Active Lifestyles are Associated with Favorable Anthropometric Measures for US Adults

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Abstract

The third National Health and Nutrition Examination Survey (NHANES III) data was used to describe relationships between activity intensity and frequency and obesity for US adult men (n = 7428) and non-pregnant women (n = 8140). Compared with active men and women, inactive and partially active men and women are at increased risk of obesity (OR = 1.41, inactive men; OR = 1.73, partially active men; OR = 1.61, inactive women; OR = 1.26 partially active women) and abdominal obesity (OR = 1.53, inactive men; OR = 1.62, partially active men; OR = 1.61, inactive women; OR = 1.51 partially active women). Inactive women had the highest body mass index (BMI), waist circumference (WC), and waist to hip ratio (W:H) measures (28.1, 93.7 cm, 0.89. respectively) compared with partially active and active women ($P < 0.05$). WC (93.7 cm) and W:H (0.94) measures were lower for active men compared with inactive and partially active men ($P < 0.05$). Active US adults had more favorable anthropometric measures and reduced risk of obesity than both partially active and inactive adults.

Obesity is an epidemic in the United States and a major public health concern. This condition has been associated with multiple chronic diseases: heart disease, stroke, hypertension, type 2 diabetes, and some types of cancer (Department of Health and Human Services (DHHS), 2006 May 31a). The increase in the proportion of the population with excess body weight has raised public health concerns and focused interest on behavioral risk factors that can be changed to reach or maintain a healthy weight.

Body weight is affected by multiple factors: behavior, environment, heredity, socioeconomic status, and cultural influences (DHHS, 2006 May 31c). But specifically, obesity is the result of a positive balance between energy consumed and energy expended. Physical activity is a modifiable lifestyle factor that may reduce obesity. According to 2005 data from the Behavior Risk Factor Surveillance System (BRFSS), an estimated 25% of the population engages in no leisure-time physical activity (DHHS, 2006 Oct 8). In fact, poor diet and inactivity (16.6%) were second only to smoking (18.1%) for actual leading causes of death in 2000 (Mokdad, 2004).

Physical activity has been associated with numerous beneficial effects on the body (Pate et al, 1995), including reduced risk of obesity (Hu et al. 1999; King et al. 2001; Laitinen, Pietiläiene, Wadsworth, Sovio, & Järvelin 2004; Mohan, Gokulakrishnan, Deepa, Shanthirani, & Datta, 2005; Pitsavos, Panagiotakos, Lentzas, &bStefanadis 2005). There is interest in better understanding the relationships between physical activity and anthropometric measures to slow or reverse the current trend of increasing rates of overweight and obesity. Our study is the first to study relationships between the intensity and frequency of physical activity and waist circumference, W:H, and abdominal obesity for a sample representative of the US population. The purpose of this study was to identify relationships between intensity and frequency of physical activity and BMI, WC, W:H and obesity risk for a sample representative of US adults. A secondary purpose was to describe differences in BMI, WC, and W:H across different levels of leisure-time physical activity for adults.

Methods

Participants

Data were obtained from NHANES III, which is a national survey with data that is made available to the public. NHANES III collected health and nutritional information from non-institutionalized US citizens over the age of two months. A standardized interview was done in the subject's home and a physical examination was carried out in a Mobile Examination Center (MEC). The number of sample persons for this survey was 39,695, with 33,994 of these individuals being interviewed and 30,818 being both interviewed and examined (Centers for Disease Control and Prevention (CDC), 1997a).

Procedures

NHANES III participants, ages 20 years and above, were included in this study. Approximately half of those both examined and interviewed in the NHANES III survey (N = 15,568) qualified for this analysis. Pregnant women were excluded from this data analysis. Based on the variables included in a specific analysis run, participants with missing data values were further excluded. IRB approval was granted by the participating university. An informed written consent was not utilized, because this research study was a secondary data analysis.

Physical activity was self-reported, with data collected as part of an interview. Participants were asked if they participated in the following activities over the past month: (1) walking, (2) jogging or running, (3) bicycling, (4) swimming, (5) aerobics, (6) dancing, (7) calisthenics, (8) gardening or yard work, (9) lifting weights, or (10-14) any other exercises, sports, or physically active hobbies. The first nine questions were for specific activities (1-9) and the last four questions were provided for up to four additional activities not specifically asked by survey questions. The reported frequency for one month was divided by 4 to estimate frequency per week. Each type of activity was assigned a value for intensity, thus intensity did not vary between participants for the same activity. The intensity levels (metabolic equivalents (METs)) assigned to an activity was based on a standardized coding scheme (CDC, 1997a).

