Published in final edited form as:

Med Sci Sports Exerc. 2009 February ; 41(2): . doi:10.1249/MSS.0b013e3181864c05.

Monthly Variation in Physical Activity Levels in Post-Menopausal Women

Mark A. Newman¹, Kelley K. Pettee², Kristi L. Storti¹, Caroline R. Richardson³, Lewis H. Kuller¹, and Andrea M. Kriska¹

¹Department of Epidemiology, University of Pittsburgh, Pittsburgh, PA 15261

²Department of Exercise and Wellness, Arizona State University, Mesa, AZ 85212

³Department of Family Medicine, University of Michigan and VA Medical Center, Ann Arbor, MI, 48109

Abstract

INTRODUCTION—Month-to-month variation in physical activity levels in a cohort of post-menopausal women participating in a single site clinical trial undergoing lifestyle intervention was investigated prior to and after lifestyle intervention.

METHODS—Participants were Caucasian and African-American women (mean age 57.0 ± 3.0) from the Women On the Move through Activity and Nutrition (WOMAN) study. Physical activity was measured subjectively by questionnaire and objectively by pedometer at baseline and at the 18-month follow-up.

RESULTS—At baseline, prior to intervention, pedometer steps were highest in the summer months (7,616 steps/day), lower in the fall (6,293 steps/day), lowest in winter (5,304 steps/day), and then rebounded in the spring (5,850 steps/day). Physical activity estimates from the past-week subjective measure followed the same seasonal pattern. After 18-months, the lifestyle change group significantly increased their pedometer step counts when compared to the health education group ($p < 0.0001$). At 18-months, pedometer step counts for the health education group followed a pattern similar to that found in the entire group prior to intervention, whereas, month-to-month step counts for the lifestyle change group appeared to remain consistent throughout the year.

CONCLUSIONS—These results confirm previous reports that suggest physical activity levels fluctuate throughout the year. Lifestyle intervention, which includes a physical activity component, not only increases step counts, but appears to reduce some of variation in physical activity levels over the course of a year in post-menopausal women.

Keywords

pedometer; seasonality; post-menopause; lifestyle intervention

Introduction

Cardiovascular disease (CVD) is currently the leading cause of mortality among older women in the United States (1). Increasing physical activity levels can reduce the risk of developing chronic illness including cardiovascular disease and diabetes (13). Post-menopausal women (age 45–64 years) are among the least active subgroups in the United

States, with more than 38% of women in this age group reporting being physically inactive during their leisure time (14). Understanding more about patterns of physical activity levels in post-menopausal women, will guide the field in developing better methods for physical activity assessment in this unique, and currently underserved, population.

Environmental changes in temperature, precipitation, and number of daylight hours are thought to provoke seasonal changes in physical activity levels (6). In parts of the United States (US) where weather patterns fluctuate with the changing seasons, it appears that activity levels may vary by season. For example, in the Southwestern US, physical activity levels may drop during the summer months due to the hot and dry climate. In contrast, in the Northeastern US, physical activity may decline in the cold, snowy, winter months. A number of previous investigations, set in geographical areas with distinct seasons, found that individuals reported peak physical activity levels during summer months, during which the weather was more conducive to being physically active (6,10,12). The issue of seasonality in physical activity research is important as it may relate to health-related outcomes. For example, findings from the Seasonal Variation of Blood Cholesterol (SEASON) study showed combined moderate intensity household and leisure time activity doubled (i.e., increase of 2.0–2.4 MET-hours/day) during the summer in comparison with winter, in men and women ages 20–70 years (6). In the SEASON study, the issue of seasonality was not limited to changes in physical activity levels; seasonal differences were also observed in relation to blood lipid levels. Average total cholesterol peaked in men during the month of December and women during the month of January when physical activity levels were lower, which suggests that fluctuations in physical activity levels across seasons may positively or negatively influence health-related outcomes (7). There is currently a lack of research regarding how seasonal variations in physical activity affect post-menopausal middle-aged women.

The purpose of the current report is to determine if variations occur in leisure physical activity levels across the year and secondly to examine the influence of a lifestyle intervention on this variation in activity in post-menopausal women. Physical activity levels will be examined both at baseline (prior to randomization), and after 18-months in post-menopausal women randomized to either a lifestyle change group or a health education group. It is hypothesized that there will be fluctuations in baseline physical activity levels throughout the year. We also hypothesize that physical activity levels among women randomized to the lifestyle change group will be less influenced by month to month climate changes after 18-months of a structured lifestyle intervention than the health education group.

