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ADULT PHYSICAL ACTIVITY BEHAVIOR: A TREND ANALYSIS

CHRISTINE BROOKS

Department of Sports Management and Communication, The University of Michigan, 401 Washtenaw Avenue, Ann Arbor, MI 48109, U.S.A.

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Abstract—One of the health objectives for the nation is to have 60% of adults 18–64 years regularly active in vigorous physical activity by 1990. In this paper an effort is made to determine whether American society is making satisfactory progress toward this goal. Two independent databases are analyzed: time diaries collected from a national sample of American adults in 1981; and the Simmons Market Research Bureau, Inc., survey undertaken in 1984. Participation of adults 25–64 in moderate to vigorous activities that included racquet sports, swimming, hiking, bicycling, skiing, jogging, outdoor gardening, skating, etc. is compared between the two time periods.

After adjusting for social desirability bias the results indicated there were a similar number of non-participants of the activities analyzed in 1981 and 1984. There was, however, an increase in the number of adults participating occasionally in vigorous activity, although, there did not appear to be any increase in the number who were regularly active, i.e. at least 3 days/week. Thus, while there are indications that adults 25–64 years are adopting more vigorous activity, less than 20% were regular enough in 1984 for improvements in cardiovascular functioning to occur. Unless there were dramatic increases in the activity status of adults 18–24 years of age which was not assessed in this study, the 1990 goal is unlikely to be met.

Adult physical activity behavior   Exercise   Physical activity trends

Objective C of the Fitness Objectives for the Nation established in 1980 by the Department of Health and Human Services states:

> By 1990, the proportion of adults 18–65 participating in vigorous physical exercise should be greater than 60 percent [1].

How realistic is this objective? Is American society moving toward or away from physically active lifestyles? To answer these questions some baseline measure of adult physical activity behavior is necessary. Unfortunately, published surveys during the 1980 time period suffer from inadequate sample design, sample size or exercise assessment [2–5]. None has proved adequate for establishing a reasonably reliable baseline measure.

One database not yet analyzed for potential baseline data is a national survey on how Americans allocate their time. The study was conducted in 1981 by The Institute for Social Research at The University of Michigan. The data were collected via time diaries and provide an opportunity to obtain some notion as to how physically active adults were in 1980*, the year Objective C was established.

A second database containing potential follow-up information on adult physical activity behavior is the Simmons Market Research Bureau, Inc. (SMRB) survey conducted in 1984†. This was a survey of approximately 19,000 American adults 18 years and older on their media and product usage. A portion of the questions dealt with frequency of participation in activities that require levels of energy ex-

*These data were made available by the Inter-university Consortium for Political and Social Research. The data for Time Use in Economic and Social Accounts, 1981 were originally collected by F. Thomas Juster, Paul Courant, Greg J. Duncan, John P. Robinson and Frank Stafford. Neither the original collectors of the data nor the Consortium bear any responsibility for the analysis or interpretations presented here.

†These data were made available by Mr Edward Barz of the Simmons Market Research Bureau, Inc. for the purposes of contributing to the public fund of knowledge on adult physical activity behavior.

penditure sufficient to contribute to improved cardiovascular functioning if undertaken on a regular basis.

In this paper, these two databases are analyzed in an effort to gain some notion of trends in adult physical activity behavior from 1981 to 1984. The goal is to determine if progress is being made toward the National Objective for 1990 and if it will be met.

DATABASE 1: THE TIME DIARY DATA

Estimating Baseline Participation for 1980

The reader is referred to **Time, Goods and Well-being** [6] for a thorough discussion of the time diary data since only those aspects pertinent to this paper are covered here.

Features of the time diaries

The diaries were collected by a recall technique developed from several experimental studies in the early 1970s [7, 8]. It consisted of an open ended question format. The respondent was asked "what were you doing at one minute past midnight on the previous day [diary day]?" followed by "where were you?", "who was with you?", "were you doing anything else at the same time?" and then "what did you do next?" Time was recorded on a continual scale and the interview continued until activities over 24 consecutive hours had been recorded. All diary activities were later coded into 200 mutually exclusive categories along with actual time duration.

