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Activities Contributing to Total Energy Expenditure in the United States: Results from the NHAPS Study

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Abstract

Background: Physical activity is increasingly recognized as an important factor influencing health and disease status. Total energy expenditure, both low-intensity and high-intensity, contributes to maintenance of healthy body weight. This paper presents the results of a quantitative approach to determining the activities that contribute to total energy expenditure in the United States.

Methods: Data from the National Human Activity Pattern Survey (NHAPS) were used. In 1992–1994 the NHAPS sampled 4,185 females and 3,330 males, aged 18 years and over, weighted to be representative of the 48 contiguous United States. A detailed report of each activity performed in the previous 24 hours was obtained. A score was created for each activity, by multiplying duration and intensity for each individual and summing across individuals. This score was then used to rank each activity according to its contribution to total population energy expenditure, for the total sample and separately for each gender, race, age, region, and season.

Results: This analysis reveals our society to be primarily sedentary; leisure time physical activity contributed only approximately 5% of the population's total energy expenditure. Not counting sleeping, the largest contributor to energy expenditure was "Driving a car", followed by "Office work" and "Watching TV". Household activities accounted for 20.1% and 33.3% of energy expenditure for males and females respectively.

Conclusion: The information presented in this paper may be useful in identifying common activities that could be appropriate targets for behavioral interventions to increase physical activity.

Background

The United States Surgeon General's report on physical activity observed that a lack of physical activity has been associated with increased risk of mortality and morbidity from coronary heart disease, high blood pressure, colon cancer, diabetes, obesity related outcomes, and depression [1]. There is extensive agreement that regular high-intensity physical activity has cardiovascular and other

health benefits [1]. The health benefit of moderate-intensity physical activity is the subject of more debate, but there is wide agreement about its value. In 1995, the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) made a joint recommendation that 30 minutes/day of moderate activity for most days of the week would improve the health status of individuals who do so on a long-term

basis [2]. Recently, the Institute of Medicine recommended doubling the amount of moderate physical activity previously advised, to 60 minutes/day [3].

In contrast to the cardiovascular and other health benefits attributed to moderate and vigorous activity, the maintenance of a healthy body weight is a function of total energy expenditure, including low-intensity expenditure such as household activities or sedentary jobs, the kinds of activities that most people engage in most of the time. Prevention of population weight gain requires that we understand all domains of energy expenditure and include them in strategies for preventing obesity. This report provides insight about those other domains.

This paper presents the results of a quantitative approach to determining the activities that contribute to total energy expenditure in the United States, using data from the National Human Activity Pattern Survey (NHAPS) [4]. By quantifying all forms of physical activity, we have identified those activities that are the most important contributors overall, as well as within each gender, race, age and region. These results provide for the first time a picture of the nature of total energy expenditure in the United States population. They may be useful in guiding strategies for obesity prevention and in the design of physical activity assessments.

Methods

Description of the NHAPS dataset

The National Human Activity Pattern Survey (NHAPS) was conducted by the Survey Research Center at the University of Maryland, for the U.S. Environmental Protection Agency. The data from the respondents were collected from October 1992 through September 1994. Respondents were selected using the random-digit dial method, from each of the contiguous 48 states, using sampling stratified by the four major census regions and by weekend/weekday. The final number of interviews represents 63% of all household telephone numbers selected. Among households where an eligible respondent was reached, the cooperation rate was 76%. The data were collected by computer-assisted telephone interviews, lasting

approximately 25 minutes, and demographic data include age, gender, education and location of residence.

The survey included a 24-hour recall of daily activities for 9386 participants. All activities (or non-activities, including sleeping) over a 24-hour period were reported. This methodology is analogous to 24-hour dietary recalls used by national surveys of dietary intake [5]. Without prompting about the nature of the activities, respondents were asked to start with the time of arising on the previous day, and to describe everything they did and the time spent doing it – for example, "8:00–8:20, getting dressed; 8:20–8:30, eating breakfast." Activities were recorded in the respondents' own words, and recoded later by the authors. In addition to the identification of the specific physical activity, information on location and duration of the activity was obtained.

Study Population

The NHAPS study surveyed 9,386 individuals, of which 7,515 were adults. Survey methods and demographic information on the entire study population have been previously described [4,6]. Of the 7,515 adults, 4,185 (55.7%) were females and 3,330 (44.3%) were males. The study population was predominantly white (81.9%, n = 6152); 9.6 % (n = 719) were African-American. Other ethnic groups consisted of Hispanic (3.7%, n = 279), Asian (1.6%, n = 123), and Other (1.6%, n = 121). An additional 121 individuals refused to identify their ethnicity. Most (87.6 %) of the participants had obtained high school degrees or higher. Individuals were interviewed throughout the year. The age distribution of the sample can be found in Table 1.