For this secondary data analysis, the reported activities were divided into moderate (3-5 METs) or vigorous (≥ 6 METs) activities. Three groups were created: (1) inactive, (2) partially active, and (3) active. The active group was defined as ≥ 5 moderate activity sessions per week, ≥ 3 vigorous activity sessions per week, or a total of ≥ 5 moderate or vigorous activities per week. The partially active group reported sessions of moderate or vigorous activity but less than required for the active group. The inactive group reported no moderate or vigorous activity. These groups were based on current physical activity recommendations for intensity and frequency and were similar to those created in previously NHANES research (Al-Zahrani, Borawski, & Bissada 2005; DHHS, May 31a).

The anthropometric data included BMI, WC, and W:H. BMI and WC are related to amount of body fat, while W:H measures body fat distribution. The measurements for these variables were collected during the examination portion of the survey (CDC, 1997b). BMI was calculated from weight and standing height measurements taken during the MEC examination. WC and buttocks circumference measurements were taken. The W:H was calculated as WC/butt circumference (CDC, 1997b). BMI values were categorized into normal (> 18.4 and < 25), overweight (≥ 25 and < 30), and obese (≥ 30) (DHHS, Oct 15). Abdominal obesity was defined as a waist circumference ≥ 102 cm for men and ≥ 88 cm for women (DHHS, Oct 15). A W:H ≥ 1 was defined as obese (National Center for Chronic Disease Prevention and Health Promotion, 2004 Nov 9).

Covariates that have been associated with body weight were included in the regression analyses are as follows: age, sex, ethnicity, residence location (rural/urban), income (P:I), education, smoking (current smoker or not current smoker), marital status, energy intake, and alcohol. Information for these variables was collected during the interview conducted in the home (CDC, 1997a). Age groups were created to report mean BMI by activity group: 20-29, 30-39, 40-49, 50-59, 60-69, and 70+ years.

Data Treatment and Analyses

Means (SE) were calculated and ANOVA tests conducted to determine differences in BMI, WC, and W:H across activity groups. Logistic regressions were performed to study the relationships between physical activity and anthropometric measures. BMI, WC, W:H were dependent variables for the regression analyses. All variables for this study were pulled from NHANES III data files using Microsoft Access. SPSS (14.0) and WesVar (3.0S) were used for recoding variables. WesVar was used to calculate descriptive statistics and run regression analyses.

Results

A total of 15,568 men (n = 7428) and non-pregnant women (n = 8140), 20 years and older, were included in this study. The mean age was 45.0 years, specifically 43.7 years for men and 46.1 years for women. The ethnicity distribution was 41.4% non-Hispanic white, 27.9% non-Hispanic black, 26.8% Mexican-American, and 3.9% other. Twenty six percent were smokers and 48.6% lived in urban areas.

Approximately 15% of all participants were classified into the inactive group, 41% were classified into the partially active group, and 44% were classified into the active group. Eleven percent of men were inactive, 40% were partially active, and 49% were active. Alternatively, 19% of women were inactive, 42% were partially active, and 39% active. The mean (SE) BMI was 26.5 (.09) for all participants and 26.6 (0.09) for men and 26.5 (0.13) for women. The mean (SE) WC was 91.9 (0.20) cm for all participants, 95.4 (0.21) cm for men, and 88.7 (0.33) cm for women. The mean (SE) W:H was 0.91 (0.001) for all participants, 0.96 (0.001) for men, and 0.87 (0 .002) for women.

Mean BMI values for women are provided in Table 1 by age and activity groups. Across all age groups, the inactive group had higher mean BMI values than the active group. The inactive group had the highest mean BMI values across age groups, and inactivity rates increases from 13.9% in the 20-29 age group to 33% in the 70+ age group. The mean BMI values for inactive women in the 40–49, 50–59, and 60-69 years were ≥ 29 and therefore approaching the cutoff for obesity.

Table 1. ***BMI (Mean ± SE) by age and activity group for women.***

	Activity Groups		
	Inactive	Partially Active	Active
Age Groups			
20-29 y	25.34(0.693)*	24.37(0.311)	23.84(0.270)
	n = 335(13.9%)	n = 680(45.2%)	n = 581(40.9%)
30-39 y	28.14(0.631)†*	26.90(0.343)*	24.94(0.331)
	n = 337(14.2%)	n = 777(47.7%)	n = 560(38.1%)
40-49 y	29.75(0.832)†*	26.98(0.325)	25.93(0.362)
	n = 326(16.7%)	n = 587(46.1%)	n = 391(37.2%)
50-59 y	29.63(0.686)*	28.78(0.461)*	27.38(0.308)
	n = 246(19.9%)	n = 397(42.7%)	n = 318(37.5%)
60-69 y	29.14(0.473)†*	27.59(0.397)*	26.60(0.219)
	n = 338(21.7%)	n = 382(32.7%)	n = 368(45.6%)
70+ y	27.01(0.360)*	26.55(0.263)	25.78(0.225)
	n = 588(33.0%)	n = 422(29.5%)	n = 467(37.6%)

Active, ≥ 5 moderate or ≥ 3 vigorous activity sessions per week, or a total of ≥ 5 moderate or vigorous activities per week. Partially active, reported moderate or vigorous activity but less than recommended. Inactive, no moderate or vigorous activity reported.

