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Abstract

Objectives: To identify age differences in physical activity (PA) participation for women. **Methods:** Data from 3,952 women 25+ from the 2003–2006 National Health and Nutrition Examination Surveys (NHANES) were used to analyze participation patterns for 17 PA types. **Results:** The top five leisure PAs by participation rate for all ages were walking (42%), dancing (20%), treadmill (15%), biking (11%), and yoga (10%). Participation in running, dancing, treadmill, and team sports declined around ages 35 to 44, and participation in household PA, walking, weightlifting, and hiking declined around ages 55 to 64. At age 75+ further substantial decline in most activities occurred. Nativity status was the most important moderator for age-related PA decline. **Conclusions:** Total PA declines with age but significant decline does not occur until ages 55 to 64. Major decline in leisure PA participation starts earlier at ages 35 to 44. While age-related declining patterns differ for different activities, the top five most popular leisure activities are similar for all age groups.

Keywords

age, women, physical activity types, leisure PA, household PA, transportation PA

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Introduction

Physical activity (PA) is considered one of the most effective measures for preventing and controlling chronic illnesses, enhancing psychological well-being, and reducing the risk of premature mortality (U.S. Department of Health and Human Services, 1996). According to the Office of Research on Women's Health at the National Institutes of Health (National Institutes of Health Office of Research on Women's Health, 2010), there are striking gender differences in prevalence, progression, and outcome of numerous medical conditions, including diabetes, obesity, and cardiovascular diseases, all of which have been associated with PA. Past research has consistently reported that PA declines with age and that women are less physically active than men (Caspersen, Pereira, & Curran, 2000; DiPietro, 2001; Hawkins et al., 2009; Sallis, 2000; Shaw, Liang, Krause, Gallant, & McGeever, 2010; Troiano et al., 2008; Trost, Owen, Bauman, Sallis, & Brown, 2002). Past research has also reported that age-related PA decline patterns are different for women than for men, with a more rapid decline of leisure PA among women than among men (Shaw et al., 2010). Because men and women have different levels of PA, and the factors associated with activity levels are not consistent across the genders (Trost et al., 2002), gender-specific PA research is needed to obtain insights into gender-related PA behavior for knowledge building and for targeted policy interventions. Unfortunately, while many past studies on age-related PA behavior have acknowledged gender differences and reported descriptive statistics by gender, few studies have investigated women's PA in detail. Our discussion of the existing literature below includes age-related PA patterns for both men and women, with gender differences noted when possible.

For both men and women, studies have reported that the prevalence of PA was lower for older adults than for younger adults, and that age-related PA decline might not be linear (Hawkins et al., 2009; Sallis, 2000). Verbrugge and colleagues (1996) reported a curvilinear pattern in leisure PA across age groups with peak participation occurring at ages 30 to 49 and less participation for both younger and older adults. Shaw and colleagues (2010) reported that leisure PA was stable or even increased among adults younger than approximately age 33 but decreased within middle-aged and older adults at increasingly steep rates. The decline of leisure PA by age was more rapid for women than for men, mostly due to gender differences in time-varying health factors (Shaw et al., 2010).

Age-related PA decline might vary by activity type and the intensity of the activity. Walking was reported as the most prevalent activity among American adults of all ages (DiPietro, 2001). For younger men, running, team sports,

and weightlifting were popular activities, while for younger women aerobics was popular. The most prevalent activities among older adults tended to be lower intensity activities such as walking, yard work/gardening, golfing, and biking (DiPietro, 2001). Caspersen et al. (2000) described age-related changes for five PA patterns: (a) physical inactivity, (b) regular sustained light-to-moderate activity, (c) regular vigorous activity, (d) strengthening activity, and (e) stretching activity. Four of these patterns failed to improve with age, with the exception of the regular vigorous activity pattern. However, this exception was probably because their definitions of these patterns were age-sex adjusted so regular vigorous activity was actually less vigorous for older people than for younger people. Statistically significant differences between men and women were consistent across age groups for patterns of physical inactivity, regular sustained, and for strengthening. For the regular, vigorous activity pattern, men had significantly higher prevalence than women for the two oldest age groups, while women had a higher prevalence than men for the stretching pattern for ages 65 to 74. Saint Onge & Kruger (2011) utilized data for 15 leisure PA types to identify three categories of leisure activity: team sports such as baseball, basketball, volleyball, soccer, and football; fitness activities such as walking, running, aerobics, stretching, cycling, stair climbing, and weightlifting; and facility-based activities such as swimming, tennis, and golfing. Although age was not their focus, it was used as a control. Age was negatively associated with participation in team sports and fitness exercises, but positively associated with participation in facility-based sports. Marquez and colleagues (Marquez et al., 2011; Marquez & McAuley, 2006) found that among Latino adults age 50 or older, the top three leisure activities for both genders were walking for errands, walking for leisure, and stretching/flexibility exercises. Dancing was the fourth most popular activity with an increased participation rate with age. Women participated in significantly more light intensity household PA than men (Marquez et al., 2011; Marquez & McAuley, 2006). Van Mechelen et al. (2000) classified activities into organized sport, nonorganized sport, and other activities for young Amsterdam adults, and found that organized sport was at low levels at every age, whereas nonorganized sport was the primary component of activity that declined. Other activities actually increased significantly with age, indicating that examining only summary measures of activity may obscure a variety of underlying patterns.

