Open Access
eISSN: 2508-9056

Exercise Medicine

Exercise Medicine 2018; 2:1 | https://doi.org/10.26644/em.2018.001

Brief Report

Cardiorespiratory Fitness and Leisure Time Physical Activity are Low in Young Men with Elevated Symptoms of Attention Deficit Hyperactivity Disorder

Kathryn Fritz[1,*], Patrick J. O'Connor[1]

[1]Department of Kinesiology, University of Georgia, 102B Ramsey Student Center, 330 River Rd., Athens, GA 30602 USA.

Article Information

History:
Received: November 9, 2017
Accepted: January 3, 2018
Published: January 4, 2018

Keywords:
Adult ADHD self-report scale
College students
Fitness
Mental health
Physical activity

ABSTRACT

Objectives: The purpose of this study was to determine whether cardiorespiratory fitness and leisure time physical activity in men screening positive for ADHD were low compared to age- and sex-matched reference values.
Methods: 30 college men screening for ADHD were recruited. Data were collected between October 2014 and April 2015. Maximal cycle exercise tests were performed to assess cardiorespiratory fitness and typical 7-day leisure time physical activity was self- reported.
Results: Mean cardiorespiratory fitness was 0.94 SD lower than age- and sex-matched reference values. Cardiorespiratory fitness and ADHD symptoms were significantly negatively associated (r= -.39). Leisure time physical activity was 0.3 SD lower than a prior study of 411 college students. A linear regression showed a significant prediction of cardiorespiratory fitness from the combination of ADHD symptoms and leisure time physical activity.
Conclusions: Men screening positive for ADHD was characterized by low cardiorespiratory fitness and leisure time physical activity.

INTRODUCTION

Cardiorespiratory fitness (CRF) is a marker of physical and mental health and is associated with decreased risk of all-cause mortality, cardiovascular disease, type 2 diabetes and depressive symptoms [1-3]. CRF is lower in major depressive disorder [4] which is comorbid with attention deficit hyperactivity disorder (ADHD) [5]. Genes and behavior can influence CRF. Heritability estimates of CRF range from 25% to 65% [6], and sedentary individuals who adopt a leisure time physical activity program increase CRF by an average of ~10% [7,8]. Maintaining higher levels of CRF protects against both the development of depressive symptoms in adolescents [9] and the onset of depression complaints made to physicians among adult men and women [10]. The extent to which chronic leisure time physical activity (LTPA) or CRF are associated with the symptoms of ADHD among adults is unknown.

Acute physical activity appears to be beneficial for attenuating symptoms of ADHD. Single bouts of exercise have improved signs of hyperactivity in children [11] and feelings of confusion and cognitive performance in adults and children with ADHD symptoms [12-15].

Regular physical activity has been suggested as beneficial for those experiencing ADHD symptoms [16,17] and CRF appears to be low in children with ADHD, but it is unknown if adults with ADHD are characterized by lower than average LTPA or CRF. One study compared children with ADHD to reference data and found that children with ADHD on average performed below the 25th percentile on a 20 meter shuttle run test [18], indicating an increased risk for low CRF. A second study of 70 boys (7-12 years) with and without ADHD revealed lower estimated CRF among those with ADHD based on a 20 meter shuttle run and treadmill performance time [19].

The aims of the current study were to investigate (i) if CRF and LTPA in young adult men screening positive for adult ADHD are low compared to age- and sex-matched ref-

Correspondence: Kathryn Fritz, Department of Kinesiology, University of Georgia, 102B Ramsey Student Center, 330 River Rd., Athens, GA 30602 USA.
E-mail address: kmfritz@uga.edu

erence data, (ii) if self-reported ADHD symptoms are significantly related to either CRF or LTPA, and (iii) if CRF could be predicted from LPTA or ADHD symptoms. Moderate negative correlations were hypothesized between ADHD symptoms and both CRF and LTPA, and it was expected that CRF could be predicted from LPTA and ADHD symptoms.

METHODS

The study was approved by the University of Georgia's Institutional Review Board (Study ID: MOD00001810). This analysis is ancillary to a published parent study focused on psychological responses to acute exercise [15]. Potential participants were recruited from university class announcements, posted flyers and email messages to listservs. Qualified participants were male, 18-26 years old, not currently taking CNS acting medication and without contraindications to exercise who screened positive for adult ADHD. Excluded were smokers and those indicating the presence of a current mental disorder other than ADHD.

