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REGULAR ARTICLE

Moving in Sync: Hourly Physical Activity and Sedentary Behavior are Synchronized in Couples

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Abstract

Background Overall time spent in moderate-to-vigorous intensity physical activity (MVPA) and sedentary behavior are both correlated in couples. Knowledge about the nature and psychosocial correlates of such dyadic covariation could inform important avenues for physical activity promotion.

Purpose The present study investigates hour-by-hour covariation between partners (i.e., synchrony) in MVPA and sedentary behavior as partners engage in their daily lives and links it with person-level MVPA/sedentary behavior, temporal characteristics, and relationship variables.

Methods We used 7-day accelerometer data from two couple studies (Study 1, n = 306 couples, aged 18–80 years; Study 2, n = 108 couples, aged 60–87 years) to estimate dyadic covariation in hourly MVPA and sedentary behavior between partners. Data were analyzed using coordinated multilevel modeling.

Results In both studies, hourly MVPA and sedentary behavior exhibited similarly sized dyadic covariation between partners in the low-to-medium range of effects. Higher MVPA synchrony between partners was linked with higher individual weekly MVPA and higher individual weekly sedentary levels, whereas higher sedentary synchrony between partners was associated with higher individual weekly MVPA but lower individual weekly sedentary levels. MVPA and sedentary synchrony were higher in the morning and evening, more pronounced on weekends, and associated with more time spent together, longer relationship duration, and time-varying perceptions of higher partner closeness.

Conclusions This study demonstrates that MVPA and sedentary behaviors do not occur in a social vacuum. Instead, they are linked with close others such as partners. Thus, capitalizing on social partners may increase the effectiveness of individual-level physical activity interventions.

Keywords MVPA • sedentary behavior • accelerometer • synchrony • couples

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Introduction

Insufficient physical activity and too much sedentary behavior are associated with increased morbidity and mortality risk [1, 2]. Overall physical activity (PA) is low, and sedentary lifestyles are common in the general population [3, 4]. Demographic changes and increasing health care costs due to high chronic disease burden prioritize a better understanding of what helps and hinders PA engagement over the adult lifespan, and especially in old age. PA is shaped by the social context in which it occurs, particularly by romantic partners [5, 6]. Little is known about the extent to which intraday PA patterns covary in couples (i.e., PA synchrony; [7]). This study fills this gap by investigating hour-by-hour synchrony in moderate-to-vigorous intensity physical activity (MVPA) and sedentary behavior between partners.

PA guidelines recommend a minimum of 150 min of MVPA per week, defined as any activity ≥ 3 metabolic equivalents [3]. MVPA is not limited to exercise. It can be performed as part of daily life activities such as lawn raking, vacuuming, or brisk walking. However, only around 20% of adults worldwide meet PA guidelines [3], with a percentage that is even smaller in older adults (10%–15%; [8]). With each increasing year in age from mid to older adulthood, physical activity is estimated to decrease by about 1.3% [9]. This may, at least in part, be due to barriers to physical activity that are more prevalent in old age such as health concerns, fear of falling, or fear of pain [10]. Given that PA is a core vehicle for health promotion across the lifespan and in old age in particular [1], it seems crucial to identify factors that contribute to or hinder PA engagement. Furthermore, societal changes such as decreases in manual labor and advances in technology and transportation have led to an increase in sedentary behavior, defined as waking behavior ≤ 1.5 metabolic equivalents while in a sitting or reclining posture [11]. Younger, middle-aged, and older adults accumulate on average about 9.5, 9.7, and 10.0 hr of sedentary behavior a day [12]. Empirical evidence shows health benefits of reducing sedentary behavior (e.g., [13]), making time spent in sedentary behaviors an additional lifestyle factor related to health that the present work focuses on.

Most PA studies have primarily targeted the individual, thereby neglecting the role of close others [14]. Yet, physical activity does not occur in a social vacuum. Instead, it is strongly influenced by the people around us [7, 15]. Persons in romantic relationships share their everyday environments, engage in many joint activities, and care about each other's health, making romantic relationships a key context for investigating MVPA and sedentary behavior [7]. Studies investigating an individual's overall amount of PA (person-level PA) have demonstrated that MVPA and sedentary time are correlated in couples [15–17]. Furthermore, longitudinal studies show that if one partner becomes more or less active, the other partner is more likely to exhibit similar changes in PA levels [6, 18].

Yet, literature investigating factors that contribute to this overall physical activity concordance is sparse. Theories suggest that there could be two different underlying mechanisms, with implications for intervention development. First, concordance may be a result of shared environments such as neighborhood walkability and financial resources that affect partners similarly [19]. Second, partners may influence each other's behaviors in beneficial or unfavorable ways [20]. In the first scenario, one may look at changing environmental factors that are external to the relationship. In the second scenario, one may focus on the dynamics within a given relationship and try to promote factors that result in one partner joining in when the other partner goes for a walk.

