Concordance of Physical Activity Trajectories Among Middle-Aged and Older Married Couples: Impact of Diseases and Functional Difficulties

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Objectives. This study examined spousal concordance of physical activity trajectories among middle-aged and older married couples and the influences of recent diseases and functional difficulties on individuals’ trajectories and those of their spouses’.

Method. Participants included 5,074 married couples aged 50 or older in the Health and Retirement Study in 2004–2010. Participants were categorized into 4 physical activity trajectories (i.e., stable active, adopters, relapers, and stable sedentary) using confirmatory latent class growth analysis. Individuals’ trajectory memberships were predicted by their spouses’ memberships, together with recent diseases and functional difficulties of both couple members.

Results. In the main, corresponding husbands’ trajectories predicted wives’ trajectories and vice versa. More functional difficulties predicted higher likelihoods of unfavorable trajectories among individuals but not of their spouses’. Among wives, more recent diseases predicted slightly more physical activity in subsequent data waves but not trajectory memberships.

Discussion. Results supported spousal concordance in physical activity trajectories. The negative impact of functional difficulties was considerably contained within individuals. Increases in physical activity after acquiring diseases among wives were small and short lived. More research is needed to understand the underlying processes, which can be used to improve the design of future physical activity interventions directed toward women, men, and couples.

Key Words: Health promotion—Longitudinal methods—Physical activity.

Physical activity is linked to many health benefits (Bauman, 2004). However, most adults do not obtain the recommended amount of physical activity, and the prevalence of those meeting the recommendation decreases with age (Haskell et al., 2007). Social units, such as couples, have been identified as an interpersonal intervening point for physical activity promotion, with some effective programs having been delivered to young couples (Burke, Giangiulio, Gillam, Beilin, & Houghton, 2003). Considering that retiring and retired couples may have increased time spent together and their mutual influences on one-another’s behaviors, this study examined the role of the spouse in shaping physical activity trajectories and how their diseases and functional limitations may affect one-another’s physical activity behavior.

The benefits of marriage on health are well recognized. For example, being married is associated with lower risk of stroke incidence (Maselko, Bates, Avendaño, & Glymour, 2009) and cardiovascular mortality (Molloy, Stamatakis, Randall, & Hamer, 2009). One contributing factor to the health benefits of marriage is through a shared commonality of health-related behaviors. Molloy and colleagues (2009) found behavioral factors including smoking, drinking, and being physically active explained one third of the protective effects of marriage on cardiovascular mortality. Between couple members, strong evidence has been found for the concordance of health and health behaviors (Meyler, Stimpson, & Peek, 2007), and the spousal concordance in health behaviors extends into later life (Walker & Luszcz, 2009). Thus, the benefits of marriages are likely shared between these linked lives.

Concordance Theories

Multiple concordance theories, including assortative mating, shared resource hypothesis, social control, and interdependence theory (Lewis et al., 2006; Meyler et al., 2007), have been proposed to explain spousal concordance in health behaviors. Assortative mating suggests that individuals are attracted to marry those who share similar characteristics such as attitudes, personality, and behaviors (Montoya, Horton, & Kirchner, 2008). For example, physically active people may be more attracted to those who are similarly active. The shared resource hypothesis suggests that the characteristics of couple members converge as a result of shared resources such as the physical environment, social networks, and financial resources.
Social control refers to the direct and indirect attempts made by social partners to monitor and shape each other’s behaviors (Umberger, 1992). For patients with diabetes, for example, spouses were found to be the major source of support for health-related behaviors, with married men receiving social control more often than women (August & Sorkin, 2010). Although men may receive more health advice from a spouse, women seem more motivated to comply with their spouse across various stages of exercise adoption (Troped & Saunders, 1998). In contrast with the partner’s influences, interdependence theory (Lewis et al., 2006) suggests that the interdependence between couple members can transform a person-centered motivation to a relationship-centered motivation. In other words, maintaining the relationship is the primary focus for interdependent people. For instance, when a spouse experiences a health threat, couple members may develop communal coping strategies, such as engaging in physical activity together, to overcome the shared challenge.

Many models of successful aging emphasize the agentic capacity of older adults (Baltes & Baltes, 1990; Kahana, Kahana, & Zhang, 2005). That is, older adults actively exercise control over their own lives. For marriages in late life, a personal decision to initiate or maintain physical activity is thus partly shaped by physical constraints, shared resources, as well as mutual influences.

**Spousal Concordance in Physical Activity**

Among various health behaviors, the spousal concordance of physical activity is less established. In a review of spousal concordance, Meyler and colleagues (2007) found that several health behaviors including dietary intake, smoking, drinking, and drug use were interrelated between couple members. Using rudimentary indicators of physical activity, studies have also shown that couple members’ physical activity is correlated (Jurj et al., 2006; Wilson, 2002). For instance, among 66,130 couples in China, the percentage of agreement was 66.4 between couple members on whether they participated in exercise regularly ($\kappa = .22$; Jurj et al., 2006). In this study, husbands’ physical activity was reported by the wives with the help of the husbands, which might inflate the level of concordance. Using 4,746 married couples in 1992 of the Health and Retirement Study (HRS) conducted in the United States, Wilson (2002) found the percentage of agreement between couple members’ exercise levels (i.e., none, moderate, or high) to be 49.1% ($\kappa = .13$). The spousal concordance in these studies might be underestimated due to weak sensitivity in physical activity measures.

