Physical activity in women of reproductive age in a transitioning rural Polish population

Katharine M.N. Lee[1], Mary P. Rogers[1*], Andrzej Galbarczyk[2], Grazyna Jasienska[2], Kathryn B.H. Clancy[1,3]

Short running title:

Physical activity in reproductive age Polish women

Institutional Affiliations

[1]Department of Anthropology, University of Illinois Urbana-Champaign, Urbana, IL
[2]Department of Environmental Health, Faculty of Health Sciences, Jagiellonian University Medical College, Krakow, Poland
[3]Beckman Institute of Advanced Science & Technology, University of Illinois Urbana-Champaign, Urbana, IL

Keywords:

Physical activity, pedometry, domestic labor

---

[*] MP Rogers current affiliation: Institute for Genomic Biology, University of Illinois Urbana-Champaign

Abstract

Objective:
Health research often focuses on moderate and vigorous intensity physical activity while neglecting low-intensity habitual activities. We aim to understand habitual physical activity in women from a transitioning economy using a physical activity monitor.

Methods:
This study investigated physical activity in 68 healthy premenopausal women (age 18-46) in rural Poland using FitBit One activity trackers for one week. Standard anthropometric techniques were used to measure height, weight, and body fat. Daily physical activity data was analyzed for step counts as well as duration and intensity.

Results:
This sample of rural Polish women traveled a mean of 8428 (SD=2650) steps per day. Time spent lightly active, fairly active, and very active were measured as 337.1 (SD=87.8), 19.6 (SD=30.5), and 6.7 (SD=8.6) minutes per day, respectively. Total time active and time spent lightly active were associated with daily steps ($p<0.001$ for both), and time lightly active increased with age ($p=0.02$). No other significant relationships were observed between physical activity measures and BMI, age, or body fat.

Conclusions:
In this sample, women spend a significant amount of time engaged in light-intensity physical activity and travel a relatively high number of steps per day. Our data suggest that in this population, total daily activity does not depend on age in women between 18-46. We suggest that measurement methods which include low-intensity activity may better characterize habitual physical activity in women who are expected to be performing large amounts of domestic labor.

Introduction

Women spend a significant amount of time doing domestic labor such as housework (Altintas & Sullivan, 2016), and domestic labor is largely characterized by light-intensity physical activity between 1.5-3 metabolic units (METS) (Ainsworth et al., 2011). For decades, research focused on moderate and vigorous intensity physical activity (MVPA) (Pate et al., 1995), but recent research shows that time spent lightly active is physiologically distinct from time sedentary (Tremblay, Colley, Saunders, Healy, & Owen, 2010). Measurement of light-intensity physical activity is thus important to understand overall physical activity, particularly among those who engage in significant domestic labor. People generally over-estimate time spent in MVPA and have difficulty accurately estimating time spent sedentary; therefore

objective measures of physical activity are useful for examining physical activity levels (Celis-Moralis et al., 2012; Dhurandhar et al., 2014).

Here, we report on physical activity in women from a rural region of Poland. The Mogielica Human Ecology Study Site in mountainous southern Poland is undergoing transition from a subsistence agricultural environment to a more wage-labor economy (Colleran, 2014). Our previous work used self-reported physical activity measures and indicated that women in this region still tend farms or gardens and perform significant amounts of domestic labor (Jasienska, Ziomkiewicz, Thune, Lipson, & Ellison, 2006). We hypothesize that women in this region are likely to spend a large portion of their day physically active at low intensity and that this low-intensity activity can be successfully quantified using physical activity monitors.

Methods

Rural Polish women (n=68) aged 18-46 from the Mogielica Human Ecology Study Site in the Beskid Wyspowy mountain region of Poland (pp 28-32, Jasienska, 2013) were recruited. All women were healthy, non-smoking, pre-menopausal, with regular menstrual cycles (based on self-report). Women were not (currently or within the past six months) pregnant, nursing, or on hormonal birth control. Standard anthropometric techniques were used to quantify height, mass, and body fat (Antón, Snodgrass, & Bones and Behavior Working Group, 2009) at enrollment. Body fat was measured using a Tanita bioimpedence scale (using the "female" setting). The University of Illinois Institutional Review Board approved this research (protocol #13856) and all participants provided written informed consent prior to study participation.

The FitBit One (FitBit Inc., San Francisco, CA) activity monitor was used to collect physical activity data. The FitBit has been validated for step counts during walking at multiple

speeds (Takacs et al., 2014), has moderate to high validity for measuring energy expenditure in healthy adults (J.-M. Lee, Kim, & Welk, 2014), and is among the more accurate activity monitors available for the consumer market (Ferguson, Rowlands, Olds, & Maher, 2015). The FitBit One was initialized for each woman (sex, height, weight, age) and worn on the trunk (waistband, front pocket opening, or center front of bra) according to manufacturer instructions. Data was downloaded from FitBit servers using the FitBit developers API and custom software (K. M. N. Lee, 2018). Daily physical activity data is recorded in preset categories by the FitBit device and was downloaded as steps per day, minutes spent lightly active (intensity <3 METs), minutes spent fairly active (3-6 METs), and minutes spent very active (>6 METs). Following the methodology of Ferguson, et al . (2015), we combined fairly active and very active categories as a means to approximate time in MVPA. Total time active is the sum of time spent in all three activity categories.