Weighting of the data

Sample weights were calculated for each subject to achieve estimates representative of the U.S. population as of the 1990 census. The weighting included adjustment for census region and for unequal probabilities of selection, due to factors such as oversampling of households with children and households with multiple phone lines, under-sampling of adults from multiple-adult households, and oversampling of weekend interviews. Further information

Table 1: Age distribution of Adults in the NHAPS Study¹.

Age Group	N	Percent of Adult Population (%)	Weighted Percent of Adult Population (%)
18–24	733	9.8	13.7
25–34	1622	21.6	23.5
35–44	1489	19.8	20.5
45–54	1187	15.8	13.8
55–64	962	12.8	11.5
65–74	816	10.9	9.9
75 and over	533	7.1	7.1

¹National Human Activity Pattern Survey (NHAPS). 173 adults (2.3 %) refused to provide their age

on this weighting process has been previously described [6]. For the 173 adults who refused to provide their age, a median weight was assigned. Weights were used in the final score (energy expenditure) calculation and rankings.

Development of the activity groups and MET values

The NHAPS Diary file was composed of 157,234 records of activities completed by the participants. There were 125,533 entries after elimination of entries that were either performed by a child (age < 18 years), interviewed through a proxy, ambiguous, or incomprehensible. Each diary entry of the 7,515 adults was then evaluated and grouped together with similar activity descriptions. For example, a diary entry of "just sitting and relaxing" was grouped together with "reading the paper" under the activity category of "Activities performed while sitting or lying quietly." There were on average seventeen diary entries per adult describing the previous 24 hours. The number of entries ranged from one to fifty-nine entries per adult.

The 125,533 mentions of activities were initially coded to 255 categories using activities described in the Compendium of Physical Activities [7]. The Compendium of Physical Activities and the Compendium Update by Ainsworth et al. [7,8] were used to assign the appropriate metabolic expenditure values (METs; 1 MET = 1 kcal·kg⁻¹ body weight·h⁻¹) for each activity category. Activities that were similar conceptually and in activity level (MET value) were further grouped to make up the final 88 activity categories. Activities that were performed by fewer than ten individuals were grouped with similar activities to form more general categories. For example, activities such as ping pong (n = 1, MET = 4.0), and miniature golf (n = 3, MET = 3.0) were grouped with other sports to form the category "Other light recreational sports". Categories that included activities with more than one MET value were assigned a MET value equal to the average of the MET values in that category.

Some individuals did not provide any further description of their time at work besides "regular job". In order to classify the type of activity performed by such respondents, we used the specified location in which the "regular job" took place. For example, if the "regular job" took place in an "office building", the activity was categorized as "office work". When such information was not available, activities were grouped with those specified as office work. There were 101 of the 9,386 individuals (1%) who did not remember or refused to describe their activities during some portion of their previous 24 hours. These time periods were assigned a MET value equivalent to sitting quietly and grouped with activities in the category "activities performed while sitting quietly".

The activity categories are shown in the Appendix (see Additional file 1, "Appendix A.doc"), together with the MET values and the identification of activities classified by the authors as leisure time or household activities.

Score creation (MET × duration)

Energy expenditure was determined by calculating a Score for each mention of an activity (i.e., each of the 125,533 mentions of activities). As body weight was not available on the dataset, it was not possible to calculate the energy expenditure at an individual level. Instead we created a Score for each activity performed, based on the duration and intensity of the activity. The Score was calculated by multiplying the MET value assigned to that activity (kcal kg⁻¹ body weight hour⁻¹) times the reported duration of activity (hour). The Score was thus equivalent to the kcal kg⁻¹ body weight associated with an individual's specific activity. This score was further multiplied by the sample weight assigned to the individual in order to make the sample estimates representative of the 1990 US Census data, as previously discussed. Thus, each description of an activity performed in the past 24 hour period was given a weighted score which takes into account the MET value associated with that activity and the duration.

Rankings

The contribution of each activity category to the total population energy expenditure was calculated by summing the Scores of all mentions of that activity. That is, for example, the contribution of "Driving a car" to total energy expenditure is calculated as the sum of the Scores of all times that "Driving a car" was mentioned. Thus, the total Score attributed to each of the 88 activity categories is the sum of the scores (MET * duration) of each time that activity was performed, summed over all individuals in the dataset. The amount contributed by an activity thus takes into account not only its intensity (MET value), but also the frequency of its performance by the population, and its average duration. The percent of total energy expenditure contributed by each activity category is calculated as the contribution from that activity category divided by the sum of all activities over the entire population. Activity categories were then ranked in order of their percent contribution to the energy expenditure of the population. The ranking was performed on the total sample, and separately by gender, race, age, EPA region, census region and season.