Most dyadic PA studies aggregate MVPA/sedentary data over a certain time frame (e.g., a day or a week; [15, 16]). One previous study examining PA linkage in partners (i.e., synchrony) on the day-level demonstrates that, on days when spouses engage in more moderate activity than usual, their partner is more active, too. However, aggregation at the person or day level makes it impossible to tell if partners' PA unfolds in a time-concordant or -discordant fashion. A moment-to-moment linkage in PA levels in partners would indicate that interpersonal processes may contribute to PA concordance, over and above shared overall environmental contexts. We extend previous findings by choosing a smaller time resolution and investigating PA synchrony in everyday life on an hourly basis [21]. Illuminating the everyday mechanisms behind PA synchrony will provide insight into potential leverage points for intervention.

PA synchrony is defined as the dyadic association between two partners' concurrent MVPA and sedentary behaviors independent of partner location. Accelerometer data from two independently conducted couple studies are analyzed using a coordinated analysis approach [22]. By replicating findings across varying samples and measures utilizing separate but parallel statistical analyses, we hope to strengthen generalizability and provide a more rigorous test of our research questions. We hypothesized that hour-by-hour MVPA and sedentary behavior are correlated between partners (synchrony; [6]). Given that physical activity such as biking, walking, and active commuting often occurs in company [23], we further expected that higher MVPA synchrony would be linked with higher individual MVPA and lower individual sedentary behavior. No predictions regarding relationships between sedentary synchrony and individual MVPA/sedentary levels were made. Physical activity has been shown to vary by time of day and day of week with higher levels in the afternoon/evening and on the weekend [24]. Consequently, we examined whether MVPA/sedentary synchrony varies depending on temporal characteristics (time of day and weekday vs. weekend). Based on prior studies demonstrating reactivity to physical activity measurement with initially increased levels [25], we also explored wear day as a linear predictor to examine whether synchrony changes across the study period. Finally, relationship characteristics such as the amount of time partners spend together, the quality of the relationship, and feelings of connectedness influence how many and what kinds of activities romantic partners engage in together [26–29]. We thus investigated MVPA/sedentary synchrony in association with these relationship characteristics. In line with research pointing to the complementarity of quantitative and qualitative factors of social relationships in predicting health behaviors [30], we consider both quantitative aspects such as time spent together and relationship duration as well as global and time-varying qualitative aspects (overall relationship quality and day-to-day variations in closeness).

Methods

Secondary analyses of two couple studies were performed. We present relevant methodological information below; more details are published elsewhere (Study 1; [31], Study 2; [32]).

Study Designs and Participants

Study 1 uses baseline data of a subsample of 306 heterosexual, cohabiting couples from Berlin (Germany; *M* age = 38.2 years, *SD* = 15.6, age range: 18–80 years; mostly Caucasian) who participated in a previously published randomized controlled trial ("Days in motion", NCT01963494; https://clinicaltrials.gov/; see [31]). From the total sample of 338 couples, 32 couples (9.47%) were excluded due to missing data on study variables. Exclusion criteria of the trial were being a minor, a body mass index of less than 17.5, insufficient German language skills, paraplegia, pregnancy, restrictions on being physically active (e.g., due to disability), severe disease or injury (e.g., cardiovascular disease, injury of the musculoskeletal system), being a competitive athlete, engaging in vigorous physical exercise for more than 3 hr per day, and participating in other physical activity-related or weight loss-related intervention programs. The trial was conducted between March 2013 and December 2016. Over the course of 1 year, participants were asked to take part in a baseline assessment, a main and a booster intervention, and five follow-up assessments. Study 2 uses baseline data of a subsample of 108 older couples from Vancouver (Canada) who participated in a study on spousal health dynamics (*M* age = 71.0 years, *SD* = 6.0, age range: 60–87 years; 57% Caucasian, 36% Asian, 7% other; see [32]). From the total sample of 119 couples, 11 couples (9.24%) were excluded due to missing data on study variables. An additional nine couples did not finish the repeated daily life assessments and one couple did not have sufficient command of the English language to be included. Study 2 was conducted between March 2013 and April 2017. The study involved two interview sessions, 7 days of repeated daily life assessments, and two annual follow-ups for the subsequent 2 years. For the purpose of this manuscript, we only used data from the first assessment point of the two larger projects. Recruitment strategies in both studies included advertisements in public spaces, newspapers, social media, and existing subject pools in Study 2. Ethical approval was granted by the Institutional Review Board of the Freie Universität Berlin (Study 1) and the Clinical Research Ethics Board of the University of British Columbia (Study 2). Participants gave written informed consent and received 287.70€ (Study 1) and $400 CAD (Study 2) per couple as reimbursement for full study participation. At baseline, couples completed questionnaires and were instructed to wear an ActiGraph GT3X activity monitor (ActiGraph, Pensacola, FL) during waking time for seven consecutive days while engaging in their typical everyday activities. In Study 2, couples also completed electronic momentary assessments four times per day over the 7-day period (at waking, 11:00 AM, 4:00 PM, and 9:00 PM).

