Seasonal Variation in Adult Leisure-Time Physical Activity

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ABSTRACT

PIVARNIK, J. M., M. J. REEVES, and A. P. RAFFERTY. Seasonal Variation in Adult Leisure-Time Physical Activity. *Med. Sci. Sports Exerc.*, Vol. 35, No. 6, pp. 1004–1008, 2003. **Purpose:** To determine the effect of season on self-reported leisure-time physical activity (LTPA) behaviors of Michigan adults. **Methods:** Data were obtained from the 1996 Michigan Behavioral Risk Factor Survey conducted throughout the year. Survey respondents were considered active if they reported participating in at least one LTPA during the past month. Complete information regarding type, frequency, and duration of up to two LTPA was available on 2843 adults (1635 women and 1208 men). Four seasons were defined as winter (January–March; $N = 677$), spring (April–June; $N = 759$), summer (July–September; $N = 760$), and fall (October–December; $N = 647$). Total weekly leisure-time energy expenditure was quantified ($kcal \cdot kg^{-1} \cdot wk^{-1}$) from MET intensities, duration, and frequency of activity sessions per week. Seasonal differences were identified using ANOVA. **Results:** Average (±SEM) weekly leisure time energy expenditure was significantly greater ($P < 0.001$) during spring (17.5 ± 0.8 $kcal \cdot kg^{-1} \cdot wk^{-1}$) and summer ($17.5 \pm 0.7$ $kcal \cdot kg^{-1} \cdot wk^{-1}$) compared with winter ($14.8 \pm 0.7$ $kcal \cdot kg^{-1} \cdot wk^{-1}$) and fall ($15.0 \pm 0.7$ $kcal \cdot kg^{-1} \cdot wk^{-1}$). Duration of the first activity was significantly greater ($P < 0.05$) in summer (58.6 ± 1.6 min) compared with winter (53.4 ± 1.8 min). However, intensity (4.6 ± 0.1 METs) and frequency (3.1 ± 0.1 sessions per week) of the first activity did not differ among seasons. A second activity was performed by 1319 (46.4%) of active individuals and was more common in the spring (46.8%) and summer (54.5%) compared with fall (42.6%) and winter (39.4%) ($\chi^2 = 31.0$; $P < 0.01$). When both active and inactive subjects are considered, the *Healthy People 2010* recommendation for moderate physical activity was met only during spring and summer. **Conclusion:** Weekly leisure-time energy expenditure averaged ~15–20% higher during spring and summer. Much of this difference was due to active respondents participating in a second activity during these seasons. **Key Words:** ENERGY EXPENDITURE, EPIDEMIOLOGY, EXERCISE, HEALTH SURVEYS

In the late 1970s, it became apparent that seasonality might play a role in the association between physical activity (PA) and cardiovascular disease. Magnus et al. (6) examined the relationship between leisure-time physical activity (LTPA) and heart disease incidence in The Netherlands. They found that acute coronary events were less likely to occur in individuals who remained active at least 8 months of the year, although the authors did not indicate which months were coincident with the greatest PA. In 1989, the Framingham offspring study investigators found that PA was positively related to improved cardiovascular disease risk factor profiles including greater high-density lipoprotein (HDL) cholesterol, lower BMI, and less smoking (4). The authors indicated that PA behaviors showed a seasonal trend with, as expected, more LTPA occurring in the summer months.

More recently, other investigators have studied the relationship between seasonality and PA in the United States (2,5,7) and elsewhere (12). Although all authors indicated that LTPA was greater in the summer, the seasonality effects were not always well quantified, and no studies included a population-based sample. Crespo et al. (3) studied LTPA of individuals participating in the third National Health and Nutrition Examination Survey (NHANES III). Although the authors could not quantify respondents' activity habits (as duration was not known), they felt that prevalence figures for those indicating no LTPA might have been underestimated because interviews were conducted in the northern states during the summer, and southern states during the winter. In 1997, the Centers for Disease Control and Prevention (CDC) published a report using the Behavior Risk Factor Surveys (BRFS) indicating the prevalence of physical "inactivity" by month in the United States (2). The authors noted the appearance of a seasonality effect for inactivity, which ranged from a high of 35% in January to

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a low of 25% in June. The authors indicated that this effect most likely reflected changes in temperature and precipitation associated with the various seasons.

