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**ARTICLE**

# Obesity-Related Health Risk and Lifestyle Behaviours: A Descriptive Study

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## Abstract

*Background:* Obesity continues to be a public health concern given its association with multiple comorbidities spanning both physical and mental health. Researchers have documented that both increased Body Mass Index (BMI) and centrally patterned obesity (i.e., waist circumference) are independently associated with health. As such, national health organizations (e.g., Health Canada) have identified an obesity health-risk classification system based on a combination of BMI and waist circumference scores. *Purpose:* The objective of this study was to examine differences in physical activity and sedentary behaviour in community-dwelling adults who differ in terms of their obesity-related health risk classification. *Methods:* Participants' ($n$ = 50; age = 39 ± 14 yr (mean ± SD) BMI and waist circumference scores were measured resulting in the following groups based on obesity-related risk classifications: (a) 'Least', (b) 'Increased', or (c) 'High'. Following assessment of anthropometric variables, each participant was asked to wear a SenseWear™ Armband across a seven day monitoring period and scores recorded for active energy expenditure, step count and sedentary behaviour. *Results:* A significant multivariate effect (Pillai's = 0.40, $F$ (6, 86) = 3.60, $p$ = 0.003, $\eta_p^2$ = 0.20, observed power = 0.94) was noted across risk classification groups. Differences were found in the amount of time spent in active energy expenditure for bouts of ten minutes or more ($p$ = 0.002); specifically between those classified as Least versus High Risk ($p$ < 0.05). *Conclusion:* Participation in active energy expenditure in bouts greater than or equal to ten minutes should be promoted as a parameter for influencing obesity-related ill health in order to allow adults to reach optimal health benefits and reduce their risk. **Health & Fitness Journal of Canada 2015;8(4):3-13.**

*Keywords:* Body composition, Adults, Physical activity, Sedentary behaviour, SenseWear™ Armband

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## Introduction

Overweight and obesity are defined as an abnormal and excessive accumulation of body fat that may have a detrimental effect on one's health (World Health Organization [WHO], 2013a). Being overweight/obese continues to be a major public health concern leading to the development of multiple comorbidities (e.g., Type II diabetes, cardiovascular disease; Callahan, 2013) and affecting physical and psychological health (Rabbitt and Coyne, 2012). Body Mass Index (BMI) is the most commonly used measure of overall adiposity with values often used to classify an individuals' health risk (Health Canada, 2003a). However concerns over the use of BMI values have been raised as they do not distinguish between fat and lean mass (Lavie et al., 2010; Thibault and Pichard, 2012). As such the utility of other measures of adiposity that are relatively simple to assess and demonstrate their feasibility to predict relevant health outcomes have been investigated (Yusuf et al., 2005). Waist circumference (WC) scores have been used as a proxy marker of abdominal fat mass and consequently a good predictor of health (Ross et al., 2008). As both BMI and WC scores are independent predictors of health (Janssen et al., 2002), Canadian and international health agencies have recommended their combined use when assessing obesity-related health risk (Health Canada, 2003b; WHO, 2000). As a result a graded obesity-related health risk classification system (Table 1) has been developed and found to be effective for differentiating people by health conditions (Elobeid et al., 2007; Li et al., 2007; Walls et al., 2011; Zhu et al., 2002). Douketis (2005) further recommended that the obesity-related health risk classification system should be combined with lifestyle behaviours to determine a person's overall risk for disease onset or progression. Other than Wądołowska et al. (2008) investigation of food intake; however, we know of no existing research documenting whether lifestyle behaviours differentiate across obesity-related health risk classifications endorsed by Health Canada (2003b). In order to reduce this gap, adherence to different targeted physical activity recommendations and sedentary behaviour were explored.

Physical activity refers to any bodily movement produced by skeletal muscles that requires energy expenditure (WHO, 2013b). According to Canadian guidelines, adults aged 18 to 64 years should aim to participate in 150 minutes of moderate-to-vigorous physical activity (MVPA; ≥ 3.0 METs) per week in bouts of ten minutes or more to accrue health benefits (Tremblay et al., 2011). Pedometer determined step count serves as a second common physical activity target. While current Canadian guidelines do not translate to step counts (Tremblay et al., 2011) the criterion of at least 10000 steps per day has often been used in conjunction with recommendations for MVPA as a complementary measure of adherence to physical activity recommendations (Colley et al., 2011). Sedentary behaviour is any activity equal to < 1.5 metabolic equivalent units [METs] (Tremblay et al., 2010). As individuals can be classified as both physically active and sedentary based on energy expenditure, our understanding of the consequences of leading a sedentary lifestyle should be viewed as an independent construct when predicting health risk (Owen, 2012).