Age-related PA decline might be moderated by demographic factors such as race/ethnicity. However, such interaction effects have rarely been examined. Hawkins et al (2009) used 2003 to 2004 accelerometer data from the National Health and Nutrition Examination Surveys (NHANES) and found that while PA decreased with age for both men and women, with men

being more active than women at all ages. Hispanic women were an exception as they were found to be more active at middle ages (40-59). Their results suggested the potential moderating effect of race/ethnicity on age-related PA decline.

In summary, although both gender and age differences in PA have been well documented, the full picture of PA decline is still not clear (Sallis, 2000). Due to the complexity of PA measurement, the classification of PA has varied widely in the literature. Objective measures of PA using accelerometer data typically classified PA by frequency, intensity, and duration, while subjective measures of PA in recent literature often classified PA for its purpose such as aerobic, strengthening, and stretching. While classifying PA by intensity, frequency, duration, and purpose is useful in studying the health benefits of PA, it overlooks the meaningful behavioral context of PA that may reflect individuals' personal identities and preferences (Saint Onge & Krueger, 2011). Such behavioral context is important for policymakers and educators in public health and health promotion because intensity and frequency of PA do not occur in isolation, but in context such as hiking, golfing, and gardening. Understanding age differences in types of PA in context can help policymakers and educators develop age-appropriate PA promotion programs, and evaluate the differential effectiveness of public health efforts promoting PA among individuals at different life stages (Macera & Pratt, 2000; Trost et al., 2002). This study investigates PA patterns of different age groups among U.S. women 25 and over by categorizing PA into 17 mutually exclusive behavioral categories: household PA, transportation PA, and 15 leisure activities: walking, dancing, treadmill, bicycling, running, team sports, weightlifting, yoga, hiking, swimming, golfing, fishing, tennis, bowling, and other leisure PA.

Hypotheses

The age-related decline in PA participation is probably most attributable to biological factors, such as the age-related reduction of dopamine, which is associated with the motivation for locomotion (Ingram, 2000). Progression of aging is often accompanied by age-related declines in vision, gait and balance impairment, vestibular dysfunction and muscle weakness, which may lead to an increased probability of fall and other PA-related injuries (Rubenstein & Josephson, 2006). As such, activities that require a higher level of physical functioning, such as higher intensity PA, may see faster declines with age than activities that require a lower level of these functions, such as lower intensity PA. Based on the existing literature, this research was guided by the following general hypotheses:

1. Both participation rate and time spent in total PA decrease by age. However, the pattern of decline may not be linear.
2. The most popular types of PA vary by age, with a tendency towards lower intensity activities for older women compared with younger women.
3. The patterns of PA decline differ by activity type, with higher intensity activities starting to decline earlier than lower intensity activities.
4. Age-related PA decline may be moderated by key socioeconomic and demographic variables such as nativity, race/ethnicity, education level, and income.

For the 17 PAs in this study, Table 1 shows the Metabolic Equivalent of Task scores (MET, $3.5 \text{ ml O}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) for moderate activity in the PA categories under study. For hypotheses 2 and 3, activities could be loosely ranked by their average MET scores. The top five higher intensity activities were running, tennis, swimming, hiking, and other leisure PA. The lowest intensity activities were yoga, bowling, weightlifting, golfing, and walking/transportation. However, recognizing that each activity had a range of intensities and that within-activity differences could be larger than between-activity differences, we did not form specific hypotheses regarding each activity.

Method

Data from women age 25 and over from the National Health and Nutrition Examination Survey (NHANES) 2003-2006 waves were analyzed (Centers for Disease Control and Prevention, 2003-2006). The NHANES is a program of studies designed to assess the health and nutritional status of adults and children in the United States. The survey combines interviews and physical examinations. For this study, the interview module of PA data was used. These data included an extensive array of questions related to daily activities and detailed information about specific leisure-time activities. After excluding subjects who were not able to be physically active due to health conditions and subjects who were pregnant at the time of interview, the final sample size was 3,952.

In a behavioral context, a common four-category classification for PA is: (a) occupational (work-related), (b) household (housework, yard work, physically active child care, chores), (c) transportation (walking or bicycling for the purposes of going somewhere), and (d) leisure-time (discretionary or recreational time for hobbies, sports, and exercise (Centers for Disease Control and Prevention, 2012). While NHANES had a question related to occupational

Table 1. Weighted Participation Rates for Various Physical Activity (PA) Types.

	Avg. MET ^a	Age 25-34	Age 35-44	Age 45-54	Age 55-64	Age 65-74	Age 75+
Meeting recommendation	N.A.	61%	59%	59%	54%	52%	35%
Total PA	N.A.	89%	89%	89%	84%	81%	65%
Household PA	4.0	71%	73%	74%	68%	62%	40%
Transportation PA	3.5	27%	24%	24%	17%	17%	19%
Total leisure PA	N.A.	74%	68%	69%	63%	60%	42%
Walking	3.5	46%	43%	46%	43%	40%	27%
Dancing	4.5	31%	22%	17%	18%	12%	7%
Treadmill	5.3	21%	16%	16%	16%	9%	7%
Biking	4.0	11%	13%	14%	10%	6%	5%
Yoga	2.5	14%	11%	11%	9%	7%	7%
Weightlifting	3.0	10%	9%	9%	6%	3%	2%
Running	6.5	17%	9%	7%	3%	1%	0%
Swimming	6.0	8%	6%	5%	7%	9%	3%
Hiking	6.0	8%	6%	6%	4%	4%	1%
Team sports	5.0	9%	6%	1%	1%	1%	1%
Golfing	3.5	2%	2%	3%	1%	1%	0%
Fishing	4.3	2%	1%	2%	3%	2%	1%
Bowling	3.0	2%	2%	1%	1%	1%	2%
Tennis	6.0	2%	2%	1%	2%	1%	0%
Other leisure PA	5.5	10%	7%	5%	4%	4%	3%

Note: PA = Physical Activity.