In a recent review article, Owen et al. (9) indicated that understanding and influencing PA levels in whole populations requires a strong focus on environmental determinants (including seasonality) of inactive lifestyles. Better understanding of these factors is needed to help in the development of effective policies designed to positively impact PA on a regular basis throughout the year. Thus, the purpose of this investigation was to determine the effect of seasonality on self-reported LTPA behaviors of Michigan adults, using a population-based sample.

METHODS

The Michigan Behavioral Risk Factor Surveillance System (BRFSS) is a component of the national BRFSS. It is an ongoing effort composed of annual, population-based, telephone surveys conducted by state health departments in cooperation with the CDC. In 1996, Michigan conducted the BRFS monthly across the calendar year. Households were selected using random-digit-dialing methods; within eligible households, one randomly selected adult aged 18 yr or older was interviewed. The response rate was 54%.

The 1996 BRFS collected information on the two LTPA that the respondent spent the most time doing during the past month while not at work. Participants were asked, "during the past month, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?" Follow-up questions were asked about the type, distance, frequency, and duration of each activity. Participants were then asked whether they had a second activity that they participated in during the past month. If the respondent indicated "yes," then details about type, distance, etc., of the second activity were recorded.

The total sample included 5085 individuals, 1315 of whom were nonexercisers, i.e., they reported no LTPA in the preceding month, and 58 gave no response. Of the remaining 3712 individuals who indicated performing LTPA, complete physical activity data were obtained on 2843 respondents: 1208 men and 1635 women. We excluded subjects from the analysis because of incomplete data regarding time, type, and/or duration of activities performed. For purposes of this study, the four seasons were defined according to when surveys were completed: winter (January, February, and March; $N = 677$); spring (April, May, and June; $N = 759$); summer (July, August, and September; $N = 760$); and fall (October, November, and December; $N = 647$).

The BRFS lists 55 different activities to choose from when coding the respondent's specific activity. Based on these responses, we assigned a MET value to each of the 55 activity options using the Compendium of Physical Activities (1). In some cases (e.g., running, swimming), the compendium provides a range of MET values, depending on the speed and/or intensity. In these cases, we assigned the average value. Activities not included as part of the 55 items BRFS list were coded as "other." Because we did not have access to further details regarding this "other" activity, these respondents were not included in our analyses. However, the "other" category was not indicated for any first activity and was only mentioned by 131 of 1450 individuals (9%) reporting a second activity. The seasonal breakdown of this "other" response category was winter = 24, spring = 34, summer = 35, and fall = 38.

Because 1 MET is equivalent to 1 $kcal \cdot kg^{-1} \cdot h^{-1}$, we were able to calculate each individual's weekly caloric expenditure and index it by body weight ($kcal \cdot kg^{-1} \cdot wk^{-1}$). This was done by multiplying the MET level of activities performed by the duration of activity and by the number of days the activity was performed per week. This indexing was performed because caloric expenditure is highly correlated with body weight for most physical activities (8).

Data analyses were performed using SUDAAN (11) to account for weighting and complex sampling design. Weights were calculated using the inverse probabilities of selection and were adjusted using a poststratification weighting factor based on age, gender, and race. Means, SE, and 10th, 25th, 50th, 75th, and 90th percentiles for weekly leisure-time energy expenditure were calculated for age, gender, race, education, household income, and season. Seasonal variation in physical activity profiles was examined statistically using one-way ANOVA using the PROC REGRESS procedure in SUDAAN. Analyses were performed on four separate outcomes: overall weekly energy expenditure ($kcal \cdot kg^{-1} \cdot wk^{-1}$), average MET intensity ($kcal \cdot kg^{-1} \cdot h^{-1}$), average number of sessions per week, and average session duration (in min). Chi-square analysis (χ^2) was performed to examine the proportion of respondents indicating no LTPA for either a first or second activity. Statistical significance was set at an alpha level of $P < 0.05$. In addition to calculating respondents' weekly leisure time caloric expenditures, we also report their first and second activity choices performed during the various seasons. Activities performed by 5% or more of respondents within each season were listed.