Women wore FitBits for a mean of 6 days during the mid-to-late luteal phase of the menstrual cycle. The first and last days of FitBit data were removed from analysis, as women only wore the FitBit for part of these days. All women wore the FitBit for at least 3 full days. The mean for each participant was calculated from daily data. Multiple linear regression was used to adjust for age when comparing physical activity measures with BMI and body fat. Separate simple linear models were used for the remaining comparisons. All calculations were performed in R (3.3.3).

Seven women participated in this study twice, with the second occurrence two years after the first. Both of these were included in our analyses after Wilcoxon rank-sum tests on the absolute value of the difference confirmed steps were not the same between years ($p=0.015$), and

further inspection confirmed these data were not the most extreme points in our sample. Therefore, our calculations were performed on 75 observations.

Results

Age was not associated with mean daily steps ($p=0.26$), total time active ($p=0.50$), time fairly active ($p=0.11$), or time very active ($p=0.42$). Age was positively associated with time spent lightly active, but it did not explain much of the variance ($p=0.02$, adjusted $R^2=0.06$). Summary statistics can be found in Table 1.

The mean total time active and time lightly active were positively associated with mean steps per day ($p<0.001$, adjusted $R^2=0.59$, and $p<0.001$, adjusted $R^2=0.31$, respectively, Figure 1). Age-adjusted mean daily steps were not related to BMI ($p=0.79$) or body fat ($p=0.75$). Age-adjusted total time active was also not associated with BMI ($p=0.50$) or body fat ($p=0.75$).

Discussion

In this cross-sectional study, women spent a large portion of their day being active at low intensity, as we would expect from our previous work (Jasienska et al., 2006) and from time use studies (Altintas & Sullivan, 2016). Age was not associated with physical activity as measured with pedometry, although there was a slight positive association between age and time spent lightly active. This suggests that as women age, they are completing approximately the same amount of physical activity (as measured in steps), but taking those steps marginally more slowly. We did not see a corresponding decrease in time spent at higher intensity physical activity. Because time active and time lightly active were both associated with daily steps, we suggest that pedometry is an effective and affordable method to help quantify habitual physical activity in people who tend to perform time-intensive labor.

In sedentary populations where sports and leisure-time exercise constitute the main portion of physical activity, a focus on MVPA may be an effective measure of physical activity and energy expenditure. However, in this population, as in many populations of women, physical work is usually time-intensive rather than energy-intensive. Conflating light-intensity activity with sedentary time mischaracterizes physical activity and energy expenditure (Tremblay et al., 2010), and furthermore underestimates time-intensive domestic labor.

Our results suggest that focusing on MVPA population research disregards the gendered and time-intensive work that women often perform. Given recent calls for more accurate and objective measures of energy balance (Dhurandhar et al., 2014), we suggest studies that focus only on MVPA are missing a significant source of energy expenditure and time allocation. Light-intensity physical activity can be easily measured using commercially available physical activity monitors. Including this physiologically important low-intensity physical activity may improve our understanding of population differences in the incidence of activity-related long-term health outcomes.

Acknowledgements

We first and foremost wish to thank the women who participated in this study. We additionally would like to thank Pan Doktor Leszek Pieniązek and Pani Położna Emilia Bulanda for their work on this project. This work would not be possible without all of our research assistants, including (in alphabetical order) Kristina Allen, Vilimira Asenova, Haley Ban, Priya Bhatt, Klaudia Dziewit, Sara Gay, Juliana Georges, Fatima Godfrey, Denise Herrera, Piotr Hutka, Szczepan Jakubowski, Ansley Jones, Jacob Kanthak, Monika Kukla, Karolina Miłkowska, Rachel Mitchell, Agata Orkisz, Kamila Parzonka, Anna Pawińska, Bryana Rivera, Aleksandra Starnawska, Zarin Sultana, Monika Szlachta, Katarzyna Szulc, Aleksandra Wojtarowicz, and Kevin Zavala. We thank Dr. Laura Shackelford for her encouragement and guidance in writing this manuscript.

This material is based upon work supported by the National Science Foundation under Grant Numbers 1317140, BCS-1732117, BCS-1650839, and the Graduate Research Fellowship under Grant Number DGE-1144245. Any opinion, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation. This work was also supported by Wenner-Gren #084918, Wenner-

Gren # 089812, The American Philosophical Society Lewis and Clark Fund for Exploration and Field Research, the University of Illinois Department of Anthropology Summer Research Fund, The Beckman Institute Cognitive Science/Artificial Intelligence Award, the University of Illinois Graduate College Dissertation Travel Grant, and Grant-In-Aid of Research from Sigma Xi, The Scientific Research Society

Author Contributions

KL developed the research question, designed the study methodology, led the statistical analysis, and wrote the manuscript. KL and MR collected the data. KC, AG, and GJ provided logistical support. MR, AG, GJ, and KC edited the manuscript.