Four independent estimates of time use were obtained for each respondent. The interviews were conducted at approximately 3 month intervals so that each quarter of the calendar year was represented. Diary days were conveniently selected such that two were weekdays, one was a Saturday and the other a Sunday. The first interview was conducted in person and the remaining three by telephone.

Synthetic week estimate

Using a method developed by the original investigators, a synthetic week of leisure time physical activity participation was formed from the four time diaries. The two week day diaries were weighted so that an aggregate time over 5 weekdays could be estimated. This aggregate weekday time was added to that recorded in the Saturday and Sunday diaries to provide an estimate of the amount of physical activity undertaken in one full week.

The pattern of days and seasons making up the synthetic week were as follows: wave 1 (Feb–April) consisted predominantly of weekdays; wave 2 (May–July) were a mixture of all 7 days with Sunday being most heavily sampled day; wave 3 (Aug–Sept) were Saturday and Sunday diaries; and wave 4 (Nov–Dec) were weekdays. Thus, over the warmer months there is a good representation of both Saturdays and Sundays capturing the seasonal variability in weekend activities. It is important to realize that this synthetic week is not intended to represent the amount of physical activity undertaken by a specific individual. It simply allows an estimate of aggregate activity patterns of the adult population at large.

Data Limitations

There are several limitations to the 1981 time diary dataset. The respondents ($n = 2406$) had actually been sampled in 1975–76. At that time they were representative of American adults 18 years and older who resided in households. The 1981 time diary study was a follow-up of these respondents to see if any changes in time use were evident. There had been no contact in the ensuing 5–6 years. Consequently, only a limited number of households could be located in the follow-up. In 1981, 996 respondents entered the first wave and 734 respondents remained after wave 4 of the data collection.

Such large drop-out rates cannot, of course, be ignored. Specific types of individuals are more likely to drop out of a survey than others adversely affecting the results even when one begins with a representative sample. In commenting about the drop-out rate of respondents Juster [9] made the following observation:

> While all survey data are subject to nonresponse, it should be kept in mind that we know a good bit about the nature and character of non-response over the entire period (except for the original nonresponse in the first wave of the 1975 survey). We have data on the financial and demographic characteristics of our original respondents, and can re-weight those who completed the 1981–82 follow-up to account for the differential non-response associated with these characteristics. (p. 314)

The original investigators had calculated a weight for each respondent to increase or decrease the influence they had upon the aggregate according to sex, age, education and degree of urbanization in which the selected household was located. This correction factor adjusted the time use estimate so that it more accurately reflected the population at large in 1981. Thus, while it was not possible to cure the deficiency relating to the absence of a cohort that would have been 18 through 24 in 1981, it was possible to correct for respondent drop-out. However, despite these corrections one still cannot consider these data to be an ideal representative cross-section of the American adult population. Caution will be necessary in interpreting the results.

One further limitation relating to coding procedures must also be noted. While the coded activity categories were well suited for the purposes of the original investigators, in some cases they were not quite specific enough for an analysis of physical activity behavior. The original investigators did not probe respondents for information on whether the time specified was actual participation time or whether it included other time as well. There is no way of knowing what portion of the time allocated to racquet sports, for instance, was actually playing time, and what part was social, resting, or dressing time. Upon investigating secondary activities undertaken while respondents were participating in the primary activity, discrepancies became apparent. When respondents indicated they went swimming, for example, it merely indicated they were somewhere near water. According to secondary activities many respondents were also listening to the radio, reading or napping. Similarly, secondary activities during team sport and racquet sport participation indicated respondents did not spend the time indicated in their diaries actually playing. In essence the leisure time participation data from this set of time diaries are inflated to some degree.

Since Objective C is specifically concerned with adult participation in activities that may lead to cardiovascular improvement only leisure time physical activity involving moderate to heavy levels of energy expenditure as defined by Taylor *et al.* [10] are analyzed. These activities and their intensity codes are listed in Table 1. Moderate activities included those with intensity codes of 4.0–4.5. Those 5.0 and above were classified as heavy. Swimming was adjusted from an intensity code of 6 as proposed by Taylor *et al.*, to a code of 4 to help correct for the inflation bias previously mentioned. This was the most seriously affected activity and thus was the only intensity code adjusted.

