

# Physical Activity in an Old Order Amish Community

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## ABSTRACT

BASSETT, JR., D. R., P. L. SCHNEIDER, and G. E. HUNTINGTON. Physical Activity in an Old Order Amish Community. *Med. Sci. Sports Exerc.*, Vol. 36, No. 1, pp. 79–85, 2004. One method to assess the impact of modern technology on physical activity is to examine a group whose lifestyle has not changed markedly in the last 150 yr. The Old Order Amish refrain from driving automobiles, using electrical appliances, and employing other modern conveniences. Labor-intensive farming is still the preferred occupation. **Purpose:** The purposes of this study were to characterize the physical activity (PA) levels in an Old Order Amish farming community and to examine measures of adiposity in this group. **Methods:** Ninety-eight Amish adults (18–75 yr of age) in southern Ontario were studied. Anthropometric variables included height, weight, body mass index (BMI), and percent body fat (% BF). Participants were asked to wear an electronic pedometer for 7 d and to fill out a log sheet on which they recorded steps per day and physical activities. After 1 wk, they returned the pedometers and log sheets and filled out the International Physical Activity Questionnaire. **Results:** The average number of steps per day was 18,425 for men versus 14,196 for women ( $P < 0.05$ ). Men reported 10.0 h-wk<sup>-1</sup> of vigorous PA, 42.8 h-wk<sup>-1</sup> of moderate PA, and 12.0 h-wk<sup>-1</sup> of walking. Women reported 3.4 h-wk<sup>-1</sup> of vigorous PA, 39.2 h-wk<sup>-1</sup> of moderate PA, and 5.7 h-wk<sup>-1</sup> of walking. Men had higher levels of energy expenditure than women ( $P < 0.001$ ). A total of 25% of the men and 27% of the women were overweight (BMI  $\geq 25$ ), and 0% of the men and 9% of the women were obese (BMI  $\geq 30$ ). **Conclusions:** The Amish we studied had very high levels of physical activity, which may contribute to their low prevalence of obesity. This group probably represents an upper extreme for “lifestyle PA” in North America today. **Key Words:** FARMING, LIFESTYLE ACTIVITY, PEDOMETER, QUESTIONNAIRE, OBESITY, OVERWEIGHT

Few jobs in modern society require the same high levels of energy expenditure that were required of North American residents 150 yr ago. Although leisure-time physical activity (LTPA) has increased in recent decades (35), this increase has probably not been enough to offset the large decline in occupational physical activity. Thus, researchers have proposed that overall levels of physical activity have declined in recent decades (16,17,25,32).

Indirect evidence suggests that people in modernized societies perform less physical activity than their ancestors (3,30), but the magnitude of the difference is hard to assess. For one thing, improved methods for measuring physical activity were only recently developed, making it hard to study time trends using direct, empirical methods. Many

researchers have examined physical activity in modern, industrialized societies, but there is a lack of data on traditional farming communities. Therefore, we were interested in studying a group that uses labor-intensive farming methods and abstains from using modern conveniences such as automobiles, televisions, computers, and dishwashers.

The Amish people are a Protestant group that originated in Switzerland but came to North America in about 1727. Amish communities exist in the United States (Ohio, Pennsylvania, Indiana, and 22 other states) as well as in Canada (Ontario). The Amish believe in separation from the outside world, as well as simplicity. In their clothing, lifestyle, and religion, the Amish people emphasize humility, nonviolence, and traditional values rather than progress and technology.

In some Amish communities, farming is still the principal occupation. In contrast, only 2% of all North American workers are employed on farms, and machines now perform most of the farm work (9,38). Amish men till the soil with horses, walk or utilize horse-drawn carriages for transportation, and participate in barn raisings. Amish women do most of the childcare, food preparation, cooking, and cleaning. Both men and women raise vegetables in family gardens. The Amish follow rules (*Ordnung*) that ban the use of gasoline-powered transportation, electricity, and other modern conveniences.

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Submitted for publication March 2003.

Accepted for publication August 2003.

0195-9131/04/3601-0079

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DOI: 10.1249/01.MSS.0000106184.71258.32

A decline in physical activity is one of several factors being implicated in the tremendous increase in rates of obesity, diabetes, and other health problems in many parts of the world. To provide an indication of the magnitude of these problems, in 2000, the age-adjusted prevalence of obesity (defined as a body mass index  $\geq 30.0 \text{ kg}\cdot\text{m}^{-2}$ , or about 20% above ideal body weight) was 30.5% of U.S. adults (10). (This represents a 61% increase in obesity prevalence since 1991.) The prevalence of diagnosed diabetes mellitus has increased 43% in the same period of time (29).

The main purpose of this study was to examine the influence of modern technology on physical activity. By using a pedometer and a questionnaire, we sought to characterize physical activity levels in an Old Order Amish community. It was thought that this could provide an indication of the magnitude of the decline in physical activity in North America, over the last century and a half. A secondary objective was to examine measures of adiposity in members of this community.