Moving beyond the cross-sectional spousal correlations observed, a longitudinal study provides stronger evidence by showing simultaneous changes of couple members. For example, Franks, Pienta, and Wray (2002) showed husbands aged 51–61 who quit smoking in the past 2 years were more likely to have wives that quit during the same time period. Falba and Sindelar (2008) studied longitudinal changes in physical activity (defined as continuing, starting, stopping, and never exercising) in a sample of 6,072 couples in the years 1996 and 2000. Results showed that an individual was more likely to start exercising rather than never exercise, if her/his spouse started exercising or continually exercised during the same period (odds ratios = 1.81–2.03). In these longitudinal analyses, behaviors were measured only at two data waves. Compared with a two-wave panel design, individuals’ growth trajectories can be estimated with higher precision and greater reliability when including additional data waves (Willett, 1989).

**TIMING OF DISEASES AND DISABILITIES AND PHYSICAL ACTIVITY CHANGES**

According to life-course perspectives, human agency, social structure (e.g., linked lives), and timing are all important for promoting physical activity (Li, Cardinal, & Settersten, 2009). Among married couples, a significant health crisis (e.g., being diagnosed with a major disease or acquiring a disability) may become the turning point for an individual’s physical activity pattern. Taking an agentic approach, health behavior theories such as the protection motivation theory (Rogers, 1983) and the health belief model (Becker, 1974) suggest threats to individuals’ health may trigger the motivation to engage in positive health behaviors. Among colorectal cancer survivors interviewed 1–14 years after their first treatment, 46% reported some posttreatment exercise behavior changes (Mullens, McCaul, Erickson, & Sandgren, 2004). Family and friends of cancer survivors also have been found to have increased physical activity levels (Humpel, Magee, & Jones, 2007), which may result from developing communal coping strategies as described in the interdependence theory (Lewis et al., 2006).

Conversely, the physical strains of a disease or disability may, to some extent, inhibit an individual’s ability to participate in physical activity, with lower prevalence rates of physical activity participation reported among people with disabilities (Rimmer, Wolf, Armour, & Sinclair, 2007). Additionally, the physical strains from some cancer treatments have been found to be related to a decrease in physical activity (Demarck-Wahnefried et al., 1997; Irwin et al., 2003) and, furthermore, the physical activity level did not fully recover within 1–4 years posttreatment (Courneya & Friedenreich, 1997). In addition, the spouses of individuals who acquire a disease or disability may need to take up more family responsibilities and provide the primary care to their partners, which would decrease their available time for physical activity (Fredman, Bertrand, Martire, Hochberg, & Harris, 2006; Nomaguchi & Bianchi, 2004).

A health crisis affords both opportunities and challenges for physical activity participation. Findings from population-based studies predominately support the negative impact...
of disease and disability on physical activity participation among older adults (Kaplan, Newsom, McFarland, & Lu, 2001; Lim & Taylor, 2005). As a possible turning point, recent health conditions should be more relevant than the past/cumulated health issues. However, most studies did not differentiate recent and past diseases and functional abilities. In addition, spousal effects were not examined in these population-based studies.

For the present study, the effects of recent diseases and functional difficulties of both the individuals and their spouses on the changes in physical activity were examined following an actor–partner interdependence model (Cook & Kenny, 2005; Kenny, 1996), in which the bidirectional effects in the dyadic relationship could be examined. Using couples as the unit of analysis, individuals’ behaviors are predicted jointly by their own (i.e., actors) and their spouses’ (i.e., partners) characteristics. On the basis of population studies, diseases and functional difficulties of both the actor and partner were hypothesized to unfavorably affect the actor’s physical activity behavior, as well as their physical activity patterns over time.

**Purpose of the Study**

Using a representative sample with more than two data waves, this study was the first to address the following questions: (a) To what extent is a person’s physical activity behavior influenced by that of their spouses’ over time? and (b) To what extent is a person’s physical activity behavior influenced by their recent diseases and functional difficulties and those of their spouse’s over time? Specific hypotheses are presented after introducing the analytical approach.

**Method**

**Data Source: The HRS**

The HRS is an on-going project sponsored by the National Institute of Aging (grant number NIA U01 AG009740) and conducted by the University of Michigan. Study approval has been granted by the University of Michigan Health Sciences Human Subjects Committee. It aims to explore and explain retirement issues and the longitudinal changes in health and wealth among adults aged 50 and older in the United States. Initiated in 1992, selected participants and their household members have been interviewed biennially.

Before 2004, a single item was used to measure vigorous physical activity participation or exercise 3 times a week or more during the past 12 months (yes or no). Beginning in 2004, items regarding moderate and mild physical activity were added, and the response options were changed from binary to a 4-point frequency rating. Because of this increased sensitivity, the current analysis included only four data waves spanning from 2004 to 2010. (This analysis used Early Release data from the HRS (year 2010). These data have not been cleaned and may contain errors that will be corrected in the final Public Release version of the data set. However, the impact to the results of the current analysis should be none to minimal, given only three items on physical activity participation in year 2010 were used).

Time-invariant covariates including age, race, and education level were obtained from the data wave in 2004. Time-varying covariates including household income, employment status, body mass index (BMI), perceived health status, depressive symptoms, and social activity were extracted from each of the four data waves. For diseases and functional difficulties, data were from waves 2002 to 2010. Data from 2002 were used to account for the past health conditions and for computation of deviation scores (see the details of the data treatment below). Other than household income, couple members reported separately their own values. Data used in this analysis appear in Table 1.

**Participants and Missing Values Treatment**

Participants were selected into this analysis using the following inclusion criteria. Individuals who remained married and lived together from 2004 to 2010 were included. Across the four data waves, the numbers of couples who lived together were 6,092, 5,441, 4,979, and 4,233. Consistent with HRS’s target participants, participants aged 50 and older were included. In 2004, only 4% of the participants were younger than 50. To retain representativeness, both self- and proxy reports were included. In addition, only individuals who reported their physical activity level at least once over the study period were included. Using these criteria, the sample size was 5,074 couples. In the raw data set, wives and husbands had average ages of 64.48 (SD = 8.89) and 67.43 (SD = 9.20) years old, respectively, in 2004. Most participants were white (85%). In 2004, the average couple was married for 37.88 (SD = 14.34) years. The average annual household income was US$78,800 (SD = US$111,500) in 2004. Details of the sample are presented in Table 1.

