Journal of Time Use Research
International Association for Time Use Research (IATUR)
jtur.iatur.org

Physical Activity and Perceived Health: Can Time Diary Measures of Momentary Well-Being Inform the Association?

Sandra L. Hofferth[1], Sarah M. Flood[2], Deborah Carr[3] and Yoonjoo Lee[4]

1. Corresponding author: Maryland Population Research Center, 2105 Morrill Hall, University of Maryland, College Park, MD 20742, hofferth@umd.edu, phone: (301) 405-6403; Fax: (301) 405-5743.

2. University of Minnesota

3. Boston University

4. Seoul University

Abstract

The association between physical activity and health is well documented, yet prior research has largely ignored the context of physical activity, including its specific type and the emotions experienced while engaged in that activity. This study used interview-based time diary data on 24,016 individuals who participated in the American Time Use Survey well-being modules in 2010, 2012, and 2013 to examine the associations between sedentary and moderately vigorous activities and self-reported health, and the extent to which momentary well-being modifies that association. Respondents who engaged in housework, leisure, or play with children reported better health whereas those who engaged in sedentary activity reported worse self-rated health. Respondents who spent more time in housework reported better health, but this was not the case for leisure or playing with children. Greater positive mood and fewer somatic symptoms while engaged in activity were associated with better self-rated health, with more consistent associations for symptoms than mood. Respondent reports of momentary well-being did not explain the link between activities and perceived or actual health.

Keywords: Physical activity, health, well-being, momentary emotion, time diaries

https://doi.org/10.32797/jtur-2018-1

1 Introduction

Epidemiologic studies document that physical activity is linked to improved cardiovascular function, muscle strength, and lower body mass index (BMI), each of which is a correlate of superior overall health including reduced risk of heart attack, stroke, and diabetes (Lakka & Bouchard 2005; Miles 2007). However, documenting a physical activity-health linkage is not

straightforward. Physical activity research has traditionally focused on a limited set of activities whose duration and intensity are respondent-reported such as walking, biking, or going to the gym (Periera et al. 1997). Additionally, such research typically does not capture one's emotional and somatic reactions to the physical and social activities in which one is engaged, implying that activity is uniformly enjoyable and thus health-enhancing (Ekkekakis et al. 2011). Over the past decade, the collection of time diary data providing both duration and intensity of time spent in a broader set of daily activities as well as respondent reports of feelings during their activities (momentary emotions) enable us to test whether a positive emotional and somatic state while engaged in activity is associated with more positive self-rated health assessments.

We use daily diary data to examine three components of an active life style (household work, active leisure, and playing with children) as well as sedentary leisure activities (i.e., television, radio, relaxation, and computer use) among working-age adults ages 25 to 64 in the United States. Data are from the pooled 2010, 2012, and 2013 waves of the American Time Use Survey (ATUS), in which participants reported their emotional and physical well-being while engaged in each of three randomly selected activities on the diary day. Our study is the first that we know of to use time diary data to evaluate:

1) associations among participation, duration, and intensity of activity (classified based on metabolic equivalent [MET] values), and self-rated health;
2) the extent to which self-reported physical and emotional well-being while performing the activity are linked to self-rated health; and
3) the extent to which the associations between activity duration and self-rated health vary depending on one's activity-related feelings.

2 Background

2.1 Daily Activities and Health

Research based on both population-based surveys and randomized clinical trials documents that moderate and vigorous physical activity are linked with better physical health; exercise reduces BMI, increases bone and muscle strength, lowers blood pressure, raises high-density lipoprotein (HDL), and lowers low-density lipoprotein (LDL) (Matthews et al. 2007; Miles 2007; Penedo & Dahn 2005; van Oostrom et al. 2012). Doing vigorous activity for as little as 15 minutes a day is linked with better biomarkers of cardiovascular health, relative to doing no such activity (Aadahl, Kjaer, & Jorgensen 2007; Hu et al. 2001). In contrast, high levels of sedentary activity are linked with compromised health and well-being, reflecting processes of both causation and social selection. In the former case, sedentary activity depletes health, whereas in the latter, poor health limits one's activities to sedentary ones. Television-viewing time and overall time spent sitting are linked to an elevated risk of metabolic syndrome, a set of biological risk factors for cardiovascular disease and diabetes (Pinto Pereira, Ki, & Power 2012).

Despite pervasive evidence based on both cross-sectional and longitudinal studies documenting the protective effects of physical activity health, important questions remain unexamined (Penedo & Dahn 2005). First, most studies of activity and health rely on aggregated summaries of activity over some discrete time period, typically a week or month (Haskell 2012). When aggregated measures are used, survey respondents tend to overestimate the frequency with

which they engage in socially desirable behaviors, including exercising (Brenner & Delamater 2014), leading to potentially biased associations with health. Prior research has validated the use of time diaries to collect information on the duration of time spent in all activities over a 24-hour period (Juster & Stafford 1985; Pentland et al. 1999). The daily diary method capturing levels of physical and social engagement within the past 24 hours provides a reliable and valid representation of one's activity durations (Hofferth et al. 2008; Tudor-Locke et al. 2009).

Second, standard survey-based measures of exercise typically ask respondents to indicate how frequently they engage in "moderate" or "vigorous" physical activity or "light exercise such as gardening or taking walks" (Haskell 2012). Given the subjective nature of these measures, participants may vary widely in activities they consider "vigorous" versus "light," and these perceptions of intensity may be linked to current levels of fitness or health (Ekkekakis & Lind 2006). The level of physical exertion associated with such a broad range of activities also may vary widely, leading to either an over- or under-estimation of the association between physical activity and health, depending on the composition of the sample and the types of physical activities in which they are engaged. Increasingly, researchers incorporate a metabolic equivalent or MET value as a more precise estimate of the energy expended during an activity per unit of time (Tudor-Locke et al. 2009). The ATUS provides specific reports of individual activities throughout the diary day, with sufficient detail (438 categories) such that we can classify each activity based on its MET value, by linking activity reports to the Compendium of Physical Activities (Ainsworth et al., 2011). We focus on two types of moderately vigorous activities that are performed by most Americans fairly regularly, have different levels of social desirability, and are linked elsewhere with health: household work and active leisure (Lawlor et al. 2002; Matthews et al. 2007). Although not previously linked to health, we add a measure of active time spent playing with children as this a common activity among the 33 percent of U.S. households headed by a working-age adult living with children under 18 (Sullivan 2013; U.S. Bureau of the Census 2017). We also examine sedentary activities such as watching television, relaxing, listening to the radio, and using the computer (Pinto Perera et al. 2012). More sedentary time necessarily means less time in more active pursuits and is likely to be both cause and consequence of poor health.