Measures

MVPA and sedentary behavior

Intensity of movement was measured using accelerometers to avoid self-report biases and mislabeled MVPA or sedentary activities [33]. Hip-worn accelerometers assessed *time spent in MVPA* and *sedentary behavior* for valid wear periods during the 7-day study period. Wear time was validated using the ActiLife software and activity coding was done in line with published protocols (Study 1: [31]; see Supplementary Material A). Minutes spent in MVPA and sedentary behavior were each aggregated in hourly intervals. A variable was created that indicated partners' MVPA and sedentary behavior for each wear hour.

Relationship measures

In Study 1, waking *time spent together* during a typical week was retrospectively reported by each partner (*M* = 6.8 hrs/day, *SD* = 3.1). In Study 2, individuals reported being with their partner in 76% of all electronic momentary assessments, on average (*SD* = 19%). In both studies, partners provided information on their *relationship duration* (Study 1: *M* = 11.6 years, *SD* = 12.8; Study 2: *M* = 40.6 years, *SD* = 13.3). *Relationship quality* was measured with the German version of the Dyadic Adjustment Scale (Study 1; 12-item short form; α = .80; [34]; *M* = 46.6 out of 60, *SD* = 5.9) and the Quality of Relationships Inventory (Study 2; 23 items; α = .93; [35]; *M* = 3.8 on a 5-point scale, *SD* = 0.6). *Closeness* was assessed four times daily (Study 2) by asking "How close do you currently feel with your partner?" Scores were aggregated at the day level (M = 74.4, SD = 18.5; ranging from 0 "not at all" to 100 "very much").

Covariates

Based on previous literature on factors associated with physical activity in adults [36], participants' age, sex, education (university degree vs. not), retirement status, having children (at least one child vs. none), marital status, and body mass index were used as covariates. Models further controlled for couples' overall joint accelerometer wear hours because MVPA and sedentary levels were higher in couples with greater joint wear time. PA-related social support provided by the partner (e.g., "I helped my partner to be physically active"; [31]) was lower in couples retained for analyses versus those who were excluded. Thus, this variable was included as an additional covariate in Study 1. See Supplementary Material B for covariate descriptives.

Data Analyses

Data preparation

Study 1 excluded 25 couples (i.e., 313 couples remained) as they did not provide at least four joint valid accelerometer wear days [37]; in Study 2, five couples were excluded (i.e., 114 couples remained) due to not providing at least three joint valid wear days [38]. Two participants provided only three valid wear days in Study 2. Findings do not change if these two couples are removed from analyses. Supplementary Material A provides further details on accelerometer data preparation [37–40]. Following Bellettiere et al. [21] and based on participants' usual waking time, we removed night hours from our data set (Study 1: 0:00–6:59; Study 2: 23:00–6:59). Furthermore, we removed wear hours in which the accelerometer was worn for <60 min and/or in which only one partner was wearing the device. Due to missing data on key study variables and control variables, seven couples in Study 1 (variables: time spent together, having children, and education) and six couples in Study 2 (variables: relationship quality, closeness, education, and retirement status) were further excluded, resulting in samples of n = 306 couples (i.e., 90.53% of the total sample retained for analyses) for Study 1 and n = 108 couples (i.e., 90.76% of the total sample retained for analyses) for Study 2. To examine whether couples who were retained for analyses differed from the total sample in study variables, analyses of missing data were performed by using χ^2 tests, t-tests, and logistic regressions [41]. In Study 1, physical activity-related provided partner support (e.g., "I helped my partner to be physically active"; [31]) was the only missing-related variable and was higher in nonretained couples (i.e., n = 32 not retained couples: M = 3.23, SD = 1.33; n = 306; retained couples: M = 2.60, SD = 1.16; b = −0.42, SE = 0.15, OR = 0.66). In Study 2, no missing-related variables were found.

Statistical analyses

Data were analyzed conducting coordinated analysis using 4-level multilevel models (*R* lme4 package; [22, 42]) with hours (Level 1) nested within days (Level 2) nested within individual partners (Level 3) nested within couples (Level 4) for the two respective outcomes of MVPA (minute per hour) and sedentary behavior (minute per hour; see Supplementary Material C for R code). Partner MVPA and sedentary behavior were included as Level 1 predictors to model dyadic covariation in MVPA and sedentary behavior (synchrony). Synchrony coefficients were extracted for each couple. As Level 1 predictors, a linear hour trend (0 = 7:00 AM) and a quadratic hour trend were modeled. At Level 2, a linear wear day trend (0 = first wear day) and a dichotomous weekend variable (0 = weekday; 1 = weekend) were included. Only in Study 2, daily closeness was modeled as a Level 2 predictor. At Level 3, relationship quality and weekly individual MVPA and sedentary behavior were included. As Level 4 predictors, we included women's reports (due to high overlap between both partners' reports) on relationship duration (r = .99 in both studies) and time spent together (Study 1: r = .66; Study 2: r = .70). Covariates were entered at Level 3 (e.g., age) and Level 4 (e.g., marital status). All models were estimated using the restricted maximum likelihood procedure. Effect sizes were estimated using recommendations by Tymms [43], and explained variance was calculated using the *R* package MuMln [44].

