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ORIGINAL RESEARCH

DO THE RECOMMENDED GUIDELINES FOR PHYSICAL ACTIVITY IMPACT PERCENTAGE OF BODY FAT IN NORMAL-WEIGHT WOMEN?

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ABSTRACT

Introduction: International exercise guidelines have been designed to prevent weight gain, and subsequently improve health, in adults. However, body mass is a proxy for assessing obesity, and fat distribution also plays an important role in metabolic and cardiovascular health. Given the importance of adiposity in obesity-related disease risk, it is imperative that prescribed exercise guidelines be relevant to preventing gains in both weight and fat mass. Therefore, this study investigated the impact of achieving recommended levels of physical activity (PA) on adiposity in normal-weight women with varying levels of percentage body fat (PBF).

Methods: Anthropometric measures were performed in 107 women (age: 16-45 years; BMI: 18.5 – 24.9 kg/m^2). Air-displacement plethysmography assessed PBF. Tri-axial accelerometers, worn over 7 days, assessed moderate and vigorous PA. Independent t-tests compared PBF levels between participants who achieved recommended levels of PA and those who did not.

Results: Achieving current PA recommendations (≥150 min/week of moderate-to-vigorous PA) was associated with significantly lower PBF (27.4% ± 5.7 vs 30.3% ± 4.08; p=0.038). When PA was stratified, those achieving ≥300 min/week of moderate PA showed a trend towards lower PBF (p=0.076), while achieving ≥150 min/week of vigorous PA resulted in significantly lower PBF (24.5% ± 4.3 vs 28.3% ± 5.5; p=0.022).

Discussion: Achieving current PA recommendations was associated with a moderate, but clinically relevant decrease in PBF. The findings suggest this association is strongest for vigorous activity.

Conclusions: The findings suggest that while moderate-to-vigorous PA will help achieve lower levels of adiposity, an emphasis on vigorous PA may have the greatest impact on adiposity when prescribing exercise in normal-weight women.

Keywords: accelerometer; adiposity; female; exercise

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INTRODUCTION

According to the World Health Organization, obesity has been identified as the largest global chronic health problem, and a major risk factor for cardiovascular, metabolic, and musculoskeletal disease.[1] Obesity is considered preventable, with a strong focus on changes to lifestyle factors (e.g. physical activity, diet, sleep). Increased physical activity is associated with lower body fat levels in a wide range of populations and weight categories[2,3,4] and international exercise guidelines have been established to prevent weight gain in adults.[5,6] Specifically, physical activity recommendations issued by the American College of Sports Medicine and the American Heart Association suggest that adults complete moderate intensity aerobic (endurance) exercise for a minimum of 30 minutes on five days per week or vigorous intensity exercise for 20 minutes on three days per week.[7] However, the guidelines use outcome variables of weight, and the subsequent assessment of body mass index (BMI), as proxies for excessive adiposity.

It has been suggested that BMI in its simplistic form, cannot accurately characterise obesity.[8,9] Fat distribution and percentage body fat (PBF) may be different in individuals of similar BMI, with characteristics of metabolic dysregulation exhibited that cannot be explained by BMI alone.[10] Recent efforts have attempted to classify obesity based on more specific anthropometric and metabolic profiles; however, a variety of measures have been used to define metabolically obese (e.g. insulin resistance, decreased insulin sensitivity, the presence of obesity-related disease, metabolic syndrome, increased abdominal body fat) within this classification.[9] The concept of normal weight obesity has been proposed to explain a phenotype of metabolically obese individuals with a normal BMI, and is defined solely by the relative amount of body fat.[9] Women who have been classified as normal-weight obese showed a lower resting metabolic rate compared to women with an elevated BMI.[11] Additionally, this cohort exhibited diminished cardiorespiratory fitness and physical activity energy expenditure when compared to metabolically healthy controls.[12,13]

Given the importance of adiposity in obesity-related disease risk, it is imperative that prescribed exercise guidelines be relevant to preventing gains in both weight and fat mass. However, there is a dearth of literature investigating the impact of adhering to physical activity (PA) guidelines on women with normal BMI but varying body fat levels. Therefore, this study investigated the impact of achieving recommended levels of PA on body fatness in New Zealand European women with a normal BMI but varying levels of PBF.