Potential participants completed an online screening questionnaire, which included a demographic and health questions, the Physical Activity Readiness Questionnaire (PAR-Q), the Godin Leisure-Time Exercise Questionnaire, and the Adult ADHD Self-Report Scale V1.1 (ASRS V1.1). The ASRS V1.1 is a six-item screening questionnaire that identified individuals with elevated self-reported ADHD symptoms. The ADHD screening questions were: *"How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done?"*, *"How often do you have difficulty getting things in order when you have a task that requires organization?"*, *"How often do you have problems remembering appointments of obligations?"*, *"When you have a task that requires a lot of thought, how often do you avoid or delay getting started?"*, *"How often do you fidget or squirm with your hands or feet when you have to sit down for a long time?"* and *"How often do you feel overly active and compelled to do things, like you were driven by a motor?"* Responses to questions range from 'never' to 'very often'. The 0-24 scoring method has been shown to have 64.9% sensitivity, 94.0% specificity, and 91.5% total classification accuracy [20]. Potential participants 'screened positive' for ADHD with scores ≥12. Two of 32 participants reported having an ADHD diagnosis.

Those meeting inclusion criteria were visited the University of Georgia Exercise Psychology Laboratory to be tested. After providing written consent, participants were prepared for a graded maximal cycle exercise test, which included fitting participants with a Polar Vantage XL heart rate monitor and a face mask to measure expired gases. Participants were provided with verbal instruction on the test protocol and measures to be obtained during the test. Participants began the graded maximal exercise test by sitting on a cycle ergometer (Excalibur Sport, Lode, Groningen, The Netherlands) and pedaling at 60 to 80 revolutions per minute at a resistance that produced a power output of 50 watts for two minutes. Next, resistance was increased such that power output was increased by 25 watts every two minutes until the participant was no longer able to maintain a cadence of 60 revolutions per minute. At the end of each stage, overall rating of perceived exertion (RPE 6-20) [21], heart rate, leg pain (0-10) [22], VO_2, CO_2, V_E, and respiratory exchange ratio (RER) were recorded as described previously [23]. VO_{2peak} was defined as the highest 20-second VO_2 value obtained during exercise expressed per kilogram of body mass. Body mass was measured to the nearest 0.5 kg using a calibrated balance beam scale.

All data were entered into IBM SPSS Statistics (Version 22.0.0) which was used to perform analyses. Effect size (Cohen's *d*) was calculated as the mean difference between the sample tested and a reference group [24] divided by the pooled standard deviation. The chosen reference groups' data are from the 1999-2002 NHANES dataset. The 50th percentile cardiorespiratory fitness level for males 20-29 years old (n=288) was compared to the current sample's group mean cardiorespiratory fitness level. Pearson correlations were used to examine the degree of association between ADHD symptoms and both CRF and LTPA. A linear regression analysis was used to examine whether CRF could be predicted from ADHD symptoms and LTPA.

RESULTS

Thirty two men screened positive for ADHD and completed the parent study [15]. Two individuals were excluded from the current analysis because they did not meet the criteria for an adequate test to determine peak oxygen consumption (i.e., did not exhibit a respiratory exchange ratio [RER] ≥1.1). Mean (±standard deviation, SD) CRF was 38.7 (±7.1) $ml.kg^{-1}.min^{-1}$, CI=36.2 to 41.2. Maximal exercise test and LTPA results for each individual are reported online in supplementary materials (Supplementary Table S1). Group CRF and LTPA data are also illustrated in Figures 1 and 2, respectively.

A significant correlation was found between CRF and

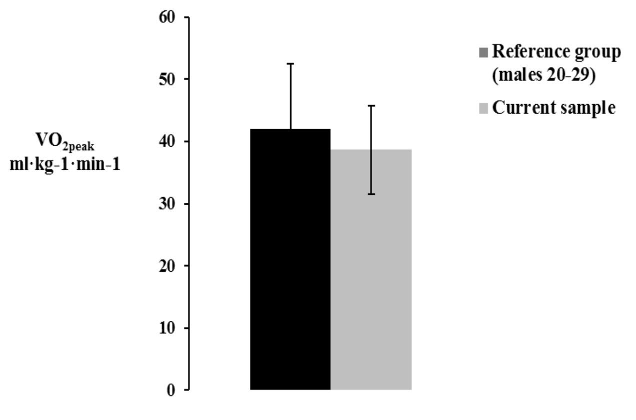

Figure 1. Fitness (mean, 95% CI) compared to an age- and sex-matched reference group of 288 males aged 20-29.
Effect size *d*=-0.83.

