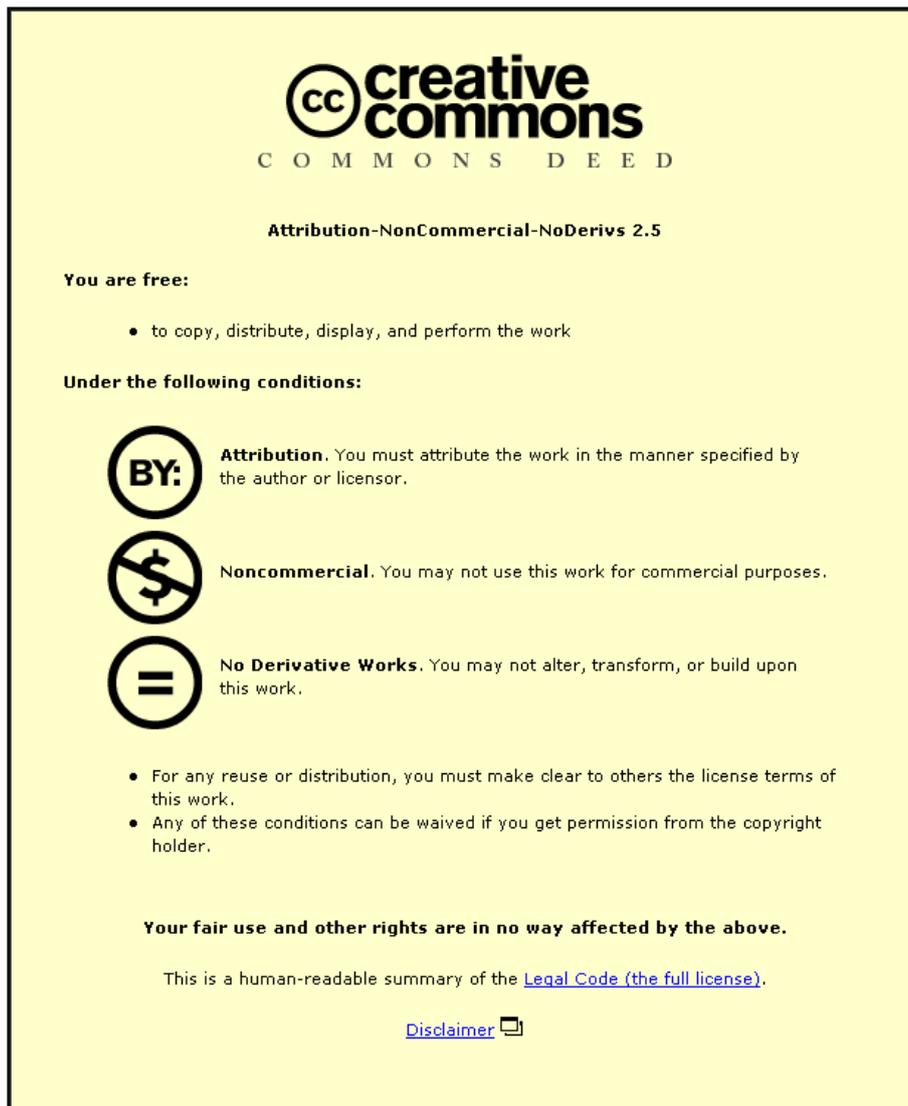


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## **Physical activity profile of Old Order Amish, Mennonite, and contemporary children**

Running title: Modernity and physical activity in children

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## **Abstract**

**Purpose:** This study explored the influence of modernity on the physical activity behaviors (e.g. intensity and timing) of children. **Methods:** Children aged 8-13 years living a traditional lifestyle (Old Order Amish; OOA n=68, Old Order Mennonite; OOM n=120) were compared with children living a contemporary lifestyle (rural; RSK n=132 and urban; USK n=93). Physical activity was objectively assessed for seven consecutive days using Actigraph 7164 accelerometers. Custom software was used to reduce the raw accelerometer data into standardized outcome variables. **Results:** On weekdays there were group differences in moderate physical activity between all lifestyle groups (OOA > OOM > USK > RSK). On the weekend, the group differences in moderate physical activity persisted between, but not within, lifestyle groups (OOA = OOM > USK = RSK). During school hours, all groups had similar activity and inactivity periods; however, they differed in magnitude with the OOA and OOM being both more sedentary and more active. Compared to in school, the OOA and OOM children had 44% lower sedentary time out of school compared to only 15% lower for RSK and USK children. **Conclusions:** Though cross-sectional, these data suggest that contemporary/modern living is associated with lower levels of moderate and vigorous intensity physical activity compared to lifestyles representative of earlier generations. Analyzing the physical activity and inactivity patterns of traditional lifestyle groups such as the OOA and OOM can provide valuable insight into the quantity and quality of physical activity necessary to promote health.

**Key Words:** MODERNITY, TECHNOLOGY, SEDENTARY, ENERGY EXPENDITURE, OBESITY, ACCELEROMETRY

## **Introduction**

**Paragraph 1.** Recent 7-day pedometer data from a nationally representative sample of 6,000 Canadian children and youth aged 5-19 years indicate that 73-91% do not accumulate sufficient daily steps (5). Likewise, recent National Health and Nutrition Examination Survey (NHANES) data show that 58% of American children aged 6-11 and 92% of adolescents aged 12-19 are not meeting the recommended 60 minutes per day of physical activity (33). Although these data suggest that many children and youth are inactive, they do not allow us to determine if this was always the case or if physical activity has declined over time. Knowing how physically active children were when childhood obesity was rare may offer insight into obesity treatment and/or prevention. Unfortunately, longitudinal physical activity data on nationally representative samples of children and adolescents are lacking (17). However, data from questionnaire and time use studies may provide some insight into physical activity trends. For example, Canadian data show no change in leisure-time physical activity from 1981-1998 (7). These data are in line with more recent U.S. data from the National Youth Risk Behavior Surveys that found no significant temporal trends in physical activity and physical inactivity between 1999 and 2005 (17).

