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Physical activity levels of community-dwelling older adults are influenced by winter weather variables

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ABSTRACT

Winter weather conditions may negatively influence participation of older adults in daily physical activity (PA). OBJECTIVE: Assess the influence of winter meteorological variables, day-time peak ambient temperature, windchill, humidity, and snow accumulation on the ground to accelerometer measured PA values in older adults. METHODS: 50 community-dwelling older adults (77.4 ± 4.7yrs; range 71–89; 12 females) living in Southwestern Ontario (Latitude 42.9° N Longitude 81.2° W) Canada, wore a waist-borne accelerometer during active waking hours (12 h) for 7 consecutive days between February and April 2007. Hourly temperature, windchill, humidity, and snowfall accumulation were obtained from meteorological records and time locked to hourly accelerometer PA values. CONCLUSIONS: Regression analysis revealed significant relationships between time of day, ambient daytime high temperature and a humidity for participation in PA. Windchill temperature added no additional influence over PA acclamation already influenced by ambient day-time temperature and the observed variability in PA patterns relative to snow accumulation over the study period was too great to warrant its inclusion in the model. Most PA was completed in the morning hours and increased as the winter month's transitioned to spring (February through April). PRACTICE: An equation was developed to adjust for winter weather conditions using temperature, humidity and time of day. IMPLICATIONS: Accurate PA assessment during the winter months must account for the ambient daytime high temperatures, humidity, and time of day. These older adults were more physically active during the morning hours and became more active as the winter season transitioned to spring.

1. Introduction

Weather and its impact on the physical activity (PA) of older adults has become a topic of increasing interest to researchers (Brandon, Jones, Gill, Speechley, & Gilliland, 2009; Chan, Ryan, & Tudor-Locke, 2006; Togo, Watanabe, Park, Shephard, & Aoyagi, 2005; Tucker and Gilliland 2007). In Canada, one half to two thirds of all people are inactive throughout the year (Merchant, Dehghan, & Akhtar-Danesh, 2007). Sixty-two percent of older Canadians adults are physically inactive (NACA, 2006), yet maintenance of physical functioning is greatly dependent on the continuation of PA as individuals age, impacting positively on morbidity and mortality (Pederson and Saltin, 2006).

Seasonality studies in both Canada (Merchant et al., 2007) and the US (Matthews et al., 2001; Pivarnik, Reeves, & Rafferty, 2003) show that winter is the most sedentary season of the year. Most recent research considering the impact of weather or seasonality on PA has employed the use of questionnaires (Humpel, Owen, Iverson, Leslie, & Bauman, 2004; King et al., 2000; Ma et al., 2006; Matthews et al., 2001; Merrill, Shields, White, & Druce, 2005; Pivarnik et al., 2003; Salmon, Crawford, Owen, Bauman, & Sallis, 2003; Stetson et al., 2005; Wilcox, Castro, King, Housemann, & Brownson, 2000) or pedometers (Chan et al., 2006; Togo et al., 2005); however, accelerometer measured PA levels give a better estimation of overall PA contribution by providing an objective measure of all movement required for activities of daily living, including ambulatory behaviour (Brandon et al., 2009, Ainsworth, Swartz, Strath, O'Brien, & King, 2000). Current research suggests that PA of older adults decreases during colder, more inclement seasons (Togo et al., 2005), and that daily precipitation (rainfall)

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Table 1
Characteristics of winter study subjects.

Characteristic	Value	Range
Age	77.4 ± 4.7	71–89
Weight (kg)	70.5 ± 12.0	43.5–93.0
Height (m)	1.6 ± 8.3	1.5–1.9
Waist-hip ratio	0.85 ± 0.09	0.65–1.05
Female	0.81 ± 0.07	0.65–0.97
Male	0.96 ± 0.06	0.88–1.05
BMI	26.2 ± 4.0	17.2–32.6
VO_2max (ml kg^{-1} min^{-1})	30.0 ± 7.6	17.5–45.8

and daytime peak temperatures have an effect on general PA and exercise class participation (Brandon et al., 2009; Chan et al., 2006). Research investigating barriers and facilitators to PA and exercise, as well as seasonality have identified weather has a factor influencing involvement in vigorous PA in adult populations (Humpel, Owen, & Leslie, 2002; Merrill et al., 2005; Pivarnik et al 2003; Sanderson, Littleton, & Pulley, 2002; Thompson et al., 2002). No study, to our knowledge have yet examined the specific impact of winter meteorological variables on PA participation in older adults.