The proportion of missing values among the variables used was 20%, which was mainly due to attrition rather than items missing. Considering a tolerance for the power falloff of less than 1% with the fraction of missing information in the range of 10%–30%, 20 imputations were performed (Graham, Olchowski, & Gilreath, 2007). Variables used in the analysis were included in the imputation model. Because imputed outcome variables (i.e., measures of physical activity) may provide little useful information, those imputed values were removed and the missingness was handled by full information maximum likelihood (von Hippel, 2007).

**Measures**

**Physical activity.**—Questions on physical activity participation in the HRS were similar to those in the Leisure-Time
Table 1. Couples’ Characteristics Over the Study Period, and Baseline Spousal Differences and Concordance (N = 2,998–5,074)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Wife</th>
<th></th>
<th>Husband</th>
<th></th>
<th>W-Hp</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical activity (0–42.5)</td>
<td>20.25 (13.07)</td>
<td>20.25 (13.08)</td>
<td>20.01 (13.18)</td>
<td>19.20 (13.62)</td>
<td>20.91 (13.59)</td>
<td>21.35 (13.81)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>64.48 (8.89)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White (1 = yes; 0 = no)</td>
<td></td>
<td>85%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education (years)</td>
<td>12.63 (2.90)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income (US$10,000)</td>
<td>7.88 (11.15)</td>
<td>7.58 (9.35)</td>
<td>7.99 (12.69)</td>
<td>7.19 (11.89)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed (1 = yes; 0 = no)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>27.91 (5.99)</td>
<td>27.92 (6.04)</td>
<td>27.94 (6.02)</td>
<td>27.86 (6.03)</td>
<td>28.33 (4.70)</td>
<td>28.29 (4.86)</td>
</tr>
<tr>
<td>Perceived health status (1–5)</td>
<td>3.31 (1.08)</td>
<td>3.31 (1.07)</td>
<td>3.23 (1.04)</td>
<td>3.32 (1.02)</td>
<td>3.21 (1.08)</td>
<td>3.22 (1.08)</td>
</tr>
<tr>
<td>CES-D (0–8)</td>
<td>1.74 (2.09)</td>
<td>1.78 (2.12)</td>
<td>1.70 (2.10)</td>
<td>1.63 (2.03)</td>
<td>1.39 (1.82)</td>
<td>1.43 (1.82)</td>
</tr>
<tr>
<td>Social activity (1–7)</td>
<td>1.50 (2.14)</td>
<td>1.55 (2.16)</td>
<td>1.37 (2.01)</td>
<td>1.35 (1.87)</td>
<td>1.67 (2.21)</td>
<td>1.68 (2.25)</td>
</tr>
<tr>
<td>Number of diseases (1–7)</td>
<td>1.63 (1.21)</td>
<td>1.69 (1.25)</td>
<td>1.81 (1.23)</td>
<td>1.92 (1.26)</td>
<td>2.01 (1.27)</td>
<td>1.79 (1.25)</td>
</tr>
<tr>
<td>Number of functional difficulties (1–12)</td>
<td>2.26 (2.50)</td>
<td>2.38 (2.52)</td>
<td>2.49 (2.60)</td>
<td>2.46 (2.55)</td>
<td>2.53 (2.64)</td>
<td>1.68 (2.10)</td>
</tr>
</tbody>
</table>

Notes. CES-D = Center for Epidemiological Studies-Depression scale. Means or percentages are presented in the first row of a variable. Numbers in the second row of a variable presented in parentheses indicate standard deviations.

*p < .05. **p < .01. ***p < .001.
Statistical Analysis

Descriptive statistics.—To explore similarities and differences between couple members, paired-sample *t* tests and two-sample tests of proportions were conducted for the continuous and binary variables, respectively, in 2004. Spousal correlations (i.e., correlation of the same variable between couple members) for all physical activity measures, as well as other variables measured in 2004 were examined, together with the autocorrelations among physical activity measures.

Latent class growth model.—For multiple-wave panel studies, latent growth modeling is the conventional method to examine change over time. A latent growth model assumes the growth processes are monotonic, and trajectories vary regularly within the population (Nagin, 1999), such as the growth of heights in early childhood. However, physical activity does not change monotonically, and individuals’ trajectories do not vary regularly. For nonmonotonically changed outcomes with irregular changes, a semiparametric, group-based approach, also known as latent class growth analysis (LCGA), is a useful option (Nagin, 1999).

This modeling technique relaxes the assumption that all individuals’ trajectories belong to one population. It examines the propensity of the existence of multiple subpopulations of growth patterns, and it allows the growth factors (e.g., intercepts and slopes) to vary across different trajectory groups (i.e., subpopulations). In LCGA, the within-cluster variance is normally minimized, and the between-cluster variance is maximized. It can be considered as a classification system for grouping individuals according to their growth trajectories. LCGA also has the advantage of taking into account the uncertainty (i.e., classification error) in assigning group membership and testing for group differences in the estimation (Roeder, Lynch, & Nagin, 1999). Thus, instead of fixed cluster memberships that are common in cluster analysis, the class memberships for LCGA are represented as probabilities. The class membership variable is known as a categorical latent variable. The advantages of this model-based approach (Roeder et al., 1999; Willett, 1989) and some additional considerations for its use in this study are elaborated on further in the Supplementary Data.