**Paragraph 4.** In contrast to these trend data, evidence suggests that U.S. children and youth walk and cycle less for transportation with active trips to school decreasing from 20.2% in 1977 to 12.5% in 2001 (29). Further, U.S. time use data suggest that increased time spent in school, child care, studying, and reading have substantially decreased play and discretionary time from 1981 to 1997 (28). However, these conflicting data are based on proxy ecological evidence that does not take into account temporal changes in a certain domain (e.g., reductions in active commuting) which may be counter-balanced by opposing changes in another domain (e.g., increases in sports participation) (27). Moreover, it is generally felt that the major impact of technology on sedentary behavior was reasonably complete by the 1950s due to the phasing out of heavy manual labor (11). Although further reductions in physical activity were expected due to advances in computer and communication technology, it was believed they would be much more subtle. Until more robust measures of physical activity are integrated into public health surveillance systems, our ability to monitor trends accurately will continue to be severely limited (18).

**Paragraph 5.** In an effort to overcome the gap in historical trend data, Tremblay et al. (30) developed a unique model to assess the impact of modernity on activity levels in children. The authors reasoned that some cultures may preserve the inherently active lifestyle of earlier generations that preceded erosions to leisure-time and occupational physical activity and the childhood obesity epidemic. Their data show that Old Order Mennonite (OOM) children are leaner, stronger and more active than contemporary-living children from both rural and urban communities. Extending the model to look further back in time, Bassett et al. (2) found that Old Order Amish (OOA) children take more steps per day and have lower rates of overweight and obesity than contemporary-living children. Although much has been learned about the physical activity of Old Order Amish and Old Order Mennonite children, only the most basic variables have been explored to date (i.e., average moderate to vigorous physical activity (MVPA) per day and average steps per day). While quantitative information is useful for informing evidence-based physical activity guidelines (i.e., how much physical activity one should do to be healthy), it offers no insights into how one might go about achieving the recommended levels of physical activity (4).

**Paragraph 6.** To fully understand the quantity and quality of physical activity of these traditional groups, further work is needed to examine their activity patterns (i.e., specific intensities and timing of activity/inactivity) (1). Therefore, the purpose of this paper was to profile the physical activity and inactivity behaviors of Old Order Amish, Old Order Mennonite, and contemporary-living children as a means of assessing the influence of lifestyle. Hypothesis one was that group differences in physical activity would be evident (i.e., Amish > Mennonite > contemporary-living children). Hypothesis two was that group differences in physical inactivity would be evident (i.e., contemporary-living > Mennonite > Amish children). Hypothesis three was that the timing (e.g., time of day and day of the week) of the physical activity of the Amish and Mennonite children would differ from that of the contemporary-living children.

## **Methods**

**Paragraph 7.** The study employed an ex post facto (comparative) design whereby the cause(s) of group differences are assumed despite the lack of an experimental design. An overall sample of 474 children was drawn from four different groups: two living a traditional agrarian lifestyle (OOA and OOM) and two living a mainstream contemporary lifestyle (rural (RSK) and urban

(USK)). The sampling procedures differed across the groups as follows: i) OOA: sampled entire population of 81 children (i.e., 100% response rate); ii) OOM: randomized by family from a prescreened list with a total eligible population of 300 with an achieved response rate of 40%; iii) RSK: self selected volunteers with a total population of 262 children and an achieved response rate of 59%; USK: self selected volunteers with a total population of 178 and an achieved response rate of 62%. As this study is based on secondary data analysis, each sample has been described in detail elsewhere (1, 2, 30, 31). In brief, the lifestyle of OOA and OOM children emphasizes simplicity and traditional values rather than progress and technology. Ownership of automobiles is not permitted. Farm tractors, telephones, and bicycles, are permitted, however, among the OOM. Farming and various labor trades are the preferred occupation. Children are educated in their own schools and formal education takes place only through to eighth grade. Therefore, we reasoned that the lifestyles of OOA and OOM children would be representative of typical physical activity behaviours of 100 and 60 years ago, respectively. The lifestyles of RSK children are typical of rural towns (pop<5000) whereas the lifestyles of USK children are typical of urban centers (pop>200,000) in Canada today.

**Paragraph 8.** As part of a larger battery of anthropometry and health-related fitness tests (peripheral to the present study), the 8-13 year old children had their height and body mass measured using a Health O Meter 402KL balance beam scale (Health O Meter Inc., Bridgeview, Illinois, United States). The attached height rod served as a stadiometer. The triceps skinfold was measured midway between the shoulder and elbow on the right arm using Harpenden C136 skinfold calipers (British Indicators, West Sussex, England). All anthropometric measures were measured using the same procedures and equipment for all samples.