## METHODS

Participants in this study were 98 Old Order Amish adults, 18–75 yr of age. Fifty-three men and 45 women were recruited. Although we were interested in measuring the physical activity levels of farmers, other members of the Amish community were studied because they, too, refrain from using modern technology.

We sought approval from the church leadership for the proposed research study. In March of 2002, the principal investigator drove to an Amish community located in southeastern Ontario, Canada, to meet with a minister/community leader. This Amish town is one of the most traditional farming communities in North America. Participants were recruited for the study using a one-page flyer that was distributed by the minister at a community-wide meeting. The initial phase of the study took place at an Amish schoolhouse, on June 5–6, 2002. A return visit was scheduled for June 17–18, 2002, to collect the data after the measurement period.

Before taking part in the study, the protocol was explained to the participants, and they were asked to read and sign a simple informed consent form. The University of Tennessee Institutional Review Board (IRB) approved the study protocol.

**Demographic characteristics.** Demographic characteristics were assessed, including age, gender, and occupation. A calibrated, electronic scale was used to obtain measures of body mass (kg), in one layer of clothing, without shoes. Height was measured using a stadiometer. The values for body mass were adjusted by subtracting 0.90 kg (to account for the weight of clothing), similar to the first National Health and Nutrition Examination Survey (NHANES I) (26). The body mass index was computed from the formula:

$$\text{BMI} = \text{weight (kg)} \times \text{height (m)}^{-2}$$

Body fat percentage estimated using a bioelectrical impedance analyzer (Tanita TBF-521, Tanita Corporation of America, Skokie, IL).

**Electronic step counter.** Participants wore a Yamasa SW-200 step counter (Yamasa Corp., Tokyo, Japan) for a 7-d period. This is the measurement period generally recommended for obtaining reliable data using step counters (4). Each person was asked to position the step counter on the waistband of the trousers or apron, close to the mid-line of the thigh. (The Amish do not wear belts.) Some men elected to keep the pedometer in the watch pocket of their trousers, which was found to be a satisfactory location. Because we wanted to determine the number of steps the Amish accumulate in their everyday lives, they were instructed not to change their level of exercise habits during the study. In addition, the following instructions were given:

- The step counter should be worn at all times for exactly 7 d, except when bathing or in bed.
- We are interested to know the total number of steps you take each day.
- As soon as you wake up each morning, put the step counter on your clothing, and wear it all day.
- Just before you go to bed each night, please remove the step counter, write down the number of steps for that day, and then re-zero the step counter.
- Repeat the procedure until 7 d are finished.

Participants kept a log of their daily steps and recorded three of the physical activities they performed each day.

Riding in a horse-drawn buggy caused only a few extra steps to be recorded on the pedometer. For instance, riding in the front seat elicited  $60 \text{ steps}\cdot\text{h}^{-1}$ , and riding in the back seat elicited  $240 \text{ steps}\cdot\text{h}^{-1}$ . We decided that this source of error was similar to what non-Amish people experience while riding in an automobile and chose to disregard it. A more serious concern was the extra steps recording when riding on horse-drawn farm equipment in the field, which created a bumpier ride. To minimize this source of error, the farmers opened the pedometer so that it lay flat when doing these activities.

We were concerned that the use of an electronic step counter might pose a problem for the Amish. However, the leadership did not object to the device, as long as it was only borrowed for the duration of the study. To put it in perspective, the Amish people in this community may accept rides in automobiles, but they cannot own them. Similarly, they are allowed to use devices such as automated blood pressure monitors, if prescribed for medical reasons.

**Physical activity questionnaire.** Participants completed the International Physical Activity Questionnaire (IPAQ). This questionnaire was developed in 1998–2000 for the purpose of having an international measure of physical activity. It has undergone extensive validity and reliability testing in 21 countries across six continents (7).

This questionnaire can either be self-administered or administered by a trained interviewer, as both give similar results (7). The respondent is asked to give information about his/her physical activity habits over the past 7 d. A key feature of this particular questionnaire is that it can be used

TABLE 1. Physical and occupational characteristics of Amish research participants (mean  $\pm$  SD).

|                           | Males ( <i>N</i> = 53)   | Females ( <i>N</i> = 45)  | Total ( <i>N</i> = 98) |
|---------------------------|--|---|------------------------|
| Age (yr)                  | 34 $\pm$ 14  | 32 $\pm$ 11   | 33 $\pm$ 13            |
| Height (cm)               | 176.9 $\pm$ 6.9  | 161.6 $\pm$ 7.7   | 169.9 $\pm$ 10.6       |
| Weight (kg)*              | 73.2 $\pm$ 9.2   | 62.6 $\pm$ 12.9   | 69.3 $\pm$ 12.2        |
| BMI (kg·m <sup>-2</sup> ) | 23.4 $\pm$ 2.5   | 23.8 $\pm$ 3.9  | 23.6 $\pm$ 3.2         |
| % Fat                     | 9.4 $\pm$ 4.3  | 25.3 $\pm$ 6.7  | 16.7 $\pm$ 9.6         |
| Obesity prevalence        | 0%   | 9%  | 4%                     |
| Overweight prevalence     | 25%  | 27%   | 26%                    |
| Occupations               | Farming 78%<br>Woodworking 8%<br>Construction 6%<br>Stove shop 4%<br>Publishing 4% | Homemaker 69%<br>Helper 18%<br>Gardening/produce work 11%<br>Carpentry 2% |                        |

\* Clothed body weight (without shoes)  $-0.90$  kg.