^aAverage moderate MET scores for activities were from the NHANES physical activity documentation at http://www.cdc.gov/nchs/nhanes/nhanes2005-2006/PAQ/PAF_D.htm

Bold numbers indicate that this participation rate was statistically significantly different at 95 confidence level from the immediate preceding age group. Asterisks indicate statistical significance when compared with the youngest age group of 25-34, with *** indicating $p < .01$, ** indicating $p < .05$, and * indicating $p < .1$.

PA, the recommended MET score for all four levels of occupational PA were below the typical moderate-to-vigorous activity cutoff level of 2.5 to 3. Thus occupational PA was excluded from our study. We focused only on household PA, transportation PA, and leisure-time PA (leisure PA), with leisure PA further divided into more detailed categories.

For household PA, NHANES respondents were asked if and for how long they did any home tasks over the past 30 days that required moderate or greater physical effort. For transportation PA, NHANES respondents were asked if and for how long they had walked or bicycled as part of getting to and from work, or school, or to do errands in the past 30 days. For leisure PA, NHANES collected data on 48 types of moderate-to-vigorous activities over the past 30 days, with detailed information on number of times and average duration of activity in minutes. For the purpose of this study, leisure activities with similar themes were combined. For example, basketball, football, baseball, softball, hockey, soccer, and volleyball were grouped into a team sports category. In addition, leisure PA categories with less than 2% participating rate for the whole sample were combined into a category titled "other leisure PA." In sum, 15 leisure PA categories, in the order of the highest to lowest participation rate for the whole sample, were created: (a) walking, (b) dancing and aerobics (dancing), (c) treadmill and stair climbing (treadmill), (d) bicycling, (e) running and jogging (running), (f) team sports, (g) weightlifting, (h) yoga and stretching (yoga), (i) hiking, (j) swimming, (k) golfing, (l) fishing and hunting (fishing), (m) tennis and racquetball (tennis), (n) bowling, and (o) other leisure PA. Adding household PA and transportation PA, a total of 17 mutually exclusive PA categories were studied. For each PA category, average MET score for each category was computed using MET information in the NHANES codebook and presented in Table 1 (Centers for Disease Control and Prevention, 2003-2004).

In addition to these 17 PA categories, two summary categories were created: total PA and total leisure PA. Both participation rates and average weekly minutes for the past 30 days were computed for each of the 17 PA categories and the two summary categories. Furthermore, a dummy variable was created to indicate if a respondent met the U.S. Department of Health and Human Services' recommendation of 150 min of moderate-to-vigorous PA per week (U.S. Department of Health and Human Services, 2008).

Six age categories were created: 25 to 34 (labeled age2534 in tables), 35 to 44 (age3544), 45 to 54 (age4554), 55 to 64 (age5564), 65 to 74 (age6574), and 75+ (age75+). This categorization allowed for nonlinearity in PA pattern across age groups, while taking into consideration key life events such as retirement, typically at the age of 65.

Descriptive statistics corrected for survey design were computed for all age groups. To tease out the effects of age from other confounders, regression models were estimated controlling for the following socioeconomic and demographic variables: marital status (married as reference group vs. not married), household size, education level (less than high school, high school graduate as reference group, some college, and college graduate), race/ethnicity (non-Hispanic White as reference group, vs. Black, Hispanic, and other races/ethnicity), income-to-poverty ratio, self-rated health (good/excellent health as reference group vs. poor/fair health), smoking status (smoking as reference group vs. not smoking), and whether data were collected during summer season. Probit regressions were conducted on the probability of participating in each of the 17 PA categories and the two summary categories while controlling for confounding variables. In addition, Tobit analyses were utilized to estimate the marginal effects of age on average weekly minutes reported for each of the 17 PA categories and the two summary categories. Tobit analyses were used to account for the truncated nature of average weekly PA minutes measures (Maddala, 1983). SAS 9.2 Proc Surveymeans, Proc Surveylogistic, and Stata 10.1 Survey Tobit were used for these analyses. Throughout the analyses, interaction terms between age and key demographic variables were tested to see if age-related PA pattern was moderated by education, race/ethnicity, foreign-born versus U.S.-born, and income-to-poverty status.

Results

For the tables, the percentage of individuals meeting the PA guidelines is presented first, followed by total PA and three subgroups of total PA: household PA, transportation PA, and total leisure PA. Leisure PA is then further divided into 15 categories and presented in the order of overall rate of participation from high to low. All statistics are presented by age categories.