Calculation of mean kcal expenditure

Two calculations were performed to help evaluate the apparent completeness of the capture of activities and the appropriateness of the MET assignments. First, we calculated the energy expenditure for the NHAPS population, and compared it with the Estimated Energy Requirement for the NHAPS population based on their age and sex dis-

tribution. The Estimated Energy Requirement (EER) for men and women can be calculated using formulae from the Institute of Medicine Dietary Reference Intakes [3]:

Men 19+ years: $EER = 662 - (9.53 \times \text{AgeDiff}) + (\text{PA} \times 15.91 \times \text{Weight [kg]}) + (539.6 \times \text{Height [m]})$

Women 19+ years: $EER = 354 - (6.91 \times \text{AgeDiff}) + (\text{PA} \times 9.36 \times \text{Weight [kg]}) + (726 \times \text{Height [m]})$

where PA is a factor reflecting activity level: Sedentary, 1.0–1.4; low active, 1.4–1.6; active, 1.6–1.9; high active, 1.9–2.5; and AgeDiff is the number of years of age over age 19. We assumed a PA value of 1.4, and used the reference heights and weights for men and women given by the Institute of Medicine [3] (70 and 57 kg, 1.77 and 1.63 m), and an age of 43 years (which was the median age in the NHAPS population).

In a second evaluation of completeness, the total hours expended is calculated (Appendix A, total persons \times Average Duration). This number, when divided by the sample size of 7,515, should equal 24 hours if the data capture is complete.

Results

The median energy expenditure score, including sleeping, was 36.8 kcal \cdot kg⁻¹ for men and 36.5 kcal \cdot kg⁻¹ for women (mean: 39.9 kcal \cdot kg⁻¹ and 37.8 kcal \cdot kg⁻¹ respectively.) Using median body weights and energy scores, the total energy expenditure would be 2885 kcal and 2469 kcal for men and women respectively. The total number of hours per person resulting from the calculation of persons \times Average Duration / 7515 is 24.01 hours per person.

The 88 activities were ranked in order of their contribution to energy expenditure for the entire sample. Sleeping or napping was the most common activity performed by the population, and averaged eight hours in the past 24-hour period, for both males and females. Sleeping or napping contributed 19% of the overall energy expenditure of the population.

In order to understand energy expenditure during waking hours only, all further descriptions of rankings will exclude sleeping as an activity. After exclusion of sleeping, the largest contributor (10.9%) to energy expenditure was "Driving a car" (Table 2). The next largest contributors were "Job: office work" (9.2%), "Watching TV or a movie" (8.6%), "Taking care of children/baby" (8.4%), "Activities performed while sitting quietly" (5.8%), "Eating" (5.3%) and "Cleaning house, general" (3.9%). With the exception of "Taking care of children/baby" and "Cleaning house", the majority of the activities that account for 50 percent of the energy expenditure of the sample are pre-

dominantly very light in intensity. The 31 activities that account for 90 percent of the total energy expenditure, not including sleeping, are listed in Table 2. Ten of the 31 activities found on this list are occupational categories. It is notable that in the list representing the top 90% of energy expenditure, only four leisure-time activities are included (#s 22, 25, 29 and 31). Two of them, swimming and exercise/aerobics, are commonly measured by physical activity assessment tools. However, together these four activities make up less than 3% of the total waking energy expenditure in this sample.

A complete list that ranks all 88 activities can be found in the Appendix, together with identifications of the activities that were categorized as leisure and household. From the Appendix the total number of hours expended on each activity and each category of activity (moderate intensity, vigorous intensity, leisure, job, etc.) can be calculated. Overall, activities that are considered leisure time physical activity made up only approximately 5% of the total energy expenditure. On any given day, approximately 86% of the population engaged in no leisure physical activities as defined here. In contrast, activities that are household-related made up 27% of the total energy expenditure for this sample. Approximately another one-fourth of energy expenditure was derived from employment. Low-intensity jobs (MET < 3.0) made up 12.7% of all energy expenditure, moderate-intensity jobs (3–6 MET) contributed 11.4%, and high-intensity jobs (MET > 6.0) contributed only 1.8% to total energy expenditure. Activities of any type (leisure, work, household or other) that represented moderate-intensity physical activity (3–6 METs) represented 33.6% (most of which were at the lower end of the range), while high-intensity physical activity (MET > 6) represented 5.5 % of total energy expenditure. On average, the population spent 2 hrs 50 minutes "Watching TV/movies" and 1 hr 25 minutes on "Activities performed while sitting quietly".

Activities by gender

In the data-based approach to activity assessment used here, all types of activities are assessed, including activities that are not often thought of as important energy expenditure contributors due to their lower intensity level (e.g. cleaning house). Using this approach, the median energy expenditure scores for men and women were approximately equivalent, 36.8 vs. 36.5 kcal \cdot kg⁻¹ for men and women respectively. Mean scores for males and females were 39.9 and 37.8 kcal \cdot kg⁻¹ respectively, suggesting that there is a subset of men who expend substantially more energy than women. These results suggest that independent of the difference in body weight between men and women, the per-kg energy expenditure of men and women is similar.