Proposed physical activity trajectories.—A confirmatory LCGA (Muthén, Khoo, Francis, & Boscardin, 2003), which constrained the number of classes and the shapes of the trajectories, was used to extract the four physical activity trajectories proposed as transitional shift patterns (Levy & Cardinal, 2006). The transitional shift patterns, which capture the longitudinal changes in the stages of change in physical activity, originally were conceived as stable active, activity adopters, activity relapsers, stable sedentary, and perpetual preparers. Stable active, adopters, relapsers, and stable sedentary represent four linear trajectories that coincide with the longitudinal changes in exercise that Falba and Sindelar (2008) studied. The trajectory of perpetual preparers was not included in this study because they can come with various different forms and cannot be adequately represented by a linear trajectory. Nonlinear trajectories could not be satisfactorily modeled given the limited measurement points in this study. The classification error resulting from the exclusion of perpetual preparers was accounted for by the LCGA.

Model specification.—Wives’ and husbands’ trajectories were defined as two separate categorical latent variables, representing couple members’ trajectory memberships. For each trajectory group, the linear trajectory was defined by an intercept and a slope, and these growth parameters between couple members were constrained to be equal. Therefore, the definitions of the transitional shift patterns were identical between couple members. The intercept latent factors were indicated by physical activity scores at the four waves with factor loadings of 1, whereas the slope factors were indicated by the physical activity scores with factor loadings of 0, 1, 2, and 3 in chronological order. The correlated residual variances of the adjacent measurement occasions for physical activity and the correlated residual variances between couple members’ physical activity at the same measurement occasions were freely estimated.

The growth parameters of the four trajectories were constrained to represent an hourglass-shaped pattern (when plotting physical activity scores against time; see Supplementary Figure S1), which was composed of stable active (i.e., high horizontal line), adopters (i.e., diagonal line showing growth), relapsers (i.e., diagonal line showing decline), and stable sedentary (i.e., low horizontal line). Specific model constraints are presented in Tables 2 and 3. The intercepts of the four trajectories and the slopes for adopters and relapsers were freely estimated. To examine how the data conform to the trajectories in the model, a nonmodel-based approach was developed to classify participants into the four trajectories, together with a nonconforming group, for comparison (see Supplementary Data).

Although log-linear models can also test the concordance of two categorical variables with more than two categories, multinomial logit regressions were selected because they are more flexible in including covariates. Thus, two sets of LCGAs were conducted, with one set predicting wives’ trajectories by their husbands’ trajectories (i.e., husband-to-wife model) and the other set predicting husbands’ trajectories by their wives’ trajectories (i.e., wife-to-husband model).

Applying this modeling technique to the first research question, we hypothesized individuals’ trajectory memberships were predicted by those of their spouses’ (hypothesis 1). The trajectory of stable sedentary served as the reference group for the comparison in the multinomial models. The comparisons between stable active and relapers, and between
COUPLES’ PHYSICAL ACTIVITY TRAJECTORIES

Table 2. Counts and Growth Factors of the Latent Classes for the Husband-to-Wife Model

<table>
<thead>
<tr>
<th>Husband’s trajectory</th>
<th>SA</th>
<th>AA</th>
<th>AR</th>
<th>SS</th>
<th>Total</th>
<th>%</th>
<th>Intercept</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable active (SA)</td>
<td>339</td>
<td>118</td>
<td>156</td>
<td>354</td>
<td>967</td>
<td>19%</td>
<td>34.60***</td>
<td>0.00</td>
</tr>
<tr>
<td>Activity adopters (AA)</td>
<td>78</td>
<td>80</td>
<td>36</td>
<td>295</td>
<td>489</td>
<td>10%</td>
<td>13.30***</td>
<td>7.10***</td>
</tr>
<tr>
<td>Activity relapers (AR)</td>
<td>109</td>
<td>73</td>
<td>165</td>
<td>443</td>
<td>790</td>
<td>16%</td>
<td>34.60***</td>
<td>−7.10***</td>
</tr>
<tr>
<td>Stable sedentary (SS)</td>
<td>236</td>
<td>246</td>
<td>337</td>
<td>2,009</td>
<td>2,828</td>
<td>56%</td>
<td>13.30***</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>762</td>
<td>517</td>
<td>694</td>
<td>3,101</td>
<td>5,074</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>15%</td>
<td>10%</td>
<td>14%</td>
<td>61%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. Constraints for the trajectories are as follows. Intercept$_{SA} =$ Intercept$_{AA}$; Intercept$_{SA} =$ Intercept$_{AA}$; Slope$_{SA} =$ Slope$_{AA} = 0$; Slope$_{SA} =$ −Slope$_{AA}$.

Table 3. Counts and Growth Factors of the Latent Classes for the Wife-to-Husband Model

<table>
<thead>
<tr>
<th>Wife’s trajectory</th>
<th>SA</th>
<th>AA</th>
<th>AR</th>
<th>SS</th>
<th>Total</th>
<th>%</th>
<th>Intercept</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable active (SA)</td>
<td>339</td>
<td>81</td>
<td>110</td>
<td>235</td>
<td>765</td>
<td>15%</td>
<td>34.61***</td>
<td>0.00</td>
</tr>
<tr>
<td>Activity adopters (AA)</td>
<td>121</td>
<td>77</td>
<td>74</td>
<td>245</td>
<td>517</td>
<td>10%</td>
<td>13.30***</td>
<td>7.10***</td>
</tr>
<tr>
<td>Activity relapers (AR)</td>
<td>155</td>
<td>37</td>
<td>166</td>
<td>335</td>
<td>693</td>
<td>14%</td>
<td>34.61***</td>
<td>−7.10***</td>
</tr>
<tr>
<td>Stable sedentary (SS)</td>
<td>350</td>
<td>294</td>
<td>441</td>
<td>2,014</td>
<td>3,099</td>
<td>61%</td>
<td>13.30***</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>965</td>
<td>489</td>
<td>791</td>
<td>2,829</td>
<td>5,074</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>19%</td>
<td>10%</td>
<td>16%</td>
<td>56%</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Notes. Constraints for the trajectories are as follows. Intercept$_{SA} =$ Intercept$_{AA}$; Intercept$_{SA} =$ Intercept$_{AA}$; Slope$_{SA} =$ Slope$_{AA} = 0$; Slope$_{SA} =$ −Slope$_{AA}$.