Third, we posit a potentially moderating role for the momentary emotional experience of activities. Prior studies are based on the implicit assumption that physical activities like exercise are perceived as enjoyable and desirable by those performing them (Ekkekakis et al. 2011). As such, their protective health effects may partly reflect the fact that individuals feel happy, engaged, and supported when performing such activities. However, mounting research suggests that physical activity is not uniformly rewarding. The health enhancing effects of physical activity, in particular, may be muted or even reversed for people who do not enjoy such activities, especially if they feel physically exhausted, ineffective, or make only a half-hearted effort when engaged in them (Ekkekakis et al. 2011; Salmon 2001). Thus, we hypothesize that the association between activities and self-rated health may be moderated by one's emotional and somatic experience while engaged in the activity. The limited research that has examined this hypothesis is based on artificial laboratory tasks, typically measuring emotional reactions to time on a laboratory treadmill. The ATUS, by contrast, focuses on one's actual lived experience; it obtains retrospective measures of one's happiness, sadness, pain, and fatigue while performing a randomly-selected activity on the diary day. We use these measures to explore the extent to which one's mood (happy/sad) and

somatic symptoms (pain/fatigue) are associated with self-rated health and whether they moderate the association between activity and perceived health.

Fourth, studies of the association between activity and health must address a potential threat to causal inference: reverse causality. Good health may enable one to participate in physically vigorous activities, whereas bad health may limit one to sedentary activities. To address concerns regarding health-based activity selection, we conduct sensitivity analyses in which we control for baseline self-rated health, reported two to five months prior to the time at which the study participants completed the ATUS daily activity diary and reported momentary well-being. Thus, we can adjust for the impact of one's health several months prior to participating in the daily activities measured in the ATUS, partially addressing concerns regarding selection and reverse causation.

An observed association between momentary well-being and self-rated health – both measured at the same point in time – also may be due to the statistical confound of current affective state (Pressman & Cohen 2005). Persons who possess high levels of positive affect and low levels of neuroticism may be particularly likely to endorse positive ratings such as "excellent" on the self-rated health scale, and may also report that they have no or few symptoms of sadness and pain on the momentary well-being assessment. To address this concern, we considered one additional health outcome measure assessed in the well-being module: a self-reported physician diagnosis of hypertension. This measure is considered more objective than self-rated health, and may be less susceptible to the influence of one's general affect (Zajacova & Dowd 2011). We also conducted a sensitivity analysis of well-being for two sample waves using a global measure of well-being rather than an activity-specific report; reports on the Cantril Ladder are considered cognitive rather than affective appraisals and as such may be less susceptible to mood- or personality-based reporting biases (e.g., Kahneman & Deaton, 2010).

2.2 Hypotheses

In sum, we explore the associations between time spent in sedentary and moderately intense physical activities that are part of most Americans' everyday lives — sedentary leisure, household work, active leisure, and playing with children — and self-rated health. We also examine the association between one's momentary emotional and physical well-being when performing the activity and self-rated health; and the extent to which these associations are moderated by one's mood or somatic symptoms when performing the activity. We hypothesize that:

1) any participation and more time spent in moderately vigorous physical activities will be related to better self-rated health, whereas any participation and more time spent in sedentary activities will have either a null or negative association;
2) momentary positive mood will be associated with better self-rated health whereas momentary somatic symptoms will be linked to poorer self-rated health; and
3) the positive association between physical activity and self-rated health will be greater the more positive one's contemporaneous emotions and the fewer one's somatic symptoms.

Finally, we conduct sensitivity analyses to partially address the possibility that self-rated health appraisals are biased by one's current affective state, and reverse-causation between activity level

and health. These sensitivity analyses are designed to ascertain the robustness of the findings to alternative interpretation.

3 Methods

3.1 Participants

The time diary approach to collecting information on daily activity is well-established and widely accepted (Bolger et al. 2003). The Bureau of Labor Statistics (BLS) first collected time diary data on a nationally representative U.S. sample of individuals 15 years and older in 2003, and has continued the study in subsequent years (http://www.bls.gov/tus/). Participants in the American Time Use Study (ATUS) are selected randomly from households completing participation in the Current Population Survey (CPS); about one-quarter of CPS participants are eligible (Hofferth, Flood, & Sobek 2013). A household participating in the CPS is administered eight monthly surveys. After a household completes the first four surveys, that household is removed from the survey for the next eight months, returning for the four remaining waves. ATUS interviews take place two to five months after the final CPS interview is completed, and are conducted by telephone in English or Spanish. Once the ATUS sample member agrees to participate in the survey, the telephone interviewer leads the respondent through his/her activities over the 24-hour period that began at 4 a.m. on the previous day and continues through 3:59 a.m. on the current day. Respondents describe in their own words the primary activities in which they were engaged. Information on the activities is collected sequentially and a start and end time are recorded for each activity, with interviewers later coding activities into 17 major categories and multiple subcategories in a three-tier system. The assigned ATUS diary days are distributed across the days of the week, with 50% allocated to weekdays, and 50% to weekend days, and they are distributed evenly across the weeks of the year. Weights constructed by survey staff are applied to adjust for the oversampling of weekends and for sample selection.

A unique attribute of this study is its use of the well-being module, developed at Princeton University for the Princeton Affect and Time Use Survey, adapted for the ATUS (Krueger 2009), and included in the 2010, 2012, and 2013 ATUS waves. After the main time diary was completed, three activities were randomly selected from among all activities lasting at least five minutes. Sleep, grooming, and personal care as well as activities for which the respondent didn't know or refused to report what they were doing were not eligible for selection. For each selected activity, respondents were asked about their feelings while performing the activity: "From 0 to 6, where a zero means you were not happy at all and a six means you were very happy, how happy did you feel during this time?" Identical items were administered for feeling sad, tired, and in pain. Because we were interested in the working age population, the present sample is limited to 24,016 participants ages 25-64 years old who responded to the well-being module.

3.2 Measures

Health

We focus on one general indicator of perceived health administered in the 2010, 2012, and 2013 well-being modules of the ATUS — the widely used five-category *self-rated health* indicator: "Would you say your health in general is excellent (1), very good, good, fair, or poor (5)?" This single-item measure is considered a more effective predictor of subsequent mortality than a

physician assessment of health, and is widely considered the "gold standard" of survey-based measures of perceived health (Ferraro & Farmer 1999). We dichotomize the indicator to reflect good or better versus fair or poor health, consistent with prior studies based on relatively healthy working-age populations (Schnittker & Bacak 2014). Although our measure assesses the respondent's perceived health on the day of the survey, it is highly reliable in the short term. Nine out of ten respondents to a similar dichotomous self-rated health measure maintained the same rating over the course of a month (Zajacova & Dowd 2011).

We also consider a self-reported physician diagnosis of hypertension, a documented indicator of long-term health (Centers for Disease Control 2013). Respondents indicate whether they were "ever told by a doctor or health professional that he/she had hypertension, also called high blood pressure or borderline hypertension." In the ATUS, 27% report a hypertension diagnosis; this rate is nearly identical to the 30% reporting hypertension in the most recent U.S. health report for 2011-12 (U.S. Department of Health and Human Services 2017).