Methods

Study Population

Five hundred and eight postmenopausal women were recruited for the Women On the Move through Activity and Nutrition (WOMAN) study, primarily through direct mailing from selected zip codes in Allegheny County, Pennsylvania from April 2002 to October 2003. Eligibility criteria for enrollment into the study included waist circumference >80 centimeters (cm), body mass index (BMI) between 25 – 39.9 kilograms per meters squared (kg/m^2), not currently taking lipid lowering drugs and having a low density lipoprotein (LDL-c) level between 100 – 160 milligrams per deciliter (mg/dL), no physical limitations that would preclude walking, no known diabetes, and no diagnosed psychotic disorder or depression. All participants provided written informed consent and all protocols were approved by the institutional review board at the University of Pittsburgh. Results from the current investigation were generated from data collected at the baseline and 18-month follow-up visit.

Group Randomization: Intervention Design

Eligible women were randomized to a health education comparison group or a lifestyle change group using a block randomized design prepared by a statistician (5). The healthy lifestyle behaviors promoted in the lifestyle change group included 150 minutes per week of moderate intensity physical activity similar to brisk walking and a caloric intake of 1300–1500 calories per day, emphasizing an eating pattern low in total fat (<17%) and saturated fat (<7%). Following these guidelines, women randomized to the lifestyle change group were asked to lose 10% of their initial body weight. The health education group included a core educational series of 6 courses offered throughout the first year.

Physical Activity Measures

Physical activity levels were assessed using both subjective and objective measurement tools. The Modifiable Activity Questionnaire, an interviewer-administered questionnaire, assesses current leisure and occupational activities over the past year (8). Physical activity levels were calculated as the product of the duration and frequency of each activity (in hours per week), weighted by an estimate of the metabolic equivalent (MET) of that activity and summed for all activities performed and data was expressed as metabolic equivalent hours per week (MET hr-wk). The Modifiable Activity Questionnaire has been shown to be both a reliable (8) and valid (8, 9) assessment tool. Leisure physical activity was also measured using a past-week version of the Modifiable Activity Questionnaire to obtain an acute estimate of physical activity levels. Study participants were asked to record leisure activities, which were done for at least 10 minutes each time, during the 7 days prior to the clinic assessment. The past-week leisure activity estimate was calculated similar to that used for the past-year MAQ.

Objective assessments of physical activity were obtained using the Accusplit AE120 (Accusplit Inc., Pleasanton, CA) pedometer in a random subgroup of WOMAN study participants at the baseline visit. Pedometer data was obtained at baseline on the first 15 women each month that completed a clinic visit, due to the limited number of pedometers available. However, at the 18-month clinic visit, pedometer data was collected in all women. Pedometers are both a valid and reliable way to measure physical activity (2). The participants were instructed to wear the pedometer clipped to their waistband over the dominant hip for one week. Participants were provided with an activity diary and were asked to record the time the pedometer was put on in the morning as well as, at the end of the day, the time that the monitor was taken off and the number of steps taken. At the end of the week the participant returned the activity diary to the investigator. The daily step counts recorded in the diary for each of the seven days were averaged for the week to obtain a seven-day average of the number of steps taken per day.

Seasons

For the purposes of this report, seasons were defined as: summer (June, July, August), fall (September, October, November), winter (December, January, February) and spring (March, April, May). These cut-points were determined in an effort to accurately capture the months, in Pittsburgh, PA, in which the weather patterns most closely resemble each other during that year.

Statistical Methods

Descriptive statistics were used to describe demographic and anthropometric data. Normally distributed variables were reported as mean $\pm$ standard deviation; non-normally distributed variables were reported as median with 25th and 75th percentiles, and categorical data as proportions.

At 18-months, descriptive statistics were also used to describe demographic, anthropometric measures and physical activity levels in the entire cohort and stratified by randomized group assignment (health education vs. lifestyle change). Depending upon the characteristics of the variable, t-tests, Wilcoxon Rank Sum, or Chi-Square (χ^2) tests were used to compare descriptive statistics between randomized groups. Finally, physical activity levels were compared between the four defined seasons using a Kruskal-Wallis test.

Results

At baseline, 508 women were randomized into the WOMAN study. Of those 508 women, pedometer data was collected at baseline on a sample of 170 women (33.5% of total study participants) and past-week leisure physical activity estimates were available for 506 women. At 18-months, 455 (90%) completed the follow-up visit. Of these 455 women, complete pedometer data was collected in 318 (70%) women during this clinic visit. Descriptive statistics for the WOMAN study baseline cohort are presented in Table 1. At baseline, the median physical activity level reported on the past week Modifiable Activity Questionnaire was 11.4 MET HR-WK while self-reported past year leisure physical activity at baseline was 12.2 MET HR-WK. Median pedometer step counts at baseline were 6,447.