Adopters and stable sedentary were the most meaningful because these pairs possessed similar initial values (i.e., intercepts) and only varied by their rate of change (i.e., slopes). To compare stable active with relapers, a separate analysis was conducted using stable active as the reference group for each of the wife-to-husband and husband-to-wife models (see Supplementary Tables S1 and S2).

Treatment of predictors and covariates.—To answer the second research question, diseases and functional difficulties were included in the LCGA models. To distinguish recent health conditions from cumulative health conditions, deviation scores, which reflect the incidence of diseases and functional difficulties over the past 2 years, were computed (e.g., deviation score for diseases in 2004 = diseases$_{2004}$ − diseases$_{2002}$). Together with the spouses’ trajectories mentioned earlier, the deviation scores for diseases and functional difficulties in 2004 were used to predict trajectory memberships, controlling for all covariates measured in 2004, as well as the past diseases and functional difficulties reported in 2002. We hypothesized higher incidence of diseases and functional difficulties would predict more unfavorable trajectories (hypothesis 2). When predicting trajectory memberships in the multinomial logit regressions, estimates are presented as relative-risk ratios (RRRs).

Incidence of diseases and functional difficulties might also exert short-term effects on physical activity behavior. Deviation scores of diseases and functional difficulties were used to predict their corresponding physical activity scores at given time points, controlling for other time-varying covariates. The estimates reflect the extent that incidence of ill-health conditions explains the amount of physical activity deviated from the estimated trajectories. Because there were no reasons to suggest the effects of time-varying predictors on the corresponding physical activity scores would vary across time points, these coefficients were constrained to be equal over the four waves. Because physical activity scores were continuous, the effects of these time-varying covariates are presented as unstandardized coefficients in the multiple regressions. We hypothesized higher incidence of diseases and functional difficulties over the past 2 years would predict lower physical activity scores at the corresponding data wave (hypothesis 3).

For both hypotheses 2 and 3, individuals’ and spouses’ diseases and functional difficulties were used to predict individuals’ physical activity behavior and their trajectories. For a more parsimonious model, only individuals’ covariates were included. For interpretation purposes, continuous predictors were standardized, whereas dichotomous predictors were coded as 1 and 0. The wife-to-husband model is shown in Figure 1.

Model evaluation.—The percentage of agreement and kappa coefficient for the correspondence between couple members’ physical activity trajectories were computed to...
facilitate comparisons with findings in the extant literature. Entropy was reported to show the quality of classification (see Muthén et al., 2002, p.465) of the LCGAs. Entropy ranges from 0 to 1, with a larger value indicating clearer classification of the latent classes (Celeux & Soromenho, 1996). Because the number of classes was confined in the current confirmatory approach, comparisons among models with different numbers of classes were not conducted. Hence, other model fit indexes (e.g., Akaike information criterion, Bayesian information criterion) were not relevant. All of the LCGAs were conducted using Mplus 6 (Muthén & Muthén, 1998–2010).

Results

Descriptive Statistics

The means/percentages and standard deviations of the studied variables are presented in Table 1. In 2004, the mean physical activity scores for wives and husbands were 20.25 (SD = 13.07) and 20.91 (SD = 13.59), respectively. Physical activity scores generally declined over the 6-year time period studied for both wives and husbands. Compared with their husbands, wives were less physically active from 2004 through 2008. However, this within-couple difference was nonsignificant in 2010. The cross-sectional spousal correlations of physical activity scores were weak and consistent over waves (rs = .26). Physical activity was moderately stable over a period of 2–6 years, with the autocorrelations of physical activity scores ranging from .47 to .57 for wives and .48 to .59 for husbands.

Spousal Concordance

Results showed a high level of consistency between husband-to-wife and wife-to-husband models in terms of the trajectory distribution, as well as their corresponding growth parameters. The trajectory distributions and growth parameters are shown in Tables 2 and 3. The entropy measures of the husband-to-wife and the wife-to-husband models were both satisfactory (i.e., .76 for both), indicating that participants were successfully classified into the latent trajectories. Most were stable sedentary (61% for wives and 56% for husbands), and the fewest were adopters (10% for both). The remainder were stable active (15% and 19%, respectively) and relapsers (14% and 16%, respectively). The percentages of agreement between couple members...
on physical activity trajectories were 51% in both models, with kappa coefficients being .19 for both, suggesting poor agreement (Landis & Koch, 1977).

Results of the multinomial logit regressions for husband-to-wife and wife-to-husband models are shown in Tables 4 and 5, respectively. The top section of the tables shows whether individuals’ physical activity trajectories were predicted by those of their spouses’ after controlling for time-invariant and time-varying predictors. The predictions for the corresponding types of physical activity trajectories between couple members were all significant (RRRs = 1.76–5.79, ps < .05), except for predicting the membership of adopters for husbands by the membership of adopters for wives with stable sedentary as the reference group (RRR = 1.70, ns). Together with the kappa coefficients discussed earlier, results suggested that the physical activity trajectories were interrelated between couple members, which supported hypothesis 1.

Effects of Diseases and Functional Difficulties

In general, the effects of diseases on trajectory memberships were minimal and inconsistent, whereas both past and recent functional difficulties of the couple members consistently predicted their own trajectory memberships but not their spouses’. The more functional difficulties they had, the more likely they were to be stable sedentary. For instance, husbands who experienced recent functional difficulties were less likely to be identified as stable active (RRR = 0.79, p < .001) and adopters (RRR = 0.74, p < .01) compared with stable sedentary. Thus, hypothesis 2 was only partially supported.