The present study addresses at least two gaps in the literature. First, guided by Douketis (2005) an exploration of obesity-related health risk in relation to physical activity and sedentary behaviour was undertaken. Our current understanding of the relationship between physical activity and adiposity has typically been generated separately based on scores of either BMI or WC (Ross and Janssen, 2007), although the

**Table 1: Obesity-Related Health Risk Classifications.**

| Waist Circumference | Body Mass Index | | |
|---|---|---|---|
| | **Normal** | **Overweight** | **Obesity Class 1** |
| < 102 cm (Males)<br>< 88 cm (Females) | Least Risk | Increased Risk | High Risk |
| ≥ 102 cm (Males)<br>≥ 88 cm (Females) | Increased Risk | High Risk | Very High Risk |

true nature of this relationship has been debated (Summerbell et al., 2009). Further to this, rates of sedentary behaviour are increasing regardless of weight and body composition (Scheers et al., 2012a) suggesting that the association between these constructs is complex. Second, the assessment of sedentary behaviour has typically been conducted through self-report (e.g., Atkin et al., 2012) and rarely linked with known health risk factors (e.g., obesity-related health risk; Henson et al., 2013). Therefore, the purpose of this descriptive study was to examine differences in adults based on their obesity-related health risk in terms of physical activity and sedentary behaviour using multi-sensor technology. Consistent with Scheers and colleagues (2012a), it was hypothesized that participants would display (a) lower levels of physical activity the higher their obesity-related health risk, and (b) higher levels of sedentary behaviour the higher their obesity-related health risk.

## Methods

Data were collected from 52 participants using non-probability (purposive and snowball) sampling procedures. Inclusion criteria were: (a) between the ages of 18-64 years, (b) willing to commit to the full length of study, (c) can speak and write in English, (d) currently free of any ambulatory restrictions, and (e) have a valid email account. Data collection commenced in December 2013 and ended in February 2014. Ethical clearance was granted prior to participant recruitment from the institutional Research Ethics Board.

## Measures

*Demographics.* Age, gender, ethnicity, education, and employment status were collected via self-report for descriptive purposes.

*Anthropometrics.* Anthropometric data was collected via two means. First, height was measured using a wall-mounted stadiometer (Seca 222, Hanover, MD) and weight using a portable electronic scale (My Weigh PD-750). BMI was calculated using the following formula: BMI = (weight (kg)/height (m)$^2$) rounded to the nearest 0.10 kg·m$^2$. Participants were then classified as normal weight (18.50-24.99 kg·m$^2$), overweight (25.00-29.99 kg·m$^2$), or obese (≥30.00 kg·m$^2$) using PHAC's criteria (2011). Second, a non-stretchable tape measure (Seca 201 tape measure; Seca, Hamburg, Germany) was used to determine participant's WC measurement (cm), while in a standing position. Consistent with protocol outlined by the Heart and Stroke Foundation of Ontario (2010), the measurement of WC was assessed at the point located halfway between the uppermost border of the iliac crest and lower border of the costal margin (i.e., the tenth rib). The average of two measurements, during which the participant breathes in and out, was reported and rounded to the nearest 0.10 cm.

*Lifestyle Behaviours.* The SenseWear™ Armband (SWA; BodyMedia, Inc., Pittsburgh, PA) was used to assess physical activity and sedentary behaviours. This device has a built-in, multi-sensor monitoring system capable of measuring a host of variables (e.g., METs, steps) as well as providing minute-by-minute estimates of time spent in different physical activity intensity levels (Scheers et al., 2012b). Raw data collection by the SWA occurs in 1-min periods by five different sensors on the armband including a biaxial accelerometer. Validity evidence for the SWA scores have been reported in previous field-based studies using samples of community-dwelling adults (Scheers, Philippaerts, & Lefevre, 2012a, 2013; Johannsen et al., 2010).