RESULTS

Although the overall prevalence of inactive individuals was found to be 25.9% across all months, this number was affected significantly by season. The percentage of survey respondents indicating no LTPA in the preceding month was significantly higher ($\chi^2 = 75.3$; $df = 3$; $P < 0.0001$) in the winter (32.5%) and fall (28.7%) compared with spring (23.4%) and summer (17.0%). The percentage of participants who undertook a second leisure-time activity was highest in the summer (54.5%), followed by spring (46.8%), fall (42.6%), and winter (39.4%). These differences were statistically significant ($\chi^2 = 31.0$; $df = 3$; $P < 0.01$).

Among those who were active, overall weekly LTPA energy expenditure averaged 16.3 $kcal \cdot wk^{-1} \cdot kg^{-1}$ (SEM = 0.4). Table 1 shows a breakdown of LTPA energy expenditure by demographic group. In general, greater energy expenditure was associated with being male and young.

TABLE 1. Energy expenditure (kcal·kg^{-1}·wk^{-1}) from leisure-time physical activity by demographic subgroups.

	N	Mean	SEM	Percentile				
				10th	25th	50th	75th	90th
Age (yr)								
18–24	329	22.7	1.4	2.0	6.0	14.8	32.7	52.4
25–34	652	16.2	0.7	2.2	4.8	11.4	21.5	34.5
35–44	698	15.4	0.7	2.2	4.9	10.4	20.1	34.0
45–54	516	14.7	0.7	2.2	4.8	9.8	17.5	32.8
55–64	319	14.4	0.8	1.9	5.4	10.8	20.2	29.0
65–74	209	15.4	1.2	2.1	5.1	10.9	19.0	30.0
75+	111	11.3	1.1	2.0	3.9	7.4	16.0	24.0
Gender								
Male	1208	19.5	0.6	2.5	5.9	13.0	24.9	45.9
Female	1635	13.3	0.4	2.0	4.0	9.4	18.0	29.0
Race								
White	2417	16.0	0.4	2.1	5.0	11.0	20.9	35.0
Black	296	16.7	1.2	2.2	4.4	10.9	22.5	39.8
Other	119	23.0	3.5	1.9	3.8	11.1	23.8	53.2
Education								
< high school	194	17.4	1.6	1.8	4.0	10.8	21.1	41.7
High school grad	868	14.7	0.6	1.9	4.5	9.5	18.5	32.8
Some college	897	16.7	0.6	2.2	4.9	11.4	22.3	36.4
College grad	879	17.2	0.6	2.7	5.8	12.2	22.9	35.8
Income ($)								
< 10K	118	17.2	2.0	2.0	3.7	9.4	23.3	42.2
10–19.99K	218	13.9	1.1	1.9	4.0	9.9	18.3	32.4
20–34.99K	757	15.1	0.7	2.0	4.7	9.8	18.3	34.0
35–50K	552	17.0	0.9	2.0	4.7	11.1	22.4	36.0
> 50K	955	17.2	0.6	2.8	5.7	12.1	22.4	37.1
Total	2843	16.3	0.4	2.1	5.0	11.0	21.1	35.9

There was also evidence for a J-shaped relationship between leisure-time energy expenditure and education and income.

ANOVA revealed that weekly LTPA energy expenditure was significantly greater during the spring and summer compared with winter and fall seasons (Table 2; $P < 0.001$). Analysis of session duration revealed that participants performed their first activity for approximately 5 min longer per session in the summer compared with winter (Table 3; $P < 0.05$). No other analyses including average MET intensity, sessions per week, and duration of the second activity showed any statistically significant seasonal effects (Table 3).