This investigation aimed to examine the impact of winter weather on the PA levels of older adult's ≥70 years of age, who are community-dwelling, physically independent and regular exercisers. We hypothesized that as temperature decreased and snowfall increased PA would decline.

2. Materials and methods

2.1. Participants

The membership list (N = 370) from a local older adult, exercise centre was used to randomly sample research participants. Inclusion criteria required participants to be 70$^+$ years of age who regularly attending the exercise classes (1-h, 2–3 times per week). A random numbers table was employed against eligible exercise centre attendees' identification numbers, and an exercise centre staff member initially contacted eligible participants by phone. Those who verbally consented were scheduled for a baseline assessment at our laboratory. One hundred individuals, who met the inclusion criteria, were contacted, of which 50 declined to participate. Individuals refused because they were ill or recovering from illness, were too busy, or were going to be away during the evaluation period. The remaining 50 individuals (33 females, 17 males) consented to participate and entered the study. This study was approved by the University Research Ethics Board.

2.2. Measurement

During the baseline laboratory assessment, participants provided written consent, completed a short health questionnaire, and were given instructions on how appropriately wear the accelerometer (ActiGraph GT1 M, ActiGraph, Pensacola, FL.). Epoch times were preprogrammed and set at 1-min intervals, yielding mean accelerometer output in counts per minute (cts/min). A count is equivalent to 1 G (9.8 m/sec^2) of force attributed to vertical movements (ambulatory activity) registered by the accelerometer uniaxial sensors. Counts are averaged over a 1-min epoch to give a cts/min value.

The ActiGraph GT1 M accelerometer (3 cm x 4 cm x 1 cm; 27 g) was worn by consenting participants on a nylon band around their waist for 7-consecutive days. Participants wore the accelerometer during waking hours only, and were asked to remove the monitor when doing any water-based activities (bathing, swimming, etc). The accelerometer was worn over the participant's dominant leg, at the side of the hip. Participants recorded the time when they put-on the accelerometer each morning, while dressing, and when they removed the accelerometer each evening, just before going to bed.

Data was cleaned to eliminate non-wearing time from hourly PA calculations. Cleaned data consists of hourly PA averages calculated using only the minutes when participants were wearing the monitor. Cleaning the data, to eliminate '0′ counts when accelerometer was not worn improves the estimation of the true mean to determine hourly averages of PA. Therefore, the time period used for accelerometer monitoring was set between 7 am and 7 pm. PA counts before or after this 12-h assessment period were removed from the final analysis. This assessment provided an opportunity to track PA accumulation throughout the day to determine when participants were most physically active and to observe longitudinal changes in PA accumulation as winter months transitioned to spring (February through April).

Participants' anthropometric measurements were collected from fitness appraisal data collected by a qualified personnel and included measurements of height, weight, and estimated VO_{2max}

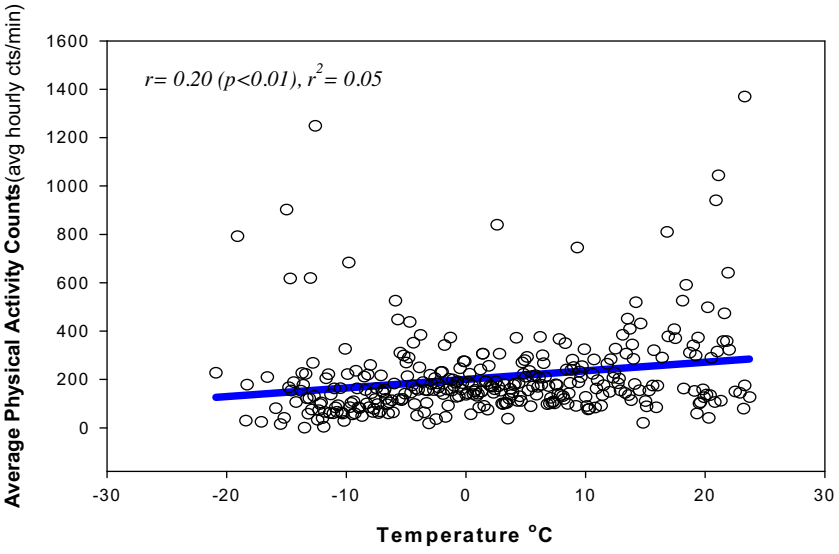

Fig. 1. Physical activity counts vs. ambient daytime high temperature.