of lower intensity and ambulatory stress, which may complement the physical abilities and interests of seniors. Golf is not only a viable exercise option for older individuals, but also is an activity requiring cognitive engagement. Successful golfers likely exhibit higher degrees of mental preparation, concentration, and positive emotions (Thomas, Londeree, Lawson, Ziogas, & Cox, 1994). Mental preparation and intellectual stimulation may facilitate cognitive processes as a division of cognitive training, which is thought to enhance or maintain brain function across the lifespan (Ball et al., 2002; Scarmeas, Levy, Tang, Manly, & Stern, 2001; Wilson et al., 2002).

Table 2: Weighted multivariable linear regression evaluating the association between select physical activities and cognitive function

	Model 1			*Model 2*		
Meeting MVPA Guidelines	**β**	**95% CI**	**P-Value**	**β**	**95% CI**	**P-Value**
For Aerobics	2.2	-3.3, 7.8	0.42	1.7	-3.9, 7.4	0.53
For Bicycling	4.3	-0.2, 9.0	0.06	3.5	-1.3, 8.3	0.14
For Golf	5.3	1.3, 9.3	0.01	4.7	0.6, 8.7	0.02
For Walking	2.6	0.3, 4.9	0.02	2.1	-0.4, 4.7	0.09
For Yard Work	4.1	-0.1, 8.4	0.05	3.0	-0.8, 6.7	0.11

Two models were computed: Model 1) the 5 binary meeting MVPA guidelines variables (aerobics, bicycling, golf, walking and yard work) serving as independent variables; and Model 2) same as Model 1, but an overall physical activity variable (MVPA MET-min-month) was also included in this model. In both models, covariates included age, gender, race-ethnicity, mean arterial pressure (average of 4 manually assessed blood pressures), C-reactive protein, self-reported smoking status, measured body mass index, and physician-diagnosed diabetes status.

The novelty of our findings extend previous research exploring the relation between the selection of physical activity modality and health status among special populations (Blanchard et al., 2003; Dai et al., 2015; DiPietro, Williamson, Caspersen, & Eaker, 1993; CDC, 2000; Services, 1996; Spees, Scott, & Taylor, 2012). A preliminary understanding of the popularity and likeability of certain physical activities, the diversity of physical activity options available in terms of intensity and physiologic impact, as well as an analysis of average individual time devoted to participation in these activities (Dai et al., 2015), provided us with a strong platform of research to reference in our exploration of this novel topic. We examined the plausibility for individual-specific physical activity to influence cognition, both irrespective of overall volume of engagement in physical activity, then adjusting for total time allocated to the chosen individual-specific modes of physical activity. Individual-specific physical activity was associated with higher cognition among this sample of older adults, particularly for lower-intensity exercise, which accentuates the importance for tailored development of physical activity programs not only safe for the elderly population, but also enjoyable, and appropriate for accomplishing health-specific goals. These health goals may be achieved through a careful selection of activity that is appropriate to an individual's preferences, fitness level, ambulatory capacity and pre-existing comorbidities. Despite our use of an objective measure of cognitive function, future research should address the limitations of our study, which includes the cross-sectional study design and subjective measure of MVPA engagement.

In conclusion, this study underscores the differential association between individual-specific physical activity and cognition within the broader United States older adult population. Specifically, our findings demonstrated that various individual activities were favorably associated with higher cognition, but when adjusting for overall volume of physical activity, only golf-based physical activity was associated with greater cognitive function. This latter point needs verification in future research. Such work should also examine whether sociocultural and intellectual parameters moderates this specific finding. Despite our multivariate model demonstrating no evidence of collinearity, it is possible that this adjustable model is at risk of overfitting. Thus, at this point, it seems reasonable for health professionals to promote multiple safe forms of physical activity to older adults.