* Values are significantly different from the active group ($P < 0.05$).

† Values are significantly different from the partially-active group ($P < 0.05$).

Percentage of sample in each activity by age group is weighted to represent the US population.

Analysis weighted for sampling.

BMI, WC, and W:H were compared across activity levels in Table 2. For women, there were significant differences across activity levels for each of the anthropometric measures. Lower anthropometric measures were observed with increasing activity level. For men, WC and W:H were lower for the active group compared with both the inactive and partially active groups. A significant difference for BMI was observed between active and partially active men, but not between active and inactive men ($P = 0.073$).

For the combined analysis including both men and women, the inactive and partially active groups had an increased risk of obesity compared with the active group (Table 3). This relationship was true for both men and women across all anthropometric measures, with the greatest risk of obesity associated with the partially active

Table 2. ***Mean (SE) anthropometric measurements by activity levels***

	Activity Level		
	Inactive	Partially Active	Active
BMI			
All (N = 15 568)	27.57(0.202)†*	26.88(0.141)*	25.88(0.086)
Men (n = 7428)	26.65(0.215)	27.14(0.179)*	26.18(0.116)
Women (n=8140)	28.07(0.296)†*	26.65(0.175)*	25.53(0.119)
Waist Circumference			
All (N = 14 896)	94.60(0.508)†*	92.75(0.312)*	90.21(0.250)
Men (n = 7120)	96.26(0.816)*	97.19(0.434)*	93.65(0.303)
Women (n = 7776)	93.71(0.688) †*	88.83(0.392)*	86.21(0.377)
Waist to Hip Ratio			
All (N = 14 874)	0.9208(0.00270)†*	0.9109(0.00157)*	0.9028(0.00173)
Men (n = 7106)	0.9713(0.00377)*	0.9652(0.00205)*	0.9437(0.00175)
Women (n = 7768)	0.8936(0.00327)†*	0.8629(0.00195)*	0.8554(0.00247)

* Values are significantly different from the active group ($P < 0.05$).

† Values are significantly different from the partially-active group ($P < 0.05$).

Analysis weighted to represent US population and account for variance in the sample.

group for men and inactive group for women. Generally, there were not significant differences in the odds of being in the obese group based on whether the men or women fell into the inactive or partially active groups. The exception to this was for obesity based on BMI among women, with greater odds of falling into the obese category with inactivity (OR = 1.28, 95% CI: 1.05-1.55).

Table 3. ***Physical activity group predicts odds of falling into obese category.***

	OR_{Men}	OR_{Women}	$OR_{Combined}$
BMI[1]	n = 6644	n = 7119	N = 13,763
Inactive vs. Active	**1.41(1.044, 1.895)**	**1.61(1.341, 1.921)**	**1.59(1.355, 1.874)**
Partially Active vs. Active	**1.73(1.349, 2.224)**	**1.26(1.035, 1.525)**	**1.47(1.251, 1.719)**
Inactive vs. Partially Active	0.81(0.625, 1.056)	**1.28(1.054, 1.549)**	1.09(0.946, 1.249)
WC[2]	n = 6,483	n = 7010	N = 13,493
Inactive vs. Active	**1.53(1.174-1.998)**	**1.61(1.317-1.974)**	**1.63(1.391-1.920)**
Partially Active vs. Active	**1.62(1.302-2.003)**	**1.51(1.252-1.829)**	**1.56(1.341-1.811)**
Inactive vs. Partially Active	0.95(0.698-1.288)	1.07(0.896-1.267)	1.05(0.930-1.183)
W:H[3]	n = 6472	n = 7002	N = 13,474
Inactive vs. Active	**1.41(1.140-1.741)**	**1.42(1.050-1.933)**	**1.43(1.189-1.713)**
Partially Active vs. Active	**1.69(1.354-2.107)**	**1.44(1.119-1.864)**	**1.63(1.376-1.927)**
Inactive vs. Partially Active	0.83(0.636-1.094)	0.99(0.750-1.297)	0.88(0.722-1.064)

Odds ratio (95% confidence interval). Abbreviations: Part A, partially active; BMI, body mass index; WC, waist circumference; W:H, waist to hip ratio. Models adjusted by age, sex (for combined analysis only), ethnicity, urban/rural, income, smoking, education, energy intake, and alcohol. Analysis weighted to represent US population and account for variance in the sample.

[1]BMI - Obese (BMI ≥ 30) compared with normal and overweight categories combined (BMI 18.5-29.9).

