Life Course Trajectories of Grip Strength by Gender, Marital Status, and Time Use: An Examination Using Time-Varying Effect Models

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Introduction

Increases in aging population and longevity necessitate more research into patterns of healthy aging across adulthood. One indicator of healthy aging is grip strength, which is an easily collected, widely used, and useful measure of overall muscle strength and physical health (Stevens et al., 2012). Studies that look at longitudinal age trajectories of grip strength find consistent aging patterns for both men and women: grip strength increases until the 30s, peaks around 30 to 40 years of age, and begins to decline thereafter (Dodds et al., 2014; Frederiksen et al., 2006).

Many studies have examined the correlates of grip strength because it is a strong predictor of later life frailty, morbidity, and mortality. For example, in studying the factors associated with grip strength among older adults, Sternang and colleagues (2015) found that being married was associated with higher grip strength only for men. This finding builds on a larger literature about the role of marital status in healthy aging, which, for instance, suggests that although being married is a significant determinant of physical health (Berkman, 1984), the benefits of marriage are stronger for men compared to women (Rogers, 1995).

Gender differences in the effects of marital status on grip strength may be related to differences between men and women in daily time usage, especially in the domains of housework and occupational work. Studies consistently evince gendered time commitments across the life course, where women spend more time doing house chores and caring for family members while men spend more time engaged in occupational work-related activities (Bird & Fremont, 1991; Ng & Popkin 2012). Considering that engaging in household and work-related activities are significantly associated with physical health (Sparks, Cooper, Fried, & Shirom, 1997; Tsunoda et al., 2013), but with differential rewards and costs for men and women (Bird & Fremont, 1991; Williams & Umberson, 2004), it is possible that the association between time devoted to work and home with grip strength may differ by gender and marital status.

However, studies that look at the associations between marital status, gender, time use, and grip strength have only focused on particular life course stages, such as young adulthood or

later life. There is lack of knowledge regarding how these factors interact across the life course. Given that the health and time-use implications of marital status change across the life course (Williams & Umberson, 2004) and that the determinants of grip strength vary with age (Sternang et al., 2015; Tsunoda et al., 2013), it is necessary to test how marital status, gender, and time use dynamically affect grip strength across the life course.

To study the implications of gendered life course trajectories in time use and grip strength across adulthood, we use Time-Varying Effect Models (TVEM) that allow for more nuanced and flexible approach in studying changes across age. The specific aims of this study are as follows:

1) Examine trajectories in grip strength across adulthood by gender;

2) Examine trajectories in grip strength across adulthood by gender and marital status;

3) Examine trajectories in time spent on household work and occupational work across adulthood by gender and marital status;

4) Examine changes in the association between time spent on household work and grip strength across adulthood by gender and marital status;

5) Examine changes in the association between time spent on occupational work and grip strength across adulthood by gender and marital status.

Methods

Sample

We use data from the second wave of the Midlife in the United States Study (MIDUS Ⅱ) and the MIDUS Refresher. MIDUS is a nationally representative survey that focuses on investigating the roles of behavioral, psychological, and social factors in age-related differences and changes in health throughout adulthood. MIDUS Ⅱ consists of a sample of community-dwelling adults ages 35 to 85, which was collected from 2004 to 2009. From 2011 to 2014, MIDUS recruited additional cohort of adults aged 25 to 75 to replenish the baseline cohort. In addition to the main survey, subsamples of participants in both MIDUS Ⅱ and the MIDUS Refresher participated in subprojects including the National Study of Daily Experiences (NSDE) and the Biomarker Project. NSDE is a daily diary study in which the respondents participated in short telephone interviews about their day-to-day experiences across 8 consecutive evenings. The biomarker project involves comprehensive biological assessments that aim to facilitate the integrative analysis between psychosocial factors and biological systems.

We combine data from MIDUS Ⅱ and the MIDUS Refresher and draw an analytic sample of respondents who participated in both NSDE and the Biomarker Project. The final analytic sample contained 1,347 participants between the ages of 27 to 86 (M = 55.83, SD = 12.26), 56% of whom were female.

Measures

Grip strength. As a part of Biomarker Project, MIDUS conducted physical function assessments of the respondents, including the measurement of grip strength. Grip strength was determined using a hand grip Dynamometer. Hand supported on surface, the participants were asked to grip and squeeze the Dynamometer as hard as they can. Measurements (kg/force) were taken three times for both right and left hand, and the average of the three readings of the dominant hand was used for analysis.