REFERENCES

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., . . . Leon, A. S. (2000). Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc, 32(9 Suppl), S498-504. https://doi.org/10.1097/00005768-200009001-00009

Ball, K., Berch, D. B., Helmers, K. F., Jobe, J. B., Leveck, M. D., Marsiske, M., . . . Vital Elderly Study, G. (2002). Effects of cognitive training interventions with older adults: a randomized controlled trial. JAMA, 288(18), 2271-2281. https://doi.org/10.1001/jama.288.18.2271

Beckman, K. B., & Ames, B. N. (1998). The free radical theory of aging matures. Physiol Rev, 78(2), 547-581. https://doi.org/10.1152/physrev.1998.78.2.547

Blanchard, C. M., Cokkinides, V., Courneya, K. S., Nehl, E. J., Stein, K., & Baker, F. (2003). A comparison of physical activity of posttreatment breast cancer survivors and noncancer controls. Behav Med, 28(4), 140-149. https://doi.org/10.1080/08964280309596052

Bosma, H., Stansfeld, S. A., & Marmot, M. G. (1998). Job control, personal characteristics, and heart disease. J Occup Health Psychol, 3(4), 402-409. https://doi.org/10.1037//1076-8998.3.4.402

Cals, M. J., Succari, M., Meneguzzer, E., Ponteziere, C., Bories, P. N., Devanlay, M., . . . Coudray-Lucas, C. (1997). Markers of oxidative stress in fit, health-conscious elderly people living in the Paris area. The Research Group on Ageing (GERBAP). Nutrition, 13(4), 319-326. https://doi.org/10.1016/s0899-9007(97)00079-8

CDC, Centers for Disease Control and Prevention. (2000). Prevalence of leisure-time physical activity among overweight adults-United States, 1998. Morb Mortal Wkly Rep, 49(15), 326-330.

Chrousos, G. P., & Gold, P. W. (1992). The concepts of stress and stress system disorders. Overview of physical and behavioral homeostasis. JAMA, 267(9), 1244-1252. https://doi.org/10.1001/jama.1992.03480090092034

Dai, S., Carroll, D. D., Watson, K. B., Paul, P., Carlson, S. A., & Fulton, J. E. (2015). Participation in Types of Physical Activities Among US Adults--National Health and Nutrition Examination Survey 1999-2006. J Phys Act Health, 12 Suppl 1, S128-140. https://doi.org/10.1123/jpah.2015-0038

DiPietro, L., Williamson, D. F., Caspersen, C. J., & Eaker, E. (1993). The descriptive epidemiology of selected physical activities and body weight among adults trying to lose weight: the Behavioral Risk Factor Surveillance System survey, 1989. Int J Obes Relat Metab Disord, 17(2), 69-76.

Epel, E. S. (2009). Psychological and metabolic stress: a recipe for accelerated cellular aging? Hormones (Athens), 8(1), 7-22. https://doi.org/10.14310/horm.2002.1217

Finkel, T., & Holbrook, N. J. (2000). Oxidants, oxidative stress and the biology of ageing. Nature, 408(6809), 239-247. https://doi.org/10.1038/35041687

Georgiades, A., Sherwood, A., Gullette, E. C., Babyak, M. A., Hinderliter, A., Waugh, R., . . . Blumenthal, J. A. (2000). Effects of exercise and weight loss on mental stress-induced cardiovascular responses in individuals with high blood pressure. Hypertension, 36(2), 171-176. https://doi.org/10.1161/01.hyp.36.2.171

Kostka, T., Drai, J., Berthouze, S. E., Lacour, J. R., & Bonnefoy, M. (2000). Physical activity, aerobic capacity and selected markers of oxidative stress and the anti-oxidant defence system in healthy active elderly men. Clin Physiol, 20(3), 185-190. https://doi.org/10.1046/j.1365-2281.2000.00245.x

Loprinzi, P. D. (2015). Dose-response association of moderate-to-vigorous physical activity with cardiovascular biomarkers and all-cause mortality: Considerations by individual sports, exercise and recreational physical activities. Prev Med, 81, 73-77. https://doi.org/10.1016/j.ypmed.2015.08.014

Loprinzi, P. D., Herod, S. M., Cardinal, B. J., & Noakes, T. D. (2013). Physical activity and the brain: a review of this dynamic, bi-directional relationship. Brain Res, 1539, 95-104. https://doi.org/10.1016/j.brainres.2013.10.004

Loprinzi, P. D., & Kane, C. J. (2015). Exercise and cognitive function: a randomized controlled trial examining acute exercise and free-living physical activity and sedentary effects. Mayo Clin Proc, 90(4), 450-460. https://doi.org/10.1016/j.mayocp.2014.12.023