When predicting husbands’ trajectory memberships, the husband-to-wife and the wife-to-husband models differed by whether the wives’ trajectory memberships were included as predictors (i.e., comparing the right half of Table 4 and the right half of Table 5). Hence, how the inclusion of the wives’ trajectories might affect the effects of the covariates, including recent diseases and functional difficulties, on the husbands’ trajectory memberships could be examined. The same holds true when predicting the wives’ trajectory memberships. After the inclusion of the spouses’ trajectories as predictors, the effects of past diseases and functional difficulties on class memberships were reduced mainly in the wife-to-husband model. For example, effects of wives’ past diseases

Table 4. Estimates of the Husband-to-Wife Model With Stable Sedentary Being the Reference Group (N = 5,074)

<table>
<thead>
<tr>
<th>Wife Trajectory</th>
<th>Husband Trajectory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SA</td>
</tr>
<tr>
<td>Husband’s trajectory</td>
<td>5.56***</td>
</tr>
<tr>
<td>Actor-specific factors</td>
<td>1.80*</td>
</tr>
<tr>
<td>Age</td>
<td>0.71***</td>
</tr>
<tr>
<td>White</td>
<td>0.95</td>
</tr>
<tr>
<td>Education</td>
<td>1.28**</td>
</tr>
<tr>
<td>Employed</td>
<td>0.68**</td>
</tr>
<tr>
<td>Perceived health</td>
<td>0.76***</td>
</tr>
<tr>
<td>CES-D</td>
<td>1.43***</td>
</tr>
<tr>
<td>Social activity</td>
<td>0.99</td>
</tr>
<tr>
<td>Common factors</td>
<td>1.22***</td>
</tr>
<tr>
<td>Household income</td>
<td>1.09</td>
</tr>
</tbody>
</table>

Notes. AA = activity adopters; AR = activity relapers; BMI = body mass index; CES-D = Center for Epidemiological Studies-Depression scale; PA = physical activity; SA = stable active. Continuous predictors were standardized.

*Presented in the column are relative-risk ratios (RRRs) of the time-invariant covariates predicting class memberships.

**Presented in the column are unstandardized regression coefficients (Rs) of the time-varying covariates predicting physical activity of the corresponding time points.

*p < .05. **p < .01. ***p < .001.
Table 5. Estimates of the Wife-to-Husband Model With Stable Sedentary Being the Reference Group (N = 5,074)

<table>
<thead>
<tr>
<th>Wife’s trajectory</th>
<th>RRR</th>
<th>RRR</th>
<th>RRR</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA</td>
<td>0.66***</td>
<td>0.78**</td>
<td>0.84*</td>
<td>0.97</td>
</tr>
<tr>
<td>AA</td>
<td>1.00</td>
<td>0.65*</td>
<td>1.25</td>
<td>0.94</td>
</tr>
<tr>
<td>AR</td>
<td>1.38***</td>
<td>0.99</td>
<td>1.18*</td>
<td>0.86*</td>
</tr>
</tbody>
</table>

Actor-specific factors

<table>
<thead>
<tr>
<th>Age</th>
<th>0.64**</th>
<th>1.49*</th>
<th>0.67**</th>
<th>0.84***</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>0.73***</td>
<td>0.95</td>
<td>0.98</td>
<td>0.01</td>
</tr>
<tr>
<td>Education</td>
<td>1.46***</td>
<td>1.12</td>
<td>1.09</td>
<td>1.82***</td>
</tr>
<tr>
<td>Employed</td>
<td>0.99</td>
<td>0.99</td>
<td>0.91</td>
<td>1.12***</td>
</tr>
<tr>
<td>BMI</td>
<td>1.21***</td>
<td>1.24**</td>
<td>1.20***</td>
<td>0.63***</td>
</tr>
<tr>
<td>Perceived health</td>
<td>0.99</td>
<td>0.99</td>
<td>0.91</td>
<td>1.12***</td>
</tr>
<tr>
<td>CES-D</td>
<td>0.99</td>
<td>0.99</td>
<td>0.91</td>
<td>1.12***</td>
</tr>
<tr>
<td>Social activity</td>
<td>1.11</td>
<td>1.05</td>
<td>1.09</td>
<td>0.27**</td>
</tr>
</tbody>
</table>

Common factors

<table>
<thead>
<tr>
<th>Household income</th>
<th>0.91</th>
<th>0.81*</th>
<th>0.91</th>
<th>0.93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past diseases</td>
<td>0.64***</td>
<td>0.81</td>
<td>0.63***</td>
<td>1.00</td>
</tr>
<tr>
<td>Recent diseases</td>
<td>1.02</td>
<td>0.98</td>
<td>1.05</td>
<td>0.19*</td>
</tr>
<tr>
<td>Recent functional difficulties</td>
<td>0.76***</td>
<td>0.94</td>
<td>0.77***</td>
<td>−0.44***</td>
</tr>
</tbody>
</table>

Husband’s health

<table>
<thead>
<tr>
<th>Past diseases</th>
<th>0.94</th>
<th>0.89</th>
<th>1.00</th>
<th>0.92</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past functional difficulties</td>
<td>0.84*</td>
<td>0.93</td>
<td>1.01</td>
<td>0.92</td>
</tr>
<tr>
<td>Recent diseases</td>
<td>1.06</td>
<td>1.06</td>
<td>1.04</td>
<td>0.12</td>
</tr>
<tr>
<td>Recent functional difficulties</td>
<td>0.92</td>
<td>0.95</td>
<td>0.94</td>
<td>−0.05</td>
</tr>
</tbody>
</table>

Notes. AA = activity adopters; AR = activity relapers; BMI = body mass index; CES-D = Center for Epidemiological Studies-Depression scale; PA = physical activity; SA = stable active. Continuous predictors were standardized.