Participation and Time Spent in Selected Activities

Our focal variables capture components of active lifestyle, including *whether* and *how much time one spent* engaged in such activities, and one's self-rated momentary emotional and physical well-being when engaged in those activities. Activities are classified by their MET value, which provides an estimate of the energy expended during an activity, per unit of time. It is expressed as the ratio of the metabolic rate during the activity to a standard resting metabolic rate of 1. First, we consider *participation in sedentary leisure activities.* Almost all respondents (86%) spent time in sedentary activities such as watching television on their randomly selected day. Except for computer use, which is coded with a MET of 1.9, the activities in this category have a MET value between 1.0 and 1.4 on the Compendium of Physical Activities (Ainsworth et al. 2011). Sedentary activities exclude sleeping, which is classified and controlled separately. A substantial amount of sedentary time in ATUS is associated with waiting or traveling to another activity and does not represent leisure time; therefore, we excluded it from this activity category. To measure duration we summed time (in minutes, scaled by dividing by 10) spent in primarily home-based leisure-time activities, including watching TV, relaxing, thinking, using the computer, and listening to the radio and music. We also created an indicator for any participation.

Second, we consider *participation in moderate to intense physical activities*. Over half of respondents (57%) engaged in such activities on the diary day. We first identified all activities reported in the daily diary with a MET of 3 or greater, combining activities with a MET of 3 to 4, frequently reported, and those 5 and over, infrequently reported (Rennie et al. 2003). Given their heterogeneity, some activities may be considered more enjoyable than others (e.g., Sullivan 2013). Consequently, we disaggregated moderately intense and vigorous activities into three main categories: active household work (38%), active leisure (14%), and active play with children (9%). Appendix A provides a complete listing of activities included in each category.

Momentary Well-being

We also consider emotions and physical symptoms when performing each of the four types of activities described above. We created two scales at the person level: a) *positive emotion or mood* is an average of individual responses to the happy and sad (reverse-coded) items, and b) *somatic symptoms* are the average of responses to the pain and fatigue items. The correlation between positive mood and somatic symptoms ranged from -.21 to -.37, depending on the activity-specific

sample used. Extensive methodological exploration of these measures documents their reliability and validity (Lee, et al. 2016).

Because these momentary assessments are obtained only for those who engaged in a specific activity, activity-level analyses using these indicators of emotional well-being are by necessity restricted only to participants, and, therefore, potentially biased. Thus, we conduct a sensitivity analysis for well-being for two sample waves using a measure that captures a cognitive rather than emotional appraisal of overall well-being, the Cantril Self-Anchoring Ladder (Cantril 1965), administered to all participants in 2012 and 2013. This measure asks: "Please imagine a ladder with steps numbered from zero at the bottom to ten at the top. The top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you. If the top step is 10 and the bottom step is 0, on which step of the ladder do you feel you personally stand at the present time?" The research team that developed the momentary emotion measures used in the ATUS argues that individuals can recall episodic emotions with some detail; concurrent retrospective reports of momentary feelings in specific episodes show good consistency, provided the episode is sufficiently recent (Kahneman et al., 2004; Krueger 2009). In contrast, global reports of well-being do not reflect actual experience because there is no specific episode to recall.[1]

Control Variables

We adjusted statistically in all analyses for social and demographic factors that have been linked with components of a physically active life as well as with overall physical health: Sex, age, education, family income, race/ethnicity, marital status, and parental status. *Sex* refers to whether one identifies as male; female is the reference category. *Age* is measured in years. *Education* refers to the number of years of schooling completed. *Family income* is the total combined income for all family members from all sources, including employment, business, Social Security, and any other monetary income, in the year prior to the interview; income (including no income) is then categorized into five quintiles based on the national distribution each year (U.S. Bureau of the Census, 2015). *Race* refers to whether one self-identifies as non-Hispanic white, non-Hispanic black, Asian/Pacific-Islander, Hispanic, or other race/ethnicity. The small "Other" category (2% of the sample) was combined with non-Hispanic white to form the omitted category. *Marital status* refers to whether one is married; not married is the comparison category. *Parental status* refers to whether one has coresidential children under 18.

Finally, we adjusted other aspects of one's diary day, in particular, key activities that affect the discretionary time available. *Total hours worked* refers to the hours one worked for pay on the diary day (0, 1 to 6, 6 to 8, or 8+ hours); 0 hours is the omitted category. We also controlled for *total duration slept* (in minutes) on the diary day. Individuals have schedules that differ on weekend and week days; we controlled for *whether the diary day was a weekend day or week day*.

Previous Health

To address the concern that activity participation is selective on the basis of one's pre-existing health, we supplemented the ATUS data with a control for health at an earlier point in time. We

[1] The correlation between mood and the Ladder measure was .37 to .39 for all samples except child play, where its association was .20. The correlation between symptoms and life satisfaction was -.27 to -.30, except for the leisure group, with a correlation of -.23.

linked data from the core ATUS interview and its well-being module with *self-rated health reported two to five months earlier* in the Annual Social and Economic Supplement (ASEC) of the CPS (IPUMS-CPS) (King et al., 2010).[2] If prior health influences current activity participation, the documented association between current activities and self-rated health would be reduced considerably after adjusting for prior health.

3.3 Research Design

Using pooled 2010, 2012, and 2013 ATUS data from the well-being module, we created four separate samples; each includes participants in one of our four focal activities (sedentary leisure, household work, active leisure, and play with children) who reported momentary assessments of well-being for that activity. We present descriptive statistics for the total sample and for each of the four subsamples. All analyses used the survey-constructed weights.

We first conducted separate multivariate logistic regression analyses of the hypothesized association of any participation in and, then, minutes spent in each category of activity (i.e., sedentary activity, active household work, active leisure, and active play with a child) with self-rated health. Second, we tested whether momentary emotions and symptoms were associated with self-rated health. Third, we tested the extent to which the association between participation in the activity and self-health is moderated by momentary well-being at the time of the activity. All analyses include background controls. Finally, we conducted sensitivity analyses in which we replicated all models using the dichotomous outcome of a doctor's diagnosis of hypertension, which is presumably less susceptible to affective bias. We also report on analyses using an alternative well-being measure – the Cantril Self Anchoring Ladder. Finally, to test for selection bias we added a control for self-rated health two to five months earlier to the main models to evaluate whether results are sensitive to a control for prior health.

4 Results

4.1 Univariate and Bivariate Analyses

Descriptive statistics and *t*-test results are presented in Table 1. Characteristics of the pooled 2010, 2012, and 2013 ATUS data (*N*=24,016) appear in column 1. With the exception of a smaller fraction in the fourth quintile of income, sociodemographic characteristics of sample participants are similar to those of the U.S. population as a whole (not shown). Only 17% reported being in fair or poor health, and 27% said that a doctor or health professional had ever told them they had high blood pressure.