A breakdown of specific first and second activities performed in each season is shown in Table 4. Walking was the most common activity performed and represented 49.6% of all first activities, 16.9% of all second activities, and overall, 39.3% of all activities.

DISCUSSION

Our purpose was to determine whether there is a seasonality effect on LTPA in Michigan adults. Michigan is a state with four distinct seasons. The national weather service indicates that January temperatures average ~25°F for a high and ~15°F for a low. In contrast, high temperatures in July average ~80°F with lows of ~60°F. Average high and low temperatures may vary from 5° to 10°F, depending on the locale. In addition, snowfall amounts vary greatly with a seasonal average of ~115 inches in the Upper Peninsula to ~40 inches in the Detroit Metro area.

Overall, demographic breakdown of leisure-time energy expenditure is in agreement with previous studies (14). The unusually high mean LTPA energy expenditure values seen in the least educated and lowest income groups, and those whose race was not white or black, was likely due to a combination of a few extreme values and fewer respondents in those categories. This effect was not as strong when examining the median, or 50th percentile values.

Comparisons can be made between our results and those of other investigators who quantified the seasonality effects on LTPA. Levin et al. (5) studied the PA behaviors of 78 subjects throughout the yr, using the Minnesota LTPA questionnaire. They found energy expenditure (calculated in MET·min^{-1}·d^{-1}) to be 40% higher in June compared with March. Direct comparison with the present study is difficult, because the Minnesota survey includes all LTPA, not just a maximum of two primary activities. However, we also found that the month associated with the highest LTPA energy expenditure was June (22.2 kcal·kg^{-1}·wk^{-1}), where

TABLE 2. Energy expenditure (kcal·kg^{-1}·wk^{-1}) from leisure-time physical activity by season.

	N	Mean	SEM	Percentile				
				10th	25th	50th	75th	90th
Season								
Winter	677	14.8^b	0.7	1.9	4.0	9.9	18.9	32.8
Spring	759	17.5^a	0.8	2.4	5.4	11.9	23.1	38.1
Summer	760	17.5^a	0.7	2.3	5.8	12.4	23.4	40.6
Fall	647	15.0^b	0.7	2.0	4.7	9.6	19.3	31.5
Total	2843	16.3	0.4	2.1	5.0	11.0	21.0	35.9

^{a,b} Mean energy expenditure values are significantly different from each other ($P < 0.001$).

TABLE 3. Average (±SEM) METs, sessions per week, and minutes per session of leisure-time physical activity.

	N	METs	Sessions per Week	Minutes per Session
First activity				
Winter	677	4.7 ± 0.1	3.0 ± 0.1	53.4 ± 1.8[b]
Spring	759	4.6 ± 0.1	3.2 ± 0.1	58.0 ± 1.7
Summer	760	4.6 ± 0.1	3.0 ± 0.1	58.6 ± 1.6[a]
Fall	647	4.6 ± 0.1	3.0 ± 0.1	54.8 ± 1.8
Total	2843	4.6 ± 0.1	3.1 ± 0.1	56.4 ± 0.9
Second activity				
Winter	271	5.1 ± 0.1	2.2 ± 0.1	57.4 ± 3.5
Spring	362	5.1 ± 0.1	2.0 ± 0.1	67.2 ± 3.5
Summer	410	5.0 ± 0.1	2.0 ± 0.1	65.9 ± 3.0
Fall	276	5.0 ± 0.1	2.0 ± 0.1	65.3 ± 3.7
Total	1319	5.0 ± 0.1	2.0 ± 0.1	64.4 ± 1.7

[a,b] Significant difference ($P < 0.008$) between values in a column.

BRFS participants averaged 73% greater activity than those who responded in January, which had the lowest quantity of LTPA (12.8 $kcal \cdot kg^{-1} \cdot wk^{-1}$).