**Paragraph 9.** Each child's physical activity was objectively measured for seven consecutive days via accelerometry. All pertinent data collection and analytical procedures related to the accelerometry portion of the study are described in Table 1. The raw data were analyzed using custom software KineSoft version 2.0.95 (KineSoft, New Brunswick, Canada) to produce a series of standardized outcome variables similar to the procedures of Esliger et al. (8) (9). The main variables of interest were average minutes of sedentary, light, moderate, and vigorous intensity physical activity per day. Because the timing of activity and inactivity was of interest, the intensity variables were analyzed with the following time period groupings: weekday, weekend day, and hourly. Physical activity was measured using the same procedures and

accelerometer model for all samples. In addition to parental consent, each child provided written assent to participate in the study. All procedures were approved by the Institutional Research Ethics Boards of the University of Saskatchewan and University of Tennessee.

### *Statistical Analyses*

**Paragraph 10.** One-way ANOVAs were used to test for group differences in chronological age, month of data collection (i.e., seasonality), and accelerometer wear time. Subsequent analyses used MANCOVA models with chronological age and wear time as the covariate to determine group differences in anthropometric variables and physical activity and inactivity variables. Owing to the skewed distribution of the moderate and vigorous physical activity variables, these data were log transformed. All statistical tests were performed on the transformed data; however, in all cases the non-transformed means and standard deviations are presented. Paired samples t-tests were used to determine within group differences in the weekday versus weekend day physical activity variables. The influence of time of day on physical activity and inactivity was described visually via 24 hour x 7 day area plots for each group. Where appropriate, models used Bonferonni adjustments for post-hoc comparisons and alpha was set at  $p < 0.05$ . All analyses were performed using SPSS for Windows version 15.0 (SPSS Inc., Chicago, IL).

## **Results**

**Paragraph 11.** The characteristics of the study sample are displayed by group in Table 2. The sample size lost to technical failure of the accelerometers was 13.9, 0.0, 8.5, and 2.7% for the OOA, OOM, RSK, and USK groups respectively. The traditional lifestyle groups were diligent in wearing their accelerometers and recording on/off times on their logs. As a result, the average sample size lost to participant non-compliance (i.e., not wearing the accelerometer for at least 10 hours per day for at least 4 weekdays and 1 weekend day) was 0.0, 0.0, 12.6, and 13.1% for the OOA, OOM, RSK, and USK groups respectively. Impressively, 100% of the OOA and OOM children had 7 days of valid data. All groups exceeded the daily wear time requirement with OOA children having the greatest average amount of wear time (14.5 hours per day) and RSK and USK children having the least (13.4 hours per day). The extra wear time was a result of the 1-2 hour earlier morning wake-up times of the traditional groups and their 30-70 minute earlier bed times.

**Paragraph 12.** The descriptive characteristics of the participants are displayed by group in

Table 3. The samples are sex balanced; however, because the OOM children were older than the other groups, all further analyses controlled for age since it is well established that physical activity declines with age (22). OOA children were shorter than RSK children, weighed less than OOM and RSK children, and had lower BMI and triceps skinfolds than all other groups.

#### Influence of Lifestyle on Physical Activity and Inactivity

**Paragraph 13.** Support for hypothesis one was evident on weekdays where there were group differences in moderate intensity physical activity (4-6.99 METs) between traditional lifestyle groups and contemporary lifestyle groups (OOA > OOM > USK > RSK; 90, 69, 58, 49 minutes per weekday respectively) (Figure 1). On the weekend, the group differences in moderate intensity physical activity persisted between, but not within, lifestyle groups (OOA = OOM > USK = RSK; 55, 54, 36, 40 minutes per weekend day respectively) (Figure 2). There was relatively little vigorous physical activity ( $\geq 7$  METs) accumulated on any day of the week. On weekdays OOA children accumulated a greater amount of vigorous physical activity compared to all other groups (Figure 1). Although the greater amount of vigorous physical activity in OOM children compared to RSK children was statistically significant, it is unlikely to have biological significance. With even fewer minutes of vigorous physical activity accumulated on the weekend by all groups, it was of little surprise that there were no differences between groups (Figure 2). Likewise, there were no group differences in inactivity behaviours between lifestyle groups on weekdays (Figure 1); however, on weekend days the USK children accumulated more sedentary time than any other group and the RSK children were more sedentary than the OOM children (Figure 2).

#### Influence of Day of the Week and Time of Day on Physical Activity and Inactivity

**Paragraph 14.** All within group differences between weekday and weekend day physical activity and inactivity were significant with the exception of the USK group for sedentary time and vigorous physical activity and the RSK group for light activity (Figures 1,2).

**Paragraph 15.** Plotting and visualizing the hourly physical activity behaviors by intensity and group revealed some interesting temporal trends (Figure 3). Focusing on school days (i.e., Monday-Friday from 08:00-15:00), it appears that the groups have similar patterns in physical activity and inactivity (i.e., they have the same activity and inactivity ‘hotspots’). Comparing the two peak sedentary hours of the school day (i.e., 09:00-10:00 and 13:00-14:00) showed that OOA and OOM children spent on average, 50 of every 60 minutes during these two, one-hour

blocks being sedentary compared to 40 of every 60 minutes for the contemporary children. Although being more sedentary during school hours, the OOA and OOM children were more active overall as evidenced by the higher amounts of moderate physical activity. In fact, both traditional groups had a pronounced tri-modal pattern of moderate physical activity, peaking during the morning commute (08:00-09:00), morning recess (10:00-11:00), and lunch (12:00-13:00) hours (Figure 4). Notably, the hour during lunch break was on average the most active for all groups even when compared to free time on evenings and weekends. On average, OOA and OOM children spent 9 of every 60 minutes during these three, one-hour blocks being moderately active (compared to only 5 of every 60 minutes in the RSK and USK children). In fact, with the exception of the peak in moderate physical activity over the lunch break, it was difficult to discern clear peaks during the morning commute and/or the morning recess in the contemporary groups. The hourly contribution of vigorous physical activity was negligible across all groups over these three time periods.