Table 2: Activities that account for 90% of energy expenditure in the United States, not including sleeping¹.

Rank	Activity Description	MET	Percent of Total Score (%)	Cumulative Percentage (%)	Number of people
1	Driving car	2.3	10.9	10.9	6574
2	Job: Office work, typing	1.5	9.2	20.1	2094
3	Watching TV/movie, home or theater	1.0	8.6	28.8	5919
4	Taking care of child/baby, (feeding, bathing, dressing)	3.0	8.4	37.2	6545
5	Activities performed while sitting quietly	1.3	5.8	42.9	4086
6	Eating (sitting)	1.5	5.3	48.2	6843
7	Cleaning house, general	3.0	3.9	52.2	1489
8	Talking/ Visiting, in person or on phone	1.5	3.8	56.0	2858
9	Job: Industrial plant/factory (e.g. assembly line)	3.0	3.8	59.7	333
10	Food preparation (e.g. cooking, baking, setting table)	2.0	2.9	62.7	3996
11	Job: Construction site	5.5	2.8	65.4	119
12	Job: Light intensity, stand/walking (e.g. hospital staff, real estate)	3.0	2.7	68.1	291
13	Yard work-general (e.g. mowing lawn, trimming hedges)	4.3	2.6	70.7	559
14	Attending event (social) involving talking while sitting	1.6	2.2	73.0	1499
15	Shopping for non-foods (e.g. clothing)	2.3	2.1	75.0	1408
16	Job: Light standing (e.g. store clerk, bartender, hair stylist, lab work)	2.0	1.8	76.8	289
17	Job: Farm hand (chores: baling hay, cleaning barn)	8.0	1.5	78.4	57
18	Job: Restaurant staff (e.g. waiter, chef)	3.0	1.5	79.9	129
19	Job: Teaching class	1.8	1.1	81.0	195
20	Laundry	2.2	1.1	82.0	863
21	Walking, moderately, (e.g. doing errands, walking to school)	2.8	1.0	83.1	716
22	Fishing and Hunting	3.3	0.9	84.0	103
23	Cleaning kitchen (sweeping)	3.3	0.9	84.9	689
24	Shopping for food, putting groceries away	2.4	0.9	85.7	1125
25	Swimming	7.0	0.8	86.6	96
26	Job: Mechanic	3.0	0.7	87.3	56
27	Gardening: Weeding, landscaping, picking vegetables	3.7	0.6	87.9	198
28	Remodeling, repairing house, workshop, concrete work	3.6	0.6	88.5	123
29	Exercise, aerobics	6.5	0.6	89.1	248
30	Job: Driving (e.g. truck driver, bus, ambulance, tractor)	2.7	0.6	89.7	88
31	Dancing/ Heavy Partying (all styles of dancing)	4.0	0.6	90.2	122

¹National Human Activity Pattern Survey (NHAPS).

The types of activities contributing to these expenditure levels are shown in Table 3, by gender, for activities contributing to the top 90% of energy expenditure. Ninety percent of men's energy expenditure can be described by thirty-one activities, while women's energy expenditure can be described by twenty-five. The two lists of activities in Table 3 demonstrate the difference in time and energy expenditure between males and females in their typical activities during the day. There are five activities mentioned on these two lists that were not present on the previous list for the entire sample. The energy expenditure for leisure time physical activity was slightly higher for males (6.5 %) than females (4.2 %) (data not shown). Household related activities accounted for 20.1 and 33.3 % of the energy expenditure for males and females, respectively. Only 16.4% of males and 11.3% of females reported performing at least one occurrence of leisure time physical activity during the previous 24-hour period.

Activities by ethnic Group

The NHAPS study included subjects from five ethnic groups across the country. While activities are described below for each ethnic group, these representations of usual activity patterns should be interpreted with caution for the Asian and Other groups, due to small sample size.

Lists of activities contributing to daily energy expenditure were calculated for each ethnic group (data not shown). Each list uncovered additional activities that were not seen on the overall list. The list for Whites was similar to the overall list of activities except for the addition of two more activities: "Moving, packing items" and "Sports: Golf". The list for African-Americans included the additional activity of "Caring for another person". The list for Hispanics included the additional activity of "Household chores, light cleaning". The list for Asians included two additional activities: "Sports: Golf" and "Playing with

Table 3: Activities accounting for 90% of energy expenditure in the United States for males and females¹.

