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Original Contribution

Influence of sedentary behavior, physical activity, and cardiorespiratory fitness on the atherogenic index of plasma

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BACKGROUND: Atherogenic index of plasma (AIP), calculated as LOG_{10} (triglycerides/high-density lipoprotein-cholesterol), may have greater utility over other metrics in predicting risk for cardiovascular disease (CVD). Previous work demonstrates the associations of physical activity (PA), sedentary behavior, and cardiorespiratory fitness (CRF) with triglycerides high-density lipoprotein (HDL-C) and CVD.

OBJECTIVE: Limited research has examined these parameters and their potential additive associations with AIP, which was the purpose of this study.

METHODS: Data from the 2003–2004 National Health and Nutrition Examination Survey (NHANES) were used (N = 307 adults 20–49 years). Sedentary behavior and moderate-to-vigorous physical activity (MVPA) were assessed via accelerometry. CRF was assessed via submaximal treadmill testing. Using median values, a PACS (Physical Activity Cardiorespiratory Sedentary) score (ranging from 0–3) was created, indicating the number of these positive characteristics (eg, above median CRF) each participant possessed.

RESULTS: Above median MVPA was associated with significantly lower AIP values (β = −0.09; 95% CI, −0.17 to −0.01; *P* = .03), whereas above-median CRF (β = −0.0009; 95% CI, −0.09 to 0.08; *P* = .98) and below-median sedentary behavior (β = −0.02; 95% CI, −0.13 to 0.08; *P* = .60) were not. Compared to those with a PACS score of 0, those with a score of 1 or 2 did not have significantly reduced AIP values (β = 0.02; 95% CI, −0.06 to 0.10; *P* = .59, and β = 0.007; 95% CI, −0.12 to 0.13; *P* = .90, respectively); however, those with a score of 3 did (β = −0.14; 95% CI, −0.28 to −0.001; *P* = .04).

CONCLUSION: Interventions targeting improvements in lipid profile (AIP) may wish to promote adequate MVPA over CRF or decreased sedentary behavior.

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Introduction

Cardiovascular disease (ie, disorders of the heart and/or blood vessels) is the leading cause of mortality in the United States, accounting for nearly one third of all deaths.[1] According to a report from the National Center for Health Statistics, life expectancy could increase by nearly 7 years if all forms of early onset of major cardiovascular disease (CVD) were prevented,[2] along with improvements in non-CVD morbidity (eg, type II diabetes, depression, and certain types of cancer), as well as quality of life.[3] In addition to its considerable cost of human lives (800.9 thousand deaths in 2013 in the US.),[1] CVD presents an enormous financial burden. It has been estimated that coronary heart disease (CHD), which accounts for 50% of CVD mortality,[4] costs the United States $108.9 billion annually in health care services, medications, and loss of work productivity.[5] Fortunately, there are ways to combat and prevent the deleterious consequences of CVD.

It is well established that lifestyle changes can reduce the risk for CVD morbidity and mortality.[6] Lifestyle behaviors known to associate with CVD include, for example, poor dietary habits and physical inactivity. There is substantial evidence to support the effectiveness of physical activity and dietary changes on the outcome of CVD, including several statements from the American Heart Association[7] on exercise,[8] physical activity interventions,[9] and diet/lifestyle recommendations.[10] Notably, these behaviors have been shown to associate with a number of risk factors that may contribute to CVD, such as elevated total cholesterol, triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), blood pressure, and glucose, as well as decreased high-density lipoprotein cholesterol (HDL-C).[11–14] Identifying predictive CVD risk factors is inarguably a critical step in the prevention of CVD and premature CVD-related mortality, as it assists in formulating the goals/objectives of intervention strategies (eg, decrease bodyweight, improve physical activity levels) aimed at risk reduction. An equally important step is to develop and implement the most effective screening strategies, designed to identify (as early as possible) individuals who are at the greatest risk for developing CVD.

As an example of recent efforts to improve CVD screening strategies, the American College of Cardiology/American Heart Association (ACC/AHA) task force recently developed the pooled cohort equations,[15] which were specifically designed to predict 10-year risk of developing a first atherosclerotic cardiovascular disease–related event. Notably, these equations have recently been shown to have predictive validity with respect to CVD-specific,[16] cancer-specific,[17] and all-cause mortality.[16] In addition to these new predictive equations, various indices have been developed to assess individual CVD risk factors. For example, several measures of lipid profile have been explored for their associations with health-related outcomes (eg, CVD). Atherogenic index of plasma (AIP) is calculated by logarithmically transforming the ratio of TG/HDL-C[18] and has been shown to have promising utility as a predictor of CVD, to a greater extent than other measures of lipid profile (TG/HDL-C ratio,[19] Castelli Risk Index 1 [total cholesterol/HDL-C], Castelli risk index II [LDL-C/HDL-C], and Atherogenic Coefficient [non-HDL-C/HDL-C]).[20] This greater predictor of CVD from the AIP may possibly be due to a stronger correlation of AIP with lipoprotein particle size (specifically, the ratio of the smallest LDL particles to the largest LDL particles, which better correlates with total concentration of atherogenic lipoprotein particles).[21] The potential utility of AIP as a predictor for CVD served as motivation for the present investigation of modifiable factors that may be associated with AIP. Specifically, we were interested in exploring the potential individual and additive associations of physical activity (specifically MVPA), sedentary behavior, and cardiorespiratory fitness (CRF) with AIP. This is a worthwhile investigation for various reasons, which are detailed in the subsequent two paragraphs.

The health benefits of exercise are known include positive effects on lipid profile, mainly decreased TG and increased HDL-C levels[11] (both of which are included within the AIP calculation).[21] Notably, several studies have previously demonstrated an inverse association between aerobic exercise and AIP.[22–24] We felt it important to also include CRF within the current model, given previous indications that CRF may be more closely associated with certain health outcomes (eg, CVD-related events and CVD-specific mortality) than physical activity levels.[25] This may be due to the fact that age, gender, genotype, smoking status, weight status, and presence of medical conditions (eg, hypertension) are all considered, along with physical activity levels, to be determinants of CRF. Although physical activity is considered a principal determinant of CRF, with previous evidence to suggest a (positive) dose-response relationship between the two,[26,27] CRF may be influenced by a number of additional modifiable and nonmodifiable determinants,[25] thus making it important to examine its unique association with AIP in addition to any potential combined (with physical activity and/or sedentary behavior) associations on AIP. Although limited in investigation, a significant association between CRF and AIP is plausible, given significant (favorable) associations of CRF with CVD risk factors, including TG and HDL-C levels.[28]

Notably, sedentary behavior was included within our evaluated model given the associations of physical inactivity with CVD-related outcomes (eg, a dose-response relationship between sitting time and CVD-specific mortality, as well as CVD-related events),[29] and recent suggestions that sedentary behavior may negatively influence health outcomes, independent of MVPA.[30] The notion that sedentary behavior may independently associate with health outcomes has inspired examinations of the joint effects of sedentary behavior and MVPA on mortality[31–33] and health-related quality of life[34] for instance. To our knowledge, no previous study has explored the potential