Participation Rates by Types of PA

Table 1 presents weighted descriptive statistics on participation rates for various PA types by age. Table 2 presents marginal probabilities of participation in various PA types by age while controlling for the list of covariates discussed earlier, computed from Probit regression results. The descriptive results and the multivariate Probit results were similar, indicating that age-related PA patterns could not be explained away by differences in education, race/ethnicity, marital status, family size, smoking status, and general health.

Table 2. Marginal Probability of Age on Participation in Various Physical Activity (PA) Types: Probit Regression Results.

	Age 35-44	Age 45-54	Age 55-64	Age 65-74	Age 75+
Meeting recommendation	-2%	-3%	-8%**	-9%**	-24%***
Total PA	0%	-3%	-8%***	-9%***	-19%***
Household PA	2%	1%	-5%*	-8%***	-25%***
Transportation PA	-1%	0%	-8%***	-9%***	-8%***
Total leisure PA	-5%***	-7%***	-15%***	-14%***	-29%***
Walking	-2%	-2%	-7%***	-9%***	-21%***
Dancing	-7%***	-13%***	-11%***	-17%***	-24%***
Treadmill	-4%***	-6%***	-7%***	-11%***	-12%***
Biking	2%	2%	-3%	-6%***	-8%***
Yoga/stretching	-2%	-3%	-6%***	-6%***	-7%***
Weightlifting	-1%	-2%	-6%	-9%***	-10%***
Running	-4%***	-7%***	-13%***	-19%***	-26%***
Swimming	-1%	-3%***	-2%	0%	-7%***
Hiking	-2%	-2%	-3%*	-3%*	-11%***
Team sports	-2%*	-7%***	-6%***	-7%***	-9%***
Golfing	-1%	0%	0%	1%	0%
Fishing	0%	0%	-1%	-1%	-3%***
Bowling	0%	-1%	-1%	-1%	0%
Tennis	0%	-1%	-1%	-1%	-1%
Other leisure PA	-2%	-4%***	-6%***	-5%***	-7%***

Note: PA = Physical activity. **Bold** numbers indicate that this participation rate was statistically significantly different at 95 confidence level from the immediate preceding age group. Asterisks indicate statistical significance when compared with the youngest age group of 25-34, with *** indicating $p < .01$, ** indicating $p < .05$, and * indicating $p < .1$. All marginal effects controlled for marriage status, family size, education, race/ethnicity, income-poverty ratio, self-rated health, smoking status, and data collection season, and were corrected for survey sampling design and weights.

The percentage of women meeting the PA guidelines decreased from 61% for those ages 25 to 34 to 39% for those 75 or older. However, the decline was not evenly distributed. There were no statistically significant differences among age groups until the age of 55. While the decline for those ages 55 to 74 was significant, the largest decline was for the 75+ age group. Total PA participation rate had a similar pattern as the rate of meeting PA guidelines.

Participation rate in household PA was stable at about 71% to 74% until age 55, when the rate declined to 68%. A second and more substantial decline was for the 75+ group, which had a participation rate of only 40%. Transportation PA participation rate was fairly stable from ages 25 to 54, with moderately but statistically significant lower participation rates from age 55

and on. Participation rates in leisure PA might be described as showing a significant drop every 20 years, with statistically significant declines occurring at around ages of 35, 55, and 75.

The top five leisure activities by participation rate for all ages were walking (42%), dancing (20%), treadmill (15%), biking (11%), and yoga (10%). Walking, dancing, and treadmill were the top three for all age groups, whereas running instead of biking was in the top five for the youngest group of 25 to 34, and swimming instead of biking for the retirement group of 65 to 74. Yoga was either number four or five for all age groups.

Multivariate results in Table 2 show that the participation rate in total PA, household PA, and total leisure PA had two significant age-related decline points, one at ages 55 to 64 and the other at 75+. Compared with those 25 to 34, individuals 55 to 64 had an 8% lower participation rate in total PA, 5% lower participation rate in household PA, and 15% lower participation rate in total leisure PA. Also compared to those 25 to 34, individuals 75+ had a 19% lower participation rate in total PA, 25% lower participation rate in household PA, and 29% lower participation rate in total leisure PA. Transportation PA had only one significant age-related decline point at ages 55 to 64 where participation rate was 8% less compared with those ages 25 to 34.

For detailed leisure PA categories, multivariate results show that three activities with the lowest participation rates did not show a statistically significant decline with age: golfing, bowling, and tennis. Most other activities showed a monotonic declining pattern with significant declines occurring approximately every 20 years. Four activities (dancing, running, treadmill and team sports) started to decline during early middle adulthood (ages 35-44), other activities (walking, yoga, weightlifting, and hiking) did not start to decline until late-middle adulthood (ages 55-64). Participation in fishing did not start to significantly decline until late adulthood of 75+. Swimming and biking showed an inverse-U pattern by age. The participation rate in swimming declined from ages between 25 to 34 and ages 45 to 54, but increased for ages 55 to 64 and ages 65 to 74, before declining again for age 75+. The participation rate in biking increased from ages between 25 to 34 and ages 45 to 54 before declining from ages 55 to 64 and on.

Time Spent in Types of PA

Table 3 presents weighted descriptive statistics for mean weekly minutes spent in various activities, both unconditional (i.e., including those who did not participate) and conditional (i.e., excluding those who did not participate). The unconditional means show that the average total weekly PA minutes were 44% lower for women 75+ (207 min/week) compared with women

Table 3. Unconditional and Conditional Mean Weekly Minutes Spent in Various Physical Activity (PA) Types by Age.