*Presented in the column are relative-risk ratios (RRRs) of the time-invariant covariates predicting class memberships.

p < .05. **p < .01. ***p < .001.

(RRR = 0.88, p < .05) and functional difficulties (RRR = 0.86, p < .05) on husbands being stable active rather than stable sedentary became nonsignificant (RRRs = 0.93 and 1.00, ns) after the inclusion of the wives’ trajectories. Results suggested that the husbands’ trajectories were affected by the wives’ past diseases and functional difficulties via the wives’ trajectories. Although a formal test of indirect effect is not available for multinomial models, a partial mediation was supported following the procedures suggested by Baron and Kenny (1986). However, the effect sizes were small.

Similar to the time-invariant effects, recent diseases (Bs = 0.01 and 0.12, ns) and functional difficulties (Bs = −0.06 and −0.05, ns) from the spouses were not predictive of the individuals’ physical activity in the corresponding data waves. On the other hand, individuals’ recent functional difficulties predicted a lower level of physical activity that deviated from the estimated trajectory (Bs = −0.44 and −0.50, for wives and husbands, respectively). Unexpectedly, recent diseases predicted a higher level of physical activity that deviated from the estimated trajectory among wives (B = 0.19, p < .05). Results only partially supported hypothesis 3.

DISCUSSION

To examine the role of a spouse in explaining an individual’s physical activity trajectory, this study investigated the spousal concordance of physical activity trajectories over a 6-year period using the HRS and examined the time-invariant and time-varying effects of recent diseases and functional difficulties on physical activity. The cross-sectional spousal correlations of physical activity for each of the measurement occasions were fair, whereas the autocorrelations were moderate. The cross-sectional results regarding spousal concordance were comparable with those found in previous studies (Jurj et al., 2006; Wilson, 2002).

Trajectory Distribution and Spousal Concordance

Using a confirmatory LCGA, four physical activity trajectories including stable active, adopters, relapers, and stable sedentary were extracted separately for wives and husbands. The stable active and stable sedentary patterns included approximately three quarters of the individuals, showing a strong behavioral inertia among the couples over the 6-year period. The high proportions in stable sedentary...
for both wives (61%) and husbands (56%) were particularly alarming. Breaking these longstanding sedentary habits will require well-designed interventions (Li et al., 2009). About a quarter of the individuals were classified as adopters and relapers, with relapers outnumbering adopters. Results were consistent with the decline in physical activity observed with age. The proportions of people classified in favorable physical activity trajectories (i.e., stable active and adopters) were much less than those seen in the studies among college students (Levy & Cardinal, 2006) and people with multiple sclerosis (Levy, Li, Cardinal, & Maddalozzo, 2009), which is likely due to differences in sample characteristics. With a representative sample of middle-aged and older married couples, the current findings set a reference for future comparisons with other age groups or those in different marital statuses.

Evidence from the percentage agreement and the kappa coefficient between wives’ and husbands’ trajectories, together with the subsequent LCGA, demonstrates that couple members were quite likely to have the same trajectories. Compared with cross-sectional spousal correspondence in past studies, such as kappa coefficients of .22 (Jurj et al., 2006) and .19 (Wilson, 2002), the magnitude of the longitudinal correspondence (κ = .19) shown in this study was comparable and substantively important. Considering the cross-sectional concordance, one may expect a lower longitudinal correspondence. The comparable longitudinal concordance might be explained by advances in measurement (i.e., more sensitive physical activity measures) and analyses (i.e., LCGA took into consideration the classification uncertainty).

With stable sedentary being the reference group, the RRRs predicting the corresponding stable-active group were the largest, followed by those for relapers and adopters, indicating the extent of concordance might differ across trajectory groups. Spousal correspondence for stable active was considerable, whereas the correspondence for relapers and adopters was relatively weaker. Results were not unexpected because there might be temporal differences in the onset of behavioral changes even when spousal influences existed. Thus, although individuals could be influenced by their spouses, they might not necessarily change together at the same time. Significant RRRs off the diagonal in the top panels of Tables 4 and 5 might support this interpretation. On the other hand, the correspondence in terms of the onset of change was not a concern when predicting stable active.

The inclusion of spouses’ trajectories in predicting individuals’ trajectories did not change the effects of the health predictors and covariates. Thus, these demographic and health factors did not seem to explain spousal concordance. Assortative mating might contribute much to the concordance, but its effect cannot be singled out given the design and analytical approach of the current study (Falba & Sindelar, 2008).

### Individual’s and Spouse’s Diseases and Functional Difficulties

**Actor–partner interdependence.**—Overall, only the individual’s recent functional difficulties consistently predicted individual’s trajectories. Nevertheless, past diseases and functional difficulties of the wives predicted husbands’ trajectories. These spousal effects were small and they were mediated by wives’ trajectories. Results seem to favor the view that older adults may exercise high agentic control over their actions (Baltes & Baltes, 1990; Kahana et al., 2005). Events such as a spouse’s health-related incidents may not affect the behaviors of an individual that much. The benefits and motivations from the perceived vulnerability, as well as the communal healthy behavior changes, may also limit the time available for physical activity considering the increased responsibilities in caregiving and household chores. Thus, the impact on the individuals seems more negative and that on the spouses was mixed.

Husbands’ physical activity seemed to be slightly more dependent on their spouses, rather than the opposite. The health conditions may limit the activity of the wives, and thus affect the husbands’. Consistent with findings on social control (August & Sorkin, 2010), wives may exert more control over husbands’ behaviors. In view of this interdependency, when wives’ physical activity drops, their attempts to monitor and change their husbands’ activity may also decrease resulting in lower physical activity among husbands. The reverse may not hold true because men are less likely to exert social control (August & Sorkin) and seek help (Addis & Mahalik, 2003), thereby confining their negative impact to themselves.