Male		Female	
Rank	Activity Description	Rank	Activity Description
1	Job: Office work, typing	1	Driving car
2	Driving car	2	Taking care of child/baby (feeding, bathing"center"230;)
3	Watching TV/movie, home or theater	3	Watching TV/movie, home or theater
4	Taking care of child/baby (feeding, bathing...)	4	Job: Office work, typing
5	Job: Industrial plant/factory	5	Cleaning house, general
6	Job: Construction site	6	Activities performed while sitting
7	Activities performed while sitting	7	Eating (sitting)
8	Eating (sitting)	8	Food preparation (cooking, baking...)
9	Yardwork-general: mowing lawn, trim	9	Talking/ Visiting, in person or on phone
10	Talking/ Visiting, in person or on phone	10	Job: Light intensity, stand/walking
11	Job: Farm hand	11	Shopping for non-foods (e.g. clothing)
12	Attending event (social) involving talking	12	Attending event (social) involving talking
13	Job: Store clerk, bartender, hair stylist	13	Laundry
14	Job: Light intensity, stand/walking	14	Job: Industrial plant/factory
15	Cleaning house, general	15	Job: Store clerk, bartender, hair stylist
16	Fishing and Hunting	16	Job: Restaurant staff (e.g. waiter, chef)
17	Shopping for non-foods (e.g. clothing)	17	Yardwork-general: mowing lawn...
18	Job: Mechanic	18	Job: Teaching class
19	Food preparation (cooking, baking...)	19	Cleaning kitchen (sweeping)
20	Job: Restaurant staff (e.g. waiter, chef)	20	Shopping for food, putting groceries away
21	Job: Driving (e.g. truck driver, bus driver...)	21	Walking, moderately, (e.g. doing errands...)
22	Remodeling, repairing house, workshop	22	Swimming, exercise
23	Walking, moderately, (e.g. doing errands...)	23	Home projects (sewing, wrapping presents...) ²
24	Sports: Golf ²	24	Gardening: Weeding, landscaping...
25	Dancing/ Heavy Partying (all styles)	25	Moving, packing items ²
26	Job: Teaching class		
27	Car maintenance, repair ²		
28	Gardening: Weeding, landscaping...		
29	Swimming, exercise		
30	Exercise, aerobics		
31	Yardwork-hard: chopping firewood, digging... ²		

¹National Human Activity Pattern Survey (NHAPS). Exclusive of sleeping/naping ²Activities that were not present on list for entire sample

children, baby". The list for Others included two additional activities: "Job: Painting" and "Home projects".

The number of activities needed to capture 90% of the energy expenditure varied by ethnic group, with the most number of activities used to describe the White group and the least number of activities used to describe the African-American group (Table 4). The White group's percentages for both leisure time physical activities and household-related energy expenditure were the highest among the ethnic groups. African-Americans had the lowest percentage of leisure-time physical activity and Asians had the lowest percentage of household-related activities. The African-American group also had the highest percentage of individuals who did not report any leisure time physical activity in the past 24-hour period. Scores for Hispanics were intermediate between the White and African American group.

Past studies have indicated that minority women often have lower physical activity levels than other subgroups [9,10]. A further division of ethnic group by gender was used to examine differences in activity patterns between men and women, by ethnic group. The mean Scores, and percentages for leisure time physical activity and household related activities for White, African-American, Hispanic and Asian males and females are displayed in Table 5. In all ethnic groups except Asians, there is a pronounced difference between the two genders in the amount of energy expenditure attributed to household related activities, and to leisure time activities. In each ethnic group, the percentage of energy expended on household related activities was higher for females than males. The percentage of energy expenditure due to leisure time physical activities was higher for males in each ethnic group except for Asians. As in previous research, African-American women were found to have the lowest expend-

Table 4: Physical Activity Patterns of each Ethnic Group in the NHAPS Survey⁴.

Race	Number of Individuals (N)	Number of activities ¹	Leisure Time Physical Activities (%) ²	Household Related Activities (%) ²	No participation in LT PA (%) ³
White	6152	32	5.6	27.2	85.9
African-American	719	21	3.6	24.0	90.8
Hispanic	279	27	5.2	26.2	86.7
Asian	123	22	5.5	22.5	82.9
Other	121	25	4.0	25.0	85.9

¹Number of activities to account for 90% of energy expenditure for each group. ²Percentage of energy expenditure for each group. ³Percentage of individuals who did not report at least one occurrence of leisure time physical activity in the past 24-hour period. ⁴National Human Activity Pattern Survey (NHAPS). 173 individuals refused to identify their ethnicity and are not included in this table.

Table 5: Race and Gender Patterns of Physical Activity in the NHAPS Study³.