Marital status by gender. Marital status was determined based on the question from the MIDUS main survey asking "*Are you married, separated, divorced, widowed, or never married?*" Those who were married were coded as 1 and the rest were coded as 0. Then, combining this with gender information, we created four categories by gender and marital status: coded 1 = men not married, 2 = men married, 3 = women not married, and 4 = women married.

Time spent on household work. NSDE asked detailed questions about respondents' daily time use. We focus on responses to the questions: "*How much time did you spend taking care of or doing things with your children?*" and "*How much time did you spend on chores?*" The respondents originally answered in hours and minutes, and we recoded the data so that time spent would be expressed in hours (e.g. 1 hour and 30 minutes was recoded as 1.5 hours). Time spent with children and time spent doing chores were averaged across 8 days separately, and then the two mean values were summed to calculate mean total time spent doing household work.

Time spent on occupational work. Amount of time spent doing occupational work was measured with a question "*How much time did you spend on activities related to business, paid work, or school – including travel time and time spent looking for work?*" Similar to the above, the responses were recoded into hours and averaged across 8 days.

Covariates. Demographic characteristics were included in the analysis as covariates, including level of education, logged household income, race, and household size.

Analysis

We use Time-Varying Effect Modeling (TVEM) implemented using the Weighted TVEM SAS Macro (Dziak, Li, & Wagner, 2017) to estimate changes in grip strength with age and to examine changes in the association between time spent on household work and occupational work and grip strength across age. TVEM is an extension of linear regression that permits modeling changes in the mean level of a certain variable or in the association between two variables more flexibly, in a nonparametric way (Shiyko, Lanza, Tan, Li, & Shiffman, 2012). It has advantages over other methods that are traditionally used to model changes such as latent growth modeling, because with TVEM there is no need to divide time into arbitrary intervals, to constrain a specific shape of change (e.g. linear, quadratic, cubic), or to assume that the effects of a covariate on the outcome are constant over time. Strength of the association or mean levels of the outcome variable are estimated along continuous time scales, and parameter estimates are allowed to change with time. The intercepts and regression coefficients are

summarized graphically using plots that show the parameter values and corresponding confidence intervals over time.

In this analysis, age was used as an indicator of time because our aim was to examine changes in grip strength, time spent doing household work, and time spent doing occupational work across age. First, we estimated intercept-only models separately for the four age by marital status groups to examine changes across age in the mean levels of grip strength, time spent on household work, and time spent on occupational work for men and women. Then, we added the time use variables in the model to estimate the age-varying associations between time spent on household work and grip strength and between time spent on occupational work and grip strength. We ran separate models for household work time and occupational work time for the four marital status by gender groups, and included education level, race, logged household income, and household size as covariates.