METHODS

This focused investigation examines one aspect of a larger cross-sectional study concerned with women's health. The methodology of this study has been previously described.[14]

Normal-weight New Zealand European women (16-45 years, BMI <25 kg/m^2) recruited from the wider Auckland area were included in this investigation. Inclusion criteria consisted of being post-menarche but pre-menopausal (defined by at least one complete year of regular menstrual cycle). Participants were excluded if they were pregnant, currently breastfeeding, or diagnosed with any metabolic condition (coronary heart disease, hypertension, diabetes, cancer, gastrointestinal disorders interfering with food digestion and absorption, endocrine, thyroid, or kidney disease, liver disorders and blood borne diseases such as Hepatitis B). The study was approved by the university's Human Ethics Committee, and the study was conducted in accordance with the Declaration of Helsinki. Prior to data collection, written informed consent was obtained from the participants. All measurements were taken in the morning before 10am and participants were instructed to abstain from exercise, food, or beverages (excluding water) for a minimum of 12 hours overnight, prior to measurements.

Height was measured to the nearest 0.1 cm using a calibrated stadiometer. Height was determined from the average of two measurements. If the second measure was not within 1% of the first measure; a third measure was taken and the median of the three measures was used. Body mass was measured to the nearest 0.1 kg using an electronic scale within the air displacement plethysmography device (Bod Pod; COSMED, Rome, Italy). BMI (kg/m^2) was calculated from these measurements.

Air displacement plethysmography (Bod Pod; COSMED, Rome, Italy) was used to assess PBF. Specifically, the thoracic gas volume method and Siri's equation were used to calculate PBF.[15]

Tri-axial accelerometry (Actigraph wGT3X+, Pensacola, FL, USA) was used to assess PA over a period of seven consecutive days. The device was secured on the participant's right hip using an adjustable belt. Participants were instructed on the correct position and orientation of the accelerometer that needed to be maintained. Participants were also reminded to wear the accelerometer at all times (excluding any water-based activities) during a typical week. A typical week was defined as one during which they attended work/school/university or maintained their normal home activities for five days and participated in normal after-work and weekend activities. Weeks during which participants were taking holidays or other days off, or when public holidays, school holidays, or special events occurred, were avoided. The accelerometers collected data at a sampling rate of 100 Hz, which was assessed in 60 s epochs. Participants were included in the analysis if they had valid data (>10h/day)[16] for four week days and one weekend day.[17]

Sleep time was assessed and removed from the analysis using previously established algorithms[18] via Matlab computer software (**The MathWorks, Inc., Natick, MA, USA). PA levels were identified using the 2008** National Health and Nutrition Examination Survey **cut-points, which have been widely used and recently validated.**[19] Specifically, minutes spent in moderate (2020-5998 counts/min) and vigorous (≥5999 counts/min) activity were identified. Moderate-to-Vigorous physical activity (MVPA) was a summation of moderate and vigorous activity (>2020 counts/min). To investigate the impact of PA guidelines on PBF levels, the participants were allocated to groups based on those who met, or did not meet, established PA guidelines (as defined by current ACSM guidelines) for minutes spent in MVPA (>150 min/week), moderate PA (>300 min/week), and vigorous PA (>150 min/week).[20]

Statistical analysis was completed using IBM SPSS statistics package version 20 (IBM corporation, New York, USA). Variables were tested for normality using the Kolmogorov–Smirnov and Shapiro-Wilk tests and for homogeneity using the Levene's test. Independent t-tests were completed to compare differences in PBF between those who did and those who did not meet PA guidelines. Significance was set at a level of $P<0.05$.

RESULTS

A total of 127 participants were recruited for the study. Participants with missing (n=9) or incomplete (n=11) accelerometer data were excluded from analysis. Characteristics for the remaining 107 participants can be found in Table 1.

When participants were classified into groups based on achievement of PA guidelines, differences existed in PBF (Table 2). Participants who did not achieve the recommended amount of MVPA (150

Table 1. Participant characteristics (n= 107).

Variable	Mean ± SD	Range
Demographics		
Age (years)*	30.6 (25.6 – 39.2)	16.6 – 44.9
Weight (kg)	61.8 ± 6.7	43.7 – 77.0
Height (cm)	167.7 ± 6.5	149.4 – 182.5
BMI (kg/m^2)	22.0 ± 1.6	18.7 – 24.9
PBF (%)	27.9 ± 5.6	17.3 – 43.9
Accelerometer measures (% of total wear time)		
Sedentary	61.33 ± 8.04	40.39 – 79.52
Light	34.42 ± 7.47	18.62 – 51.51
MVPA	4.25 ± 2.14	0.57 – 10.99

** Median (25th – 75th Percentile)*

Note: PBF: percentage body fat; MVPA: moderate to vigorous physical activity

Table 2. Differences in percentage body fat between participants who did and did not achieve recommended physical activity levels