BMI, body mass index.

Obesity defined as BMI  $\geq 30$  kg·m<sup>-2</sup>; overweight defined as BMI  $\geq 25$  kg·m<sup>-2</sup>.

in all types of societies, from industrialized nations to third-world countries. The developers of the questionnaire suggest that the typical examples of activities (e.g., aerobics, bicycling, and tennis) be replaced by culturally relevant examples with the same MET levels (5), as determined from the Compendium for Physical Activities (2).

The short form of the IPAQ questionnaire asks people to report on four items. Participants were asked to report the frequency (days per week) and duration (minutes per day) of vigorous activity, moderate activity, and walking. In addition, the questionnaire asks about time spent sitting on weekdays. Vigorous activities are defined as those requiring hard physical effort and that make a person breathe much harder than normal, whereas moderate activities are those that require modest physical effort and make a person breathe somewhat harder than normal. Examples provided in the present study for vigorous activity were heavy lifting (8 METs), shoveling/digging (8.5 METs), chopping/sawing wood (6 METs), and tossing straw bales (8 METs). Examples given for moderate activity were carrying light loads (4 METs), gardening (4 METs), feeding farm animals (4 METs), and stacking wood (5 METs).

**Data analysis.** The IPAQ data were summarized by computing the amount of time spent per week in each of four categories (vigorous activity, moderate activity, walking, and sitting). The number of METs per minute per week was computed from duration  $\times$  frequency  $\times$  intensity for each of the three activity categories, using an average value of 8 METs to represent vigorous activity intensity, and an average value of 4 METs to represent moderate activity intensity and walking. One MET is equal to an oxygen uptake of 3.5 mL·kg<sup>-1</sup>·min<sup>-1</sup>, or 1 kcal·kg<sup>-1</sup>·h<sup>-1</sup>, and represents the average rate of energy expenditure at rest.

The average values for steps per day were computed over the 7-d measurement period for each individual. Missing data were computed by taking the average numbers of steps per day for the other week days or weekend days. Differences between men and women, for IPAQ data (MET·min·wk<sup>-1</sup>) and average steps per day were examined using a Student's independent *t*-test. Gender differences for specific days of the week were further explored using a two-way analysis of variance (gender  $\times$  day), using SPSS 11.0.1 for Windows (SPSS Inc., Chicago, IL). The alpha level was set at 0.05 for all comparisons.

Frequency distributions were constructed for the IPAQ and pedometer data to see whether the data were normally distributed. Because the data approximated a bell-shaped curve, mean values were computed by gender for the major dependent variables and relationships between physical activity, adiposity, and other variables were examined using Pearson's product-moment correlation coefficients (*r*).

## RESULTS

The Amish community had a population of 455 people in 2000. Approximately 232 of them were adults 18 yr of age or older. The number of participants (98 individuals) thus represented 42% of the adult population of this farming community. The age distribution of our study group was as follows: 18–19 yr (*N* = 7), 20–29 yr (*N* = 38), 30–39 yr (*N* = 31), 40–49 yr (*N* = 9), 50–59 yr (*N* = 8), and  $\geq 60$  yr (*N* = 5). The gender and age distribution of the study group was similar to that of the entire community and is typical for the Amish. However, it is different than that seen in other rural non-Amish populations (18). The reason is due to the fact that Amish parents have an average of seven children (19), leading to a “bottom heavy” age distribution.

The physical characteristics and occupations of these participants are shown in Table 1. The prevalence of obesity (BMI  $\geq 30$  kg·m<sup>-2</sup>) was only 4% in the Amish people we studied. The prevalence of overweight (BMI  $\geq 25$  kg·m<sup>-2</sup>) was 26%, in this group of Amish participants.

Pedometer data were collected on 96 individuals. Ninety-four individuals returned the IPAQ questionnaires, but two of them were discarded due to a high number of hours ( $>18$  h·d<sup>-1</sup>) spent in activity. (It appeared that these participants did not understand that walking and moderate activity were mutually exclusive categories.) This left 92 persons with valid questionnaire data.

Amish men reported doing an average of 10.0 h·wk<sup>-1</sup> of vigorous activity and 42.8 h·wk<sup>-1</sup> of moderate activity. Amish women reported doing 3.4 h·wk<sup>-1</sup> of vigorous activity and 39.2 h·wk<sup>-1</sup> of moderate activity per week. The amount of time spent in walking and sitting is reported in Table 2. The overall IPAQ scores were normally distributed.