Preliminary Results

Grip Strength Across Age, by Gender and Marital Status

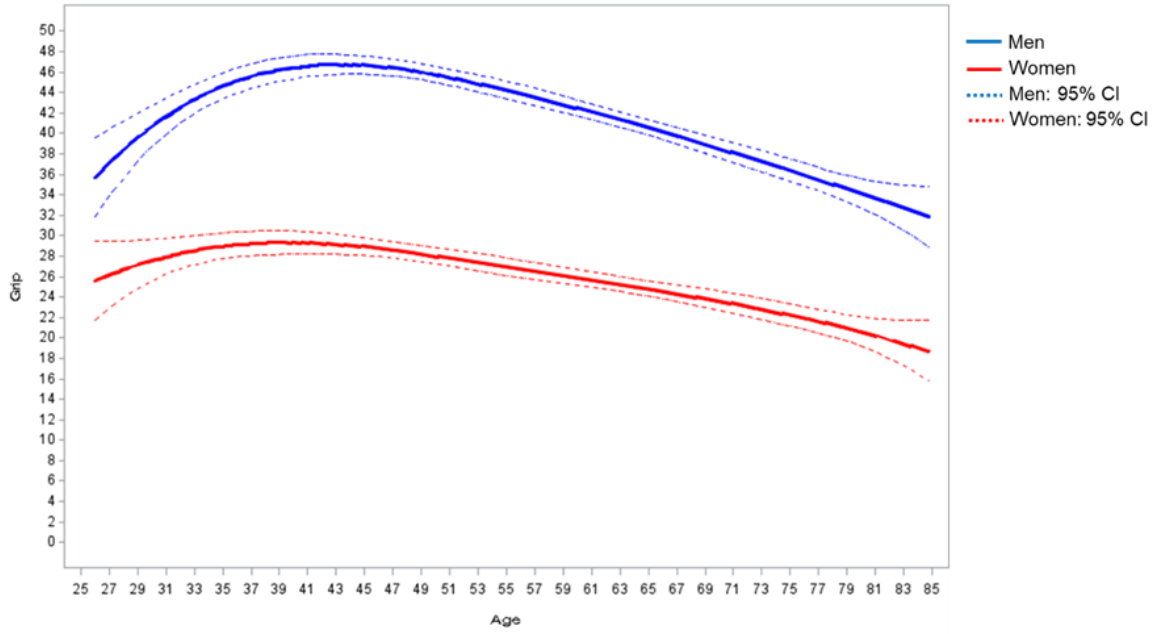

Figure 1. Grip strength across age, by gender

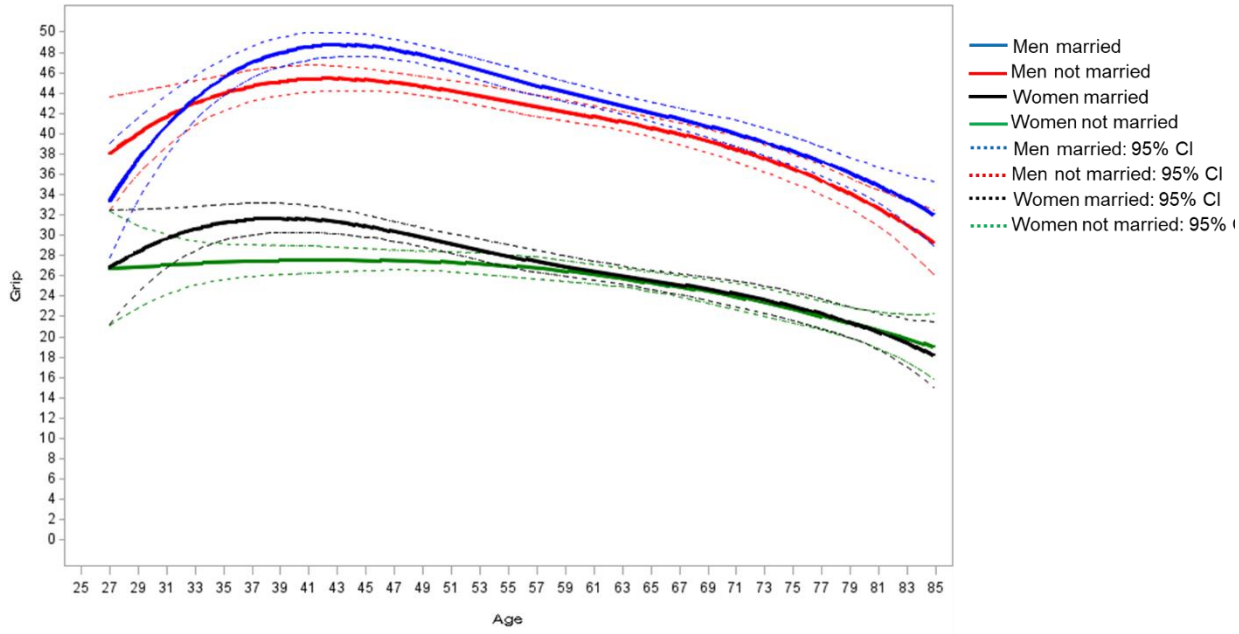

Figure 2. Grip strength across age, by gender and marital status

Figures 1 and 2 present differences in the mean levels of grip strength across age separately by gender (Figure 1) and by gender and marital status (Figure 2). The graphs also show 95% confidence intervals to quantify statistical uncertainty in the estimates, such as whether grip strength estimates differ from 0 or whether differences between groups are likely to be statistically significant at that age. In general, non-overlapping confidence intervals indicate statistically significant differences.

Figure 1 shows that women overall have significantly lower grip strength compared to men. For both men and women, grip strength increased between the ages of 25 and 40, and then continuously decreased past middle-age. Of note, a grip strength of 26 to 32 kg is considered as "intermediate" and less than 26 kg as "weak" for men. For women, a grip strength of 16 to 20 kg is considered "intermediate" and less than 16 kg "weak" (Alley et al., 2014).