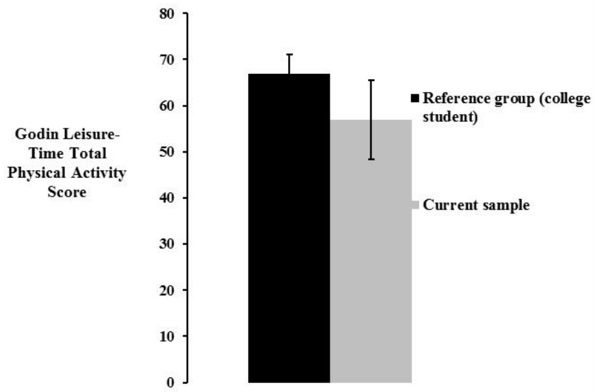

Figure 2. Physical activity (mean, 95% CI) compared to a reference group of 411 college students.
Effect size *d*=-0.3.

ADHD symptom scores, r=-0.39, p=0.03, and a scatterplot is provided in Figure 3. The relationship between ADHD symptom scores and LTPA was insignificant, r=-0.02, p=0.92. A linear regression showed a significant prediction of CRF from the combination of ADHD symptoms and leisure time physical activity, $F(2,27)$=5.095, p=0.01, adjusted R^2=0.22, $B_{ADHD\ symptoms}$=-1.28 (p=0.03), B_{Godin}=0.11 (p=0.04).

DISCUSSION

To our knowledge, this is the first study to objectively measure CRF in adults screening for adult ADHD. The results suggest that young men screening positive for adult ADHD are characterized by low CRF. Mean CRF was low by a large Cohen's d effect size magnitude compared to several age- (20 to 29 years) and sex-matched reference groups, including when comparisons were made with samples of (i) 199 Norwegian men tested using cycle ergometry (d=-2.0) [8], (ii) 288 United States participants from the 1999 to 2004 National Health and Nutrition Examination Survey who completed treadmill tests (d=-0.83) [24] and (iii) 513 participants who completed treadmill tests in one of eight laboratories in the United States (d=-0.94) [25]. CRF varies by country and exercise testing mode. CRF is higher in Scandinavian countries and with treadmill testing because of the larger muscle mass compared to cycle ergometry, which may account for some of the difference between the present group and the U.S. reference groups. Regardless, no prior similar study of adults with ADHD or adults screening for adult ADHD exists. The low CRF in the present group does not appear to be primarily a function of the sample being unwilling to give a strong effort. All participants showed respiratory exchange ratio and heart rate responses indicative of maximal exercise [26], and all but one individual reported a peak perceived exertion rating that ranged from "hard" to 'maximal' exertion. One individual reported a peak perceived exertion of 13 (somewhat hard) which is lower than expected for a maximal test. However, that individual had a peak heart rate of 180 and a peak respiratory exchange ratio of 1.1 both values indicative of an adequate maximal exercise test. The VO_{2peak} of this individual, 31.3 ml.kg^{-1}.min^{-1}, was not an outlier for this sample. Previous studies have investigated exercise tests that can estimate CRF levels in children and compared those with ADHD to those without ADHD. Results from these studies are mixed and may have been influenced by the methods used to estimate CRF, but results from one study revealed significantly lower estimated CRF in children with ADHD when compared to a reference group [18]. Data from each individual tested has not been included in the prior reports focused on samples of children.

Self-reported LTPA levels also were low when considered in comparison to a group of college men [27]; however, the magnitude of this effect size was smaller than for CRF. The linear correlation between LTPA and ADHD symptom scores was statistically insignificant, however, the addition of LTPA to a regression used to predict CRF increased the accuracy of the prediction. We are unaware of prior studies examining physical activity patterns among adults with ADHD symptoms. However, results from one epidemiological study with older adults showed ADHD symptoms were positively associated with the presence of cardiovascular disease and an increased number of chronic diseases as well as negatively associated with self-perceived health [28], all of which are associated with physical inactivity. Increased risk for obesity/overweight has also been suggested for individuals with ADHD [29]. Moreover, results from one study indicated reduced self-reported weekly energy expenditure in late adolescence was related to increased ADHD symptoms in early adulthood [30]. Thus, there appears to be a complex relationship between physical inactivity and ADHD symptoms that bears further investigation.