Amish men accumulated 18,425  $\pm$  4,685 steps per day (mean  $\pm$  SD), whereas Amish women accumulated 14,196  $\pm$  4,078 steps per day, averaged over 7 d (see Fig. 1). The

TABLE 2. Self-reported physical activity from the International Physical Activity Questionnaire (IPAQ) in Amish adults (mean  $\pm$  SD).

|  | Males (N = 48)     | Females (N = 44)  | Total (N = 92)    |
|--|--------------------|-------------------|-------------------|
| Vigorous (h-wk <sup>-1</sup> )         | 10.0 $\pm$ 9.2*    | 3.4 $\pm$ 4.5     | 6.9 $\pm$ 8.1     |
| Moderate (h-wk <sup>-1</sup> )         | 42.8 $\pm$ 20.6    | 39.2 $\pm$ 20.9   | 41.1 $\pm$ 20.7   |
| Walking (h-wk <sup>-1</sup> )          | 12.0 $\pm$ 17.1#   | 5.7 $\pm$ 10.4    | 9.0 $\pm$ 14.5    |
| Sitting (h-d <sup>-1</sup> )           | 3.3 $\pm$ 1.6      | 2.8 $\pm$ 1.3     | 3.1 $\pm$ 1.5     |
| IPAQ score (MET-min-wk <sup>-1</sup> ) | 17,952 $\pm$ 7338* | 12,438 $\pm$ 5582 | 15,315 $\pm$ 7086 |

\* Significant difference between males and females ( $P < 0.001$ ).

# Significant difference between males and females ( $P < 0.05$ ).

IPAQ score reflects the sum of vigorous, moderate, and walking physical activities (PA) (vigorous PA = vigorous time  $\times$  8 METs; moderate PA = moderate time  $\times$  4 METs; walking PA = walking time  $\times$  4 METs)

highest 1-d total was 51,514 steps per day, recorded by an Amish farmer who performed harrowing (smoothing the ground surface after plowing and planting), while walking behind a team of five Belgian horses for the entire day. The highest 1-d total reported by an Amish woman (41,176 steps) was for a farm wife who arose at 3:30 a.m. to help her husband with the barn chores so he could work in the hay field.

Figure 2 shows the average daily steps on the various days of the week. Men took significantly more steps than women, on all days except Sunday ( $P < 0.01$ ). Sunday had lower step values than other days of the week ( $P < 0.001$ ). On an individual basis, 95% of the participants took fewer steps on Sunday. Mean step counts did not significantly increase with age in either men or women (data not shown), so the data were not stratified by age.

Pearson product moment correlation coefficients ( $r$ ) were computed to show the strength of the relationships for major variables in the study. The IPAQ total physical activity scores (MET-min-wk<sup>-1</sup>) was significantly related to the pedometer value ( $r = 0.469$ ), providing evidence of concurrent validity. Figure 3 shows the relationships between the two measures of physical activity, for men and women separately. Body mass index was significantly related to percent body fat ( $r = 0.544$ ) measured by the Tanita bioelectrical impedance analyzer (BIA). (Fig. 4 shows these data graphically, for both genders.) Although percent body fat was inversely related to average steps per day ( $r = -0.356$ ) and the overall IPAQ score ( $-0.424$ ), there were no signif-

icant relationships between these variables when the data were analyzed for males and females separately.

## DISCUSSION

**IPAQ.** Amish adults performed a large amount of moderate-to-vigorous physical activity. Men reported about 43 h-wk<sup>-1</sup> of moderate work and 10 h-wk<sup>-1</sup> of vigorous, whereas women reported roughly similar values for moderate work but far less vigorous. One hundred percent of the Amish people we studied met the Centers for Disease Control and Prevention (CDC)/American College of Sports Medicine (ACSM) criteria of at least 30 min of moderate physical activity per day, most days of the week (31).

The levels of physical activity performed by the Amish are far greater than those reported in other parts of the world. Craig et al. (7) recently described the levels of physical activity in 1974 individuals living in 12 countries using the IPAQ short form. The great majority of them were employed, well educated, and working in large cities, though rural samples were included from four countries. On the IPAQ questionnaire, the median level of PA reported was 2514 MET-min-wk<sup>-1</sup>, equivalent to about 10.5 h-wk<sup>-1</sup> spent in moderate activity. The Amish people we studied reported a mean of 15,315 MET-min-wk<sup>-1</sup>, as a result of doing about 50 h of walking and moderate activities and several hours of vigorous activity each week.

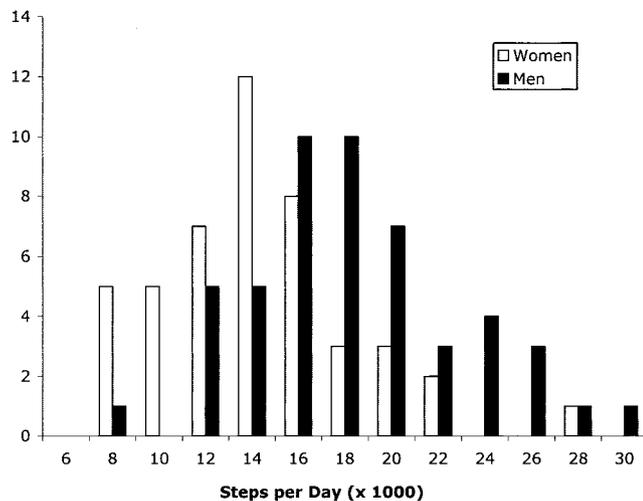


FIGURE 1—Frequency histogram showing steps per day (averaged over one week) in Amish research participants. The y-axis shows the frequency (number of observations) in each step category.