Figure 2 presents changes in mean levels of grip strength for men and women by marital status. For both men and women in between ages 35 and 50, those who were married had significantly higher grip strength compared to those who were not married. This may reflect marriage selection effects, where healthier individuals are more likely to get married (Waldron, Hughes, & Brooks, 1996). Interestingly, as men and women reach their late 50s to early 60s, differences in grip strength by marital status seem to disappear. Steeper decreases in grip strength among married than unmarried individuals in their 40s, especially for women, is the reason these differences decline over time. It is an open question what contributes to the steeper decreases for married than for unmarried older adults.

Time Spent on Occupational Work by Gender and Marital Status

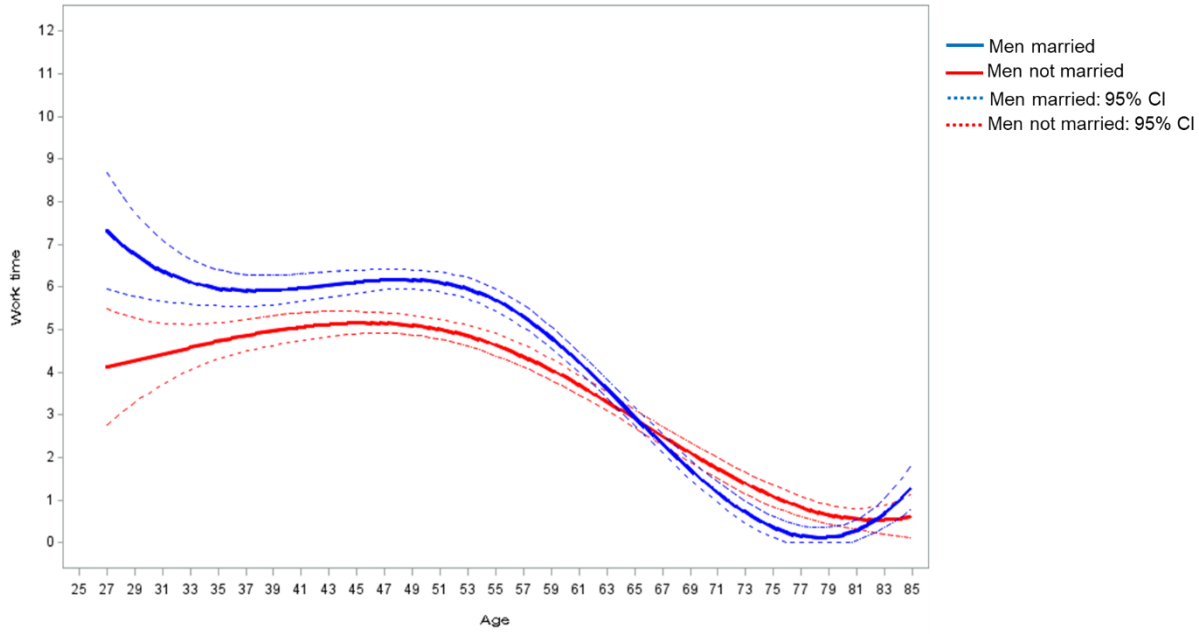

Figure 3. Time on occupational work across age by marital status for men

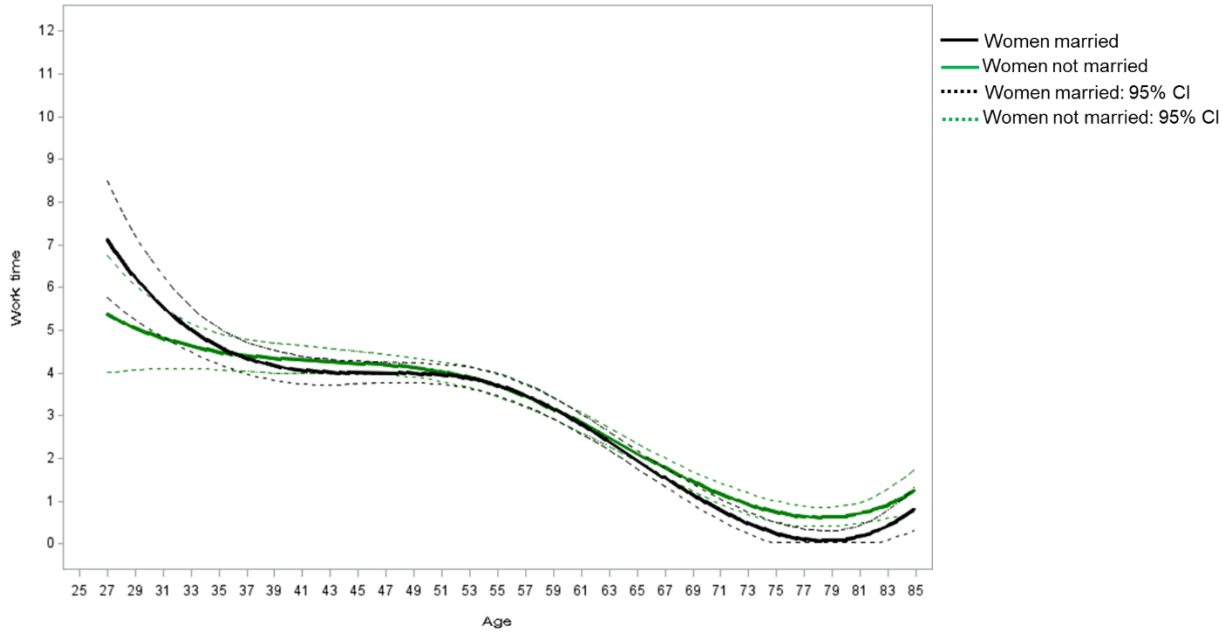

Figure 4. Time on occupational work across age by marital status for women

Figures 3 and 4 show the mean level differences in time spent on occupational work across age by marital status for men and women. For men, time spent working for both married and unmarried adults starts to decrease in the late 50s, presumably due to transition to retirement. The results also suggest that men who were married spent significantly more time working compared to those not married in young adulthood through the middle-age (25 to 60). In later life, those not married spent more time working.

Married and unmarried women show a similar but slightly different pattern than was seen for men in occupational work across ages. For them, time spent working decreased as women reached late 50s. However, there were no significant differences by marital status. Women who were married and not married spent similar amounts of time working across adulthood.