Procedure

The study purpose was examined using a non-experimental design. Individuals who expressed interest in the study were provided a Letter of Invitation and Consent Form to further explain study requirements. Those who agreed to participate had their anthropometric measures taken by the primary investigator (KMB) and were given an orientation regarding the use and wear of the SWA device. Participants were asked to wear the SWA for a total of seven consecutive days for at least 23 hours per day. The SWA was only to be removed during water-based activities and for battery charging.

Two email reminders were sent to participants across the seven-day monitoring period. The first email was to remind participants to charge the device on the fourth day of wear for a total of one hour as a precaution against data loss. The second email was to remind participants to attend their final appointment. Upon completion of the data collection period, participant data was uploaded onto a laptop. The device was then configured to the participant using the individual's gender, birth date, height, weight, handedness, and smoking status. Participants were then debriefed and provided individualized feedback given their SWA scores.

**Data Analyses**

Descriptive statistics were calculated to analyze participant demographic, anthropometric, and SWA data. BMI and WC values were used to classify individuals into different obesity-related health risk groups (i.e., 'Least', 'Increased', 'High' and 'Very High') as per Health Canada (2003b) guidelines. Physical activity data was re-labelled active energy expenditure if activities were engaged in at an intensity of $\geq$ 3.0 METs and for at least a continual 10 min bout (AEE-10) consistent with Canadian Guidelines (Tremblay et al., 2011). Step count was the total number of steps taken each day. Sedentary behaviour was expressed as the time spent sleeping, laying down, and any minute-by-minute activities spent throughout the day at <1.5 METs (Tremblay et al., 2010). For AEE-10, step count and sedentary behaviour, the average across the monitoring period was calculated.

Study hypotheses were tested using a One-Way Multivariate Analysis of Variance (MANOVA) to examine differences on AEE-10, step count and sedentary behaviour by obesity-related health risk classification. Pillai's criteria was used given the small total sample size and the unequal number of participants assigned to each obesity-related health risk classification (Hair et al., 2009). Eta-squared ($\eta^2$) and partial eta-squared ($\eta_p^2$) effect sizes were also calculated to complement null hypothesis significance testing (Harlow et al., 1997). Interpretation of effect sizes for small ($\eta^2$ = 0.09), moderate ($\eta^2$ = .14), and large ($\eta^2$ = 0.22) effects were based on eta-squared values (Fay and Boyd, 2010).

## Results

Consistent with Scheers et al. (2012c), participants were deemed compliant if they wore the SWA for a minimum of five days with at least 85% (i.e., 20.40 hours) of wear time per day across the monitoring period. Of those individuals providing data ($n$ = 52), 3.85% ($n$ = 2) were deemed non-compliant and were removed from subsequent analysis. The final sample investigated in this study totalled 50 participants (Age = 39 ± 14 yr (mean ± SD)). On average, participant BMI values were classified as 'overweight' (BMI = 27.3 ± 5.3 kg·m$^2$) and WC values were below cut-points for men (WC = 94.3 ± 12.3 cm) and women (WC = 83.2 ± 12.8 cm). Based on obesity-related health risk classification, participants were classified as 'Least' ($n$ = 16; 32.00%), 'Increased' ($n$ = 21; 42.00%), or 'High' ($n$ = 13; 26.00%) risk. Differences across classification by demographic variables revealed no significant differences ($p$ > .05) with the notable exception of gender ($\chi^2$ = 5.95; $p$ = 0.05; Table 2). Interpretation of the Kruskal-Wallis $H$ test indicated that more participants in 'Least' and 'High' risk groups were female ($n$ = 13; $n$ = 9 respectively), while those at 'Increased' risk were more likely to be male ($n$ = 12).

Descriptive statistics and bivariate correlations across study variables can be found in Table 3. On average participants engaged in 54.55 min of AEE-10, 7539.38 steps per day and 1044.29 min per day of SB across the monitoring period. Engagement in AEE-10 was inversely associated with obesity-related health risk classification ($r$ = -0.54). The magnitude of the effect was moderate (Cohen, 1992).