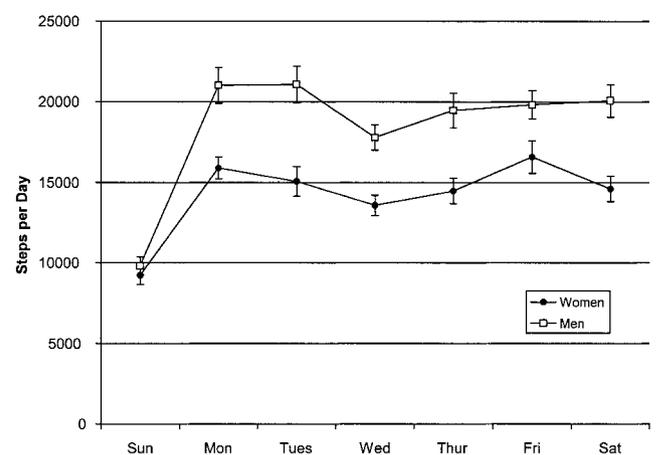


FIGURE 2—Mean number of steps per day for Amish men (N = 51) and women (N = 45), on various days of the week. Men had significantly higher values than women ( $P < 0.01$ ), for all days except Sunday. Sunday had lower step values than other days of the week ( $P < 0.001$ ).

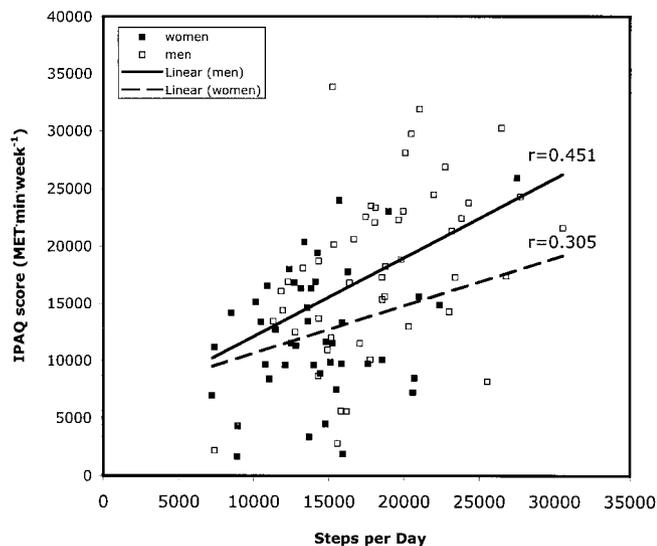


FIGURE 3—Comparison of steps per day and International Physical Activity Questionnaire (IPAQ) scores, in Amish men and women.

The types of activities performed by the Amish were mostly related to farm work. We visited during planting season when plowing, disking, planting, harrowing, and cultivating were common among the farmers, as well as cutting and baling hay. Men also did construction work, stove manufacturing, and furniture making. Amish women performed childcare and cooking, as well as household chores, gardening, produce selling, laundry, and care and feeding of farm animals. There was no leisure-time activity reported, except that two subjects listed “fishing.” This shows that differences exist in the types of physical activity performed by the Amish and people in modernized societies (27).

**Steps per day.** Amish men and women accumulated high numbers of steps on Monday through Saturday. Sunday was a day of rest, as evidenced by lower pedometer values compared with other days of the week (Fig. 2). Men accumulated more steps than women on all days of the week

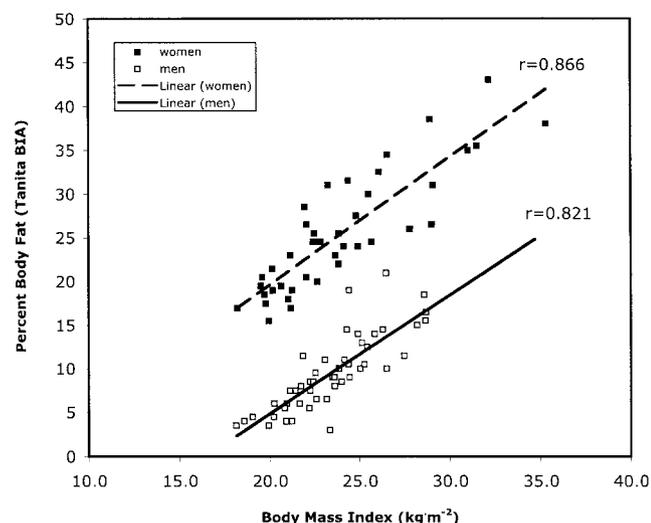


FIGURE 4—Comparison of body mass index and estimated percent body fat (Tanita bioelectrical impedance analyzer), in Amish men and women.

except Sunday. It is important to note that these Amish adults had higher daily step counts than those reported for other populations (15,33). The Amish did not appear to have a significant age-related decline in steps per day. The correlation between age and steps per day was not significant ( $r = -0.011$ ), nor were significant correlations found when men and women were analyzed separately ( $r = -0.213$  and  $+0.243$ , respectively).