	Age 25-34			Age 35-44			Age 45-54			Age 55-64			Age 65-74			Age 75+		
	All Mean	Con. Mean	All Mean	All Mean	Con. Mean	All Mean	All Mean	Con. Mean	All Mean	All Mean	Con. Mean	All Mean	Con. Mean	All Mean	Con. Mean	All Mean	Con. Mean	
Total PA	373	417	334	374	347	391	335	397**	332	411***	207	318***	227***	91	161	86	40	148***
Household PA	123	174	137	186	156	210**	158	233	156	251	91	227***	91	161	86	40	148***	204***
Transportation PA	37	138	31	132	26	107	25	143***	17	100***	31	161	86	40	148***	204***	40	148***
Total leisure PA	213	287	166	243***	164	237***	151	241***	159	263***	86	204***	148***	40	148***	204***	40	148***
Walking	59	128	56	129	68	147	58	135	58	146	40	148***	148***	40	148***	204***	40	148***
Dancing	41	132	21	96***	16	92***	16	88***	17	143***	8	125***	125***	8	125***	204***	8	125***
Treadmill	28	132	17	103***	19	115***	20	129**	15	174***	9	128***	128***	9	128***	204***	9	128***
Biking	8	75	11	84	12	85*	10	103	5	90***	3	59***	59***	3	59***	204***	3	59***
Yoga/stretching	9	65	9	77	8	74	10	117**	6	89***	6	91***	91***	6	91***	204***	6	91***
Weightlifting	8	74	7	79	9	101	4	69***	2	69***	3	119***	119***	3	119***	204***	3	119***
Running	17	100	9	95***	7	112***	4	139***	1	245***	0	182***	182***	0	182***	204***	0	182***
Swimming	9	110	6	97**	3	66***	8	107	12	138	3	131v	131v	3	131v	204***	3	131v
Hiking	11	126	9	155*	5	88**	4	94***	12	306**	1	108v	108v	1	108v	204***	1	108v
Team sports	7	81	6	102**	1	98***	1	96***	1	54***	1	85v	85v	1	85v	204***	1	85v
Golfing	1	83	1	54	3	146	7	251	6	259	1	116	116	1	116	204***	1	116
Fishing	2	96	3	141	5	173	3	197	7	538	1	211*	211*	1	211*	204***	1	211*
Bowling	2	96	1	32	2	182	2	128	3	264	5	241	241	5	241	204***	5	241
Tennis	2	91	2	114	1	87*	1	75	1	180**	1	208*	208*	1	208*	204***	1	208*
Other leisure PA	8	83	9	126	5	87***	3	77***	11	266**	4	140***	140***	4	140***	204***	4	140***

Note: PA = Physical activity. "All mean" denotes unconditional means including everybody in the age group. "Con. Mean" denotes conditional means including only participants of this activity. **Bold** numbers indicate that time spent in this activity was statistically significantly different at 95 confidence level from the immediate preceding age group. Asterisks indicate statistical significance when compared with the youngest age group of 25-34, with *** indicating $p < .01$, ** indicating $p < .05$, and * indicating $p < .1$.

25 to 34 (373 min/week). Among the three major categories, the decline was the highest for total leisure PA (60%) and the lowest for transportation PA (15%). Average household PA minutes showed an inverse-U shape, with those 45 to 74 spending more time than either the younger or older women. When the sample was limited to PA participants, the mean total weekly PA minutes declined 24% from 417 min for those between 25 to 34 to 318 min for those 75+. While the decline in total weekly PA minutes was statistically significant from age 55+, compared with the youngest group of 25 to 34, drastic decline did not occur until age 75+.

The unconditional means were highly affected by participation rates and thus had similar patterns as the participation rates presented earlier. Focusing only on those who participated in the activities, the top five leisure activities in terms of weekly minutes for all ages were fishing (177-min), golfing (158-min), walking (137-min), hiking (134-min), and bowling (127-min). However, some activities were in the top five for most age groups, while others were in the top five for only one or two age groups. Walking and fishing were in the top five in terms of conditional means for five age groups, with the exception of ages 65 to 74 for walking and ages 25 to 34 for fishing. Time spent in running was in the top five for all four age groups over 45. Golfing was in the top five for three age groups between 45 and 74. Dancing and swimming were only in the top five for the youngest group of 25 to 34.

Mean weekly walking minutes for participants were stable across age groups, whereas mean weekly minutes for yoga and biking for participants were the highest for those 55 to 64. Nine out of the 15 leisure PA categories exhibited a “retirement peak” pattern, where the mean minutes per week for participants were the highest among those 65 to 74. These leisure activities were dancing, treadmill, running, swimming, hiking, golfing, fishing, bowling, and other leisure PA.

