



Original Research

Meeting USDHHS Physical Activity Guidelines and Health Outcomes

E. EARLYNN LAUER^{†1}, ALLEN W. JACKSON^{#2}, SCOTT B. MARTIN^{#2}, and JAMES R. MORROW, JR^{#2}

¹Department of Kinesiology, Recreation, and Sport Studies, University of Tennessee, Knoxville, TN, USA; ²Department of Kinesiology, Health Promotion, and Recreation, University of North Texas, Denton, TX, USA

[†]Denotes graduate student author, [#]Denotes professional author

ABSTRACT

International Journal of Exercise Science 10(1): 121-127, 2017 Current public health physical activity (PA) guidelines suggest ≥ 500 METmin/week of PA, with additional benefits beyond 1000 METmin/week (i.e., a dose response). Revised U.S. PA guidelines are scheduled for 2018. The purpose was to relate health markers (blood pressure, percent fat, BMI, blood glucose, cholesterol, and cardiorespiratory fitness) to verify the dose response for PA guidelines revision. 505 non-smoking participants self-reported PA behaviors and completed medical screening. MANCOVA controlling for age and gender determined the relation between health markers and PA. MANCOVA indicated significantly ($P < .001$) different health markers of percent fat, BMI, glucose, and treadmill time as a function of PA. Post-hoc Helmert contrasts (1] < 500 METmin/week vs. ≥ 500 METmin/week and 2] 500 to < 1000 METmin/week vs. ≥ 1000 METmin/week) indicated that meeting the PA guidelines was associated with better health markers and higher cardiorespiratory fitness. Effect sizes were greater for contrast 1 than for contrast 2, suggesting a plateauing effect. Revised public health guidelines should consider achievement of ≥ 500 METmin/week to be most important, with additional modest gain thereafter. Revised PA guidelines should stress the importance of achieving 500-1000 METmin/week.

KEY WORDS: Cardiorespiratory fitness, exercise evaluation, physical fitness, public health

INTRODUCTION

The 2008 U.S. Physical Activity Guidelines (PAG) (19) suggesting improved health benefits with increasing physical activity (PA) are being revised with proposed publication in 2018. The current PAG recommend achieving ≥ 500 METmin/week of PA for health benefits and additional benefits when achieving ≥ 1000 METmin/week. PA can be defined as bodily movement that enhances health and can be divided into three categories by intensity: light,

moderate, and vigorous. Light PA consists of activities such as walking leisurely to work, moderate PA includes recreational swimming or moderately paced biking, and vigorous PA involves most competitive sports and heavy housework or yardwork (1). Individuals can be categorized into PA groups when intensity is considered with duration of the activity, essentially calculating a total volume of PA conducted. To simplify the calculation and interpretation of this volume and of these categories, metabolic equivalent (MET) of task values was developed to describe the relative intensity of the task based on the ratio of the working metabolic rate to a resting metabolic rate. MET-minutes (METmin) can be used to describe both intensity and duration in a single value based on the Compendium of Physical Activities (1).

Although regular PA can lead to long term health benefits, including impacting mortality, the U.S. Centers for Disease Control and Prevention reports (<http://www.cdc.gov/physicalactivity/data/facts.html>) less than half the U.S. population achieve the recommended amounts of PA per week (20). Snyder et al. (15) indicate that providing the public with important health messages that promote the commencement of healthy behaviors rather than cessation of bad behavior is essential to behavior change. The current PAG suggest most health benefits occur with at least 150 minutes of moderate intensity PA per week (or approximately 500 METmin/week) (18). While many Americans do not meet the specific PAG, the PAG advocate that some PA is better than none (19). Further, Hill (7) claims, "when it comes to physical activity, every little bit counts", a concept supported by the PAG. Thus, the PAG suggest that any PA is beneficial to physical health, with optimum threshold health benefits achieved when accruing ≥ 150 minutes of moderate intensity exercise per week (the equivalent of 500 METmin/week), and increased health benefits with PA beyond 150 minutes of moderate intensity exercise per week. While this recommendation is theoretical and data-based, there have been limited reports specifically comparing health outcomes for those achieving various levels of the PAG. Jackson et al. (16) provided evidence that meeting national physical activity muscular strengthening guidelines was related to obesity categorization. There is a need to determine which health outcomes improve with increasing PA as revision of the PAG is considered. Physical health can be measured by specific health markers during routine medical screenings to efficiently and effectively analyze changes resulting from behavior modification.