Figure 1 examines the seasonal differences of step counts for the sample of 170 women who wore the pedometer at baseline, prior to randomization. It is important to note that each woman is represented once in this figure, depending on the date of her baseline visit. At baseline, participants did not differ significantly by age, body mass index (BMI) or waist circumference by season; however, there were notable difference in physical activity levels. Pedometer steps were highest in the summer months, lower in the fall, lowest in winter, and then rebounded in the spring. Although not statistically significant, pedometer step counts at baseline were higher in the summer months when compared to the winter ($p=0.06$).

Figure 2 illustrates leisure physical activity levels, as assessed by the past-week version of the Modifiable Activity Questionnaire, by month over a 1.5 year duration. Due to the normal flow of the clinic, it took approximately 1.5 years to get all 508 women in for any one clinic visit. Similar to the objective pedometer data, self-reported leisure activity levels also fluctuated throughout the year and were lowest in the winter months.

Descriptive statistics for women with complete physical activity data at 18-months is presented in Table 2, stratified by randomized group assignment. When compared to the health education group, the women in the lifestyle intervention group had significantly lower BMI, waist circumference, and body weight (all $p < 0.0001$). The lifestyle change group significantly increased physical activity levels at 18-months when compared to the health education group, which was confirmed by both subjective and objective measures of physical activity ($p=0.003$ and <0.0001 , respectively).

Figure 3 presents the pedometer step counts at the 18-month follow-up visit by month and randomized group assignment. When examining pedometer step counts over 18 months by randomized group assignment, the lifestyle change group was significantly more active, averaging over 2,000 steps more per week when compared to the health education group ($p=0.0001$). Furthermore, the sum of the absolute value around the mean across the months of the intervention was less than half in the lifestyle change group when compared to the health education group (8,089 steps vs. 16,813 steps). These findings suggest that the lifestyle intervention not only improved step counts in the women randomized to that group but also appeared to have attenuated the variation in physical activity levels that are commonly observed over the course of the year.

Discussion

In this large cohort of post-menopausal women, fluctuations in physical activity levels were examined at baseline and at the 18-month follow-up visit. Seasonal variation in physical activity, likely due to weather, has been suggested in the literature (6, 12) but has yet to be examined in post-menopausal women. Seasonal variation was found at baseline, prior to any intervention with differences noted between summer and winter. This is in line with findings from the Behavioral Risk Factor Surveillance System study which showed a high prevalence of physical inactivity in the winter months and low prevalences of physical inactivity during the summer months (3).

This cohort of post-menopausal women at baseline had a median step count of 6,447 (4,823, 8,722) steps per day, which would be considered 'low active' (5,000–7,499 steps/day) and not 'sedentary' (<5,000 steps/day) according to established pedometer step-count criteria (11). This may be due, in part, to a 'volunteer effect' as the women in this study had committed to being part of a 5 year clinical trial. Kriska *et al.* described this possible 'volunteer effect' when comparing physical inactivity data from participants in the Diabetes Prevention Program (DPP), a multi-center randomized clinical trial that involved an intensive lifestyle component, with a subgroup of people with impaired glucose tolerance from the Third National Health and Nutrition Examination Survey (NHANES III) (4). The DPP cohort represents a volunteer sample of individuals committed to a long-term intervention. In contrast, the NHANES III subgroup represents a random sample of the U.S. population comprised of individuals from NHANES III that would have met DPP entry criteria, as both groups completed the same physical activity questionnaire used in NHANES III. The authors found that physical inactivity in the DPP cohort was significantly less than that reported in the NHANES III subgroup for every age, gender and ethnic group.

The goal of any physical activity intervention is to use physical activity as a means to slow, prevent, or even reverse a disease process. This can only be achieved, in the long-term, by making physical activity a regular part of a healthy lifestyle (13). When examining median weekly pedometer step counts 18-months into the physical activity intervention, women randomized to the lifestyle change group were not only significantly more physically active but their physical activity levels also appeared to be more consistent throughout the year when compared to women in the Health Education group. The implications of these findings suggest that lifestyle intervention may not only serve to increase participant's physical activity levels but may also promote life-long behavior change, which may help participants to attain regular physical activity levels year-round.