Sequeira et al. (33) conducted a study of 497 Swiss residents (25–79 yr of age) in 1988–1989. These individuals wore a pedometer for 1 wk. The average number of steps per day decreased with age from 11,900 to 6,700 for men and from 9,300 to 7,300 for women, in the youngest to oldest age groups.

A study of 500 Japanese residents was conducted in 1994. The average number of steps per day was measured in men and women, ages 30–39, 40–49, 50–59, 60–69, and 70 yr and older. Steps per day decreased with age from 8,240 to 4,652 for men, in the youngest to oldest age groups. Similarly, the average number of steps per day decreased with age from 7,233 to 3,930 in women (15). A Japanese researcher’s recommendation for physical activity is to accumulate at least 10,000 steps per day for cardiovascular health (14). Nearly all of the Amish adults we studied (93%) met this recommendation.

**Prevalence of obesity.** There was a low prevalence of obesity and overweight in the Amish community we studied. Only 4% of these Amish adults were obese ( $BMI \geq 30$ ), and only 26% were overweight ( $BMI \geq 25$ ). These rates are far lower than in the rest of Canada, or the United States (10,22,36). In Canada, the prevalence of obesity in adults 20–74 yr of age is 14.9%, and the prevalence of overweight is 50.7% (22). In the United States the rate of obesity is 30.9% and the prevalence of overweight ( $BMI \geq 25$  computed from measured height and weight) is 64.5% of the adult U.S. population (10).

The high levels of physical activity in this Amish community probably contribute to the low prevalence of obesity (12,13,37). Based on the IPAQ estimates, the self-reported physical activity was roughly  $3100 \text{ kcal}\cdot\text{d}^{-1}$  in men and  $1850 \text{ kcal}\cdot\text{d}^{-1}$  in women. Other factors may contribute as well; the Amish rarely snack between meals, and they have limited access to fast foods.

Our findings in terms of obesity prevalence differ from those reported in a study of Amish residents living in other communities in North America. Fuchs et al. (11) conducted interviews with 400 Amish adults in Holmes County, OH, using the Behavioral Risk Factor Survey (BRFS). A representative sample of non-Amish adults living in Holmes County ( $N = 773$ ) were administered the same survey by telephone. The prevalence of obesity ( $>120\%$  of ideal body weight) was similar in Amish men (28.1%) and non-Amish men (27.9%). Obesity was actually *more* prevalent among Amish women (39.9%) than non-Amish women (30.8%). The researchers suggest several possible reasons for the high rate of obesity in Amish women: 1) Amish women have more pregnancies than non-Amish, 2) food plays an

important role in Amish culture, and 3) there is less of a stigma attached to being overweight in Amish society.

Differences in obesity prevalence in Amish living in Ohio and Ontario could result from differences in work-related activity. In 1970, approximately 72% of Amish in Holmes County made their living from farming, but by 1991 this figure had fallen to about 40% (24). Many of the Amish in Ohio are employed in tourism and micro-industries such as cabinet shops, construction work, quilting and craft work, lawn furniture production, and agricultural equipment sales (23). In contrast, nearly 80% of the Ontario Amish men we studied listed farming as their principal occupation.

Hostetler (18) notes that, "The Amish work hard and eat accordingly." However, there are few studies regarding dietary intake in the Amish. A PubMed search on "dietary intake" and "Amish" turned up no published articles between 1969 and 2002 that quantified their daily intake ( $\text{kcal}\cdot\text{d}^{-1}$ ). However, an unpublished study reported higher-than-normal caloric intake values in this group ( $3599 \text{ kcal}\cdot\text{d}^{-1}$  in Amish men and  $2019 \text{ kcal}\cdot\text{d}^{-1}$  in Amish women) (39). The Amish diet is typical of the pre-World War II rural diet. It includes meat, potatoes, gravy, eggs, vegetables, bread, pies, and cakes, and is quite high in fat and refined sugar.

**Technology and physical activity.** From the standpoint of physical activity, an Amish farmer's lifestyle might resemble that of rural residents in North America in the mid-to-late 1800s. The Amish take advantage of farming tools developed before that period. Such tools include the steel-blade plow (invented by John Deere in 1837) and the mechanical harvester (invented by Cyrus McCormick in 1834) (1).

The Old Order Amish have a robust work ethic that emphasizes physical labor. They have elected to keep most types of modern technology out of their lives, in order to live close to the land and maintain strong family ties and a sense of community (18,21). Farming has remained the preferred occupation in the Amish (21,28). However, we noted several ancillary occupations among Amish men including carpentry, woodworking, a sawmill, a harness shop, and a publishing house with a German printing press. The Amish emphasize practical skills and knowledge over book learning. They are educated in their own schools, and formal education ends after the eighth grade (20).