In the Framingham offspring study, Dannenberg et al. (4) found that the winter season was associated with significantly lower LTPA (712 $kcal \cdot wk^{-1}$) compared with the other seasons (1156 $kcal \cdot wk^{-1}$). In a more recent report of a study performed in Massachusetts (7), Matthews et al. found that moderate intensity LTPA was higher in July compared with January. The cyclical nature of activity level appeared to follow the same pattern as that of average daily temperature and hours of daylight.

Our study results show a clear seasonality effect when examining caloric expenditure associated with LTPA. These 1996 Michigan results reinforce the findings of a recent MMWR report documenting a seasonality effect on physical inactivity in the United States as a whole, using 1994 data (2). In addition, our data show energy expenditure of those reporting LTPA in the previous month was 20.8% less in the winter, and 16.0% less in the fall, compared with both spring and summer seasons. Because a smaller percentage of individuals perform *any* LTPA during winter and fall, the seasonality effect on overall energy expenditure is even greater when comparing all MI adults sampled.

The public health significance of the seasonality effect on LTPA can be seen when put in perspective with the *Healthy People 2010* objectives for physical activity (13). Recommendation 22–2 is to "increase the proportion of adults who engage regularly, preferably daily, in moderate activity for at least 30 minutes per day." If an individual walks briskly (4.5 METs), 30 $min \cdot d^{-1}$, 5 $d \cdot wk^{-1}$, she/he will meet this recommendation and expend ~11.2 $kcal \cdot kg^{-1} \cdot wk^{-1}$. By comparison, data from Figure 1 show that this recommendation was achieved, on average, only during the spring and summer seasons.

In those reporting LTPA, the main reasons for higher energy expenditure during spring and summer compared with fall and winter in our study was that more active individuals performed a second activity and, to a lesser extent, session duration was slightly longer. Our data showed that 7% more respondents reported a second activity in spring and summer compared with fall and winter. The time difference among seasons was most evident in winter activity sessions that averaged 8 min less than those performed in the summer (Table 3). These data support those of Dannenberg et al. whose study participants performed fewer sessions per week for a shorter period of time in the winter compared with all other seasons (4).

In contrast to seasonal differences found in the proportion of respondents performing a second activity and in duration of each session, there was remarkable consistency across seasons in number of sessions performed per week for both first (3.1 ± 0.1 sessions per week) and second (2.0 ± 0.1 sessions per week) activities. In addition, average MET intensity remained constant across seasons at 4.6 ± 0.1 METs for the first activity and 5.0 ± 0.1 METs for the second (Table 3). A factor contributing to the consistency of MET intensity was that walking was the first activity for nearly half the active BRFS respondents, regardless of season. Walking was also the most popular second activity, ranging from 15 to 20% of those reporting one.

TABLE 4. Seasonality of activities performed by ≥5% of respondents indicating a first and second activity.

	Winter		Spring		Summer		Fall	
	Type	%	Type	%	Type	%	Type	%
First activity	*N* = 677		*N* = 759		*N* = 760		*N* = 647	
	Walking	45.9	Walking	50.6	Walking	50.8	Walking	51.0
	Aerobics	9.2	Stationary cycle	6.2	Bicycling	6.7	Stationary cycle	8.3
	Stationary cycle	9.2	Running	5.5	Gardening	5.8	Aerobics	6.3
	Weight lifting	6.4	Aerobics	5.1				
	Running	5.2	Bicycling	5.0				
Second activity	*N* = 271		*N* = 362		*N* = 410		*N* = 276	
	Walking	18.5	Walking	15.5	Walking	14.9	Walking	20.3
	Stationary cycle	12.9	Bicycling	12.7	Golf	10.7	Weight lifting	12.3
	Weight lifting	11.1	Golf	9.9	Bicycling	10.0	Stationary cycle	12.0
	Aerobics	5.5	Weight lifting	9.7	Gardening	8.8	Golf	6.5
	Calisthenics	5.5	Gardening	6.6	Weight lifting	8.3	Aerobics	5.8
	Running	5.2	Stationary cycle	6.4	Swimming	7.3	Basketball	5.1
	Snow skiing	5.2			Stationary cycle	7.3		