Race	Gender	Number of Individuals (N)	Number of activities ¹	Leisure Time Physical Activities		Household Related Activities		Mean Score (kcal/kg)
				(%) ²	(kcal/kg)	(%) ²	(kcal/kg)	
White	Male	2753	31	6.7	2.70	20.3	8.18	40.3
	Female	3399	26	4.5	1.71	34.0	12.92	38.0
African-American	Male	277	23	6.3	2.39	16.7	6.35	38.0
	Female	442	17	1.5	0.55	29.7	10.87	36.6
Hispanic	Male	124	25	6.3	2.48	20.0	7.86	39.3
	Female	155	19	4.5	1.68	32.2	12.04	37.4
Asian	Male	63	17	3.2	1.12	21.7	7.62	35.1
	Female	60	21	8.1	3.05	23.4	8.82	37.7

¹Number of activities to account for 90% of energy expenditure for each group. ²Percentage of energy expenditure for each group ³National Human Activity Pattern Survey (NHAPS). 173 individuals refused to identify their ethnicity and are not included in this table.

iture on leisure time physical activities. They do perform, however, a much larger percentage of household related activities than their male counterparts.

Each ethnic and gender subgroup also provided additional activities that were not on the overall activity list or their respective gender activity list. For White males, there were four activities that did not appear on the overall list: "Sports: Golf", "Car maintenance, repair", "Yardwork – hard: e.g. chopping firewood..." and "Job: Feeding/ Working with livestock." White females include three more additional activities that were not on the overall list: "Home projects (sewing...)", "Moving, packing items" and "Washing dishes/loading dishwasher". The list created for African-American males included three activities that were not on either the overall or male activity list. These were "Caring for another person", "Sports: soccer", and "Sports: Basketball". African-American females also included the activities of "Caring for another person" and "Exercise, aerobics". The list for Hispanic males included two activities that were not on either the overall or male

activity list: "Sports: Basketball" and "Sports: Soccer." Hispanic females also included two additional activities that were not on the list generated for females: "Dancing/ Heavy Partying..." and "Playing outdoors with others". For Asian males, there were three activities that did not show up on the list generated for all males: "Cleaning kitchen (sweeping)", "Playing with children", and "Other moderate recreational sports." The list for Asian females included two activities that were not on the overall list: "Sports: Golf" and "Home projects (sewing...)". The activities of "Sports: Golf" and "Fishing and Hunting" were also on the Asian female list but not on the list generated for all females.

Activities by age

The results in Table 6 demonstrate a decreasing trend in the amount of energy expended on leisure time physical activities with increasing age. This is paralleled by an increasing amount of energy being spent on household related activities with increasing age. Mean scores for the study population peaked in the age group of 35–44 years

Table 6: Physical Activity Patterns of each Age Group in the NHAPS Survey¹.

Age Group	Number of Individuals (N)	Leisure Time Physical Activities (%) ²	Household Related Activities (%) ²	No participation in LT PA (%) ³	Mean Score (kcal/kg)
18-24	733	7.9	18.6	82.1	38.4
25-34	1622	6.7	23.8	82.2	40.0
35-44	1489	4.8	26.6	87.2	40.2
45-54	1187	4.7	26.9	87.4	39.1
55-64	962	3.6	30.5	89.5	38.7
65-74	816	5.2	35.2	88.4	36.7
75+	533	1.9	36.0	92.3	34.0

¹National Human Activity Pattern Survey (NHAPS). ²Percentage of energy expenditure for each group. ³Percentage of individuals who did not report at least one occurrence of leisure time physical activity in the previous 24-hour period.

and dropped off in successive years. Each age group included activities different from those found in the overall list. The lists for the older age groups (65-74 and 75+ years) had the largest number of different activities. The activity list for the age group of 65-74 years included six activities that were not on the overall list: "Sports: Golf", "Yardwork - hard: e.g. chopping firewood...", "Home projects (sewing...)", "Game, board or cards...", "Petcare: walking..." and "Household chores, light cleaning." The activity list for the age group of 75 years and over included six activities that were not on the overall list as well: "Painting walls", "Volunteer work, unspecified", "Game, board or cards...", "Home projects (sewing...)", "Household chores, light cleaning" and "Washing dishes/ loading dishwasher."

Activities by region

Physical activity patterns were also evaluated by region (Table 7). Energy expenditure for leisure time physical activity was the greatest for the Pacific (California, Nevada, Arizona, Hawaii), New England (Maine, New Hampshire, Vermont, Massachusetts, Connecticut and Rhode Island) and Mountain (Washington, Oregon, Idaho, Alaska) regions. The Central region (Nebraska, Kansas, Iowa, and Missouri) had the lowest energy expenditure for leisure time physical activity. The percentage of individuals who didn't mention any leisure time physical activity in the past 24 hour period was lowest in the Pacific and Mountain regions, and highest in the Central region. The South Central (New Mexico, Texas, Oklahoma, Arkansas, and Louisiana) and Central regions had the greatest energy expenditure spent on household related activities, while the North Central region (Montana, Wyoming, Utah, Colorado, North Dakota, and South Dakota) had the lowest.

As individuals were surveyed throughout the year, we also evaluated whether there were any seasonal differences in activity (data not shown). As expected, a larger percentage

of energy expenditure on leisure time physical activities was seen in the warmer seasons: summer (6.8%), spring (5.3%) and fall (5.3 %) than in the winter (3.9%) season. This is similar to the findings from the Surgeon General's report that individuals are substantially more often physically inactive in the winter months than the summer months [1].