Table 1. Moderate and heavy intensity activities undertaken by adults in 1981

Moderate intensity	Taylor Index	Heavy intensity	Taylor Index
Golf	4.0	Team sports	6.0
Frisbee/catch	4.5	Racquet sports	6.0
Exercise/Yoga	4.0	Skiing	7.0
Hunting	4.0	Jogging	7.0
Walking	4.0	Spot lessons	6.0
Hiking	4.5	Dance lessons	6.0
Bicycling	4.0		
Swimming	4.0		
Carpentry	4.0		
Outdoor garden	4.5		
Yardwork	4.0		
Social dance	4.0		

Classifying Diary Participation Time into an Activity Index

Since it is not possible to calculate the number of days the population was active from the estimated time of participation over one week the activity metabolic index developed by Taylor *et al.* [10], was utilized. Under this strategy, participation time is converted into an approximate kcal/min of energy expenditure. The formula is:

$$\mathrm{AMI} = I \times D$$

where:

AMI = Activity Metabolic Index
I = Activity intensity
D = Duration of the activity in minutes.

According to Taylor *et al.*, one intensity unit roughly equals 1 kcal/min.

Results

1981 activity participation status

Of the total sample, 54% engaged in no moderate or heavy intensity leisure time physical activity over the synthetic week. Thirty six percent participated in moderate intensity activities but no heavy intensity activities and 10% participated in heavy intensity activities. There are three ways to interpret these results.

Method 1. Since the minimum activity goal established by the Department of Health and Human Services [1] is 20 minutes of vigorous activity 3 days/week, the desired activity metabolic index is between 360 and 420 kcal/week (20 min × 3 days × 6 or 7 intensity code) of heavy intensity activity. Slightly less than 10% of adults 25–64 met this requirement.

Method 2. According to Paffenbarger *et al.* [11], 2000 kcal or more of exercise energy expenditure per week is associated with lower incidence of coronary heart disease. Thus, participation time can be analyzed according to kcal/week of energy expenditure. Unfortunately, Paffenbarger *et al.* had expanded physical activity into the work hours by asking respondents to estimate on the job activity such as flights of steps walked and other walking distance in terms of city blocks. Since such non leisure time activity was not included in the time diary analysis it was necessary to adjust the threshold levels of actual leisure time physical activity accordingly and assume that it approximated 1600 kcal/week. Under this assumption 14% of the time diary sample met threshold levels of physical activity.

Method 3. Paffenbarger's threshold levels of energy expenditure can be combined with the U.S. Department of HHS requirement. Thus, non-participants along with all those individuals not meeting the estimated Paffenbarger 1600 kcal/week energy expenditure, and those individuals not meeting the U.S. Department of HHS desired 360–420 kcal of heavy intensity exercise/week are excluded. Under these conditions approximately 16% of the population met threshold levels of leisure time energy expenditure thought to prevent cardiovascular disease.

Thus, keeping in mind the many problems encountered in using the time diary data to estimate an adult physical activity behavior baseline for 1980, it seems apparent that between 10 and 16% of adults between the ages of 25 and 64 met threshold levels of physical activity thought to prevent cardiovascular disease. Approximately 54% did nothing to stimulate their cardiovascular system and between 30 and 36% could be considered occasional participants.

DATABASE II: THE SMRB SURVEY

Estimating the Status in 1984

The analysis now turns to the Simmons database. Respondents in the SMRB survey were asked about their participation in several leisure time activities. Those closely matching activities analyzed in the time diaries were extracted so that comparisons between 1981 and 1984 could be made. These activities are listed in Table 2. Respondents could select their level of participation from one of 11 categories: 0 days in the past 12 months, 1–4, 5–9, 10–14, 15–19, 20–24, 25–29, 30–39, 40–49, 50–59 and 60 days or more. The reader is reminded that a *stylized questionnaire* such as this relies upon the respondent's ability to accurately recall their level of participation. There is also the issue of social desirability bias where respondents report behavior they perceive as acceptable and not their actual behavior [6, 12, 13]. Thus, these weaknesses of the questionnaire must be kept in mind.