The USDHHS 1996 report from the Surgeon General (17) and the 2008 PAG Committee Report (18) cite a growing body of research supporting the relationship between PA and physical health benefits. Andersen and Jakicic (2) consolidated findings from several studies to identify common health benefits due to PA. Relating the PAG to common health markers for adults achieving various levels of PA would help validate the PAG and provide evidence for possible revision. Thus, in the current study, systolic and diastolic blood pressure, percent fat, BMI, glucose, cholesterol, and cardiorespiratory fitness (CRF) were chosen to measure the relation of PA with physical health. The purpose of the current study was to relate the amount of self-reported PA to various health markers. PA was categorized as suggested by the PAG (<500 METmin/week; 500-1000 METmin/week; ≥ 1000 METmin/week).

METHODS

Participants

Participants were 505 non-smoking patients (366 males, 139 females) ranging from 19 to 88 years in age ($M = 49.8 \pm 10.0$) who completed a comprehensive physical examination at a health clinic in the southwestern United States. Smoking participants were excluded from the study due to their increased risk for cardiovascular diseases and abnormalities; thus, all participants were without any history of cardiovascular diseases.

Protocol

Participants were asked in person or online as part of a medical history questionnaire the frequency and duration of several PA behaviors: treadmill (walking or running), bicycling (outdoors), stationary cycling, walking, jogging or running (outdoors or on a track), swimming laps, aerobic dance, vigorous racquet sports, and other vigorous sports or muscle-strengthening activities. The duration (minutes per week) was combined with the MET value for each activity to create a single PA variable. Previous research on similar self-report surveys has shown correlations with other self-report PA surveys (0.09-0.81) and acceptable test-retest reliabilities (0.72-0.92) when recall is less than 1 month (10). Based on self-reported PA per week, three groups were created to distinguish participants who did not meet the PAG (Group 1: <500 METmin/week), met the PAG (Group 2: 500 to <1000 METmin/week), or exceeded the PAG (Group 3: ≥ 1000 METmin/week).

Participants were given a health examination after at least 12 hours of overnight fasting. A complete preventive medical evaluation included gathering information concerning personal demographics, health habits, and family health history, and completing a physical examination including anthropometry, resting ECG, blood chemistry tests, blood pressures, and a maximal treadmill exercise test. Skinfold measures were used to estimate percentage of body fat (8, 9).

A maximal treadmill test (TT) with a modified Balke protocol was used to measure cardiorespiratory fitness. Maximal TT has been highly correlated with maximal oxygen consumption in men ($r = 0.92$) and women ($r = 0.94$) (14). CRF is related to all-cause mortality, and this relationship can be established by MET values of treadmill time (3, 4).

Study protocol was approved by the Institutional Review Board of The Cooper Institute. Data were gathered as part of the ongoing Cooper Center Longitudinal Study (CCLS) which investigates relationships between PA and CRF with mortality and morbidities. Informed consent was obtained from participants before data collection. Data were collected at the Cooper Clinic in Dallas, TX, and protocol included a questionnaire of self-reported PA behaviors, a complete medical screening, skinfold measurement, and maximal TT. Skinfold measurements followed the protocol used by Jackson and Pollock (8, 9). Maximal TT followed a modified Balke protocol, in which pace and grade were set at 88 m/min and 0%, respectively. Then, grade was increased by 2% the first minute and an additional 1%/min until

25 minutes. Then, pace was increased by 5.4 m/min each minute until termination. The data collection procedures for the CCLS have been described in detail in a previous report (4).

Statistical Analysis

Following data collection, MANCOVAs between groups controlling for age and gender were used to determine the relation between health markers and levels of PA reported, as categorized by the PAG. Post-hoc univariate tests (i.e., univariate ANCOVAs) and subsequent Helmert contrasts followed a significant MANCOVA result. Helmert contrasts were used to examine differences between each level of the self-reported PA variable to higher level(s).

RESULTS

Table 1 presents descriptive statistics for each dependent variable by PAG status group and univariate results for PAG group differences. For PAG status level, 155 participants logged <500 METmin/week, 125 participants indicated ≥ 500 METmin/week and <1000 METmin/week, and 225 participants recorded ≥ 1000 METmin/week. MANCOVA was significant (Wilks' lambda = 0.806, $F(14, 988) = 8.03$, $P < .001$) for the seven health markers across the three PAG groups. Post-hoc univariate ANOVAs indicated percent fat, BMI, glucose, and treadmill time were significantly related to amount of PA (see Table 2). Blood pressures and cholesterol were not related to self-reported PA.

Table 1. Descriptive statistics for health outcomes by level of physical activity guidelines achieved.