The current study is not without limitations. The small sample size means there is a possibility for small sample bias. More research with larger samples is needed to determine more conclusively the extent to which adults with increased ADHD symptoms are characterized by low CRF. LTPA levels were obtained using self-report, and it is unknown how accurately individuals with ADHD are able to report their physical activity levels. The future use of objective measures

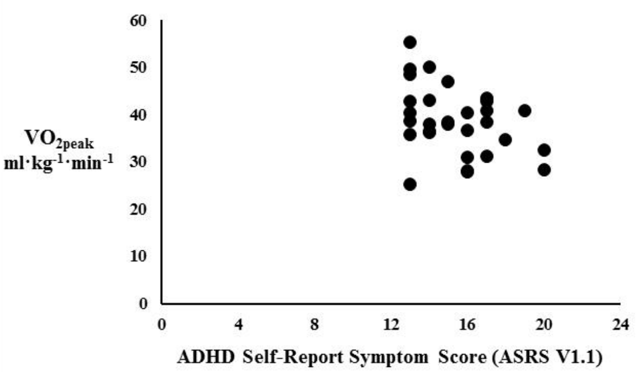

Figure 2. Scatterplot of fitness and ADHD symptom severity scores in 30 male students reporting elevated ADHD symptoms
r=-0.39, p=0.034.

of physical activity will help to confirm the extent to which adults with ADHD symptoms are physically active. The present findings also cannot be generalized to women or to adults with an ADHD diagnosis.

CONCLUSIONS

Young adult men screening positive for adult ADHD have lower CRF and appear to be less physically active compared to reference groups of men of the same age. CRF can be predicted from ADHD symptoms and LTPA, and the association between symptoms and CRF is stronger than the association between symptoms and one self-reported measure of LTPA.

ACKNOWLEDGEMENTS

The authors would like to thank the participants for volunteering to participate in the study.

Conflicts of interest

The authors declare that there is no conflict of interest.

Supplementary materials

Supplementary Table related to this article can be found at https://doi.org/10.26644/em.2018.001