Discussion

Prevention and modification of population obesity requires an understanding of the nature of the activities that comprise the current patterns of energy expenditure. These data present a graphic portrait of a society in which sedentary and low-intensity activities predominate. They also make clear that leisure time physical activity contributes a very small proportion (5%) of the total energy expenditure in the United States. The data also suggest strategies for preventing population weight gain that acknowledge and make use of the patterns described here.

It is clear that Americans need to be more physically active, and to increase the ratio of energy expended to energy consumed in order to control the increase in the prevalence of obesity. How this is to be achieved is less obvious. With such a small proportion of time and energy expended in leisure time physical activity, it is clear that this is of very low priority for most Americans. Perhaps this is in part simply a reflection of time constraints of modern life. Americans work more total annual hours than persons in most other developed countries - for example, in 2001, 1821 hours compared with 1467 hours in Germany [11]. The problem of long working hours is often compounded by long commutes. In just the decade between 1990 and 2000, the proportion of workers who commuted for 30 or more minutes a day increased from 19.6% to 33.7% [12,13]. Dual-earner families have also increased, and both husband and wife held jobs outside the home in two-thirds of married couples in the year 2000 [14]. Further, a substantial number of others are sin-

Table 7: Physical Activity Patterns of each EPA Region in the NHAPS Survey¹.

EPA Region	Number of Individuals (N)	Leisure Time Physical Activities (%) ²	Household Related Activities (%) ²	No participation in LT PA (%) ³	Mean Score (kcal/kg)
New England	464	7.2	26.2	84.5	38.5
North Atlantic	770	6.0	27.1	84.2	38.6
Mid-Atlantic	890	4.7	27.4	88.7	38.3
South Atlantic	1356	4.4	26.5	87.9	38.8
Midwest	1319	4.6	26.0	88.3	38.7
South Central	787	4.5	28.5	86.9	38.8
Central	345	3.5	28.1	91.6	39.3
North Central	276	5.7	24.9	83.3	39.4
Pacific	1005	7.6	26.0	82.8	38.4
Mountain	303	7.0	27.3	82.5	40.0

¹National Human Activity Pattern Survey (NHAPS). ²Percentage of energy expenditure for each group. ³Percentage of individuals who did not report at least one occurrence of leisure time physical activity in the past 24-hour period.

gle-parent households where the responsibilities of earning a living, raising children and maintaining a household fall on a single person. Given these time constraints, perhaps ways other than leisure-time physical activity should be found to encourage energy expenditure. These tables make clear that it is ordinary, day-to-day mundane activities that contribute the great majority of our current energy expenditure. It may be that we could achieve a greater effect by modest increases in the duration or intensity of those activities than we could by large increases in the very small percent of time spent on leisure time activities.

As with dietary interventions, it may be more successful to increase frequency or intensity of activities already commonly performed, rather than attempting to introduce new behaviors into established lifestyles. For example, at work people could be encouraged to "walk up two or down three flights". Commuters could be encouraged to park a slight distance away from their destination. This is consistent with numerous recent recommendations for an "active living" approach [1,15]. The NHAPS data suggest that this approach could have a substantial population impact, since these activities comprise such a large proportion of total energy expenditure. Such an approach could have several benefits, as light-to-moderate activity has been found to be most effective in motivating sedentary individuals [16], to benefit sedentary and obese individuals [17], and frequent moderate activity was found to be associated with better control of body fat [15].

The other observation suggested by these data is that the only "available" time in which leisure time physical activity might be performed would come from the category "Watching TV/movie, at home or theater", which accounted for two hours and 50 minutes of the population's average day. Promotion of leisure time physical

activity that was explicitly linked to a corresponding restriction in TV viewing might be more effective than unspecific promotion of increased activity.

The 24-hour recall approach reveals some important aspects of physical activity by gender and ethnic group. Women have often been reported to be less active than men, in research using self-report instruments [9]. This finding could be influenced by the types of activities assessed [18]. In the NHAPS 24-hour recall approach, all types of activities could be reported. The results indicate that women have only slightly lower activity levels than men in terms of kcal/kg body weight (medians 36.8, 36.5), although men must expend more total kilocalories due to their heavier body weights (Table 5). Women had substantially less leisure-time physical activity, but total energy expenditure was approximately compensated by a higher proportion of household activities. These results emphasize the importance of household activities, which provide approximately one-third of the daytime energy expenditure for women.