**Paragraph 16.** Compared to the in-school time, OOA and OOM children's out-of-school time (i.e., Monday-Sunday from 15:00-21:00) showed a marked decline in sedentary time and an increase in time spent in moderate physical activity. This favorable shift was less pronounced in the RSK and USK children (Figure 3). Compared to in-school time, there was on average, 44% less sedentary time out of school in the OOA and OOM children amounting to 25 of every 60 minutes (27 minutes on weekend days) being spent sedentary during this 6-hour block. However, in the RSK and USK children sedentary time out of school was only 15% lower than in school time, amounting to 31 of every 60 minutes (35 minutes on weekend days) being spent sedentary during this 6-hour block. On weekend days, the RSK and USK children's sedentary time was fairly consistent with roughly half of every hour spent sedentary. Although OOA and OOM children were more active on Saturday, they were more sedentary on Sunday. Collectively these results support the hypothesis that the groups differ with respect to the day of the week and the time of the day they accumulated their physical activity and inactivity.

## **Discussion**

**Paragraph 17.** The purpose of this study was to determine if differences in the lifestyles of children would be evident in their physical activity behaviour profile (e.g. intensity and timing). In an attempt to provide a 'window' to the past, we profiled the physical activity behaviours of

Old Order Amish and Mennonite children known to differ in their use of modern conveniences such as labor saving technologies and sedentary, multimedia-based leisure pursuits. Though cross-sectional, these data suggest that contemporary/modern living is associated with lower levels of moderate physical activity compared to lifestyles representative of earlier generations (weekdays: OOA > OOM > USK > RSK; weekend days: OOA = OOM > USK = RSK). It is important to note that the physical activity levels of RSK and USK children (i.e., 51 and 58 minutes of MVPA per day) are comparable to other similarly analyzed datasets (e.g., NHANES, 60 minutes of daily MVPA; (33)). These comparative data imply that the differences between lifestyle groups are a result of OOA and OOM children being more active (i.e., 91 and 71 minutes of MVPA per day), not USK and RSK children being less active than typical children today. The fact that these traditional groups do not participate in organized sports or attend physical education classes suggests that the group differences are likely explained by differences in lifestyle-embedded physical activities such as farm and other manual chores, active commuting, and free play. This explanation seems logical when one considers the substantial contribution that lifestyle-embedded physical activities, also referred to as NEAT (non-exercise activity thermogenesis) (19), make towards total daily physical activity energy expenditure (32).

**Paragraph 18.** Those living a traditional agrarian lifestyle, most notably OOA children, accumulated large amounts of physical activity and met or exceeded most national physical activity guidelines, including on weekdays, Health Canada's (12, 13) recommendation of  $\geq 90$  minutes per day. Therefore, the physical activity and inactivity profiles of OOA and OOM children may be a useful behavioral model for contemporary children to emulate. Perhaps the most remarkable difference between lifestyle groups was the consistently greater amount of physical activity and less time spent sedentary exhibited by the OOA and OOM children compared to the RSK and USK children in their discretionary time. Although the context or mode of this 'extra' physical activity is unknown, detailed information is available with respect to when/how this activity is accumulated. This 'how-to' information is crucial for the development of effective physical activity messages and programs that are necessary to promote healthy behavior change (4). For example, data from OOA children highlight the fact that the physical activity gap that exists for contemporary children could be made up by encouraging them to accumulate small amounts of physical activity intermittently throughout the day (e.g., during the morning commute, recess, lunch, after school commute and during the evening).

These data, which are in agreement with those recently published by Riddoch and colleagues (25), show that making small changes in behaviors can add up to significant amounts of daily physical activity.

**Paragraph 19.** Living a lifestyle reminiscent of 100 years ago, OOA children accumulated on average 55 minutes more MVPA per weekday and 18 more minutes per weekend day compared to contemporary children. The ‘extra’ time spent being active in OOA children was significant and likely contributed to their low levels of overweight and obesity (2, 31). Unfortunately information about the mode and/or context of the physical activity is unknown; however, it is likely that agricultural chores contributed to the higher activity levels in the OOA and OOM children. Based on conservative estimates (i.e., using  $4 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{hr}^{-1}$ ), this translates to an activity energy expenditure deficit of 124 kcal per weekday and 51 kcal per weekend day for the contemporary children. All else being equal, if the energy imbalance was maintained over the long term the contemporary children would be at risk of gaining ~5 kg of fat per year (assuming that 7700 kcal leads to an average of 1 kg weight gain as fat). This energy gap is similar to that found by Wang et al. (35) who suggested that consistent behavioral changes (i.e., reduced energy intake and/or increased energy expenditure) averaging 110 to 165 kcal/day may be sufficient to counterbalance the energy gap in children. Unfortunately, maintaining energy balance in a modern world is difficult since the behavioral processes that evolved in order to ensure our survival are still intact. That is, people still eat when food is available and ‘rest’ when physical activity is not required. The problem is, food is nearly always available and physical activity is seldom required (3, 24).