Columns 2 to 5 show descriptive statistics for the four activity subsamples. Conditional on participating in the activity during the diary day, the mean duration was 110 minutes of sedentary activity, 110 minutes of household work, 85 minutes of moderately intense leisure activity, and 88 minutes of play with children. Although demographic differences across the subsamples were as expected (e.g., those playing with children were younger), we detected three compositional differences that are relevant to our research questions. First, a higher proportion of individuals who performed sedentary activities and household work were in fair or poor health, relative to the active

[2] https://www.atusdata.org/atus/linked_docs/linked_generic.pdf

leisure subsample (22% and 20% versus 15%, respectively). A higher proportion of the sedentary activity and household work subsamples and a lower proportion of those who played with children

Table 1. Weighted Means (or Proportions) and Standard Deviations for Variables

	ATUS		Sedentary Leisure		Household Work		Active Leisure		Play with Children	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Dependent variables										
Perceived health										
Excellent/very good/good	0.83		0.78***		0.80***		0.85		0.89	
Fair/poor	0.17		0.22		0.20		0.15		0.11	
Hypertension	0.27		0.31***		0.30***		0.22		0.17*	
Independent variables										
Time spent in each activity (min)	—		110.15***	110.77	110.09***	110.20	85.52	100.87	88.30	78.79
Positive mood	—		4.73***	1.28	4.70***	1.21	5.17	1.02	5.64***	0.64
Somatic symptoms	—		1.88***	1.56	1.76**	1.55	1.59	1.46	1.51	1.27
Control variables										
Sex: Male	0.49		0.54***		0.45***		0.60		0.51***	
Age (in years)	44.27	10.98	45.16	11.18	46.33***	10.81	44.73	11.06	37.93***	8.60
Education (in years)	13.89	3.05	13.45***	3.03	13.54***	3.05	14.46	3.04	13.95**	3.16
Family income										
Lowest quintile	0.22		0.27***		0.23		0.21		0.21	
Second quintile	0.21		0.22*		0.22*		0.19		0.19	
Third quintile	0.20		0.20		0.19		0.18		0.21	
Fourth quintile	0.14		0.14		0.14		0.15		0.15	
Highest quintile	0.22		0.18***		0.21***		0.27		0.24	
Race										
White	0.69		0.67*		0.71		0.71		0.70	
Black	0.12		0.15***		0.09		0.08		0.06	
Asian/Pacific islander	0.05		0.04***		0.04***		0.07		0.08	
Hispanic	0.15		0.14		0.16		0.14		0.17	
Parental: Yes, children	0.39		0.32		0.37		0.33		0.80***	
Marital status: Married	0.62		0.58***		0.66		0.65		0.80***	
Total hours worked										
0 hours	0.45		0.55		0.67***		0.55		0.59	
1 – 6 hours	0.13		0.12		0.14**		0.10		0.12	
6 – 8 hours	0.15		0.12		0.07***		0.13		0.10	
8 hours more	0.27		0.21		0.12***		0.22		0.18	

Table 1 Continued

	ATUS		Sedentary Leisure		Household Work		Active Leisure		Play with Children	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Total minutes slept	466.99	113.92	469.82	120.34	488.70***	107.34	473.98	108.34	489.44*	100.16
Diary day: Weekend	0.29		0.32		0.39*		0.35		0.3	
Diary year										
2010	0.32		0.28*		0.34		0.32		0.33	
2012	0.34		0.32**		0.34		0.37		0.33	
2013	0.34		0.40***		0.33		0.31		0.33	
Life satisfaction: 0 (*Worst*) – 10 (*Best*)[a]	7.02	2.00	6.81***	2.14	7.06***	2.00	7.44	1.79	7.37	1.79
N	24,016		6,938		2,840		905		682	

Note: ATUS: American Time Use Survey. [a] This variable was only available in 2012 and 2013. *P* values for *t*-test comparing each subsample with the active leisure subsample: *p <. 05; **p < .01; ***p < .001.

had been told they had hypertension than the active leisure group (31%, 30%, and 17% versus 22%, respectively). Second, the sedentary activity, household work, and play with children subsamples had relatively fewer males and lower levels of education compared with the active leisure subsample. Third, persons in the highest income were under-represented in the sedentary leisure and household work subsamples, yet slightly overrepresented in the active leisure subsample. These results are consistent with prior studies showing that men and those with richer economic resources enjoy more active leisure time than women and lower SES persons, respectively (Drake 2013).

4.2 Multivariate Analysis of Activity Engagement and Health

Hypothesis 1

We next explored multivariate associations between activity patterns and self-rated health (Table 2). First, we present the association between any engagement in each type of activity and self-rated health in the full sample (Model 1), and between activity duration and health for respondents spending time in that activity and who were randomly sampled to report their momentary emotion (Model 2).

Spending any time in *sedentary leisure* was associated with 23% lower odds of self-reported good or better health ($OR = 0.77$, $p < .001$) (Table 2, Panel A, Model 1). Each 10 minutes of time spent in sedentary activities reduced the odds of good or better health by 1% ($OR = 0.99$, $p < .01$) (Model 2). Participation in *moderately intense household work* was associated with 17% higher odds of reporting good health ($OR = 1.17$, $p < .01$) (Table 2, Panel B, Model 1). Each 10 minutes of time spent in household work was also associated with 2% higher odds of reporting good health (Model 2; $OR = 1.02$, $p < .05$). Spending any time in *active leisure* was associated with 55% higher odds of reporting good health ($OR = 1.55$, $p < .001$) (Table 2, Panel C, Model 1). However, time spent in active leisure was not associated with self-rated health (Model 2). Spending any time *playing with children* was associated with 29% greater odds of good self-rated health ($OR = 1.29$, $p < .01$) (Table 2, Panel D, Model 1). However, the amount of time spent playing with children was not associated with perceived health (Model 2).

Hypothesis 2

Our second hypothesis is that there is an association between momentary assessment and self-rated health (Model 3). Momentary well-being while engaged in sedentary activity was associated with self-reported health (Model 3). Each additional point on the positive mood scale during sedentary activities was associated with 22% greater odds of perceiving good health ($OR = 1.22$, $p < .001$) whereas each additional point on the somatic symptoms scale was associated with a 36% reduction in the odds of perceiving good health ($OR = 0.64$, $p < .001$). As expected, momentary assessments of household work were associated with better perceived health. Each additional point on the positive mood measure was associated with 26% greater odds of perceiving good health ($OR = 1.26$, $p < .001$). Similarly, each additional point on the somatic symptoms scale was associated with 39% lower odds of perceiving good health ($OR = .61$, $p < .001$) (Model 3). As in the previous models, a higher level of positive mood *(Model 3)* during active leisure was associated with 64% greater odds of perceiving good health ($OR = 1.64$, $p < .05$), whereas higher levels of somatic symptoms were associated with 34% lower odds of perceiving good health ($OR = .66$, $p < .05$).