While all ethnic groups appear to have inadequate activity levels, African Americans in particular are consistently found to have the lowest percent of total energy expended in leisure time activities, and the highest proportion of the population reporting no leisure time activity. In addition, African Americans had lower total expenditure in kcal/kg than either Hispanics or non-Hispanic whites (Table 5). Minority groups have consistently been found to have relatively lower physical activity levels than other groups [10]. However, these surveys have not always taken into account energy expenditure from occupational and household related activities. The data presented here take into account energy expenditure from all sources, and indicate that non-leisure activities are also lower among African Americans.

Younger age groups expended more kcal/kg body weight and a larger percentage of their energy in leisure time physical activities compared to older age groups. These results are similar to the trend described in the Surgeon General's Report in 1996, in which the prevalence of physical inactivity was noted to be higher in older groups [1]. Interestingly, people aged 65–74 actually performed a higher percentage of leisure time physical activities and household related activities than did people aged 55–64 (Table 6). This may be due to the greater available time for these activities after retirement, and highlights the problem of time constraints in the promotion of physical activity.

Regions along the western and eastern coast had larger percentages of energy expenditure spent on leisure time physical activities than other groups. Nevertheless, even in the relatively more leisure-time-active regions 82.5% of persons reported no leisure-time activities.

The strength of this study lies in the large sample, the representativeness, and the 24-hour recall approach. The reasonable similarity of the energy expenditure estimates to the estimated energy requirements using the IOM formulae [3] suggest that activities shown here represent a reasonably complete capture of activities in this population, and thus may provide a valid picture of U.S. activity patterns. The physical activity methodology used here has been used in physical activity research [19] and in the social sciences and environmental exposure literature for at least 40 years, with several very large studies including a multinational study of 25,000 persons in 12 countries [4]. In addition, the method as applied to assessment of dietary intake has been the subject of extensive study, by the U.S. Department of Agriculture and other researchers, including in minority populations [20]. It is judged to be the most accurate method for the assessment of the intake of groups and the least subject to overreporting bias, and is the method used by national surveys such as the NHANES.

Response rate and missing data represent potential limitations of the study. The response rate of 63% is lower than desirable, although not too dissimilar to the response rate for the dietary data in NHANES III of 73%. As noted by Klepeis et al. [4], "When the number of interviews successfully completed (9,386) is divided by the number of interviews attempted [completed interviews (9,386) plus refusals (2,944) = 12,330], the resulting cooperation rate is over 76%. This cooperation rate is relatively high for a survey that did not utilize financial or other incentives to increase participation." No information is available on nonrespondents, but the likely bias is that persons who did participate were more interested in health, which implies that the data presented here are, if anything, opti-

mistic regarding the level of physical activity of the U.S. population. Missing data are unlikely to have a notable impact on these results, since only 1% of all respondents had any time periods that were missing a description of the activity or location.

These results represent a snapshot in time. Subjects were surveyed throughout 1992–1994. As new technologies are developed and as demographics change, new activities are created and certain activities may increase or decrease in importance. For example, video and computer game use was not as common during the time period of the survey as it is today. In view of that, these results may underestimate how sedentary our society is now. Conversely, the importance of physical activity has been increasingly emphasized in the time since publication of the Surgeon General's report in 1996 [1], so it is conceivable that some Americans have become more active. That is not supported, however, by data from the Behavioral Risk Factor Surveillance System (BRFSS), which found that trends in physical activity remained stable over the period 1990–1998 [21].

The usefulness of the activity lists presented here will of course depend on the purposes to which they may be put. The primary use may be in identifying strategies for preventing population weight gain that acknowledge and make use of the population-based activity patterns described here. The activity lists presented here reveal common behaviors that could become the focus of intervention efforts to increase their frequency or intensity. In addition, these lists may be useful in the development of assessment instruments for *total energy expenditure*. The great majority of these activities (unfortunately) do not contribute to cardiovascular fitness. Researchers studying cardiovascular fitness will continue to use instruments developed for that purpose [22]. However, like the dietary approach on which this study is based [23,24], this method has been used by one of the authors (GB) to develop a Total Energy Expenditure Questionnaire.

Conclusions

These analyses reveal the sedentary nature of most Americans. The activity lists may be helpful in identifying common activities that could be appropriate targets for behavioral interventions to increase their frequency or intensity. In addition, they may be useful to researchers seeking to assess energy expenditure.

Competing interests

None declared.

Authors' contributions

LD carried out the coding and statistical analysis, and participated in the drafting of the manuscript. RM partici-

pated in the statistical analysis and in the coordination of the study. GB conceived of the study, participated in the design and drafted the manuscript. All authors read and approved the final manuscript.

Additional material

Additional File 1

There is one additional document in Microsoft Word format with the file name, Appendix A.doc. This file contains Appendix A in the form of a table, containing the full list ranking activities performed by subjects in the NHAPS study, 1992–1994. Appendix A shows the activity categories, metabolic expenditure values and activity classifications.

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[<http://www.biomedcentral.com/content/supplementary/1479-5868-1-4-S1.doc>]

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