Current Recommendation	Did not Achieve	Did Achieve	P
≥150 min/week MVPA	30.3 ± 4.08 (n = 19)	27.4 ± 5.7 (n = 88)	0.038
≥ 300 min/week moderate PA	28.4 ± 5.6 (n = 83)	26.1 ± 4.9 (n = 24)	0.076
≥ 150 min/week vigorous PA	28.3 ± 5.5 (n = 95)	24.5 ± 4.3 (n = 12)	0.022

Note. MVPA: moderate to vigorous physical activity; PA: physical activity. Statistically significant differences have been highlighted in bold font.

min/week) showed significantly higher PBF than those who did achieve the recommended amount of MVPA (p = 0.038, small effect r = 0.20). When MVPA was separated into independent categories of moderate and vigorous activity, those who achieved more than 150 min/week of vigorous activity had significantly lower PBF than those who did not achieve 150 minutes (p = 0.022, small effect r = 0.22). While there was a similar trend in the PBF of those achieving the recommended levels of moderate activity, the differences were not statistically significant.

DISCUSSION

This study investigated the impact of achieving recommended levels of PA on body fatness in New Zealand European women with a normal BMI but varying levels of PBF. Using this approach, it was evident that those who achieved the recommended level of MVPA had a modest but significantly lower PBF compared to those not achieving the recommended levels. Previous research has shown that every unit increase in PBF was associated with 4%, 10%, and 5% higher risk of developing hypertension, metabolic syndrome, and hypercholesterolemia respectively.[21] Even with small effect sizes, a difference in 3% PBF would have substantial clinical implications on the health risk of women who achieved, or did not achieve, MVPA.

When intensity of the MVPA was stratified, vigorous PA was associated with a small but statistically significant decrease in PBF (3.8%); these results mimic those associated with MVPA recommendations and would have similar clinical implications. However, achieving 300 minutes of moderate activity per week demonstrated no significant differences in PBF. The breakdown suggests that, although achieving the recommended MVPA levels of 150 minutes per week was still associated with better adiposity results, it is the vigorous component of exercise that may be specifically associated with a reduced body fat profile. Current evidence suggests that to prevent weight gain (defined as <3% change in body weight), a target of 150-250 min/week of MVPA is recommended.[6] Our data support this recommendation, and suggest that 150 min/week of vigorous exercise might be even more effective in mitigating adverse changes in body composition. This suggestion may have significant implications on exercise recommendations, as a major focus of PA research has been placed on identifying the dose response required to reduce the risk of mortality and chronic disease.[22,23]

The findings from this study also support previous research suggesting that the current recommendations for moderate intensity PA might not be sufficient. Lee, et al. (2012) identified 420 minutes per week of moderate intensity PA as necessary to reduce risk of significant weight gain in women over a 13-year period. Furthermore, recent evidence from Norway shows that reduced weight gain over a 22 year period is associated only with PA levels greater than their current national recommendations (≥ 150 minutes per week of moderate, or ≥ 60 minutes per week of vigorous intensity PA).[24] Given the lack of significant differences in those achieving and not achieving moderate intensity PA levels, our data also support the need to revisit the current recommendations.

It is important to note that a cross-sectional study cannot inform causal relationships. Thus, it is not known if those exercising for longer duration and at higher intensities have lower body fat because of the exercise they perform, or if their body fat levels encourage them to participate in more intensive exercise. An important limitation of any observational study is the potential for confounding factors to affect the apparent associations. For example, women who participate in vigorous PA may have an overall healthier lifestyle, including diet, which in turn will affect PBF. A lack of generalisability to the main population is also a limitation due to the specific cohort of women used, and further research should assess if the same observations are seen in men and women of different ethnicities. Prospective studies are also warranted to assess whether PA may reduce or prevent PBF increases and weight gain in this group over time.

CONCLUSIONS

The current study further highlights the importance of achieving the recommended levels of PA in women who may have increased metabolic health risks not identified by their BMI. Within a homogenous group of normal-weight participants, there is a clear relationship between MVPA (and specifically vigorous PA) and adiposity in women. The findings support previous research, suggesting that an increase in vigorous PA may be an important strategy for maintaining a reduced body fat profile in those with normal body weight, and this should be the focus of exercise recommendations.

PRACTICAL APPLICATIONS

- Achieving recommended levels of moderate to vigorous physical activity is related to lower levels of body fat in normal-weight women.
- When moderate to vigorous physical activity is broken into its two components, vigorous physical activity seems to be more strongly related to lower body fat than moderate physical activity.
- While MVPA will help achieve a healthy lifestyle, an emphasis on vigorous physical activity could produce even greater health benefits.

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