The monthly fluctuations in physical activity levels across the year observed in this study suggests the need to assess physical activity levels several times per year, in areas with changing seasons or changing activity demands, in order to achieve the most accurate picture of usual activity. For example, over that year, if physical activity levels were only assessed once per year and that happened to fall sometime during harsh weather, physical activity levels could be uncharacteristically low; the converse could be true if assessments were only made during one of the more pleasant times of the year. Therefore, the issue of seasonality in physical activity assessment has important public health implications, and if not considered, has the potential to compromise study results.

A potential limitation that should be considered when interpreting these results is that this investigation did not capture 12 months of physical activity data on the same individuals but represented different women assessed over the course of the year. However, we do not believe that this compromises the overall findings as there were no significant differences in age, body mass index, or waist circumference at baseline.

Future research could take the approach of examining a cohort of women every month throughout the year and before and after a lifestyle intervention. A second potential limitation of this study is that the pedometer was used as both a physical activity assessment and intervention tool. We do not believe that this will have a major impact on study results as both the health education and lifestyle change groups were exposed to the pedometer during the study.

Conclusion

In conclusion, results of the present investigation suggest that physical activity levels, measured objectively by pedometer and subjectively by questionnaire, fluctuate throughout the year in this group of post-menopausal women measured at baseline. The results of this study also indicate that those participants randomized to the lifestyle modification group not only significantly increased their physical activity levels but also appeared to be less prone to monthly fluctuations in physical activity levels after 18-months of physical activity intervention as opposed to women randomized to the health education group.

Acknowledgments

The authors would like to acknowledge the 508 dedicated WOMAN study participants and the contributions of the WOMAN study staff, including Alhaji Buhari, Eileen Cole, Phyllis Jones, Laura Kinzel, Barbara Kolodziej, Wm. Scott Pappert, Darcy Underwood, and Dr. Laurey Simkin-Silverman. The authors would also like to acknowledge Dr. Kenneth J. Jaros for his expert review of this manuscript. This research was funded by National Heart, Lung, and Blood Institute grant R01-HL-6646.

References

1. Association AH. Heart Disease and Stroke Statistics - 2005 Update. Dallas, TX: 2004.
2. Bassett DR. Validity and reliability issues in objective monitoring of physical activity. *Res Q Exerc Sport*. 2000; 71(2 Suppl):S30–S36. [PubMed: 10925822]
3. Centers for Disease Control and Prevention (CDC). Behavioral Risk Factor Surveillance System Survey Data. Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 1994.
4. Kriska AM, Edelstein SL, Hamman RF, Otto A, Bray GA, Mayer-Davis EJ, Wing RR, Horton ES, Haffner SM, Regensteiner JG. Physical Activity in Individuals at Risk for Diabetes: Diabetes Prevention Program. *Med Sci Sports Exerc*. 2006; 38(5):826–832. [PubMed: 16672833]
5. Kuller LH, Kinzel LS, Pettee KK, Kriska AM, Simkin-Silverman LR, Conroy MB, Averbach F, Pappert WS, Johnson BD. Lifestyle intervention and coronary heart disease risk factor changes over 18 months in postmenopausal women: the Women On the Move through Activity and Nutrition (WOMAN study) clinical trial. *J Womens Health*. 2006; 15(8):962–974.
6. Matthews CE, Freedson PS, Hebert JR, Stanek EJ, Merriam PA, Rosal MC, Ebbeling CB, Ockene IS. Seasonal variation in household, occupational, and leisure time physical activity: longitudinal analyses from the seasonal variation of blood cholesterol study. *Am J Epidemiol*. 2001; 153(2):172–183. [PubMed: 11159163]
7. Ockene IS, Chiriboga DE, Stanek EJ III, Harmatz MG, Nicolosi R, Saperia G, Well AD, Freedson P, Merriam PA, Reed G, Ma Y, Matthews CE, Herbert JR. Seasonal Variation in Serum Cholesterol Levels. *Arch Intern Med*. 2004; 164:863–870. [PubMed: 15111372]
8. Pereira MA, FitzGerald SJ, Gregg EW, Joswiak ML, Ryan WJ, Suminski RR, Utter AC, Zmuda JM. A collection of Physical Activity Questionnaires for health-related research. *Med Sci Sports Exerc*. 1997; 29(6 Suppl):S1–S205. [PubMed: 9243481]
9. Schulz LO I, Harper T, Smith CJ, Kriska AM, Ravussin E. Energy intake and physical activity in Pima Indians: comparison with energy expenditure measured by doubly-labeled water. *Obes Res*. 1994; 2(6):541–548. [PubMed: 16355515]