**Paragraph 20.** Although OOA and OOM children were more active than contemporary-living children regardless of the day, on weekdays both groups spent similar amounts of time being sedentary. There were however, clear differences in how sedentary time was accumulated with group differences evident on weekend days. This is an important finding as there is mounting literature linking overall sedentary time and its pattern of accrual to health risks (10, 14, 15, 23). For example, on Sundays virtually all OOA and OOM children attend church. However, unlike the active commute to school, children travel to church with their families via horse and buggy and then sit through a service lasting two or more hours. These religious observances are easily discernable as sedentary bouts in Figure 3 when the activity profile on Saturday is compared to Sunday. No such clearly demarcated bout of sedentary time was found for the contemporary

groups on Sunday. The notion that religious observance can have an impact on the accrual of physical activity and sedentary time has been studied before. Kahan (16) found that in a group of Jewish adolescents, those most likely to observe the Sabbath and attend a synagogue accrued less MVPA and less sedentary time compared to the less observant. Another contributing factor to the relatively large amounts of sedentary time during the school day relates to the fact that OOA and OOM children are educated in one-room school houses with limited space for moving around both during and between lessons. In contrast, contemporary children attend relatively large schools and often change classrooms between lessons and may have physical education classes scheduled throughout the school day. Cohen and colleagues (6) recently showed that the indoor square footage of a school can contribute 4 and 16% to the light and MVPA of adolescent girls respectively.

**Paragraph 21.** A strength of this study was the use of objective measurements of physical activity (26). Another strength is the detailed analysis of the accelerometry data in terms of intensity and temporality. However, there are limitations to accelerometry, most notably, their inability to assess lifting and carrying activities, cycling, water-based activities, and the general lack of contextual information relating to activity mode and/or location/domain (21). For example, the fact that waist mounted accelerometers do not measure cycling could have limited the true quantification of MVPA in the OOM, RSK, and USK children all of whom ride bicycles; whereas the OOA children are disallowed. This explanation may partly explain the relatively high amounts of MVPA in the OOA children compared to the OOM children; however, one cannot forget the fact that OOM farms and homesteads are allowed some labor mechanization (e.g., tractors). Unfortunately no information was collected on activity mode. Although attempts were made to control for the month of data collection, seasonal differences were not specifically measured. In addition, specific information was not collected regarding school start and end times, recess, or lunch. Another limitation was that selection bias could not be ruled out due to the non-random nature of the sample. Although virtually all OOA children were measured, less than half of the OOM children were sampled; however, it is unlikely that the OOM children are at risk of physical activity related non-response bias as it was the most technologically conservative families that declined to participate. In contrast, the self-identifying process of contemporary school selection likely resulted in schools participating that were very supportive of physical activity. We are confident that, if anything, these limitations work to disprove our

hypotheses and therefore strengthen our findings. Finally, it should be noted that this study included only children in technologically conservative Amish and Mennonite communities. Therefore, these results should not be generalized to other less conservative religiocultural communities where fewer families farm, and modern technology is more prevalent, as physical activity is likely to be lower in these groups.

## **Conclusion**

**Paragraph 22.** Though cross-sectional, these data suggest that contemporary/modern living is associated with lower levels of moderate and vigorous intensity physical activity compared to lifestyles representative of earlier generations. Analyzing the physical activity and inactivity patterns of traditional lifestyle groups such as the OOA and OOM can provide valuable insight into the quantity and quality of physical activity necessary to promote health. Future work in this area should address differences in how children fractionalize (i.e., accumulate in bouts) their physical activity and inactivity and the impact these behaviors have on health.

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## **Conflict of Interest**

The authors declare no conflict(s) of interest. The results of the present study do not constitute endorsement by ACSM.

## Figure Captions

**Figure 1.** Mean minutes per weekday of sleep, sedentary, light, moderate, and vigorous intensity physical activity, by group

\*significantly different from all other groups; †significantly different from RSK; # indicates no within group difference between weekday and weekend day on the given variable;  $P < 0.05$

Notes: i) means are adjusted based on age and wear time covariates; ii) both moderate and vigorous physical activity are scaled according to the secondary y-axis; iii) although statistical analyses were performed on log transformed moderate and vigorous physical activity variables, non-transformed data are presented; iv) error bars represent standard error

**Figure 2.** Mean minutes per weekend day of sleep, sedentary, light, moderate, and vigorous intensity physical activity, by group

\*significantly different from all other groups; †significantly different from RSK; ‡significantly different from RSK and USK; # indicates no within group difference between weekday and weekend day on the given variable;  $P < 0.05$

Notes: i) means are adjusted based on age and wear time covariates; ii) both moderate and vigorous physical activity are scaled according to the secondary y-axis; iii) although statistical analyses were performed on log transformed moderate and vigorous physical activity variables, non-transformed data are presented; iv) error bars represent standard error

**Figure 3.** Group differences in intensity-specific physical activity profiles (7 days x 24 hours)

Note: White areas of the figure represent sleep time while the colored areas signify traffic light labeling of physical activity intensity. The sedentary activity is colored red to give the message to stop the behavior, light activity is colored yellow to give the message to be cautious of too much light activity, and both moderate and vigorous activity are colored green to give the message that these are positive behaviors.

**Figure 4.** Group differences in weekday moderate to vigorous physical activity (hour x hour)

**Note:** Table 1 cites two references not mentioned in the body of the article; Trost et al. (34) and Mattocks et al. (20).

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Table 1. Accelerometry data collection and analytical procedures.