Table 2. Logistic Regressions (Adjusted Odds Ratios) of Perceived Health on Whether Respondent Spent Any Time in Each of the Activities, the Amount of Time Spent in it among those engaged, and Momentary Well-Being

Panel A. Sedentary leisure	**Perceived Health - *AOR***			**Hypertension - *AOR***		
Variable	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Whether did the activity	0.77*** [0.66-0.89]			1.04 [0.92-1.18]		
Minutes in activity /10		0.99** [0.98-0.99]	0.99** [0.98-0.99]		1.01 [0.99-1.01]	1.00 [0.99-1.01]
Positive mood			1.22*** [1.13-1.31]			0.96 [0.90-1.03]
Somatic symptoms			0.64*** [0.61-0.68]			1.13*** [1.07-1.19]
df	21	21	23	21	21	23
Wald Chi square	1381.28***	451.83***	618.30***	1715.70***	505.06***	527.18***
N	24,016	6,938		24,016	6,938	
Panel B. Household work	**Perceived Health - *AOR***			**Hypertension - *AOR***		
Variable	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Whether did the activity	1.17** [1.06-1.30]			0.93 [0.85-1.01]		
Minutes in activity/10		1.02* [1.00-1.03]	1.02** [1.01-1.04]		0.99 [0.99-1.01]	0.99 [0.99-1.01]
Positive mood			1.26*** [1.13-1.40]			0.95 [0.86-1.04]
Somatic symptoms			0.61*** [0.56-0.67]			1.17*** [1.09-1.26]
df	21	21	23	21	21	23
Wald Chi square	1370.51***	187.25***	285.05***	1717.41***	238.15***	266.38***
N	24,016	2,840		24,016	2,840	

Panel C. Active leisure	**Perceived Health - *AOR***			**Hypertension - *AOR***		
Variable	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Whether did the activity	1.55*** [1.32-1.82]			0.78*** [0.69-0.87]		
Minutes in activity/10		1.03 [0.99-1.06]	1.02 [0.99-1.05]		0.99 [0.97-1.03]	1.00 [0.97-1.03]
Positive mood			1.64*** [1.29-2.10]			0.78* [0.64-0.95]
Somatic symptoms			0.66*** [0.54-0.80]			1.07 [0.93-1.23]
df	21	21	23	21	21	23
Wald Chi square	1393.72***	89.10***	117.05***	1725.63***	79.72***	88.75***
N	24,016	905		24,016	905	
Panel D. Play with children	**Perceived Health - *AOR***			**Hypertension - *AOR***		
Variable	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Whether did the activity	1.29** [1.07-1.55]			0.89 [0.77-1.04]		
Time in activity/10		0.99 [0.96-1.04]	1.01 [0.97-1.05]		1.01 [0.98-1.04]	1.01 [0.98-1.04]
Positive mood			0.74 [0.46-1.21]			1.01 [0.59-1.72]
Somatic symptoms			0.56*** [0.45-0.70]			1.25* [1.02-1.53]
df	21	21	23	21	21	23
Wald Chi square	1367.88***	60.93***	87.77***	1730.59***	53.32***	58.09***
N	24,016	682		24,016	682	

Note: Adjusted Odds ratios (*AOR*) are presented with 95% confidence intervals provided in brackets. Control variables including sex, age, education years, family income, race, parental status, marital status, total hours worked, total minutes slept, diary day, and diary year are adjusted in Model 1 through 3, although coefficients are not presented. In Models 2 and 3, samples are restricted to those who engaged in the specific activity (sedentary leisure, household work, active leisure, play with children) that is the focus of each Panel. Two-tailed tests indicate where $^{*}p < .05.$; $^{**}p < .01.$; $^{***}p < .001$. The model predicts the probability of being in excellent/very good/good health rather than fair/poor health or the probability of being told by a doctor or health professional that the respondent had hypertension.

In contrast to the previous models, a more positive mood during active play with children (Model 3) was not associated with perceiving better health; however, a higher level of somatic symptoms was associated with 44% lower odds of perceiving good health ($OR = .56$, $p < .001$).

Hypothesis 3

To test our hypothesis that the association between activity time and perceived health depends upon one's emotional response, we re-estimated Model 3 for each Panel in Table 2 evaluating a two-way interaction between time spent in the activity and both positive mood and somatic symptoms. None of the interactions was statistically significant at the $p < .05$ level; thus, we do not present the results in table or text (all models available from authors).

Results thus far show that engagement in household work, active leisure, or active play with children was linked to perceiving good health, whereas participation in sedentary activity was linked with perceiving poor health. In analyses focused on activity duration, more time in sedentary leisure was negatively linked and more time spent in household work was positively linked to self-rated health. For each of the four focal activities, positive mood was consistently associated with better health and somatic symptoms with poorer health.

4.3 Sensitivity Analysis: Predicting a Diagnosis of Hypertension

To explore more fully whether self-reported health reflects an underlying although unmeasured trait such as emotional stability that would influence responses to both subjective assessments, we also examined a dichotomous indicator of whether the respondent had been given a doctor's diagnosis of hypertension. Results are shown in the right-hand panel of Table 2. In contrast to the results for self-reported health, we did not find a significant association between either activity participation or duration and hypertension for sedentary leisure, household work, or playing with children (Table 2, Panels A, B, D, Hypertension Model 1). However, spending any time in active leisure was associated with 22% lower odds of reporting hypertension ($OR = .78$, $p < .001$) (Panel C, Hypertension Model 1); the amount of time spent was not so linked (Panel C, Hypertension Model 2).

The associations between somatic symptoms and hypertension were consistent for all activities except active leisure (where it was not statistically significant); those reporting more somatic symptoms had higher odds of reported hypertension (Table 2, Panels A, B, D, Hypertension Model 3). Positive mood was linked to hypertension for active leisure only, where better mood was associated with lower odds of hypertension (Table 2, Panel C, Hypertension Model 3).

4.4 Sensitivity Analysis: Assessing Health-Based Activity Selection

We compare the results from models comparable to Table 2 above with models including a dichotomized self-reported health measure for 2010 ATUS respondents who had also been interviewed in the March CPS, two to five months earlier. As expected, the CPS measure of self-rated health correlated .49 to .57 with the ATUS measure of perceived health, depending upon the sample. However, including this prior health measure did not alter the association between engagement or time spent in sedentary or moderately intense activities and perceived health of ATUS respondents or between measures of momentary assessments of well-being and perceived health (not shown). This analysis suggests that the documented associations between activity participation and self-rated health are not attributable to health-based selection into those activities.

4.5 Sensitivity Analysis: Positive Mood Bias

We re-estimated our analyses in Table 2 using the Cantril Self Anchoring Ladder instead of the momentary positive mood and somatic symptoms responses. For sedentary activities, household work, and active leisure the overall life satisfaction results measured by the Cantril Ladder were similar to the positive mood results; that is, the more positive one's overall life satisfaction, the more likely one is to report being in good versus poor health and the less likely to report having been diagnosed with hypertension (not shown). Whereas positive mood while playing with children was not significantly related to self-reported health or hypertension, overall life satisfaction using the Ladder measure was significantly positively related to self-reported health and negatively related to hypertension for those who spent time actively playing with children.

5 Discussion

We explored the complex associations among four specific activities and self-reported health of a national sample of individuals using high quality diary measures of time spent in daily activities that took into account the level of energy expended, according to MET values, and one's self-reported mood and somatic symptoms during specific activity episodes. The data also allowed us to assess sedentary activity using MET values and link it to self-rated health and to doctor-diagnosed hypertension. Our analyses expanded on prior research linking active lifestyle with health by considering distinctive aspects of the activity, including energy expended, total time spent in activities, and one's physical and emotional well-being while performing the activity.