10. Tudor-Locke C, Bassett DR, Swartz AM, Strath SJ, Parr BB, Reis JP, Dubose KD, Ainsworth BE. A preliminary study of one year of pedometer self-monitoring. *Ann Behav Med.* 2004; 28(3):158–162. [PubMed: 15576253]
11. Tudor-Locke C, Bassett DR. How Many Steps/Day Are Enough? Preliminary Pedometer Indices for Public Health. *Sports Med.* 2004; 34(1):1–8. [PubMed: 14715035]
12. Uitenbroek DG. Seasonal variation in leisure time physical activity. *Med Sci Sports Exerc.* 1993; 25(6):755–760. [PubMed: 8321115]
13. U.S. Department of Health and Human Services. Understanding and Improving Health and Objectives for Improving Health 2 vols. 2. Washington, DC: U.S. Government Printing Office; Nov. 2000 Healthy People 2010.
14. U.S. Department of Health and Human Services. Health Behaviors of Adults: United States, 2002–04. *Vital and Health Statistics.* 2006; 10(230):41–56.

Figure 1.

WOMAN baseline pedometer step counts by season. Seasonal data are presented as summer (June, July, August), fall (September, October, November), winter (December, January, February) and spring (March, April, May). Pedometer step counts are presented as median of mean steps per week. Pedometer step counts were borderline significant between summer and winter. ($p = 0.060$) $N=170$

Figure 2.

WOMAN baseline past week leisure physical activity by month and year. Past week leisure physical activity is presented as MET HR-WK and is calculated by multiplying the hrs/wk of the activity by the metabolic cost of that activity as expressed in METS. N=506

Figure 3.
WOMAN 18-month pedometer step counts by month and by group. Pedometer step counts are presented as median of mean steps per week. N=318

Table 1

Descriptive Statistics for WOMAN Baseline Cohort (N=500)

Age (years)	57.0 ± 2.9
Body Mass Index (kg/m ²)	30.7 ± 3.8
Waist Circumference (cm)	105.9 ± 11.2
Weight (lbs.)	180.2 ± 25.3
% African American	13.2%
% High School Education	97.0%
% Hormone Therapy use	59.8%
% Smoking	5.6%
Past-week leisure physical activity (MET HR-WK)	11.4 (5.4, 19.5)
Past-year leisure physical activity (MET HR-WK)	12.2 (6.6, 19.9)
Pedometer steps (N=170) (steps/day averaged over the week)	6,447 (4,823, 8,722)

All statistics presented as mean ± standard deviation unless otherwise indicated.

% African American, High School Education, Hormone Therapy use, and Smoking are presented as percentages of entire cohort.

Past-week and past-year leisure physical activity are presented as median (25th, 75th percentiles) and MET HR-WK, weighting of hrs/wk by the relative intensity of each activity, calculated by multiplying the hrs/wk of the activity by the metabolic cost of that activity as expressed in METS.

Pedometer steps are presented as median (25th, 75th percentiles).

Table 2

Descriptive Statistics for WOMAN 18-month data (N=318)

	Entire Cohort (N=318)	Health Education (N=165)	Lifestyle Change (N=153)	P-value
Age (years)	58.7 ± 2.9	58.8 ± 2.9	58.6 ± 2.9	0.3978
BMI	28.8 ± 4.3	30.3 ± 4.0	27.2 ± 4.1	< 0.0001
Waist Circumference (cm)	98.8 ± 11.9	102.4 ± 11.4	95.0 ± 11.3	< 0.0001
Weight (lbs.)	168.7 ± 27.6	177.7 ± 26.6	159.4 ± 25.5	< 0.0001
Past-week leisure physical activity (MET HR-WK)	15.7 (7.4, 22.8)	15.7(6.4, 23.0)	15.6 (8.8, 22.6)	0.5703
Past-year leisure physical activity (MET HR-WK)	14.3 (8.5, 23.3)	12.5 (6.6, 22.2)	16.2 (10.8, 24.0)	0.0029
Pedometer steps	7,735 (5,510, 9,768)	6,462 (4,705, 9,135)	8,499 (6,464, 10,150)	0.0001

Age, BMI, Waist Circumference, and Weight are presented as mean ± standard deviation.

Past-week and Past-year leisure physical activity are presented as median (25th, 75th percentiles) and MET HR-WK, weighting of hrs/wk by the relative intensity of each activity, calculated by multiplying the hrs/wk of the activity by the metabolic cost of that activity as expressed in METS.

Pedometer steps are presented as median (25th, 75th percentiles).