<b>General Information</b>	
Device	Actigraph
Model	7164
Piezosensor Orientation	Uniaxial
Number of Accelerometers Used	117
Serial Number Range	11672-23880
Average Number of Deployments Per Unit	4 (ranging from 1 to 9)
Pre-deployment Calibration Check	Yes
Technical Variability Tolerance (CV%)	≤5%
<b>Setup Information</b>	
Mode	Counts Only
Epoch	1 Minute
Deployment Method	Delivered and attached by researcher (on day 0)
Location Worn	Right hip at mid clavicular line (via adjustable nylon waist belt)
Requested Days of Wear	7 days (i.e., 10080 epochs) not including day 0
Initialization & Monitor Start Time	Delayed until next day (i.e., day 1 at 06:00)
Wear Instructions	During all *waking hours (except water based activities)
<b>Analytical Decisions</b>	
Sleep Time Appropriation	Continuous zeros indicating the start of sleep time were coded by researchers based on the transition from epochs with normal count data to epochs of continuous zeros. The accelerometer on time at wake up was marked based on the first non-zero epoch after the overnight period (informed by the participant's log sheet).
Valid Day Criteria	10 hours of wear
Valid File	At least 5 of 7 days (with at least 1 weekend day)
Modeling (i.e., imputation) of Missing Data	None

Daylight Saving Time	Files crossing DST in the fall of 2002 were corrected for the repeat hour
Cutpoint Reference(s)	For light, moderate, and vigorous intensity, age-specific cutpoints developed by the Freedson group as published by Trost et al. (34) were used. The sedentary cutpoint, although not empirically derived, has been published previously by Mattocks et al. (20).
Sedentary	0-199 counts
Light Intensity	200 counts – 3.99 METs (age specific)
Moderate Intensity	4.0 – 6.99 METs (age specific)
Vigorous Intensity	7+ METs (age specific)

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\*The start and end of the daily accelerometer wear periods was used as a surrogate for sleep time.

Table 2. Characteristics of the study sample.

Variable	OOA	OOM	RSK	USK
Sample location in Canada	Aylmer, ON	Waterloo & Wellington County, ON	Clavet, Colonsay, & Hanley, SK	Saskatoon, SK
Data collection period	Spring 2005	Fall 2002	Fall 2002	Fall 2002
Original sample	79	120	165	110
Failed to initialize/collect	10	0	8	3
Spurious data	1	0	6	0
Not enough wear time	0	0	19	14
Viable sample	68	120	132	93
7 valid days	68 (100%)	120 (100%)	105 (80%)	76 (82%)
6 valid days	-	-	24 (18%)	15 (16%)
5 valid days	-	-	3 (2%)	2 (2%)
Average daily wear minutes (SD)	873 (33)	820 (27)	805 (46)	806 (44)
Average daily non-wear minutes (SD)	567 (33)	620 (27)	635 (46)	634 (44)
Average morning "on" time (SD)	06:38 (0:25)	07:07 (0:26)	08:13 (0:31)	08:30 (0:35)
Average evening "off" time (SD)	21:05 (0:25)	20:49 (0:22)	21:28 (2:11)	22:01 (0:47)

Note: Non-wear (manually coded by the researcher) was used as a surrogate for sleep

Table 3. Descriptive characteristics of study participants; mean (SD) and range.

Variable	OOA	OOM	RSK	USK
N (% female)	68 (44)	120 (45)	132 (57)	93 (54)
Age (yrs)	10.6 (1.74) 8.0-13.9	11.6 (1.26)* 9.1-13.8	10.9 (1.20) 8.8-13.2	11.1 (1.16) 8.8-13.2
Standing height (cm)	141.0 (11.7) 119.0-165.0	149.0 (9.3) 124.5-174.5	146.3 (10.1) <sup>†</sup> 123.5-169.0	146.2 (10.3) 122.0-172.0
Weight (kg)	35.3 (10.2) 20.0-73.3	44.4 (10.1) <sup>†</sup> 23.5-70.3	41.2 (9.7) <sup>†</sup> 21.4-69.5	40.6 (9.6) 22.0-67.8
BMI (kg·m <sup>-2</sup> )	17.2 (2.6)** 13.4-31.3	19.8 (3.0) 13.2-26.7	19.0 (2.8) 11.9-26.2	18.8 (2.7) 13.9-25.8
Triceps skinfold (mm)	10.8 (4.8)** 5.0-31.7	16.5 (6.8) 6.1-33.0	17.7 (7.2) 5.2-39.8	18.0 (7.5) 5.5-39.4
Prevalence of overweight (%)	3.0	28.3	23.7	18.3
Prevalence of obesity (%)	1.5	3.3	1.5	1.1

BMI = body mass index; \* significantly different from all other groups; \*\* significantly different from all other groups when controlling for age; <sup>†</sup>significantly different than OOA when controlling for age; P<0.05