Specific individuals’ effects.—Individuals who reported having more functional difficulties in the past 2 years were less likely to show a favorable physical activity trajectory (e.g., stable active). The fact that people with more functional difficulties were less likely to be stable active was consistent with findings in previous population-based studies on aging (Kaplan et al., 2001; Lim & Taylor, 2005). In addition, husbands who reported a recent increase in functional difficulties were less likely to be adopters with stable sedentary as the reference group. Among various functional difficulties, mobility limitations are of particular concern among older adults (Morley, 2004) and relevant to physical activity participation. Rasinaho, Hirvensalo, Leinonen, Lintunen, and Rantanen (2007) found that barriers to engage in physical activity were different among older adults with different levels of mobility limitations. As a result, they suggested that ensuring a safe and accessible environment with personal support (e.g., in the form of a volunteer escort) may be particularly important for getting people with mobility limitations to adopt a more physical activity lifestyle.

Interestingly, the same effect was not found among wives. The differential types of physical activity engaged
in by women and men may be one contributing factor. For example, older men more likely engage in sporting activities, whereas older women more likely engage in domestic activities (Moschny, Platen, Klaassen-Mielke, Trampisch, & Hinrichs, 2011), with the latter less affected by functional difficulties. Women may also be more receptive and motivated to follow physical activity recommendations offered by family members (Troped & Saunders, 1998). So, increases in functional difficulty may not necessarily impede their plan to adopt physical activity.

In addition to the effects on the 6-year trajectory, the time-varying effects of functional difficulties on physical activity suggested that functional difficulties also predicted how an individual may deviate from the trajectory at a particular time. Thus, effects of functional difficulties may be both temporary and enduring. The effects may depend on the prognosis of functional difficulties. Some permanent and irreversible functional losses may lead people toward a more sedentary lifestyle (i.e., turning points). For temporary disabilities, the decrements for physical activity may occur only for a short period (i.e., lapse, but not relapse). When recovered, some people may return to being physically active. More research should be devoted to developing programs, which help people with functional difficulties adopt and maintain physical activity (e.g., Talbot, Gaines, Huynh, & Metter, 2003).

For recent diseases, no effects were found on trajectory memberships. However, a positive time-varying effect on physical activity was found among wives. Married women who were recently diagnosed with diseases were more likely to increase their physical activity at least temporarily. The effect was small, which might suggest protection motivation and subsequent physical activity behaviors triggered by diseases may only outweigh the detrimental effects of the physical strains of disease slightly. It also reflects a stronger resilience among women compared with men. As mentioned earlier, women may be more willing to adopt behavior changes as recommended by significant others (Troped & Saunders, 1998). Future studies can focus on how the diagnosis of diseases, as a potential turning point, can be capitalized on. Some findings regarding the time-invariant and time-varying effects of the covariates are discussed in the Supplementary Data.

**Limitations**

Although self-report data are widely used in population-based surveys, they are limited and objective physical activity data may further illuminate work in this area (Prince et al., 2008). Apart from that, a LCGA that was built from a few measurement occasions only allowed for fitting a linear model. Hence, the nonconforming trajectories (e.g., a rise followed by a decline) could not be modeled. Further development of modeling approaches is needed to accommodate the nonconforming trajectories. Because physical activity was not measured continuously over the study period, neither episodes of change that occur and resolve between waves nor the sequencing of spousal changes in behavior could be observed. Because recent diseases and functional difficulties were defined as incidence of diseases and functional difficulties in the past 2 years, the precise timing of the incidents could not be captured in the analysis. More precise timing should afford the opportunities to see how changes in physical activity may evolve (Loprinzi, Cardinal, Si, Bennett, & Winters-Stone, 2012). Considering the inclusion criteria, participants were likely representative of healthy couples in stable marriages, and the results should not be overgeneralized. Although the current database and its available measures of physical activity were the best available to answer the research questions, a ceiling effect on the measures of physical activity and the conservative recoding of weekly frequency might bias the prevalence of physical activity. Lastly, even though secondary data analysis allows for the relatively long-term changes in physical activity in a population-based sample with various covariates to be observed, the results remain correlational. Causality cannot be assumed.

**Conclusions**

This study demonstrated how a LCGA may facilitate a more precise classification and provide accurate estimates of transitional shifts in physical activity behavior among older adult married couples. The use of the actor-partner interdependence model (Cook & Kenny, 2005; Kenny, 1996) allowed the examination of the effects of diseases and functional difficulties of the couple members on each other. Results supported the longitudinal concordance in physical activity trajectories between couple members. Considering the impact of diseases and functional difficulties, husbands’ physical activity behavior was slightly more influenced by their spouses than was the wives'. Although the physical activity levels were higher among husbands than wives, husbands seem to be more negatively affected by their own and their spouses’ diseases and functional difficulties. Some short-term benefits were observed after the occurrence of diseases on physical activity among wives. More research effort is needed to understand the underlying processes, so as to design effective interventions for women, men, and possibly the couples.

**Supplementary Material**

Supplementary material can be found at: http://psychsocgerontology.oxfordjournals.org/

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K.-K. Li planned the study, performed the statistical analysis, and wrote the paper. B. J. Cardinal helped plan the study and revise the manuscript. A. C. Accock gave statistical advice and revised the manuscript.

Correspondence

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Health and Retirement Study (HRS) public use dataset. (2004–2010). Produced and distributed by the University of Michigan with funding from the National Institute on Aging (grant number NIA U01AG09740). Ann Arbor, MI.