Results

Descriptives of central variables for both studies are presented in Tables 1 and 2. Study 1 participants spent 431 min/week in MVPA (SD = 188; with 95% >150 min) and 3,125 min/week in sedentary behavior (SD = 655) on average; Study 2 participants spent a mean of 200 min/week in MVPA (SD = 150; with 57% >150 min) and 3,479 min/week in sedentary behavior (SD = 555). A comparison with representative samples covering the adult lifespan and older adults showed that our samples were more active and less sedentary. For Study 1, an average of 431 compared with 283 min/week MVPA and 3,125 compared with 3,843 min/week sedentary [4]. For Study 2, an average of 200 compared with 112 min/week MVPA and 3,479 compared with 3,731 min/week sedentary [45].

Results from coordinated multilevel models predicting hourly MVPA and sedentary levels for

Table 1 Means, *SD*, and intercorrelations of central study variables (Study 1; n = 306 couples)

Variable	Mean (*SD*)	2	3	4	5	6	7
1. MVPA synchrony[a]	0.35 (0.16)	.65**	.08	.13**	.15**	.28**	.12*
2. Sedentary synchrony[a]	0.36 (0.15)		.05	.05	.21**	.42**	.25**
3. Individual weekly MVPA[b] (min/week)	430.8 (187.6)			−.41**	−.08	−.08	−.18**
4. Individual weekly sedentary behavior[b] (min/week)	3,124.5 (654.6)				−.01	.01	.05
5. Relationship quality[b]	46.60 (5.94)					.38**	.05
6. Time spent together[a]	6.82 (3.11)						.28**
7. Relationship duration[a]	11.63 (12.79)						

MVPA moderate-to-vigorous intensity physical activity. MVPA and sedentary synchrony coefficients were extracted from multilevel models as estimated slopes on the couple level. Relationship quality scored on a scale from 0 to 60.

[a]Variable is on the couple level (level 4).

[b]Variable is on the individual level (level 3).

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

Table 2 Means, *SD*, and intercorrelations of central study variables (Study 2; n = 108 couples)

Variable	Mean (*SD*)	2	3	4	5	6	7	8
1. MVPA synchrony[a]	0.42 (0.18)	.63**	.14*	.00	.18**	.30**	−.01	.20**
2. Sedentary synchrony[a]	0.39 (0.14)		.25**	−.06	.25**	.24**	−.10	.23**
3. Individual weekly MVPA[b] (min/week)	199.9 (149.6)			−.28**	.10	−.07	−.18**	−.01
4. Individual weekly sedentary behavior[b] (min/week)	3,479.0 (554.8)				−.04	.17*	.20**	.03
5. Relationship quality[b]	3.77 (0.60)					.16*	−.09	.61**
6. Time spent together[a]	0.76 (0.19)						.15*	.23**
7. Relationship duration[a]	40.65 (13.35)							−.01
8. Closeness[b]	74.35 (18.51)							

MVPA moderate-to-vigorous intensity physical activity. MVPA and sedentary synchrony coefficients were extracted from multilevel models as estimated slopes on the couple level. Relationship quality scored on a scale of 1–5. Daily closeness was averaged over study days to create an individual-level mean.

[a]Variable is on the couple level (level 4).

[b]Variable is on the individual level (level 3).

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

both studies can be found in Tables 3 and 4 (Models A). Low- to medium-sized positive correlations between partners' hourly MVPA and sedentary behavior were found (model extracted synchrony slopes; Study 1 MVPA synchrony: r = .35, *SD* = 0.16; Study 2 MVPA synchrony: r = .42, *SD* = 0.18; Study 1 sedentary synchrony: r = .36, *SD* = 0.15; Study 2 sedentary synchrony: r = .39, *SD* = 0.14). Thus, in an hour when partner A engaged in more MVPA or was more sedentary than usual, the other partner was more likely to engage in more MVPA or sedentary behavior (see scatterplots in Fig. 1 for illustration). MVPA and sedentary synchrony were highly correlated (Study 1: r = .65; Study 2: r = .643). Given the different age compositions of our samples, we tested whether age was associated with levels of MVPA or sedentary synchrony. We did not find any significant age differences in synchrony in Study 1 or Study 2.

To explore correlates of synchrony, interactions were added to models (Tables 3 and 4, Models B). Higher MVPA synchrony between partners was linked with higher individual weekly MVPA in both studies (Study 1: b = 0.01, p < .001, d = 0.37; Study 2: b = 0.01, p < .001, d = 0.66). However, greater MVPA synchrony was linked with higher, not lower, individual weekly sedentary behavior in Study 1 (b = 0.01, p < .01, d = 0.11), whereas no such association emerged in Study 2. Furthermore, higher sedentary synchrony was related to higher individual weekly MVPA (Study 1: b = 0.01, p < .01, d = 0.12; Study 2: b = 0.01, p < .001, d = 0.27) and lower individual weekly sedentary behavior (Study 2: b = −0.01, p < .01, d = −0.22). Concerning temporal characteristics, MVPA synchrony (Study 1: b = 0.01, p < .001, d = 0.56; Study 2: b = 0.01, p < .001, d = 0.51) and sedentary synchrony (Study 1: b = 0.01, p < .001, d = 0.77; Study 2: b = 0.01, p < .01, d = 0.56) showed a U-shaped trajectory over the