**Figure 1**

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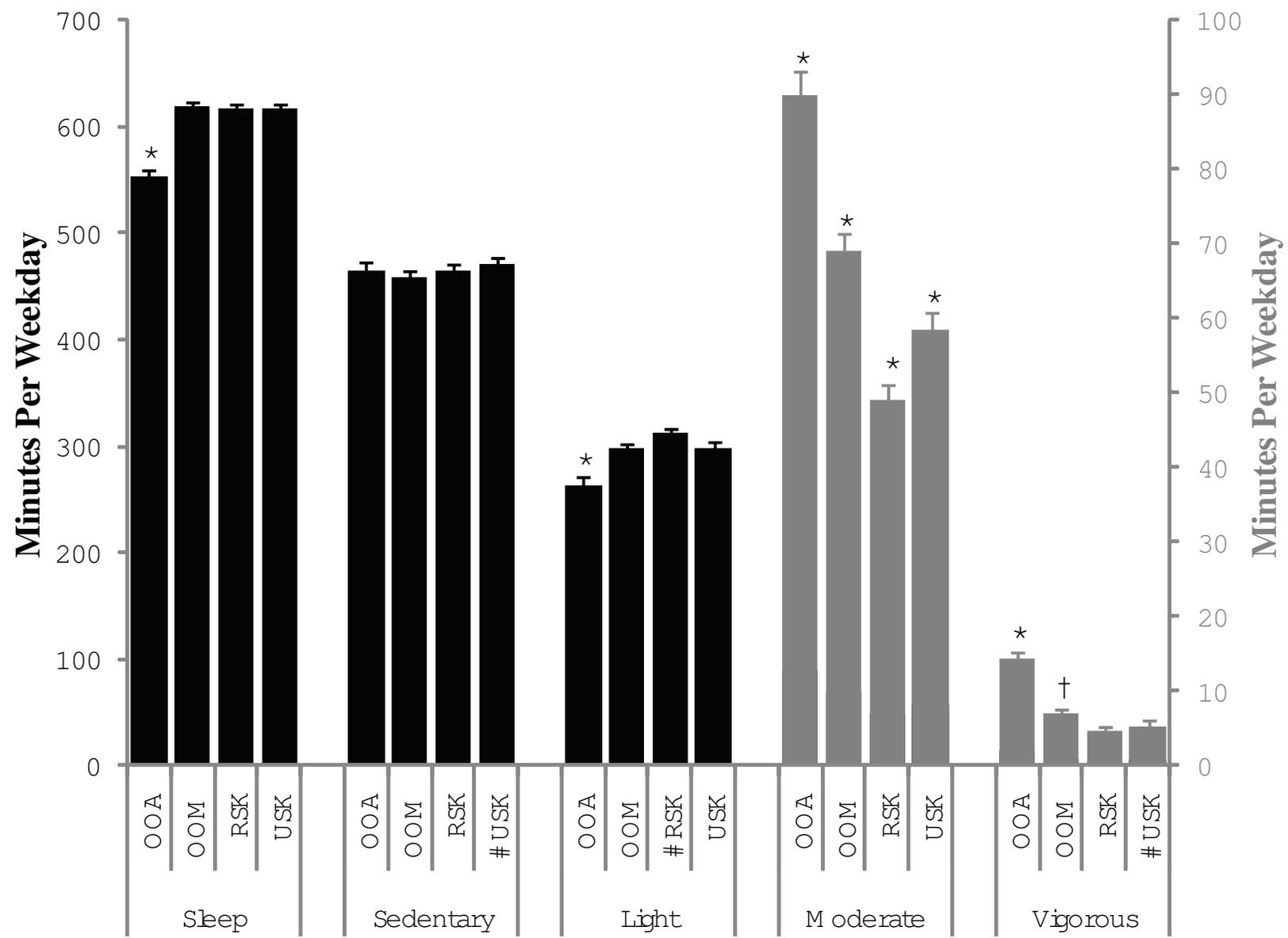