REFERENCES

1. Kodama S, Saito K, Tanaka S, et al. Cardiorespiratory fitness as a quantitative predictor of all-cause mortality and cardiovascular events in healthy men and women: A meta-analysis. JAMA. 2009; 301(19):2024-35.
2. Lee D-c, Sui X, Church TS, Lee I-M, Blair SN. Associations of cardiorespiratory fitness and obesity with risks of impaired fasting glucose and type 2 diabetes in men. Diabetes Care. 2009; 32(2):257-62.
3. Galper DI, Trivedi MH, Barlow CE, Dunn AL, Kampert JB. Inverse association between physical inactivity and mental health in men and women. Med Sci Sports Exerc. 2006; 38(1):173-8.
4. Boettger S, Wetzig F, Puta C, et al. Physical fitness and heart rate recovery are decreased in major depressive disorder. Psychosom Med. 2009; 71(5):519-23.
5. Kessler RC, Adler LA, Barkley R, et al. Patterns and predictors of Attention-Deficit/Hyperactivity Disorder persistence into adulthood: Results from the national comorbidity survey replication. Biol Psychiatry. 2005; 57(11):1442-51.
6. Teran-Garcia M, Rankinen T, Bouchard C. Genes, exercise, growth, and the sedentary, obese child. J Appl Physiol. 2008; 105(3):988-1001.
7. Lin X, Zhang X, Guo J, et al. Effects of exercise training on cardiorespiratory fitness and biomarkers of cardiometabolic health: A systematic review and meta-analysis of randomized controlled trials. J Am Heart Assoc. 2015; 4(7):e002014.
8. Loe H, Rognmo Ø, Saltin B, Wisløff U. Aerobic capacity reference data in 3816 healthy men and women 20–90 years. PLoS ONE. 2013; 8(5):e64319.
9. Ruggero CJ, Petrie T, Sheinbein S, Greenleaf C, Martin S. Cardiorespiratory fitness may help in protecting against depression among middle school adolescents. J Adolesc Health. 2015; 57(1):60-5.
10. Dishman RK, Sui X, Church TS, Hand GA, Trivedi MH, Blair SN. Decline in cardiorespiratory fitness and odds of incident depression. Am J Prev Med. 2012; 43(4):361-8.
11. Tantillo M, Kesick CM, Hynd GW, Dishman RK. The effects of exercise on children with Attention-Deficit Hyperactivity Disorder. Med Sci Sports Exerc. 2002; 34(2):203-12.
12. Gapin J, Labban JD, Bohall SC, Wooten JS, Chang Y-K. Acute exercise is associated with specific executive functions in college students with adhd: A preliminary study. J Sport Health Sci. 2015; 4(1):89-96.
13. Piepmeier AT, Shih C-H, Whedon M, et al. The effect of acute exercise on cognitive performance in children with and without ADHD. J Sport Health Sci. 2015; 4(1):97-104.
14. Pontifex MB, Saliba BJ, Raine LB, Picchietti DL, Hillman CH. Exercise improves behavioral, neurocognitive, and scholastic performance in children with Attention-Deficit/Hyperactivity Disorder. J Pediatr. 2013; 162(3):543-51.
15. Fritz KM, O'Connor PJ. Acute exercise improves mood and motivation in young men with ADHD symptoms. Med Sci Sports Exerc. 2016; 48(6):1153-60.
16. Archer T, Kostrzewa RM. Physical exercise alleviates ADHD symptoms: Regional deficits and development trajectory. Neurotox Res. 2012; 21(2):195-209.
17. Gapin JI, Labban JD, Etnier JL. The effects of physical activity on Attention Deficit Hyperactivity Disorder symptoms: The evidence. Prev Med. 2011; 52(S1):S70-4.
18. Harvey WJ, Reid G. Motor performance of children with Attention-Deficit Hyperactivity Disorder: A preliminary investigation. Adapt Phys Activ Q. 1997; 14(3):189-202.
19. Verret C, Gardiner P, Béliveau L. Fitness level and gross motor performance of children with Attention-Deficit Hyperactivity Disorder. Adapt Phys Activ Q. 2010; 27(4):337-51.
20. Kessler RC, Adler LA, Gruber MJ, Sarawate CA, Spencer T, Van Brunt DL. Validity of the World Health Organization adult ADHD self-report scale (asrs) screener in a representative sample of health plan members. Int J Methods Psychiatr Res. 2007; 16(2):52-65.
21. Borg GA, Noble BJ. Perceived exertion. Exerc Sport Sci Rev. 1974; 2(1):131-54.
22. Cook DB, O'Connor PJ, Eubanks SA, Smith JC, Lee M. Naturally occurring muscle pain during exercise: Assessment and experimental evidence. Med Sci Sports

Exerc. 1997; 29(8):999-1012.
23. Motl RW, O Connor PJ, Tubandt L, Puetz T, Ely MR. Effect of caffeine on leg muscle pain during cycling exercise among females. Med Sci Sports Exerc. 2006; 38(3):598-604.
24. Wang C-Y, Haskell WL, Farrell SW, et al. Cardiorespiratory fitness levels among US adults 20–49 years of age: Findings from the 1999–2004 National Health and Nutrition Examination Survey. Am J Epidemiol. 2010; 171(4):426-35.
25. Kaminsky LA, Arena R, Myers J. Reference standards for cardiorespiratory fitness measured with cardiopulmonary exercise testing: Data from the fitness registry and the importance of exercise national database. Mayo Clin Proc. 2015; 90(11):1515-23.
26. Tanaka H, Monahan KD, Seals DR. Age-predicted maximal heart rate revisited. J Am Coll Cardiol. 2001; 37(1):153-6.
27. Reed JA, Phillips DA. Relationships between physical activity and the proximity of exercise facilities and home exercise equipment used by undergraduate university students. J Am Coll Health. 2005; 53(6):285-90.
28. Semeijn EJ, Sandra Kooij JJ, Comijs HC, Michielsen M, Deeg DJH, Beekman ATF. Attention-Deficit/Hyperactivity Disorder, physical health, and lifestyle in older adults. J Am Geriatr Soc. 2013; 61(6):882-7.
29. Cortese S, Moreira-Maia CR, St. Fleur D, Morcillo-Peñalver C, Rohde LA, Faraone SV. Association between ADHD and obesity: A systematic review and meta-analysis. Am J Psychiatry. 2016; 173(1):34-43.
30. Rommel A-S, Lichtenstein P, Rydell M, et al. Is physical activity causally associated with symptoms of Attention-Deficit/Hyperactivity Disorder? J Am Acad Child Adolesc Psychiatry. 2015; 54(7):565-70.