Table 4 presents results from the Tobit regressions on weekly minutes spent participating in various activities, controlling for the list of confounders discussed earlier. Because of the nonlinearity nature of Tobit models, the most intuitive way of interpreting Tobit regression results is to compute average marginal effects for the independent variables (Maddala, 1983). These average marginal effects for the age categories are presented in Table 4, together with the Tobit coefficients. While total time spent in PA declined by age, the decline was modest and mostly statistically insignificant for those who were still active until late adulthood of age 75+, when a significant and substantial decline of total weekly PA occurred. Compared with those 25 to 34, the total weekly PA time was 177 min less for women 75+ on average, confounders controlled. Out of the three subcategories of total PA, household

Table 4. Average Marginal Effects of Age on Unconditional and Conditional Mean Weekly Minutes Spent in Various Physical Activity (PA) Types: Tobit Regression Results.

	Age 35-44			Age 45-54			Age 55-64			Age 65-74			Age 75+		
	Marg. effect	t-test		Marg. effect	t-test		Marg. effect	t-test		Marg. effect	t-test		Marg. effect	t-test	
Total PA	-28			-31		**	-56		**	-54			-163		***
Household PA	14			29			20			11			-54		***
Transportation PA	-4			-5		***	-13		***	-16		***	-13		**
Total leisure PA	-39		**	-50		***	-78		***	-65		***	-110		***
Walking	-4			2			-11			-15			-30		***
Dancing	-15		***	-24		***	-19		***	-16		***	-14		***
Treadmill	-8			-10		*	-13			-15		***	-14		***
Biking	4		*	3			-2			-4		***	-4		**
Yoga/stretching	-1			-3			-4			-4		***	-4		**
Weightlifting	-2			-2			-5		***	-4		***	-3		***
Running/jogging	-6		***	-13		***	-6		***	-2		***	-1		***
Swimming	-2			-5		***	-3			1			-3		***
Hiking	-3			-4			-5		*	-3			-2		***
Team sports	-3			-13		***	-3		***	-3		***	-2		***
Golfing	-1			2			1			1			0		
Fishing	0			1			-2			-1			-4		*
Bowling	-1			-2			-1			-1			0		
Tennis	0			-1			-1			-1			0		
Other leisure PA	-3			-7		*	-6		***	-4		*	-5		***

Note: PA = Physical activity. **Bold** numbers indicate that weekly time spent in this PA was statistically significantly different at 95 confidence level from the immediate preceding age group. Asterisks indicate statistical significance when compared with the youngest age group of 25-34, with *** indicating $p < .01$, ** indicating $p < .05$, and * indicating $p < .1$. All marginal effects controlled for marriage status, family size, education, race/ethnicity, income-poverty ratio, self-rated health, smoking status, and data collection season, and were corrected for survey sampling design and weights.

PA was 72 min/week less and total leisure PA was 147 min/week less. The age-related decline in time spent in transportation PA was statistically insignificant.

For detailed leisure activities, with the exception of swimming, the “retirement peak” effect observed in descriptive statistics in Table 3 largely disappeared after the confounders were controlled for, indicating that this effect was likely a result of variations in the control variables instead of age per se. Compared with young adulthood of 25 to 34, during early middle-adulthood of 35 to 44, time spent in dancing and running declined, while biking time increased. Middle adulthood (45-55) saw declines in time spent in swimming, team sports, other leisure PA, biking, and weightlifting. For the retirement age group, treadmill time decreased while swimming time increased. Late adulthood (75+) showed declines in time spent in walking, dancing, swimming, and hiking.

Moderating Effects of Socioeconomic and Demographic Variables

To investigate whether age-related PA patterns were different for various subgroups of women, age was interacted with education, race/ethnicity, nativity, and income-to-poverty ratio variables. Results (not shown in tables but available from authors upon request) show that being U.S.-born was by far the most important moderator, with statistically significant interaction effects for 12 out of the 19 PA categories (four summary categories and 15 leisure categories). For all these significant categories, U.S.-born women started out to have either higher participation rate or longer PA time or both at young ages, compared with foreign-born women. However, age-related decline was significantly higher for U.S.-born women than for foreign-born women for all of the 12 categories, which were total PA, household PA, total leisure PA, walking, dancing, treadmill, yoga, running, swimming, hiking, fishing, and other leisure PA. The seven categories that showed no difference between U.S.-born versus foreign-born women in age-related decline were transportation PA, biking, weightlifting, team sports, golfing, bowling, and tennis.

Race/ethnicity was also an important moderator. Compared with Whites, at young ages Blacks were more likely to participate in total leisure PA, particularly in bowling. However, age-related decline in these PA categories was also higher for Blacks than for Whites. Blacks were less likely to participate in yoga, running, hiking, golfing, and fishing at young ages, with lower age-related decline in these activities compared with Whites, with the exception of golfing, which did not show a differential age-decline pattern. Hispanics had a higher participation rate in total PA at young ages, with age-related

decline significantly higher compared with Whites. Participation rates and age-related patterns were similar between Whites and other races, with the exception of tennis, where other races had a higher initial participation rate but also a higher rate of age-related decline. As for total time spent in these various activities, other races tended to spend less time in total PA, household PA and total leisure PA at young ages, but their rate of decline by age was slower, compared with Whites.

A higher income-to-poverty ratio was associated with a higher participation rate in total leisure PA in general, and treadmill, weightlifting, team sports in particular, at young ages. A higher income-to-poverty ratio was also associated with a lower participation rate in bowling. Among these categories, only treadmill PA did not show a differential age-related decline by income. For the other categories, the higher the initial participation rate, the higher the rate of decline with age. Education was only a minor moderator in age-related PA patterns. College-educated women were more likely to participate in running and jogging at younger ages, but the age-related decline was higher for this group compared with those without a college education.