Figure 2

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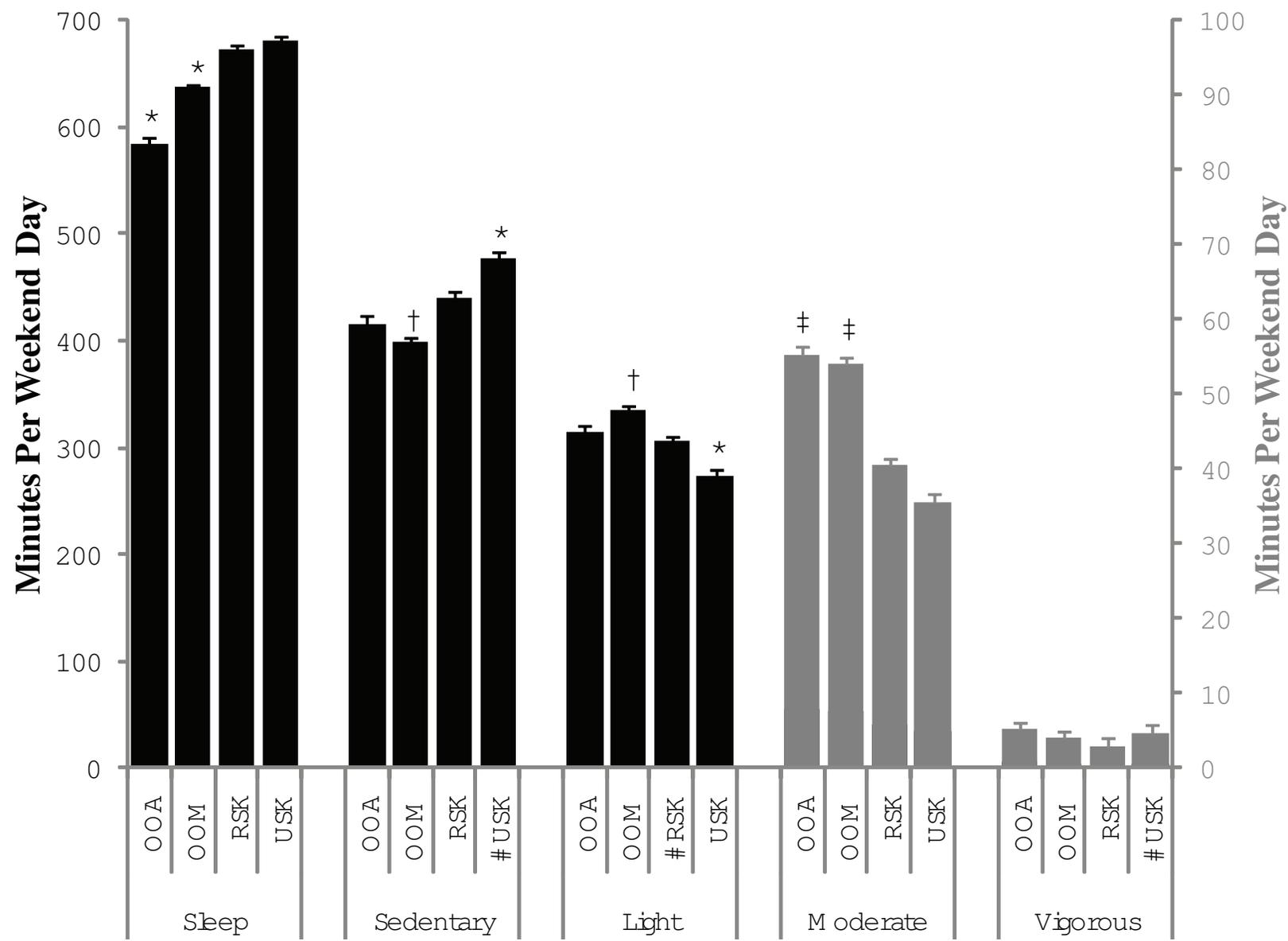
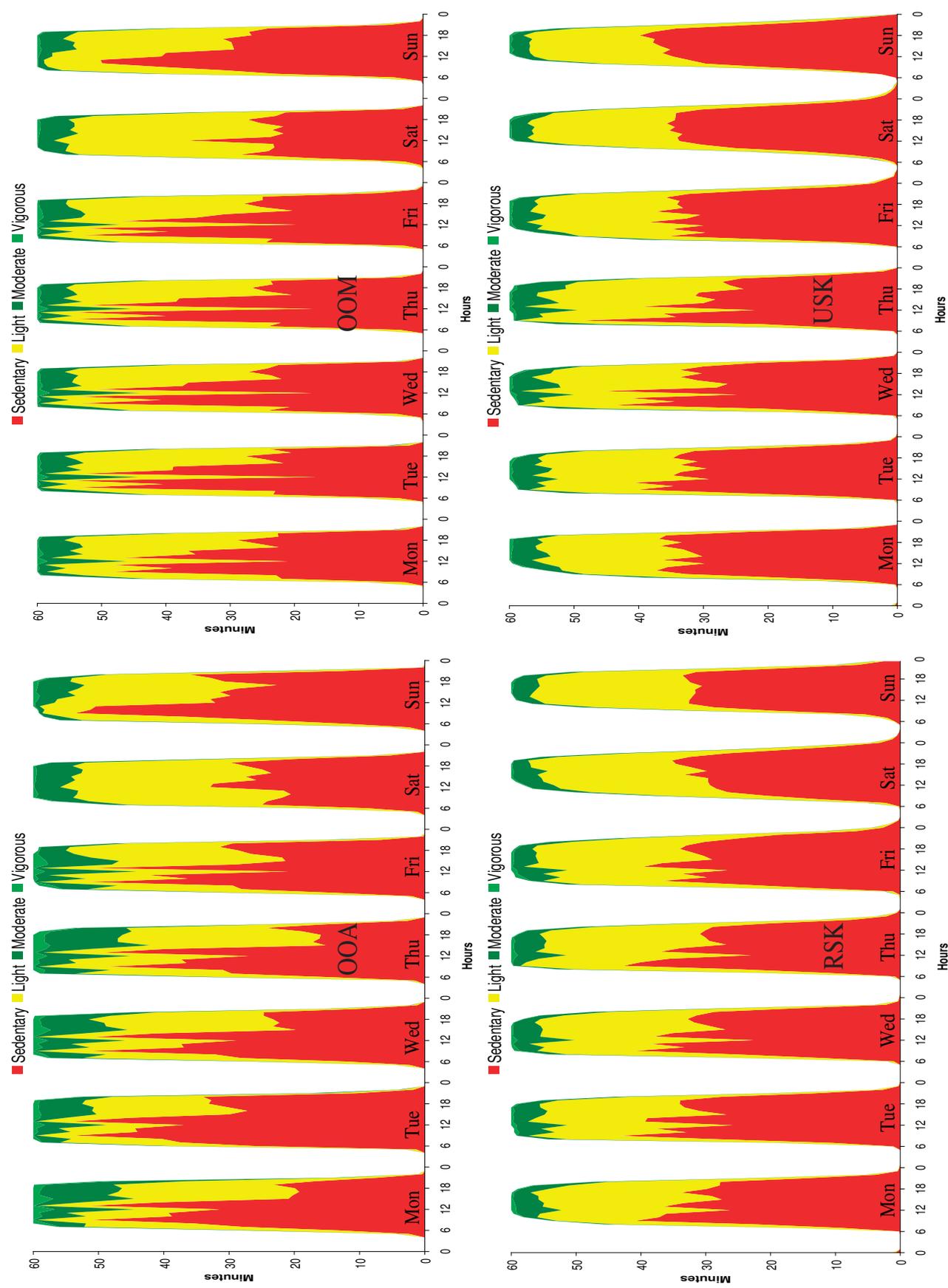


Figure 3

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**Figure 4**

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