Table 2. Moderate and heavy intensity activities undertaken by adults in 1984

Moderate Intensity	Heavy Intensity
Skating	Racquet Sports
Waterskiing	Skiing
Skin diving	Weightlifting
Swimming	Jogging
Hiking	Team sports
Backpacking	
Bicycling	
Other sport (except team sports)	
Hunting	
Golf	
Outdoor garden	
Woodworking	

Sample design

A 5 stage-stratified area probability sampling design was utilized to select respondents. Personal interviews were completed in 19,110 households. These included 9338 men and 9772 women. Overall response rates were as follows: adults 73.3%; men 68.6%; women 78.5%. In order to make direct comparisons with the time diary data only respondents between the ages of 25 and 64 were included leaving 12,989 respondents in the analysis (6568 men and 6421 women).

Weighting procedures

The SMRB sample departs from equal probability of selection in that upper income and education levels were intentionally oversampled and only one person per household was interviewed. Refusals also contributed to unequal probability of selection. A standard correction practice in this instance is to adjust the sample by attaching a weight to each respondent that is inversely proportional to his/her selection probability. After making these adjustments the sample was then checked against several demographic characteristics to independent estimates based on Census data and further adjustments were made. The final sample, therefore, represented American adults residing in households in the conterminous U.S. in 1984.

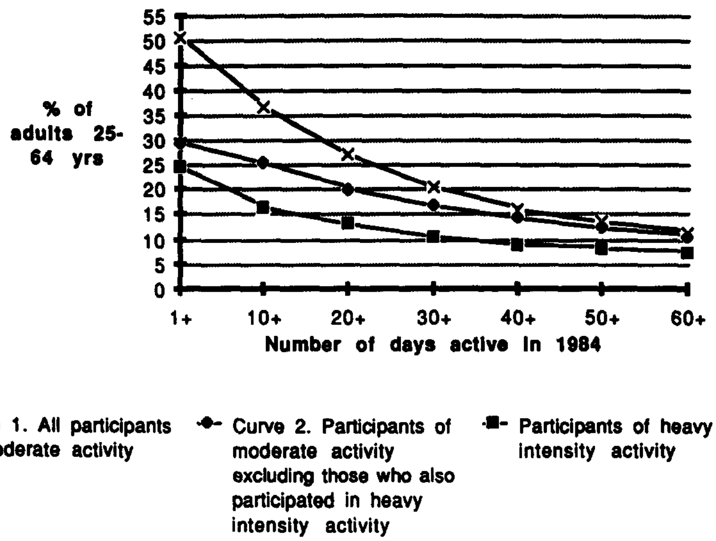

Fig. 1. Participation of adults 25–64 years in moderate and heavy intensity in 1984.

Analysis procedures

All analytic statistics are estimated from the weighted data described above. However, the SMRB data tapes did not indicate the Primary Sampling Units (PSUs) to which respondents belonged, which, incidentally, is an unfortunate practice with many surveys. Therefore, although the weights adjusted for unequal selection probabilities it was not possible to adjust for sample design effects. Standard errors were therefore inflated by two times the value actually obtained. After making this correction standard errors of the statistics resulting from the SMRB data are believed to be in the vicinity of 2%. That is, assuming constant non-sampling errors, if a different sample of the same size was drawn from the adult population the results would be within 2 percentage points of results obtained from this sample.

Results

1984 activity participation status

Since time of participation was not available in the SMRB data it was not possible to create an activity metabolic index similar to that obtained with the time diary data. However, an estimation of the number of days respondents were active in each activity was available. To calculate total activity participation categories for each activity were recoded to the median value. If a respondent checked the 1–4 day participation/year category he/she was credited with 2 days of participation; if the 5–9 days category was checked the respondent was credited with 7 days, and so forth. Those checking over 60 days were credited with 70 days of participation. The sum of these medium values over all activities provided an estimate of total participation days. Thus, while a respondent may have participated less than 60 days in each activity he/she may have a total participation of over 60 days. This procedure made it possible to obtain some notion of overall physical activity participation of American adults while accounting for the fact that some were active in more than one activity.

There was a major flaw to this procedure. In attempting to match the activities analyzed in the time diaries it was necessary to include outdoor gardening and woodworking in the 1984 analysis. Unfortunately, days of participation were not obtained for these activities. The respondent was only asked if he/she did these activities at least once during the past 12 months. Thus, if a respondent indicated that he/she gardened or did woodworking during the past 12 months he/she was simply credited with 10 days of participation.