Our first hypothesis, that spending time in key physical activities would be associated with better perceived health, was supported. After controlling for background factors (and self-reported health several months prior to engaging in activity), we found that those who spent any time in sedentary leisure on the diary day and those who spent more time in it had lower odds of perceiving good health. Conversely, those who spent any time in household work and those who spent more time in it had greater odds of perceiving good health. Both of these findings are consistent with the literature documenting a positive dose-response association between physical activity level and health (Miles 2007). In many nations, domestic activities are the major source of regular physical activity, especially for women. Women's participation in moderately intense activity such as housework has been shown to be associated with improved health and lower chance of coronary heart disease, with larger health benefits accrued as the intensity and duration of the activity increase (Lawlor et al. 2002). These patterns may not be specific to women, though gender differences in the accrual of health benefits from participation in household tasks are conceivable.

By contrast, the results were less supportive of the hypothesis linking the duration of active leisure or playing with children and perceived health. Participating in active leisure or playing with children *at all* were both associated with higher odds of superior self-rated health; however, these associations did not vary by the specific amount of time spent.

Why is spending more time in moderately vigorous leisure activities or playing with children, activities most think of as enjoyable and rewarding, *not* associated with better self-reported health, whereas spending more time in household work is? First, over half of the time spent playing with children was coded with a MET value of 3.3; this category of activity is quite heterogeneous with respect to energy expenditure and half was of low intensity. But this cannot

explain the modest association between time spent in active leisure, with much more range and variation in MET, and health. We think the lack of a significant typical dose-response pattern in the ATUS reflects relatively low levels of active leisure in our population. In our sample, only about 14% engaged in active leisure on their diary day. The first goal of most physical activity interventions is simply to get people active (Miles 2007). In our study half of the respondents who engaged in active leisure or who played with children did so for under an hour, and the top quartile of these measures was under two hours. It is important to reiterate, however, that our data are consistent with the literature showing that *any* participation in these moderately vigorous activities is linked with better perceived health (e.g., Penedo & Dahn, 2005).

Our second hypothesis, that positive mood when performing the activity would be associated with better self-reported health and somatic symptoms with poorer health, was supported for all four activities. Taken together, our findings based on real-life daily activities are consistent with laboratory-based studies showing that subjective responses, such as how individuals experience their activities both physically and emotionally, may be as germane to health as the duration of time invested (Ekkekakis et al. 2011). How people feel during their daily activities is strongly associated with their overall perceived health, an association that may reflect both causation, where enjoyable activities enhance health, as well as cognitive processes whereby those who evaluate one attribute positively, such as their mood, may also evaluate their physical health positively (e.g., Pressman & Cohen 2005). We further adjudicate between these two possibilities below as we summarize study limitations.

Finally, we predicted that more time spent in activities that were evaluated positively (positive mood) would be associated with perceiving better health and, conversely, greater time in activities that were negatively evaluated (somatic symptoms) would be associated with perceiving poorer health (Hypothesis 3). This hypothesis was not supported. The association between activity and health does not vary based on how individuals feel physically and emotionally when performing that activity. We suspect this may reflect the nature of the tasks at hand; regardless of whether one enjoys housework, one must participate in the task and as such, may reap the health benefits that accompany it (Lawlor 2002). By contrast, playing with children (an activity distinct from the less voluntary activity of providing child care) and leisure activities are pursuits that one views as enjoyable or comforting, as evidenced by the very high levels of positive mood (M=5.64 and 5.17) and low levels of somatic symptoms (M=1.51 and 1.59) reported during these activities.

Incremental increases in mood and symptoms may do little to modify the overall health benefits of engaging in these two activities. Studies that have linked more positive affect with a greater chance of continuing the activity use an artificial lab-based activity that one did not elect to do: treadmill-based exercise. We know of no other real-world studies of how mood interacts with the everyday activities engaged in by the majority of Americans in ways that may influence health. The null findings may also reflect the cognitive processes underlying respondents' assessments of mood when performing the activity. Respondents are asked to assess their feelings while performing the activity; research consistently documents that people evaluate an emotional or physical experience based largely based on how they felt at its most intense point (peak) and at its end, rather an assessment of the averaged or total sum of the experience. This process may lead to a fairly constricted range of assessments, which may be less consequential for one's self-assessed health (Fredericksen & Kahneman, 1993)

5.1 Are the findings applicable to physician-diagnosed health?

The link between any activity engagement and self-reported physician-diagnosed hypertension was similar to that for self-reported health for one activity only. Engaging in active leisure was associated with both greater odds of self-reported good health and lower odds of a hypertension diagnosis. Furthermore, the amount of time spent in any of the four focal activities was not associated with the odds of having hypertension.

5.2 Can Time Diary Measures of Momentary Well-Being Inform the Association between Activity and Health?

Although momentary mood and somatic symptoms did not moderate the health impact of daily activity, they did reveal consistent, positive, and direct links to self-rated health, and even more importantly, to physician reported hypertension, with somatic symptoms having a stronger association with hypertension than positive mood. Somatic symptoms were associated with higher odds of hypertension for those engaged in sedentary activity, household work, and playing with a child. Positive mood was associated with lower odds of hypertension only for those engaged in active leisure, consistent with our above speculation that those who engage in active leisure (and who enjoy it) may be positively disposed to other heart health-enhancing practices for which we cannot control with the data at hand. That its effects span multiple subtypes of activities and are consistently related to hypertension suggests that a somatic symptom such as pain or fatigue may be a particularly sensitive momentary assessment of health, especially among a working age sample who are largely in good health.

5.3 Limitations and Future Directions

To our knowledge, this study is the first to link daily time diary reports of four activity types in everyday life and current self-rated health, and to explore the contextual effects of contemporaneous mood and physical symptoms while participating in these activities. However, our study has several limitations that may potentially weaken its generalizability.

First, we cannot generalize from the diary day to the long-term health and well-being of the individual. That said, we believe that daily experiences accumulate over time to affect individual health and well-being (e.g., Sin et al., 2015). To the extent that individuals have fewer healthy days and more on which they do not rate their health and well-being as positively, they will rate their overall health more poorly.

Second, we use only self-reported rather than physician-assessed measures of physical health. Given the subjective nature of self-rated health, we examined whether the association between positively experienced activity time and better self-rated health reflected an individual tendency (e.g., dispositional positive affect) to rate one's experiences as uniformly positive or negative (Pressman & Cohen 2005). We found a stronger association between time in the activity with the subjective appraisal of health than the more objective indicator of a physician's diagnosis of hypertension. Whereas both mood and somatic symptoms were associated with self-reported health, somatic symptoms were more strongly associated with the odds of reported hypertension than was positive mood. These findings suggest that, compared with hypertension, self-rated health may be more reflective of one's underlying mood or temperament. The most telling result is that of all the measures of activity participation, only engaging in active leisure time was associated with lower odds of hypertension. Neither sedentary leisure nor household work nor playing with

children was associated with hypertension. Another limitation is that emotion was reported retrospectively rather than concurrently, even though the 24-hour period of retrospection is much shorter than typically used in studies of well-being. It is possible that pain is recalled more accurately than positive emotions; thus the stronger association of perceived health with discomfort rather than comfort (Schwarz & Clore, 1996).