The history of farming in the age of technology can be summarized as follows. In the mid-1930s, only 10% of farms in the United States had electricity. After the advent of the Rural Electrification Administration (REA) in 1935, cheap electricity became widely available. By 1960, over 98% of farms had acquired electricity. Light-duty motorized tractors were introduced around 1900, and the first multi-

purpose tractors were introduced in the 1920s (1). Thus, within a relatively brief period, North America was transformed from an agrarian society into a highly technological one where only a few people were involved in food production. Unlike the rest of North America, the Amish have not only resisted these technological advances in farming but they have also resisted moving to cities. [Around 1800, only 5% of U.S residents lived in cities or their surrounding areas (8) but that number has grown to 80% in 2000 (38). Similarly, in Canada, 78% of people now live in cities and suburbs (34).]

The present study has a number of limitations. We did not compare the Amish with a group of farmers that used modern farming practices or to a group of city dwellers. Only a single Old Order Amish community was studied, which means that extrapolating to other Amish groups must be done cautiously. Measurements of dietary intake were not obtained; this would have helped to verify the high levels of caloric expenditure reported in this study. Finally, seasonal variation is likely to be greater in Amish farmers than in other groups, and we only examined them at one time point during the spring (planting season). However, the amount of work done in the spring is intermediate between that done in fall and winter. In fact, the Amish advised us not to visit during harvest time because they would be too busy to take part in a research study. Winter is a slower time and the farmers typically do not go out into the fields after supper. Nevertheless, there are many activities in winter such as spreading manure on frozen fields, cutting firewood, butchering animals, mending and greasing harnesses, cutting blocks of ice, and building maintenance.

In summary, this study documented high levels of physical activity in an Old Order Amish community. This group likely represents an upper extreme for "lifestyle activity" in North America today. Importantly, the physical activity of these Amish far exceeds the minimum recommendations specified in current public health guidelines (6,14,31). We estimate that the amount of physical activity performed by Amish farmers is similar to that of distance runners, though the farmers' activity is performed at lower intensities over a longer duration. The results of the study suggest that there has been a large decline in physical activity in North America over the past 150 yr.

The authors express their appreciation to members of the Amish community for participating in the study, to David Luthy for making resources from his Heritage historical library available and for personal consultation, and to Cary Springer (University of Tennessee Statistical Consulting Services) for conducting the data analysis.

This research was supported by the Charlie and Mai Coffey Endowment in Exercise Science.