Loprinzi, P. D., & Sng, E. (2016). Mode-specific physical activity and leukocyte telomere length among U.S. adults: Implications of running on cellular aging. Prev Med, 85, 17-19. https://doi.org/10.1016/j.ypmed.2016.01.002

McEwen, B. S. (1998). Protective and damaging effects of stress mediators. N Engl J Med, 338(3), 171-179. https://doi.org/10.1056/nejm199801153380307

McEwen, B. S. (2002). Sex, stress and the hippocampus: allostasis, allostatic load and the aging process. Neurobiol Aging, 23(5), 921-939. https://doi.org/10.1016/s0197-4580(02)00027-1

Moller, P., Wallin, H., & Knudsen, L. E. (1996). Oxidative stress associated with exercise, psychological stress and life-style factors. Chem Biol Interact, 102(1), 17-36. https://doi.org/10.1016/0009-2797(96)03729-5

Musselman, D. L., Evans, D. L., & Nemeroff, C. B. (1998). The relationship of depression to cardiovascular disease: epidemiology, biology, and treatment. Arch Gen Psychiatry, 55(7), 580-592. https://doi.org/10.1001/archpsyc.55.7.580

National Health and Nutrition Examination Survey. (2007). Available at: https://www.cdc.gov/nchs/data/nhanes/nhanes_07_08/overviewbrochure_0708.pdf

Parkin, A. J., & Java, R. I. (1999). Deterioration of frontal lobe function in normal aging: influences of fluid intelligence versus perceptual speed. Neuropsychology, 13(4), 539-545. https://doi.org/10.1037//0894-4105.13.4.539

Scarmeas, N., Levy, G., Tang, M. X., Manly, J., & Stern, Y. (2001). Influence of leisure activity on the incidence of Alzheimer's disease. Neurology, 57(12), 2236-2242. https://doi.org/10.1212/wnl.57.12.2236

Services, U. S. D. o. H. a. H. (1996). Physical activity and health: a report of the Surgeon General, 278 p. Available at: https://profiles.nlm.nih.gov/ps/retrieve/ResourceMetadata/NNBBHB

Spees, C. K., Scott, J. M., & Taylor, C. A. (2012). Differences in amounts and types of physical activity by obesity status in US adults. Am J Health Behav, 36(1), 56-65. https://doi.org/10.5993/ajhb.36.1.6

Stansfeld, S. A., Fuhrer, R., Shipley, M. J., & Marmot, M. G. (2002). Psychological distress as a risk factor for coronary heart disease in the Whitehall II Study. Int J Epidemiol, 31(1), 248-255. https://doi.org/10.1093/ije/31.1.248

Thomas, T. R., Londeree, B. R., Lawson, D. A., Ziogas, G., & Cox, R. H. (1994). Physiological and psychological responses to eccentric exercise. Can J Appl Physiol, 19(1), 91-100. https://doi.org/10.1139/h94-006

Traustadottir, T., Bosch, P. R., & Matt, K. S. (2005). The HPA axis response to stress in women: effects of aging and fitness. Psychoneuroendocrinology, 30(4), 392-402. https://doi.org/10.1016/j.psyneuen.2004.11.002

Vilkki, J., & Holst, P. (1991). Mental programming after frontal lobe lesions: results on digit symbol performance with self-selected goals. Cortex, 27(2), 203-211. https://doi.org/10.1016/s0010-9452(13)80124-4

Wan, H., Sengupta, M., Velkoff, V. A., DeBarros, K. A. (2005). 65+ in the United States: 2005, Current Population Reports, Special Studies. National Institute on Aging, US Census Bureau, Washington, DC, 243 p. Available at: https://www.census.gov/prod/2006pubs/p23-209.pdf

Wechsler, D. (1958). The Measurement and Appraisal of Adult Intelligence, 4th ed. Baltimore, MD, US: Williams & Wilkins Co., 297 p. https://doi.org/10.1037/11167-000

Wilson, R. S., Mendes De Leon, C. F., Barnes, L. L., Schneider, J. A., Bienias, J. L., Evans, D. A., & Bennett, D. A. (2002). Participation in cognitively stimulating activities and risk of incident Alzheimer disease. JAMA, 287(6), 742-748. https://doi.org/10.1001/jama.287.6.742