A one-way MANOVA revealed a significant multivariate effect of obesity-related health risk on the combination of physical activity and sedentary behaviour scores (Pillai's = 0.40, $F$ (6, 86) = 3.60, $p$ = .003, $\eta_p{}^2$ = 0.20, observed power = 0.94; Table 4). Estimates of effect size were interpreted as moderate-to-large. Given the significance of the multivariate test, the univariate main effects were examined. Significant univariate main effects were obtained for AEE-10, $F$ (2, 44) = 7.02, $p$ = 0.002, $\eta^2$ = 0.12). These results suggested that individuals differed in terms of AEE-10 depending on obesity-related health risk classification, but not for steps ($p$ = 0.44; $\eta^2$ = 0.00) or sedentary behaviour ($p$ = 0.27; $\eta^2$ = 0.00). Post-hoc comparisons revealed statistically significant differences ($p$ < 0.05) such that those classified as 'Least' risk participated in a significantly greater amount of AEE-10 than those deemed 'High' risk.

**Table 2: Demographics of sample.**

| Demographics | *n* | % |
|---|---|---|
| Sex (Female) | 31 | 62 |
| Ethnicity (Caucasian) | 45 | 90 |
| Marital Status (Married/Common law) | 29 | 58 |
| Employment (Employed) | 39 | 78 |
| Education (University) | 17 | 34 |

Note: % = percent modal value

**Table 3: Descriptive Statistics and Bivariate Correlations across Study Variables**

| Variable | M | SD | Skew. | Kurt. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| 1. AEE-10 | 54.6 | 62.5 | 2.13 | 5.59 | -- | | | |
| 2. Steps | 7539.4 | 795.6 | 0.21 | -0.01 | 0.62 | -- | | |
| 3. SB | 1044.3 | 109.0 | -0.87 | 1.81 | -0.73 | -0.61 | -- | |
| 4. Classification | | | | | -0.54 | -0.09 | 0.13 | -- |

*Note*: M = Mean. SD = Standard deviation. Skew. = Univariate Skewness. Kurt. = Univariate Kurtosis. AEE-10 = Active Energy Expenditure in bouts of 10 min or more (≥ 3.0 METs reported in min). SB = Sedentary Behaviour. Classification = Obesity-related health risk. All r's greater than |0.24| significant at $p < 0.05$ (one-tailed) and |0.33| significant at $p<0.01$ (one-tailed).

**Table 4: Activity Behaviour by Obesity-Related Health Risk.**

| Variable | | M | SD | P | $\eta^2$ |
|---|---|---|---|---|---|
| AEE-10 | Least Risk | 68.83 | 51.99 | 0.002 | 0.12 |
| | Increased Risk | 46.90 | 37.70 | | |
| | High Risk | 13.82 | 14.36 | | |
| Steps | Least Risk | 6879.28 | 2473.15 | 0.44 | 0.00 |
| | Increased Risk | 7745.21 | 2515.52 | | |
| | High Risk | 6719.15 | 2514.32 | | |
| Sedentary Behaviour | Least Risk | 1056.60 | 90.18 | 0.27 | 0.00 |
| | Increased Risk | 1036.26 | 82.12 | | |
| | High Risk | 1088.99 | 99.59 | | |

*Note*: M = Mean. SD = Standard deviation. $\eta^2$ = eta squared.

## Discussion

The overall purpose of this study was to examine differences in obesity-related health risk in adults in terms of physical activity and sedentary behaviour using multi-sensor ambulatory technology. The findings of the current study suggest that time spent in AEE-10 differentiate across obesity-related health risk classifications as opposed to step count or sedentary behaviour. This study extends beyond what is known regarding obesity-related health risk and markers of ill-health (e.g., metabolic syndrome) to include consideration of lifestyle behaviours. Results can be taken to help health professionals and individuals understand a broader array of health-related constructs across levels of obesity-related health risk, which may be a potential contributor to risk status.

Overall, adherence to recommendations differed depending on physical activity target. Two-thirds (66%) of the study sample met Canadian public health recommendations for physical activity based on AEE-10, but only 18.00% ($n$ = 9) averaged more than 10000 steps per day across the monitoring period. On average, those deemed at 'Least' and 'Increased' risk met physical activity guidelines for AEE-10. When contextualized to recent Canadian population health data (Colley et al., 2011), the present sample on average engaged in greater levels of MVPA, but fewer steps. It is acknowledged that criteria determining a continuous bout of physical activity adopted by Colley et al. (2011) differed from that in the present investigation (8 versus 10 minutes respectively) as was the instrumentation used to monitor physical activity. Compliance with MVPA guidelines, step count and sedentary behaviour are more in line with Scheers and colleagues (Scheers et al., 2013; Scheers et al., 2012b) who adopted identical criteria and instrumentation. The above highlights the challenges of comparing physical activity and sedentary behaviour data across studies when different cut-point criteria and/or instrumentation is adopted.