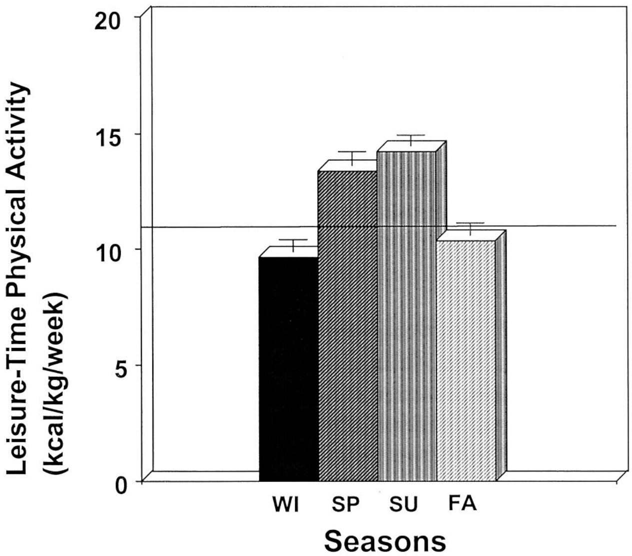

FIGURE 1—Seasonal averages (±SEM) of weekly energy expenditure from leisure time physical activity reported by adults (N = 4403) completing the 1996 behavioral risk factor survey. Seasons are winter (WI), spring (SP), summer (SU), and fall (FA). The horizontal line represents the estimated caloric expenditure needed to meet the *Healthy People 2010* recommendations for moderate physical activity.

Not surprisingly, the most popular activities after walking varied somewhat with season. Stationary cycling, aerobics, and weight lifting were popular activities during the winter and fall, whereas running, bicycling, gardening, and golf were more popular in spring and summer. Individuals wishing to perform an additional activity in the fall and winter, would likely be more successful if they have access to indoor activity modalities. This idea is reinforced by the CDC who suggested adding more indoor activities such as mall walking and dancing in the winter months (2).

There are several potential limitations to the results of this study. BRFS data are self-reported and responses may be subject to recall and estimation bias. All data are limited by the coverage and nonresponse-related errors which affect all telephone surveys. In addition, respondents were queried about a maximum of only two physical activities that contributed to some underestimation of respondents' total LTPA. However, there is no reason to suspect that there was a systematic over reporting of LTPA during spring and summer, or underreporting during fall and winter. The 1996 BRFS includes only LTPA, which does not represent total daily physical activity from household or occupational tasks. Our results do not represent the nation as a whole, and generalizability to the U.S. population may not be warranted due to weather conditions being different in other parts of the country.

Study strengths include a large statewide sample and the representativeness of the BRFS data. Also, we were able to quantify weekly energy expenditure of LTPA, rather than simply record activity minutes or sessions performed per week. We found no previous study that included quantification of LTPA energy expenditure using a population-based survey. Our results showed a definite seasonality effect in leisure-time energy expenditure with less activity performed in fall and winter.

Findings from this study have important research and public health ramifications. Investigators should be aware that sampling study participants at only one time of the year may result in under- or overestimation of yearly physical activity patterns. Although there has been no evidence of causality, others have shown that seasonal physical activity is related to coronary heart disease and cardiovascular disease risk factor status (6,10). Thus, seasonality should be considered when planning physical activity interventions. The main reasons for lower energy expenditure in fall and winter were a) fewer individuals performed *any* LTPA during fall and winter, and b) of those who were active, fewer performed a second activity during fall and winter. Intervention strategies might focus on these issues, with practitioners recommending indoor alternatives when the weather becomes a barrier to physical activity participation.

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