[2]WC – Obese (WC ≥ 102cm for men and WC ≥ 88cm for women) compared with the non-obese group (WC < 102 cm for men and WC < 88cm for women).

[3]W:H – Obese (W:H ≥ 1) compared with non-obese (W:H < 1).

Discussion

A major finding of this study is that adults should attain the recommended levels of physical activity for frequency and intensity to protect against obesity risk. Men and women who were inactive or partially active were at higher risk of obesity compared with active men and women. The inverse relationship between physical activity and anthropometric measures or obesity was consistent with other studies (Hu, 1999; King, 2001; Laitinen , 2004; Mohan, 2005; Pescatello & Murphy, 1998; Pitsavos, 2005, Seidell, Bakker, & Van der Kooy, 1990; Slattery et al., 1992; Troisi, Heinold, Vokonas, & Weiss, 1991; VanPelt et al., 1998) but conflicted with another (Mora, 2006). The lack of significant findings between inactive and partially active groups indicate the need to attain leisure-time physical activity at levels that meet current recommendations to benefit from reduced risk of obesity. The majority (56%) of the study sample did not reach recommended levels of physical activity intensity and frequency.

Active adults benefited from the more favorable BMI, WC, and W:H values compared with partially active and inactive groups. Meeting physical activity recommendations for intensity and frequency may be necessary to fully benefit from the role of physical activity in controlling body weight. In fact, partially activite men had higher mean BMI and WC values compared with inactive men. A limitation of BMI is that it does not take into account lean muscle mass, and this may partially explain the higher BMI values. An alternative explanation is that men with higher BMI and WC measures may be concerned about weight and attempting to be active but not taking part in amounts needed to lose weight or maintain a lower bodyweight. Previous research has reported that only 17% of men who were using exercise for weight loss met or exceeded 1000 calories per week (Gordon, Heath, Holmes, & Christy, 2000).

The anthropometric measures were improved across increasing activity level, with active women having the most favorable measures and inactive women having the least desirable measures. The results of this study are similar to a prospective study that reported differences between men and women regarding the protective effect of physical activity for obesity, with women benefiting more from physical activity than men (Yang, Telama, Viikari, & Raitakari, 2006). Based on these results, further research is needed to better understand the gender differences observed for men and women for the relationships between physical activity and anthropometric measures.

Partially active, middle-aged men (40-59 years) and inactive, middle-age (40-69 years) women had the highest mean BMI levels. Across middle-age groups, 40-69 years, active men had lower BMI values compared with partially active men. Across all age groups active women had the lowest BMI values compared with inactive women. The data in this study was cross-sectional, so the results do not indicate if lower activity results in lower BMI values or if the data merely reflects the fact that heavy people may find it difficult to exercise (McDowell, Hughes, & Borrud, 2006). None-the-less, targeting interventions for middle-age men and women that decrease inactivity and increase those meeting recommendations may lower obesity rates.

Professionals may benefit by using both BMI and WC to evaluate weight changes due to physical activity. WC may be a more ideal measure than BMI for evaluation of physical activity in weight management, because for men the relationship between BMI and physical activity was not as strong as between WC and physical activity. This may reflect that BMI does not account for lean muscle mass. Alternatively, women may benefit more from physical activity than do men as reflected in BMI values. Notably, WC cutoffs have been created for BMI categories and can be used in combination to evaluate risk of a coronary event (Arden, Janssen, Ross, & Katzmarzyk, 2004).

Previous studies have utilized NHANES III data to explore the health benefits of physical activity (Al-Zahrani, Borawski, & Bissada, 2005; Finkelstein, Joshi, & Hise, 2006; Kriska et al., 2006; Nelson, Reiber, & Boyko, 2002; Rohrmann, Crespot, Weber, Smith, Giovannucci, & Platz, 2005; Turner, Leaver-Dunn, Dibrezzo, & Fort, 1998). This study is the first to assess abdominal obesity risk based on intensity and frequency of physical activity for a sample representative of US men and non-pregnant women 20 years and older. Further, this study is also the first to report mean BMI, WC, and W:H values across activity levels.

Results reported in this study should be interpreted cautiously, with notable limitations. The duration of leisure-time physical activity was not measured and work physical activity was not included in this analysis. The data were cross-sectional, thus cause-effect can not be established. Alternatively, there are also several strengths for this study. Anthropometric measurements were taken by trained technicians and there were multiple, probing questions about leisure-time physical activities. Further, leisure-time physical activity was defined into activity levels and compared with current recommendations for intensity and frequency of physical activity. Finally, the sample is representative of US adults.

In conclusion, physical activity is related to obesity. Adults should aspire to meet current physical activity recommendations. WC should be measured in addition to BMI for evaluation of physical activity in weight management. Public health may benefit from programs that target middle-aged adults for increased physical activity to lower obesity rates.

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Author's Notes

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