Partial support for the first hypothesis was found depending on targeted physical activity recommendation. Significant differences corresponding to small-to-moderate effects existed for the variable AEE-10. More specifically, those who were deemed at 'Least' risk for obesity-related health complications participated in more MVPA in bouts of at least ten minutes than those classified as 'High' risk. Findings were generally in line with Scheers et al. (2012a) who reported differences in MVPA accrued in 10 min bouts across BMI classifications. Those at 'Increased' risk did not differ significantly from those in the other conditions on AEE-10. When step count was taken into consideration differences according to obesity-related health risk were not found. While this is somewhat inconsistent with existing research examining the relationship between step count and BMI scores (Colley et al., 2011; Cook et al., 2008), it may also be a function of the modest reduction in weight (i.e., 1 kg) typically reported as a result of pedometer based walking interventions (Richardson et al., 2008). Instrumentation may also be implicated as the SWA armband provides an estimate of ambulatory activity that does not include intensity. As such, researchers may want to consider intensity of ambulation as one factor to consider when looking at the relationship between step count and adiposity (Pillay et al., 2014).

The second hypothesis linked to differences in sedentary behaviour across obesity-related health risk classifications was not supported. Findings resulting from participant data support the support that of Choa Foong et al. (2014) who demonstrated no relationship between objectively measured sedentary behaviour and adiposity. Further, Chastin et al. (2012) noted a relationship between sedentary behaviour and adiposity for men only. As such it is clear that the relationship between sedentary behaviour and adiposity is complex and is in need of greater research attention.

While the results of this study hold appeal for health professionals with an interest in lifestyle behaviours and obesity, a number of limitations seem worthy of note in conjunction with future directions. First, conclusions were derived from a small sample of participants. However, this limitation was addressed in the data through the use of Pillai's criterion and the interpretation of effect sizes, which may offset concerns over statistical power and unequal sample sizes noted in the classification scheme prior to running inferential statistics (Hair et al., 2009). Second, inherent flaws to study instruments (e.g., BMI, WC, SWA™) may have impacted study findings. For example, BMI does not account of differences in sex, race and age and WC requires precision with its measurement and may be under or over-estimated. Finally, recommendations of Scheers et al. (2012c) were adopted for validity and reliability of SWA test scores. However, the SWA does not account for all forms of movement (e.g., water-based activities) and participants altering their normal physical activity over the monitoring period (i.e., Hawthorne effect; Johanssen et al., 2010; Scheers et al., 2013). Because the SWA does not allow researchers to capture mode of activity, this could underestimate the magnitude of certain activities and deflate energy expenditure values (Johannsen et al., 2010); affecting the accuracy of the results. Finally, sedentary behaviour data included sleep, which may have influenced findings. As sleep is essential for health and has been associated with obesity (Beccuti and Pannain, 2011) its inclusion is warranted.

## Conclusion

The present study provides a unique insight into adults' patterns of physical activity and sedentary behaviour based on obesity-related health risk. The present investigation has demonstrated that participation in MVPA in bouts of ten minutes or more, should be promoted as a parameter for influencing obesity-related health risk. Although other activities can be performed intermittently throughout the day, adults should try to accumulate physical activity in sustained bouts to achieve optimal health benefits (Scheers et al., 2013). Following the Canadian physical activity guidelines should be one of many ways for adults to reduce their obesity-related health risk. Also, because sedentary behaviour showed to be similar across all classifications of obesity-related health risk, it is important to still reduce time spent in sitting activities in addition to increasing physical activity levels regardless of risk status. Therefore, such findings should be considered when developing interventions to reduce the prevalence of obesity and its associated health risks (Scheers et al., 2013).

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## Authors' Qualifications

The authors' qualifications are as follows: Kimberly M. Brooks RN BScN MA, Diane E. Mack, PhD, and Philip M. Wilson, PhD.

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