Table 3 Fixed effects estimates for multilevel models predicting moderate-to-vigorous intensity physical activity (min/hr) using restricted maximum likelihood estimation (Study 1: n = 306 couples; Study 2: n = 108 couples)

	Study 1		Study 2	
	Model A	Model B	Model A	Model B
	B (*SE*)	*B* (*SE*)	*B* (*SE*)	*B* (*SE*)
Intercept	−0.02 (0.02)	−0.02 (0.02)	0.02 (0.05)	0.04 (0.05)
Individual weekly MVPA	**0.01*** (0.01)**	**0.01*** (0.01)**	**0.01*** (0.01)**	**0.01*** (0.01)**
Individual weekly sedentary	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)
Linear hour trend	**0.03*** (0.01)**	**0.02*** (0.01)**	−0.01 (0.01)	−0.01 (0.01)
Quadratic hour trend	**−0.01*** (0.01)**	**−0.01*** (0.01)**	**−0.01** (0.01)**	**−0.01* (0.01)**
Linear day trend	−0.01 (0.01)	−0.01 (0.01)	**−0.01* (0.01)**	**−0.01* (0.01)**
Weekend	**−0.03* (0.01)**	−0.01 (0.01)	−0.03 (0.02)	−0.02 (0.02)
Relationship quality	−0.01 (0.01)	−0.01 (0.01)	**−0.03* (0.01)**	**−0.03* (0.02)**
Time spent together	0.01 (0.01)	0.01 (0.01)	−0.01 (0.05)	0.01 (0.05)
Relationship duration	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Daily closeness	—	—	−0.01 (0.01)	−0.01 (0.01)
Partner MVPA	**0.32*** (0.01)**	**0.21*** (0.02)**	**0.35*** (0.03)**	**0.34*** (0.03)**
Partner MVPA × Individual weekly MVPA		**0.01*** (0.01)**		**0.01*** (0.01)**
Partner MVPA × Individual weekly sedentary		**0.01** (0.01)**		0.01 (0.01)
Partner MVPA × Linear hour trend		**−0.01* (0.01)**		**−0.04*** (0.01)**
Partner MVPA × Quadratic hour trend		**0.01*** (0.01)**		**0.01*** (0.01)**
Partner MVPA × Linear day trend		−0.01 (0.01)		−0.01 (0.01)
Partner MVPA × Weekend		**0.24*** (0.02)**		0.05 (0.03)
Partner MVPA × Relationship quality		0.01 (0.01)		−0.01 (0.03)
Partner MVPA × Time spent together		**0.02*** (0.01)**		**0.43** (0.14)**
Partner MVPA × Relationship duration		0.01 (0.01)		−0.01 (0.01)
Partner MVPA × Daily closeness		—		**0.01* (0.01)**

MVPA moderate-to-vigorous intensity physical activity. In these models, it was controlled for age, sex, education, retirement status, having children, marital status, body mass index, provided physical activity-related partner support (Study 1 only), and overall joint accelerometer wear time. MVPA and partner MVPA per hour were z-standardized, daily closeness was centered at the person mean, and all other nonbinary variables were centered on the sample mean. Coefficients < |0.01| were rounded to 0.01 or −0.01. Bold coefficients represent significant relationships.

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

day; both were more pronounced in the morning and in the evening. Synchrony levels did not show a linear trend over the 7 days, but MVPA synchrony (Study 1: b = 0.24, p < .001, d = 0.41) and sedentary synchrony (Study 1: b = 0.18, p < .001, d = 0.43; Study 2: b = 0.09, p < .001, d = 0.24) were higher on the weekend.

MVPA and sedentary synchrony were higher when partners spent more time together (MVPA: Study 1, b = 0.02, p < .001, d = 0.25, Study 2: b = 0.43, p < .01, d = 0.29; sedentary: Study 1, b = 0.02, p < .001, d = 0.37, Study 2: b = 0.24, p < .01, d = 0.28). Relationship quality was unrelated to MVPA and sedentary synchrony, whereas relationship duration showed a positive association with sedentary synchrony (Study 1: b = 0.01, p < .05, d = 0.13). MVPA and sedentary synchrony were higher on days when higher perceived closeness to the partner was reported (Study 2: MVPA, b = 0.01, p < .05, d = 0.26; sedentary, b = 0.01, p < .001, d = 0.58; Fig. 2 illustrates this interaction).