## REFERENCES

1. ACKER, D. Agriculture. In: *World Book Encyclopedia*, Vol. 1. Chicago, IL: World Book, Inc., 1997, pp. 146–161.
2. AINSWORTH, B. E., W. L. HASKELL, M. C. WHITT, et al. Compendium of Physical Activities: an update of activity codes and MET intensities. *Med. Sci. Sports Exerc.* 32:S498–S516, 2000.
3. ASTRAND, P. O., and K. RODAHL. *Textbook of Work Physiology*. New York: McGraw-Hill, 1986. p. 372–274.
4. BASSETT, D. R. Use of pedometers to assess physical activity. In: *Physical Activity Assessments for Health-Related Research*, G. J. Welk (Ed.). Champaign IL: Human Kinetics, 2002, pp. 163–177.
5. BOOTH, M. L. Assessment of physical activity: an international perspective. *Res. Q. Exerc. Sport* 71:114–120, 2000.
6. CENTERS FOR DISEASE CONTROL AND PREVENTION. Increasing physical activity: a report on recommendations of the Task Force on Community Preventive Services. *MMWR* 50(RR-18):1–14, 2001.
7. CRAIG, C. L., A. L. MARSHALL, M. SJOSTROM, et al. International Physical Activity Questionnaire: 12 country reliability and validity. *Med. Sci. Sports Exerc.* 35:1381–1395, 2003.
8. DATAPEDIA OF THE UNITED STATES 1790–2005, 2nd Ed., G. T. Kurian (Ed.). Lanham, MD: Bernan, 2001, p. 4.
9. EUROPA WORLD YEAR BOOK 2002, Vol. 1. London: Europa Publications, 2002, p. 945.
10. FLEGAL, K. M., M. D. CARROLL, C. L. OGDEN, and C. L. JOHNSON. Prevalence and trends in obesity among US adults, 1999–2000. *JAMA* 288:1723–1727, 2002.
11. FUCHS, J. A., R. M. LEVINSON, R. R. STODDARD, M. E. MULLET, and D. H. JONES. "Health Risk Factors among the Amish: results of a survey." *Health Educ. Q.* 17:197–211, 1990.
12. GUO, S. S., C. ZELLER, W. C. CHUMLEA, and R. M. SIERVOGEL. Aging, body composition, and lifestyle: the Fels Longitudinal Study. *Am. J. Clin. Nutr.* 70:405–411, 1999.
13. HAMMAN, R. F., J. I. BRANCIK, A. M. LILIENFELD. Patterns of mortality in the Old Order Amish. I. Background and major causes of death. *Am. J. Epidemiol.* 114:845–861, 1981.
14. HATANO, Y. Use of the pedometer for promoting daily walking exercise. *ICHPER J.* 29:4–8, 1993.
15. HATANO, Y. Prevalence and use of pedometer. *Res. J. Walking* 1:45–54, 1997.
16. HEINI, A. F., and R. L. WEINSIER. Divergent trends in obesity and fat intake patterns: the American paradox. *Am. J. Med.* 102:259–264, 1997.
17. HILL, J. O., and E. L. MELANSON. Overview of the determinants of overweight and obesity: current issues and research issues. *Med. Sci. Sports Exerc.* 31:S515–S521, 1999.
18. HOSTETLER, J. *Amish Society*, 4th Ed. Baltimore: The Johns Hopkins University Press, 1993, pp. 91–170.
19. HUNTINGTON, G. E. Health Care. In: *The Amish and the State*, D. B. Kraybill (Ed.). Baltimore: Johns Hopkins Press, 1993, p. 172.
20. HUNTINGTON, G. E. Persistence and change in Amish education. In: *The Amish Struggle with Modernity*, D. B. Kraybill and M. A. Olshan (Eds.). Hanover, NH: University Press of New England, 1994, pp. 77–95.
21. HUNTINGTON, G. E. *Amish in Michigan*. East Lansing, MI: Michigan State University Press, 2001, pp. 26–30.
22. KATZMARZYK P. T. The Canadian obesity epidemic: an historical perspective. *Obes. Res.* 10:666–674, 2002.
23. KRAYBILL, D. B., and S. M. NOLT. The rise of microenterprises. In: *The Amish Struggle with Modernity*, D. B. Kraybill and M. A. Olshan (Eds.). Hanover, NH: University Press of New England, 1994, pp. 149–163.
24. KRAYBILL, D. B. Introduction: the struggle to be separate. In: *The Amish Struggle with Modernity*, D. B. Kraybill and M. A. Olshan (Eds.). Hanover, NH: University Press of New England, 1994, pp. 1–17.
25. KOPLAN, J. P., and K. E. POWELL. Physicians and the Olympics (editorial). *JAMA* 252:529–530, 1984.
26. KUCZMARSKI, R. J., K. M. FLEGAL, S. M. CAMPBELL, and C. L. JOHNSON. Increasing prevalence of overweight among US adults: the National Health and Nutrition Examination Surveys, 1960 to 1991. *JAMA* 272:205–211, 1994.
27. LEE, I.-M., C.-C. HSIEH, R. S. PAFFENBARGER. Exercise intensity and longevity in men. *JAMA* 273:1179–1184.
28. LUTHY, D. *Why Some Amish Communities Fail: Extinct Settlements, 1961–1999*. LaGrange, IN: Pathway Publishers, 1997, pp. 1–26.
29. MOKDAD, A. H., B. A. BOWMAN, E. S. FORD, F. VINICOR, J. S. MARKS, and J. P. KOPLAN. The continuing epidemics of obesity and diabetes in the United States. *JAMA* 286:1195–1200, 2001.
30. PARK, R. J. Human energy expenditure from Australopithecus afarensis to the 4-minute mile: exemplars and case studies. *Exerc. Sport Sci. Rev.* 20:185–220, 1992.
31. PATE, R. R., M. PRATT, S. N. BLAIR, et al. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 273:402–407, 1995.
32. PRENTICE, A. M., and S. A. JEBB. Obesity in Britain: gluttony or sloth? *Br. Med. J.* 311:437–439, 1995.
33. SEQUEIRA, M. M., M. RICHARDSON, V. WIETLISBACH, B. TULLEN, and Y. SCHUTZ. Physical activity assessment using a pedometer and its comparison with a questionnaire in a large population study. *Am. J. Epidemiol.* 142:989–999, 1995.
34. STATISTICS CANADA. *Canada at a Glance*, 2nd Ed. Ottawa, Canada: Statistics Canada Communications Division, 2002, p. 4.
35. STEPHENS, T. Secular trends in adult physical activity: exercise boom or bust? *Res. Q. Exerc. Sport* 58:94–105, 1987.
36. TORRANCE, G. M., M. D. HOOPER, and B. A. REEDER. Trends in overweight and obesity among adults in Canada (1970–1992): evidence from national surveys using measured height and weight. *Int. J. Obes.* 26:797–804, 2002.
37. TUDOR-LOCKE, C., B. E. AINSWORTH, M. C. WHITT, et al. The relationship between pedometer-determined ambulatory activity and body composition variables. *Int. J. Obes.* 25:1571–1578, 2001.
38. U.S. CENSUS BUREAU. Employment by industry to 2000. In: *Statistical Abstract of the United States, 2001: The National Data Book*, 121st Ed. Washington, DC: U.S. Census Bureau, 2001, pp. 30–384.
39. WEALE, V. W. Eating patterns and food energy and nutrient intake of Old Order Amish in Holmes County, OH. Doctoral dissertation, Department of Human Nutrition and Food Management, Ohio State University, Columbus, OH, 1980.