Health Marker	Self-reported Physical Activity per Week			Univariate post-hoc Results	
	<500 METmin ^a	500 to <1000 METmin ^b	≥ 1000 METmin ^c	F	P-value
	n = 155	n = 125	n = 225		
Systolic BP (mmHg)	128 \pm 13 ^d	128 \pm 15	127 \pm 15	.22	.795
Diastolic BP (mmHg)	85 \pm 10	84 \pm 10	83 \pm 9	1.51	.221
Percent Fat	24.8 \pm 5.9	23.0 \pm 6.0	21.7 \pm 5.6	15.07	.001
BMI	27.3 \pm 4.6	25.9 \pm 3.4	25.8 \pm 3.9	7.58	.001
Glucose (mg/dL)	100 \pm 21	96 \pm 10	97 \pm 11	3.20	.041
Cholesterol (mg/dL)	195 \pm 33	190 \pm 35	189 \pm 36	1.74	.177
Treadmill Time (min)	15 \pm 4	17 \pm 4	19 \pm 4	52.18	.001

^aDoes NOT meet PAG; ^bMeets PAG; ^cExceeds PAG; ^dMean \pm standard deviation

Post-hoc univariate Helmert contrasts indicated that differences were largely a result of contrasting those not achieving 500 METmin/week with those achieving at least 500 METmin/week of PA. Effect sizes confirmed these results with moderate to large effect sizes for contrast 1 (those not achieving 500 METmin/week vs. those achieving at least the minimum amount of recommended PA) and very small additional effect identified with contrast 2 (those exceeding 1000 METmin/week contrasted with those who achieved 500-999 METmin/week). See Table 2.

DISCUSSION

The purpose was to relate the amount of self-reported PA, categorized into levels of PAG for Americans and compare these levels to various health markers. The results revealed that

individuals engaging in PA behaviors sufficient to meet national PAG have health profiles directly related to the amount of PA reported. There was a significant effect for the health markers when the sample was divided into three groups (those who did not meet the PAG, those who met the PAG, and those who exceeded the PAG). Furthermore, effects were substantial for 4 of 7 health markers when comparing those who did not meet the PAG to those who did meet the PAG, but additional health benefits were smaller in those who exceeded the PAG, suggesting a plateauing of the associations. The plateauing of health benefits at the highest level of PAG guidelines illustrates that moderate PA is sufficient to achieve health benefits and that the higher amounts of PA are sufficient but not necessary to accrue these benefits. This plateauing should be examined more fully in subsequent research. These findings are in agreement with a previous report that indicated significantly higher prevalence for obesity in adult women who did not meet PAG. Additionally, these results indicate that achieving the PAG for Americans is positively associated with several health markers. This information adds to the existing body of research supporting effective dissemination of specific health outcomes to affect PA behavior change in Americans (6).

Table 2. Post-hoc Helmert results.

Health Marker	<500 METmin/week	Effect Size ^a	500 to <1000	Effect Size ^b
	vs. ≥500 METmin/week P-value		METmin/week vs. ≥1000 METmin/week P-value	
Systolic BP (mmHg)	0.695	0.034	0.543	-0.021
Diastolic BP (mmHg)	0.110	0.113	0.667	-0.073
Percent Fat	0.001	0.315	0.041	-0.222
BMI	0.001	0.301	0.870	-0.037
Glucose (mg/dL)	0.012	0.179	0.507	0.041
Cholesterol (mg/dL)	0.091	0.147	0.622	-0.050
Treadmill time (min)	0.001	0.627	0.016	0.272

^aEffect Size is mean difference divided by standard deviation for Does Not Meet PAG; ^bEffect Size is mean difference divided by standard deviation of Meets PA.

The current study has several strengths and is not without limitations. The sample size is large and represents a wide age range of adults, which is in line with best practices for generalizability of results. Moreover, this research helps to confirm the legitimacy of the physical activity guidelines and their relations to health markers. In terms of limitations of the study, gender differences were not examined. Exploring the relations between PAG status and health outcomes across genders may provide valuable insights into the benefits of PA for men and women. Additionally, the apparent plateauing effect of health benefits between the two classifications that meet PAG guidelines should be examined further.

This study provides evidence of the validity of the three categorizations suggested by the PAG. The composite of health indicators is a function of how much and with what intensity PA is conducted weekly. The biggest impact on health markers occurs when one achieves the minimally recommended PA with modest improvements thereafter, most notably in cardiorespiratory fitness (perhaps a function of the increased duration and/or intensity of PA [i.e., volume] conducted by those accruing ≥1000 METmin/week of PA). Importantly, it

provides public health implications for PAG revision in the sense that 500-1000 METmin/week of PA has the most “bang for the buck” in terms of time invested in PA behaviors as an often reported hindrance to physical activity is the time necessary for PA (5, 12). Reports (11, 13) suggest individuals are unaware of how much physical activity in which to engage. Providing specific guidelines for the amount and intensity of PA that enhances health can have important public health implications, ultimately influencing behavior change.

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