Discussion

The purpose of this research was to identify age differences in types of PA among women. Our descriptive statistics on participation rates differed somewhat from estimates using U.S. Behavioral Risk Factor Surveillance System (BRFSS) data for the same time period, likely due to differences in question-wording. Using 2004 as an example, BRFSS showed that among women 18 or older, 25.9% were leisure-time physically inactive (Kruger, Ham, & Kohl, 2005). Our estimate of physical inactivity was 17.8% if household PA was combined with leisure PA, but 34.2% if household PA was not included. This discrepancy could be a result of BRFSS' PA question including some types of household PA such as gardening but not other types of household PA such as heavy cleaning, which was used as an example in the NHANES's household PA question (Centers for Disease Control and Prevention, 2003-2004).

Our first hypothesis was that both the participation rate and weekly minutes spent in total PA decreased by age but the pattern of decline might not be linear. Our results for total PA were consistent with this hypothesis. Both descriptive statistics and multivariate results showed that while the overall age pattern of total PA participation was a declining one, ages 55 to 64 and age 75+ were the two critical age periods when major declines occurred, both in participation rate and in weekly minutes. Further, decline in leisure PA started at ages 35 to 44, which was consistent with results from Shaw et al.,

who found evidence that decline in leisure PA started around the age of 33, and grew steeper at progressively older ages (Shaw et al., 2010). However, the decline in leisure PA around 35 to 44 did not lead to a decline in total PA participation due to an increase in household PA participation. Shaw et al (Shaw et al., 2010) commented that the decline of leisure PA in mid 30s was earlier in the life course than would be expected if such decline was due only to the onset of health and functional problems, and suggested that other forces might be responsible, such as a lack of time due to increasing work and family responsibilities. Our findings showed that at least for women in the mid 30's to 40's, increased family responsibility in the form of increased household PA was likely a cause for reduced leisure PA.

Our second hypothesis was that the most popular types of PA varied by age, with a tendency towards lower intensity activities for older women compared with younger women. Our results showed that the top-ranked activities did not vary much across age groups. For all age groups, participation rates in household PA and total leisure PA were about the same, while participation rate in transportation PA was substantially lower. Among leisure activities, walking by far had the highest participation rate for women of all ages, a result that was consistent with past studies (DiPietro, 2001). Dancing and using the treadmill were the second and third most popular leisure activities for women of all ages, while yoga was either number four or five. These results indicate that in general, hypothesis two was not supported because the popular activities largely remained the same across age groups. The finding that walking and dancing were among the most popular leisure activities was consistent with past findings for Latino adults (Marquez et al., 2011; Marquez & McAuley, 2006). Dancing and treadmill, as the two higher intensity leisure activities in the top five for women of all ages, may deserve special public policy attention in promoting active living among older adults. Research has found that while lower intensity activities are beneficial to health, higher intensity activities confer greater benefits for physical capacity (Brach, VanSwearingen, FitzGerald, Storti, & Kriska, 2004; Fan et al., 2013). Dancing challenges individuals both physically and cognitively and is also enjoyable (Judge, 2003); and treadmill has the advantage of convenience and often offers higher intensity structured workouts than walking. These characteristics will likely lead to increased maintenance (Robinson et al., 2003).

Our third hypothesis was that the pattern of age-related PA decline differed by activity type, with the decline starting earlier for higher intensity activities than lower intensity activities. Our results showed mixed evidence. We found evidence for three important declining age periods at 35 to 44, 55 to 64, and 75+. During the first significant decline around ages 35 to 44, the four leisure activities that declined were dancing (METs = 4.8), treadmill

(METs = 5.3), running (METs = 6.5), and team sports (METs = 5.0), all of which had higher-than-average intensity. During the second major decline around ages 55 to 64, participation rates in household PA (METs = 4.0), transportation PA (METs = 3.5), walking (METs = 3.5), yoga (METs = 2.5), and weightlifting (METs = 3.0) declined significantly. This group of activities all had lower intensities than the earlier-declining activities. This order was consistent with our hypothesis that higher intensity activities declined earlier in life than lower intensity activities. This also showed that while the leisure activity decline during ages 35 to 44 might be related to competing family demands, the types of leisure activities that declined were selective to include only higher intensity activities. The second major decline in PA during ages 55 to 64 was likely associated with age-related physical health conditions as this was the age period when many women were becoming postmenopausal. The third major decline around age 75+ included biking (METs = 4.0) swimming (METs = 6.0), and fishing (METs = 4.3). The late decline of swimming and biking was not consistent with our third hypothesis because these were higher intensity activities hypothesized to decline early with age. Saint Onge & Kruger (Saint Onge & Krueger, 2011) reported a statistically significant increase with age in participation in fitness activities, which included swimming, tennis, and golfing, for those ages 25 to 60. Our results for swimming, tennis, and golfing were consistent with their findings. These results indicate that intensity alone could not explain differences in patterns of PA decline during late life. Other factors such as the likelihood of injury (i.e. falling) may contribute to the likelihood of PA participation among older adults because falls are the leading cause of injury death for Americans 65 years and older; and recovery from physical injury is difficult for older adults (Centers for Disease Control and Prevention, 2013; Kovacs, 2005). Although swimming and biking, especially stationary biking, have relatively high intensities, they pose low risk for falls.