References:

Ainsworth, B. E., Haskel, W. L., Hermann, S. D., Meckes, N., Bassett, Jr., D. R., Tudor-Locke, C., … Leon, A. S. (2011). The Compendium of Physical Activities Tracking Guide. Healthy Lifestyles Research Center, College of Nursing & Health Innovation, Arizona State University. Retrieved from https://sites.google.com/site/compendiumofphysicalactivities/

Altintas, E., & Sullivan, O. (2016). Fifty years of change updated: Cross-national gender convergence in housework. *Demographic Research*, *35*, 455–470.

Antón, S., Snodgrass, J., & Bones and Behavior Working Group. (2009). Integrative measurement protocol for morphological and behavioral research in human and non-human primates. *Publication of the Bones and Behavior Working Group*.

Celis-Moralis, C. A., Perez-Bravo, F., Ibañez, L., Salas, C., Bailey, M. E. S., & Gill, J. M. R. (2012). Objective vs. self-reported physical activity and sedentary time: Effects of measurement method on relationships with Risk Biomarkers. *PLoS One*, *7*.

Colleran, H. (2014). Farming in transition: land and property inheritance in a rural Polish population. *Society, Biology and Human Affairs*, *78*(1&2), 7–19.

Dhurandhar, N. V, Schoeller, D., Brown, A. W., Heymsfield, S. B., Thomas, D., S\orensen, T. I. A., … the Energy Balance Working Group. (2014). Energy Balance Measurement: when something is not better than nothing. *Int J Obesity*, 1–5.

Ferguson, T., Rowlands, A. V, Olds, T., & Maher, C. (2015). The validity of consumer-level, activity monitors in healthy adults worn in free-living conditions: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1).

Healy, G. N., Dunstan, D. W., Salmon, J., Cerin, E., Shaw, J. E., Zimmet, P. Z., & Owen, N. (2008). Breaks in Sedentary time: beneficial associations with metabolic risk. *Diabetes Care*, *31*(4), 661–666.

Jasienska, G. (2013). *The Fragile Wisdom: an evolutionary view on women's biology and health*. Harvard University Press.

Jasienska, G., Ziomkiewicz, A., Thune, I., Lipson, S. F., & Ellison, P. T. (2006). Habitual physical activity and estradiol levels in women of reproductive age. *Eur J Cancer Prev*, *15*, 439–445.

Lee, J.-M., Kim, Y., & Welk, G. J. (2014). Validity of Consumer-based Physical Activity Monitors. *Medicine & Science in Sports & Exercise*, *46*(9), 1840–1848.

Lee, K. M. N. (2018, July). R Code in support of publication.

https://doi.org/10.5281/zenodo.1308115
Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., … Wilmore, J. H. (1995). Physical activity and public health: A recommendation from the centers for disease control and prevention and the american college of sports medicine. *JAMA*, *273*(5), 402–407. https://doi.org/10.1001/jama.1995.03520290054029
Takacs, J., Pollack, C. L., Guenther, J. R., Bahar, M., Napier, C., & Hunt, M. A. (2014). Validation of the Fitbit One activity monitor device during treadmill walking. *Journal of Science and Medicine in Sport*, *17*, 496–500.
Tremblay, M. S., Colley, R. C., Saunders, T. J., Healy, G. N., & Owen, N. (2010). Physiological and health implications of a sedentary lifestyle (Review). *Appl Physiol Nutr Metab*, *35*, 725–740.

Table 1: Descriptive statistics of study participants

n=75	**Mean (standard deviation)**	**Median**	**Range**
Age (years)	33.9 (7.8)	36.0	19-46
Height (cm)	164.7 (6.1)	164.3	150.0-179.4
Weight (kg)	68.3 (15.8)	66.1	46.8-137.1
BMI (kg/m^2)	25.1 (5.4)	24.1	17.9-49.4
Body fat (%)	29.3 (8.0)	28.7	11.5-47.1
Steps per day	8428 (2651)	8250.0	3203-14430
Lightly active (minutes/day)	337.1 (87.1)	329.0	131.7-522.5
Fairly active (minutes/day)	19.6 (30.5)	8.1	0-165.6
Very active (minutes/day)	6.7 (8.5)	3.4	0-33.6
Fairly active and very active (minutes/day)	26.4 (36.1)	14.3	0-189.4
Total time active (minutes/day)	363.5 (89.4)	361.7	130.7-551.5

Figure 1: Mean total time active (blue circles, dashed line) and mean time lightly active (grey triangles, solid line) are positively associated with mean steps per day.