Third, because the ATUS collects reports of momentary well-being for only three randomly selected activity episodes during the sampled day, fewer than 10% of respondents had more than one measure of well-being for our focal activities. This meant that we did not have multiple observations for within-individual comparisons. Our results may reflect unobserved individual differences.

Additionally, the likelihood of having a momentary assessment on an activity with a MET value classified as moderate to high physical activity was just above 50%. As noted earlier, the degree to which one chooses to engage in a particular activity may also condition the impact of the activity on one's perceived health and well-being. However, even after including a control for self-rated health several months earlier, the results did not change appreciably. In an additional test for reverse causality, we modeled the association between playing with children and health using instrumental variables. We found that actively playing with children was significantly associated with perceived health even when instrumented by whether the respondent had children living at home (not shown). This suggests that our results are robust.

5.4 Summary and Policy Implications

This research is the first to use daily diary data to examine how the duration and momentary assessment of sedentary or moderately vigorous activities in everyday life link to self-reported health. Among all the activities engaged in during one day we distinguished three commonly reported activity categories that were classified as having a moderate to vigorous level of energy expenditures, and one that was sedentary. We obtained detailed measurement of duration and intensity of time spent, as well as one's experienced psychological and physical well-being while carrying out these activities.

We documented a relatively simple association between engaging in sedentary or moderately vigorous activities and perceived health – respondents who engaged in sedentary activity were less likely and those who engaged in moderately vigorous activities more likely to report being in good health. Engagement in active leisure had a strong association with both better perceived health and less hypertension, whereas household work and play with children were associated with perceived health but not associated with hypertension, suggesting the evidence is weaker for true health effects. The actual amount of time spent was linked to health only for household activities and for sedentary activities, and both were in the direction hypothesized. Studies that have either ignored household work and play with children, or that combined them into a diffuse activity category may have missed a potentially important influence on population health.

Besides revisiting the association between physical activity and health using high quality 24-hour diary data, our major contribution is the examination of the role of momentary emotion in understanding linkages between four different activity types and self-reported health. We found that, regardless of activity type, positive mood when engaged in a particular activity was linked with superior perceived health whereas somatic symptoms were associated with poorer quality

perceived health; these effects persisted even after health-based selection was controlled. In contrast, only somatic symptoms were associated with hypertension. An overall life satisfaction measure, the Cantril Ladder, did as well as positive mood in predicting self-reported heath, suggesting that positive mood may be an underlying personal characteristic. These results carry potentially important implications for the study of activity and health more generally. The nature, quality, and desirability of an activity such as sedentary activity, household work, leisure activity, or playing with children are rarely considered in studies of the social correlates of health. Our research suggests that one's assessment of uncomfortable physical symptoms during activities presumed to be protective (or threatening) to health may be associated with perceived health – regardless of what the activity entails. As such, public health messages urging all healthy adults to engage in at least 2.5 hours of moderate intensity aerobic activity each week could be modified to broaden the activities recommended and to recognize individual-level differences in their momentary physical and emotional well-being (U.S. Department of Health and Human Services 2008).

Acknowledgements

Support for this research was provided by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (Grant R01-HD053654, S. Hofferth, PI, and R24-HD041041 to the Maryland Population Research Center).

References

Aadahl, M., Kjaer, M., & Torben Jorgensen, T. (2007). Influence of time Spent on TV viewing and vigorous intensity physical activity on cardiovascular biomarkers. The Inter 99 Study. *European Journal of Cardiovascular Prevention and Rehabilitation,* 14(5), 660-5. https://doi.org/10.1097/HJR.0b013e3280c284c5

Ainsworth, B. E., Haskell, W. L., Herrmann, S. D., Meckes, N., Bassett Jr, D. R., Tudor-Locke, C., ... & Leon, A. S. (2011). 2011 Compendium of Physical Activities: a second update of codes and MET values. *Medicine & science in sports & exercise*, *43*(8), 1575-1581. https://doi.org/10.1249/MSS.0b013e31821ece12

Bolger, N., Davis, A., & Eshkol Rafaeli, E. (2003). Diary methods: Capturing life as it is lived. *Annual Review of Psychology*, 54, 579–616. https://doi.org/10.1146/annurev.psych.54.101601.145030

Brenner, P.S., & DeLamater, J.D. (2014). Social desirability bias in self-reports of physical activity: Is an exercise identity the culprit? *Social Indicators Research,* 117(2), 489-504. https://doi.org/10.1007/s11205-013-0359-y

Cantril, H. *The Pattern of Human Concerns*. (1965). New Brunswick, NJ: Rutgers University Press, 1965.

Centers for Disease Control and Prevention. (2013). Self-reported hypertension and use of antihypertensive medication among adults – United States, 2005-2009. *Morbidity and Mortality Weekly Report* (April 5), 62, 237-44.

Drake, B. (2013). Another gender gap: Men spend more time in leisure activities. *Pew Research Center* (June 10).

Ekkekakis, P., & Lind, E. (2006). Exercise does not feel the same when you are overweight: The impact of self-selected and imposed intensity on affect and exertion. *International Journal of Obesity,* 30, 652-660. https://doi.org/10.1038/sj.ijo.0803052

Ekkekakis, P., Parfitt, G., & Petruzzello, S. (2011). The pleasure and displeasure people feel when they exercise at different intensities. *Sports Medicine*, 41 (8), 641-671. https://doi.org/10.2165/11590680-000000000-00000

Ferraro, K. F., & Farmer, M.M. (1999). Utility of health data from social surveys: Is there a gold standard for measuring morbidity? *American Sociological Review* 64(2), 303-15. https://doi.org/10.2307/2657534

Fredrickson, B. L., & Kahneman, D. (1993). Duration neglect in retrospective evaluations of affective episodes. *Journal of personality and social psychology*, *65*(1), 45-55. https://doi.org/10.1037/0022-3514.65.1.45

Haskell, W. L. (2012). Physical activity by self-report: A brief history and future issues. *Journal of Physical Activity and Health*, 9(Suppl 1), S5-S10. https://doi.org/10.1123/jpah.9.s1.s5

Hofferth, S., Welk, G., Treuth, M., Randolph, S., Curtin, S., & Valliant, R. (2008).Validation of a diary measure of children's physical activities. *Sociological Methodology* 38,133-154. https://doi.org/10.1111/j.1467-9531.2008.00200.x

Hofferth, S. L., Flood, S.M., & Sobek, M. (2013). *American Time Use Survey Data Extract System: Version 2.4.* [MRDF]. Maryland Population Research Center, University of Maryland, College Park, Maryland, and Minnesota Population Center, University of Minnesota, Minneapolis, Minnesota.

Hu, F. B., Leitzmann, M.F., Stampfer, M.J., Colditz, G.A., Willett, W.C., & Rimm, E.B. (2001). Physical activity and television watching in relation to risk for Type 2 Diabetes Mellitus in men. *Archives of Internal Medicine* 161(12),1542-8. https://doi.org/10.1001/archinte.161.12.1542

Idler, E.L., & Benyamini, Y. (1997). Self-rated health and mortality: A review of twenty-seven community studies. *Journal of Health and Social Behavior* 38, 21-37. https://doi.org/10.2307/2955359

Juster, F. T., & Stafford. F.P. (1985). *Time, Goods, and Well-Being*. Ann Arbor, MI: Institute for Social Research, University of Michigan.