Time Spent on Household work by Gender and Marital Status

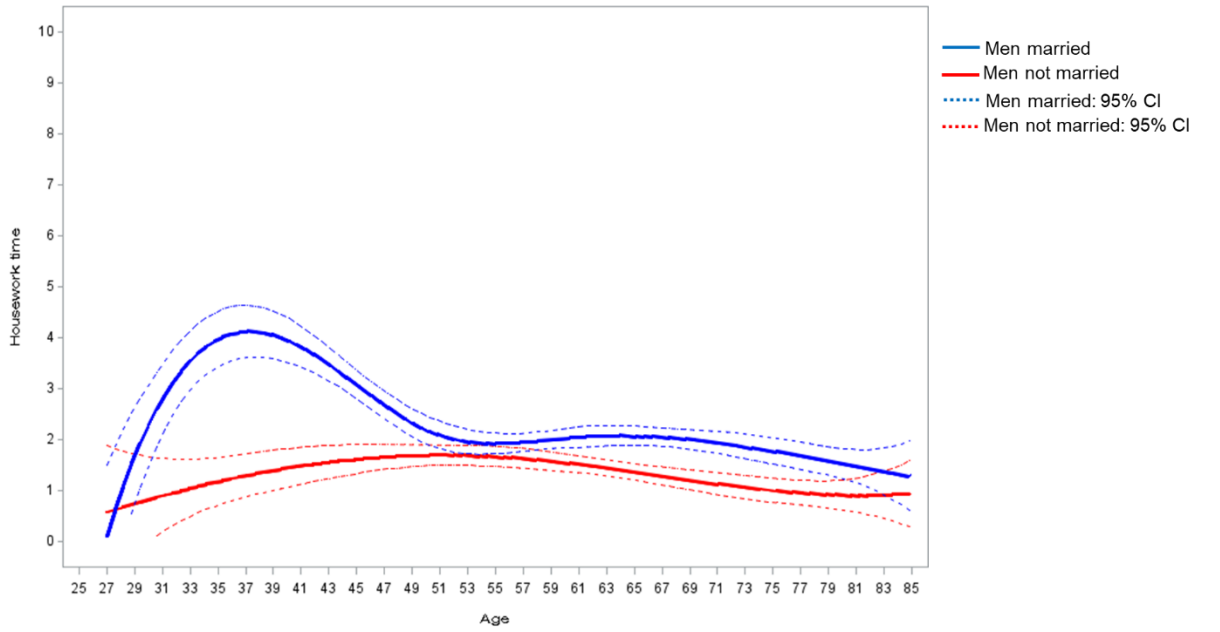

Figure 5. Time on household work across age by marital status for men

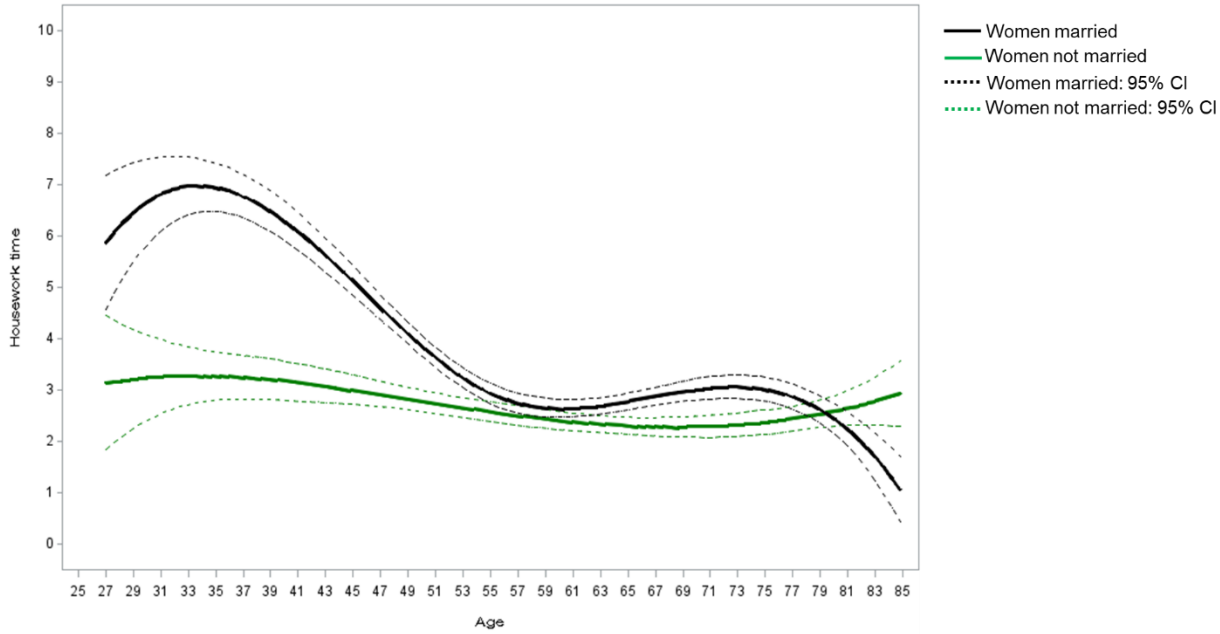

Figure 6. Time on household work across age by marital status for women

Figures 5 and 6 present the differences in time spent doing household work across age by marital status for men and women. For both men and women, those who were married spent significantly higher amounts of time doing household work compared to those not married across adulthood. Whereas unmarried individuals spend similar amount of time across all ages (as indicated by relatively flat lines), time on household work for married men and women peaked around mid to late thirties and then decrease throughout midlife. This may be due to childrearing, where parents gradually spend less time with children as children grow older and ultimately leave the household. There also was a clear gender difference. Although not apparent from the figures above, women spent significantly larger amount of time doing household work then men regardless of marital status (e.g. women not married spent more time doing household work compared to men married).

Association between Time Use and Grip Strength

Taken together, the above results suggest that higher grip strength during young adulthood to mid-life among the married compared to not married may be reflective of larger amounts of time that married men and women spend doing household work and occupational work (as presented in Figures 3 to 6). We conducted a preliminary TVEM analysis that examined the time-varying associations between time use and grip strength. This analysis indicated that for men, engaging in household work was associated with higher grip strength during mid-life (results not shown). It may be due to the nature of housework that men are engaged in that require physical strength, such as fixing the house or mowing. We plan to conduct more thorough analyses to parse out the relationships between time use in household work and occupational work and grip strength, with additional TVEM analyses that incorporates marital status as well as other supplementary methods including ANOVA and linear regression.

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