Explained Variance

Across both studies, most of the variance in MVPA and sedentary behavior was situated on the hour level (83%–91%), whereas 2%–6% were situated on the day level, 2%–8% were on the person level, and 4%–6% were on the couple level. For full variance decomposition, see the Supplementary Material D. The fixed effects of the full models (Model B) accounted for 24% and 22% of variance in hourly MVPA as well as for 26% and 36% of variance in hourly sedentary behavior in Study 1 and Study 2, respectively (marginal Pseudo-R^2; [46]). The

Table 4 Fixed effects estimates for multilevel models predicting sedentary behavior (min/hr) using maximum likelihood estimation (Study 1: $n = 306$ couples; Study 2: $n = 108$ couples)

	Study 1		Study 2	
	Model A	Model B	Model A	Model B
	B (*SE*)	*B* (*SE*)	*B* (*SE*)	*B* (*SE*)
Intercept	**0.12*** (0.02)**	**0.10*** (0.02)**	0.18 (0.11)	0.18 (0.11)
Individual weekly MVPA	**−0.01*** (0.01)**	**−0.01*** (0.01)**	−0.01 (0.01)	−0.01 (0.01)
Individual weekly sedentary	**0.01*** (0.01)**	**0.01*** (0.01)**	**0.01*** (0.01)**	**0.01*** (0.01)**
Linear hour trend	**−0.08*** (0.01)**	**−0.07*** (0.01)**	**−0.02* (0.01)**	−0.01 (0.01)
Quadratic hour trend	**0.01*** (0.01)**	**0.01*** (0.01)**	**0.01*** (0.01)**	**0.01*** (0.01)**
Linear day trend	**0.01** (0.01)**	**0.01** (0.01)**	0.01 (0.01)	0.01 (0.01)
Weekend	**−0.04** (0.01)**	**−0.04*** (0.01)**	0.02 (0.02)	0.02 (0.02)
Relationship quality	0.01 (0.01)	0.01 (0.01)	−0.02 (0.03)	−0.02 (0.03)
Time spent together	−0.01 (0.01)	−0.01 (0.01)	−0.10 (0.14)	−0.09 (0.14)
Relationship duration	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)
Daily closeness	—	—	0.01 (0.01)	0.01 (0.01)
Partner Sedentary	**0.31*** (0.01)**	**0.24*** (0.02)**	**0.33*** (0.02)**	**0.31*** (0.02)**
Partner Sedentary × Individual weekly MVPA		**0.01** (0.01)**		**0.01*** (0.01)**
Partner Sedentary × Individual weekly sedentary		−0.01 (0.01)		**−0.01** (0.01)**
Partner Sedentary × Linear hour trend		**−0.02*** (0.01)**		**−0.02* (0.01)**
Partner Sedentary × Quadratic hour trend		**0.01*** (0.01)**		**0.01** (0.01)**
Partner Sedentary × Linear day trend		−0.01 (0.01)		0.01 (0.01)
Partner Sedentary × Weekend		**0.18*** (0.01)**		**0.09*** (0.02)**
Partner Sedentary × Relationship quality		0.01 (0.01)		0.01 (0.02)
Partner Sedentary × Time spent together		**0.02*** (0.01)**		**0.24** (0.09)**
Partner Sedentary × Relationship duration		**0.01* (0.01)**		−0.01 (0.01)
Partner Sedentary × Daily closeness		—		**0.01*** (0.01)**

MVPA moderate-to-vigorous intensity physical activity. In these models, it was controlled for age, sex, education, retirement status, having children, marital status, body mass index, provided physical activity-related partner support (Study 1 only), and overall joint accelerometer wear time. Sedentary and partner sedentary were *z*-standardized, daily closeness was centered at the person mean, all other nonbinary variables were centered on the sample mean. Coefficients < |0.01| were rounded to 0.01 and −0.01. Bold coefficients represent significant relationships.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

conditional Pseudo-R^2, or variance explained by both fixed and random effects was 37% and 47% for hourly MVPA as well as 38% and 41% for sedentary behavior in Study 1 and Study 2, respectively.

Discussion

This study examined partner synchrony of MVPA and sedentary behavior in everyday life using data from two couple studies. Hourly time spent in MVPA and sedentary behavior were correlated in couples (synchrony). Higher MVPA synchrony was related to more individual weekly MVPA (Studies 1 and 2) and more individual weekly sedentary behavior (Study 1). Higher sedentary synchrony was also linked with higher individual weekly MVPA (Studies 1 and 2) and lower individual weekly sedentary behavior (Study 2). PA synchrony varied by time of day (i.e., higher in the morning and evening) and was higher on the weekend. Furthermore, MVPA and sedentary synchrony were higher when couples spent more time together (Studies 1 and 2), when partners reported higher closeness (Study 2), and when couples had a longer relationship duration (Study 1).

Synchrony of Hourly MVPA and Sedentary Behavior Between Partners

Couples with high MVPA synchrony were more likely to also show high sedentary synchrony. This points to similar behavioral patterns; when partners are active together, they may also rest together. Partners may have