Kahneman, D., & Deaton, A. (2010). High income improves evaluation of life but not emotional well-being. *Proceedings of the national academy of sciences*, *107*(38), 16489-16493. https://doi.org/10.1073/pnas.1011492107

King, M., Ruggles, S., Alexander, J.T., Flood, S.M., Genadek, K., Schroeder, M.B., Trampe, B., & Vick, R. (2010). *Integrated Public Use Microdata Series, Current Population Survey: Version 3.0*. [MRDF]. Minneapolis: University of Minnesota.

Krueger, A.B. (2009). *Measuring the Subjective Well-Being of Nations: National Accounts of Time Use and Well-Be*ing. Chicago: University of Chicago Press. https://doi.org/10.7208/chicago/9780226454573.001.0001

Lakka, T. A. & Bouchard, C. (2005). Physical activity, obesity, and cardiovascular disease. Pp. 137-63 in *Handbook of Experimental Pharmacology,* edited by A.V. Eckardstein. New York, NY: Springer.

Lawlor, D. A., Taylor, M., Bedford, C., & Ebrahim, S. (2002). Is housework good for health? Levels of physical activity and factors associated with activity in elderly women. Results

from the British Women's Heart and Health Study. *Journal of Epidemiology and Community Health* 56, 473-478. https://doi.org/10.1136/jech.56.6.473

Lee, Y., Hofferth, S., Flood, S., Fisher, K. 2016. Reliability, validity, and variability of the subjective well-being questions in the 2010 American Time Use Survey. Social Indicators Research 126 (3), 1355-1373. DOI: 10.1007/s11205-015-0923-8. PMCID: PMC4808299. https://doi.org/10.1007/s11205-015-0923-8

Matthews, C.E., Jurj, A.L., Shu, X-o., Li, H-L., Yang, G., Li, Q., Gao, Y-T., & Zheng, W. (2007). Influence of exercise, walking, cycling, and overall nonexercise physical activity on mortality in Chinese women. *American Journal of Epidemiology* 165(12), 1343-50. https://doi.org/10.1093/aje/kwm088

Miles, L. (2007). Physical activity and health. *Nutrition Bulletin* of the British Nutrition Foundation, 32, 314-363. https://doi.org/10.1111/j.1467-3010.2007.00668.x

Morgan, K., & Clarke, D. (1997). Customary physical activity and survival in later life: a study in Nottingham, UK. *Journal of Epidemiology and Community Health,* 51, 490-493. https://doi.org/10.1136/jech.51.5.490

Pavot, W. and Diener, E., 1993. The affective and cognitive context of self-reported measures of subjective well-being. *Social Indicators Research*, *28*(1), pp.1-20. https://doi.org/10.1007/BF01086714

Penedo, F. J. & Dahn, J.R. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry,* 18(2), 189-93. . https://doi.org/10.1097/00001504-200503000-00013

Pereira, M.A., FitzGerald, S.J., Gregg, E.W., Joswiak, M.L., Ryan, W.J., Suminski, R.R., Utter, A.C., & Zmuda, J.M. (1997). A collection of Physical Activity Questionnaires for health-related research. *Medicine and Science in Sports & Exercise* 29(6 Suppl), S1-205.

Pinto Pereira, S. M., Ki, M., & Power, C. (2012). Sedentary behaviour and biomarkers for cardiovascular disease and diabetes in mid-life: The role of television-viewing and sitting at work, *PLoS One,* 7(2), e31132. https://doi.org/10.1371/journal.pone.0031132

Pressman, S. D. & Cohen, S. (2005). Does positive affect influence health? *Psychological Bulletin,* 131(6), 925-71. https://doi.org/10.1037/0033-2909.131.6.925

Rennie, K. L., Hemingway, H., Kumari, M., Brunner, E., Malik, M., & Marmot, M. (2003). Effects of moderate and vigorous physical activity on heart rate variability in a British study of civil servants. *American Journal of Epidemiology,* 158(2), 135-43. https://doi.org/10.1093/aje/kwg120

Salmon, P. (2001). Effects of physical exercise on anxiety, depression, and sensitivity to stress: A unifying theory. *Clinical Psychology Review,* 21(1), 33-61. https://doi.org/10.1016/S0272-7358(99)00032-X

Schnittker, J., & Bacak, V. (2014). The increasing predictive validity of self-rated health. *PloS One,* 9, e84933. https://doi.org/10.1371/journal.pone.0084933

Schwarz, N., & Clore, G. L. (1996). Feelings and phenomenal experiences. *Social psychology: Handbook of basic principles*, *2*, 385-407.

Sin, N.L., Graham-Engeland, J.E. and Almeida, D.M., 2015. Daily positive events and inflammation: Findings from the National Study of Daily Experiences. *Brain, behavior, and immunity*, *43*, 130-138. https://doi.org/10.1016/j.bbi.2014.07.015

Sullivan, O. (2013). What do we learn about gender by analyzing housework separately from child care? Some considerations from time-use evidence. *Journal of Family Theory & Review,* 5, 72-84. https://doi.org/10.1111/jftr.12007

Tudor-Locke, C., Washington, T.L., Ainsworth, B.E., & Troiano, R.P. (2009). Linking the American Time Use Survey (ATUS) and the Compendium of Physical Activities: Methods and rationale. *Journal of Physical Activity and Health* 6(3), 347-53. https://doi.org/10.1123/jpah.6.3.347

U.S. Bureau of the Census. (2015). Table H-1: Income Limits for Each Fifth and Top 5% of Households (All Races). Washington, DC: U.S. Bureau of the Census. Retrieved April 3, 2015 (http://www.census.gov/hhes/www/income/data/historical/inequality/).

U.S. Bureau of the Census (2017). Table H-2: Households, By Type, Age Of Members, Region Of Residence, And Age Of Householder: 2015. U.S. Bureau of the Census. Retrieved March 8, 2017. (https://www.census.gov/hhes/families/data/cps2015H.html/).

U.S. Department of Health and Human Services. (2008). *2008 Physical Activity Guidelines for Americans*. Washington, DC: HHS. http://health.gov/paguidelines/pdf/paguide.pdf

U.S. Department of Health and Human Services. (2017). Health United States, 2016. Centers for Disease Control and Prevention: National Center for Health Statistics.

van Oostrom, S. H., Smit, H.A., Wendel-Vos, G.C., Visser, M., Verschuren, W.M., & Picavet, H.S. (2012). Adopting an active lifestyle during adulthood and health-related quality of life: The Doetinchem Cohort Study. *American Journal of Public Health,* 102(11), e62-8. https://doi.org/10.2105/AJPH.2012.301008

Zajacova, A., & Dowd, J.B. (2011). Reliability of self-rated health in US adults. *American Journal of Epidemiology,* 174(8), 977-83. https://doi.org/10.1093/aje/kwr204