Our fourth hypothesis was that age-related PA decline might be moderated by key socioeconomic and demographic variables such as nativity, race/ethnicity, education level, and income. Results confirmed our hypothesis. U.S.-born versus foreign-born was the most significant moderator for age-related PA decline, with lower initial rate of PA participation but also lower rate of decline with age for foreign-born women compared to U.S.-born women. Race/ethnicity, income-to-poverty ratio, and education also showed some moderating effects, but only on a smaller set of PA types. The finding on nativity is consistent with past studies reporting that foreign-born Americans were less likely to participate in leisure PA compared with U.S.-born Americans (Kandula & Lauderdale, 2005). Yet, the foreign-born population had a longer average life expectancy and a lower rate of obesity compared

with the U.S.-born population (Goel, McCarthy, Phillips, & Wee, 2004; Singh & Hiatt, 2006; Wen, Kowaleski-Jones, & Fan, 2013). While it is likely that other life-style factors such as dietary intake contributes to this seemingly contradictory phenomenon, it is also possible that the low rate of PA decline by age among foreign-born women contributes to better health outcomes for the foreign-born population, compared with the U.S.-born population.

Conclusions and Implications

In summary, we have four conclusions: (a) Total PA declines with age. However, the decline is not linear. There are two critical age periods in the decline of total PA: ages 55 to 64, and age 75 or older, when significant and substantial decline in total PA occurs. (b) The popularity of activities does not vary much by age. For all age groups, the participation rates in household PA and in total leisure PA are about the same, while participation in transportation PA has a much lower rate. Among leisure activities, walking is by far the most popular activity, followed by dancing, treadmill, and yoga. (c) While in general, higher intensity activities such as running, treadmill, dancing, and team sports decline earlier in life than lower intensity activities such as walking, yoga, and weightlifting, there are exceptions such as swimming and biking, which are higher intensity activities that do not decline early. (d) Among key socioeconomic and demographic variables, the most important moderator for age-related PA decline is U.S.-born versus foreign-born, with foreign-born women generally having lower PA participation rates in many activities but also less steep declines with age, compared with U.S.-born women.

We temper our conclusion with several caveats. First, self-reported PA measures are known to have reporting bias, in that people tend to overestimate their PA amount and intensity level. This could cause problems in our results if age and overestimation behavior are correlated, which we do not have information of. Second, time constraint is a major factor affecting PA participation. While NHANES 2003-2004 has occupation data that can be used as proxies for time constraint, such data are not released for NHANES 2005-2006. Due to the low participation rates for some PA types, we opted to keep both waves of data to maximize our sample size. This decision limited our ability to control for the effect of time constraint on PA participation, especially for those in the retirement age range. This also limited our ability to control for differential access to workplace exercise leagues and facility (Saint Onge & Krueger, 2011). Third, because of the cross-sectional nature of the NHANES data, we were not able to distinguish age effects from cohort and period effects. Past studies have found that PA among Americans have been increasing over time

(Kruger et al., 2005), and that the prevalence of reported volitional inactivity has been decreasing over time among older U.S. adults (DiPietro, 2001). These trends indicate the potential existence of cohort effects or period effects or both. Adjusting for cohort and period effects is likely to change our estimated age-related PA patterns. However, more detailed research with better data is needed to understand the relative size of age, cohort, and period effects of PA changes over time. Fourth, we excluded respondents with functional limitations that prevented them from engaging in PA because for this population, participation in leisure PA was not a choice they could make. Because older people are more likely to have functional limitations than younger people, our estimates of age-related decline in PA would be higher if those with functional limitations were included.

Despite these limitations, our study has several strengths. First, we advance prior work on age differences in PA by focusing on detailed behavioral categories of activities in addition to summary measures, resulting in a more comprehensive coverage than in prior studies (Saint Onge & Krueger, 2011; Scheerder, Vanreusel, Taks, & Renson, 2002; Wilson, 2002). Second, we analyze both participation rates and weekly minutes of participation instead of participation rates alone, thus allowing us to gain better insights into the complexity of age differences in PA patterns. Third, our detailed analyses allow us not only to identify key age periods when total PA decline occurs, but also the complex patterns of such decline, such as substituting household PA for higher intensity leisure PA around ages 35 to 44 so that total PA stays about the same.

Our results suggest that public health efforts promoting various types of PA will have differential impact on women of different ages. For example, improving walkable neighborhood environment is likely to benefit more women of all ages than developing leisure destinations such as golf courses. Team sports and running facilities are more likely to benefit younger women than older women, while yoga facilities may benefit women of all ages. Given the health benefits of higher intensity activities (Brach et al., 2004; Fan et al., 2013), four leisure activities: dancing, treadmill, swimming, and biking are worth special attention. Dancing and treadmill are higher intensity leisure activities that are also among the most popular for women of all ages. Developing programs and building facilities for dancing and providing subsidy for treadmills or gym facilities to increase access to treadmill workouts may be effective ways of encouraging all women, but especially older women to engage in higher intensity activities. Swimming and biking, two other higher intensity leisure PAs that exhibit late age decline, may also be worth promoting among older adults as these activities may pose low risk of injury for older women and are thus more acceptable to them.

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