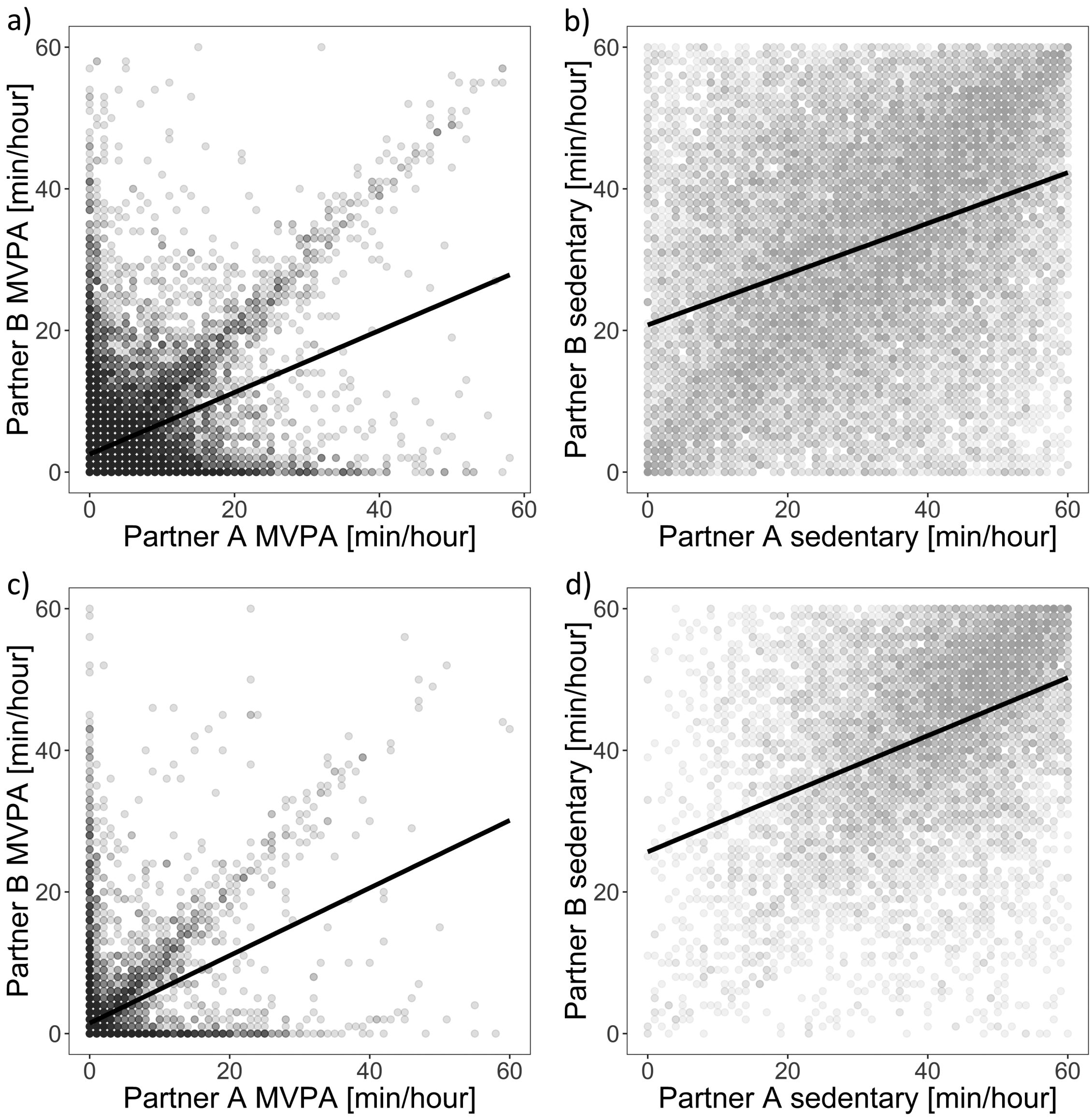

Fig. 1. Scatterplots of partner A's and partner B's minutes spent in moderate-to-vigorous intensity physical activity (MVPA) per hour for Study 1 (a) and Study 2 (c) and minutes spent in sedentary behavior per hour for Study 1 (b) and Study 2 (d). Each data point represents a couple's value for a single wear hour.

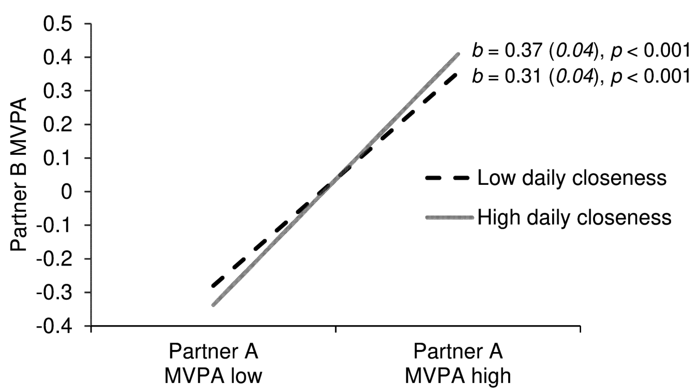

Fig. 2. Illustration of the two-way interaction between partner A moderate-to-vigorous intensity physical activity (MVPA) and daily closeness on partner B MVPA. Partner MVPA and closeness were treated as continuous variables in all models and are depicted at high and low levels ($M \pm 1$ *SD*) for illustrative purposes only. b = unstandardized coefficient of simple slope. *SE* of simple slopes are given in parentheses. Partner A MVPA and Partner B MVPA are z-standardized minutes per hour.

similar behavioral norms and share activities such as watching TV, running errands like grocery shopping, or going for a walk [14]. Partners may further serve as each other's role models for health-related behaviors [47, 48]. Besides shared routines and environments, partners may also actively influence each other's behavior through social exchange processes, including spousal control or support [15, 49].