The results are as follows: 33.5% of Americans between the ages of 25 and 64 did not participate in any of the activities analyzed; 48.7% participated between 1 and 60 days and the remaining 17.8% were active over 60 days.

The breakdown of adult participation into moderate and heavy intensity activity participation is provided in Fig. 1. On the vertical axis is the percentage of adults between the ages of 25 and 64 years who were active. On the horizontal axis are seven categories representing the number of days per year respondents were active. Categories range from *participated at* *least once during the past 12 months (1+); to participated at least 60 days (60+).* Participation in moderate activities is shown as two curves. Curve 1 includes respondents who also participated in heavy intensity activities. Curve 2 excludes respondents who engaged in heavy intensity activity. Thus, 63.3% of adults 25–64 years participated at least once in moderate intensity activities (curve 1). After eliminating the heavy intensity activity participants, however, 40% of the population participated only in moderate intensity activity and 9.4% were active more than 60 days. Approximately 27% of the population participated at least once in heavy intensity activities and 8.4% participated more than 60 days.

Comparison between 1981 and 1984

The SMRB and time diary data are not directly comparable so the findings can only provide a sense of adult physical activity status and trends. Inconsistencies must be taken into consideration. First, although hiking was included as one of the activities in the SMRB dataset, walking for exercise was not. These were both available for analysis in the time diary data. Some SMRB respondents may have perceived hiking to be similar to walking for exercise and checked that activity—others may not have. A further difference is that exercise/yoga, social dance and frisbee/catch were included in the moderate intensity participation analysis of the time diary data and not in the SMRB data analysis*. Thus, participation changes in moderate activity may be affected and the number of non-participants in 1984 may have been slightly lower than is indicated.

With these limitations in mind, Tables 3(a) and (b) provide a comparison between 1981 and 1984. Approximately 54% of the 1981 time diary sample were non-participants of the activities analyzed. In 1984, 33.5% of the sample were non-participants [Table 3(a)]. The percentage who participated at least once in moderate intensity activity shows a slight, but not substantial increase from 36 to 40%. Participation in heavy intensity activities in 1981 and 1984, on the other hand, does show a substantial increase suggesting that active adults in 1984 were undertaking higher intensity activity.

The question is whether these differences are simply a function of the inherent biases (i.e.

*The time diary data had originally been analyzed with another purpose in mind. See Brooks [14].

Table 3(a). Percentage of adults 25–64 who participated at least once in activities requiring moderate to heavy levels of energy expenditure

	Percent of adults 25–64 years		
Activity status	1981	1984	1984 adjusted†
Non-participants	54.0	33.5	53.4
Moderate intensity*	36.0	39.9	27.9
Heavy intensity	10.0	26.6	18.6

*Excludes individuals who were also participants of heavy intensity activity.
†Adjusted for social desirability bias i.e. it was assumed that approximately 30% of respondents who said they participated did not actually do so.

Table 3(b). Percentage of adults 25–64 who met the minimum level of physical activity requirements thought to promote cardiovascular improvement

	Percent of adults 25–64 years	
Activity status	1981	1984
Percent who met the DHEW requirements of 3 days per week of heavy intensity activity	10.0	8.4
Percent who were at least moderately active 3 days/week	16.0	17.8

recall and social desirability bias) of the SMRB stylized questionnaire. In the situation where participation vs non-participation is being measured, i.e. when the respondent simply had to indicate "yes" or "no" to the question "Did you participate in these activities during the past 12 months?" which does not require an estimation of the number of participation days, recall bias is probably minor. It seems reasonable to assume that respondents would have a fairly clear notion if they jogged, biked, swam etc. at least once over the past 12 months. A problem with recall becomes an issue when respondents are asked to estimate the number of participation days and in this situation the results would be affected. The results reported in Table 3(a), therefore, are not seriously affected by recall bias. The data in Table 3(b) indicating the percentage who were at least moderately active 3 days/week, on the other hand, include error due to recall. Social desirability bias occurs when respondents "know" they did not jog during the year but felt it more desirable to indicate that they did so. In other words, they provide intentionally erroneous response.

The impact either of these biases have on the results is difficult to assess. In fact, measuring recall bias with these data was not possible. However, since respondents in the SMRB sur-

Table 4. Analysis of adults who claimed to have jogged or biked at least once in 12 months but did not own jogging shoes or a bicycle

Percentage who did not own shoes	Number of days respondents claimed to jog				All adults 25–64 years
	1–10	11–30	31–60	Over 60	
Did not own jogging shoes	55.7	45.5	32.5	21.8	38.9
Did not own jogging or tennis shoes	43.0	37.7	24.2	19.2	31.4
Did not own a bicycle or a stationary bicycle	41.1	38.0	30.7	30.4	37.3

vey were also asked about their ownership of certain sports items there was a potential inbuilt check as to how serious social desirability bias may have been. Two activities, jogging and bicycling, were selected and a comparison was made between respondents who said they jogged or biked and their ownership of jogging shoes or a bicycle. The questions—*How often did you jog (bike) in the past 12 months?*—and—*Please indicate which of the following sports equipment items you own* (the respondent was provided with a list of 26 items that included jogging shoes, a bicycle and a stationary bike)—were far enough apart in the questionnaire that they potentially acted as *lie detectors*.

The size of the discrepancy that resulted from this comparison was totally unexpected. Over one third of the respondents who said they jogged or biked at least once during the year also claimed later in the questionnaire that they did not own jogging shoes or a bicycle (Table 4). The discrepancy was most serious among those who claimed to jog or bike less than 30 days. One possible explanation for the jogging/jogging shoe ownership discrepancy was that some respondents perhaps considered tennis shoes to be jogging shoes. The analysis was, therefore, rerun allowing tennis shoes to count as jogging shoes. There was only a slight difference in the result (Table 4). It was not possible to estimate the number of respondents who may have used a stationary bike at a health club but this certainly cannot account for more than 10% of the biking/bicycle ownership discrepancy.

How one is to account for these findings is puzzling. Unlike some activities where equipment can be rented, one must own jogging shoes if one is to seriously undertake jogging as an activity. The possibility exists that word interpretation may explain some of the discrepancy i.e. perhaps sneakers, or running shoes may have been more recognizable to respondents than jogging or tennis shoes. Yet, there was a sizeable number of respondents who claimed to own jogging shoes but did not claim to jog. Similarly, almost 50% of the adults claimed to own a bicycle but indicated they did not use it. That is, it appears unlikely that word interpretation could explain much of the discrepancy for either activity.

While it has been known for some time that the stylized questionnaire is less than satisfactory for measuring physical activity behavior, to the author's knowledge the actual impact of social desirability bias has never been assessed. Although further investigation is certainly warranted the implication from the findings presented here is that when a stylized questionnaire is utilized one third of the respondents may be succumbing to social desirability pressure when questioned about their physical activity behavior.

After adjusting for social desirability bias, therefore, there is a strong possibility that 53% of adults 25–64 years rather than 34% were non-participants of the activities analyzed. And 18.6%, not 26.6% participated at least once in heavy intensity activity in 1984. Thus, after allowing for social desirability bias there was apparently little difference in the percentage of active adults between the ages of 25 and 64 from 1981 to 1984 but there does appear to have been more who were at least occasionally participating in heavy intensity activity.

There is a sobering aspect even to this finding. While the number occasionally participating in heavy intensity activity may have increased regular participation does not show any measurable change over the two time periods [Table 3(b)]. In 1981 10% met the more stringent DHHS requirements of 3 days/week of vigorous physical activity. In 1984 approximately 8.4% were active in heavy intensity activity more than 60 days/year. Given the biases within the data and the absence of such activities as sports and dance lessons in the SMRB data these differences are not substantially different. If the less stringent definition of the minimum level of physical activity thought to promote cardiovascular improvement is used, (i.e. moderate intensity activity over 3 days/week is an acceptable minimum), then approximately 16 and 17.8% met the requirements during the two respective time periods. Again the differences are not large enough to outweigh the biases and errors within the data.

The major changes in the physical activity behavior of adults within the 25–64 age range between 1981 and 1984, therefore, apparently occurred in the number who were occasionally active in heavy intensity activities. Regularity of participation, however, is another matter. Unless there were dramatic increases in physical activity participation among the 18–24 age category that was not included in this study it is unlikely that the 1990 goal will be met.

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