In both studies, partners spent a substantial amount of time together, which indicates that a large share of activity assessments were spent in close physical proximity. However, proximity could not be examined on the hourly level. Future research should assess partners' presence by complementing accelerometry with spatial data.

Links of MVPA and Sedentary Synchrony With Individual Weekly PA Levels

Results support the notion that partners who—in terms of their MVPA—are more "in sync" also show higher individual weekly MVPA. This dovetails with previous research indicating that persons were more likely to increase their PA if their partner had done so [6, 18]. Such findings support recent innovations in PA interventions that recognize the importance of the partnership for PA [50, 51]. Indeed, interventions that include the partner may be more effective in enhancing PA than individual-based interventions—even if PA change is quantified on the individual level [52].

Lower sedentary synchrony was related to higher individual weekly sedentary behavior in Study 2. Highly sedentary older adults may have health limitations, which in turn may require the partner to take over more daily chores, resulting in less sedentary synchrony [53]. In Study 1, however, higher MVPA synchrony was linked with higher individual weekly sedentary behavior. This counterintuitive finding may be explained by an increased need to rest after being active due to physical fatigue or the belief that one can "afford" to be more sedentary after having engaged in MVPA [54]. To shed light on factors underlying dyadic MVPA and sedentary associations, future studies could combine accelerometry with reports of behavioral responses after engaging in MVPA.

Links of MVPA and Sedentary Synchrony With Temporal and Relationship Characteristics

Synchrony in MVPA and sedentary behavior were particularly high at the beginning and at the end of the day and on the weekend. This observation coincides with the assumption that partners have joint routines at these times (e.g., joint meals; going for a walk on a Sunday). Controlling for weekend effects, synchrony did not differ between study days. Thus, we did not find evidence for potential measurement reactivity [25]. Furthermore, results show that MVPA and sedentary synchrony were higher in couples who spent more time together and were linked to higher perceived closeness to the partner in Study 2. This is in line with prior findings indicating that on days when older couples exercised together, they reported more positive marital events and higher daily marital satisfaction [55]. Shared activities may generate intimacy between partners and maintain close relationships [27, 56]. Regarding relationship duration effects, no links with MVPA synchrony were found in either study. In Study 1, sedentary synchrony was higher in couples with longer relationship duration; we note that the effect size was rather small. Couples with longer relationship duration might have established a higher number of joint sedentary routines such as joint meals and watching TV together. Furthermore, findings are in line with studies demonstrating that partners become more similar to each other over time [57]. In the older adult sample of Study 2, no association was found between sedentary synchrony and relationship duration. Possibly, effects could not be detected in Study 2 due to the distribution of relationship length, that is, 97 out of 108 couples had been in a relationship with their current partner for 20 years or longer. Overall relationship quality was not associated with MVPA or sedentary synchrony, which might be explained by high levels of relationship quality in both of our samples and little between-couple variation. Similar to longitudinal findings on relationship quality–individual PA links [31], relationship quality might operate as a moderating factor for synchrony changes over time (e.g., couples with higher relationship quality might be more likely to explore further joint activities and could, therefore, increase their synchrony over time).

Strengths, Limitations, and Future Directions

This study's strengths include parallel self-reports and objective movement information from adult couples that allowed us to examine PA synchrony using a fine-grained hourly resolution. The present data analytic approach could be a useful basis to examine PA synchrony parameters in other dyad studies with available accelerometer data. Present findings may inform future intervention studies about types of situations (e.g., in moments when partners are feeling closer to each other) and times (e.g., on the weekend) that could be targeted in momentary PA interventions ("Just-in-time adaptive interventions"; [58]). It also provides insight into the kinds of couples that may derive specific benefit from dyadic PA interventions. For example, future research could test whether interrupting synchronized prolonged sitting time is particularly important in couples with longer relationship duration. Furthermore, dyadic PA intervention studies often evaluate intervention effectiveness using individual outcome parameters [59]. However, dyad-related parameters such as PA synchrony should also be examined to learn more about possible mechanisms to inform targeted dyadic interventions. We used different algorithms for wear time validation and activity coding for Studies 1 and 2, recognizing differences in samples (adult lifespan vs. older adults). However, these differences do not diminish comparability of findings between studies as we investigate within-person fluctuations in hourly MVPA and sedentary behavior, and link these fluctuations to the partner's within-person fluctuations of the respective outcome. As critical differences in study design and measurement prohibited pooling data between studies, we chose to base our data-analysis approach on recommendations by Hofer and Piccinin [22], who define *coordinated analysis* as the analysis of multiple independently collected data sets using parallel statistical protocols. As a strength of the present article, we demonstrate that findings replicate across varying samples, designs, and measures with positive implications for generalizability and validity.

Limitations include that analyses are correlational and explore concurrent associations; thus, the predictive direction between synchrony and its proposed correlates needs further investigation. Samples were more active and less sedentary than the general population [4, 45] and lived in metropolitan areas. Findings may not generalize to less active individuals or those residing in rural areas. In future research, tailored recruitment strategies should be implemented to examine synchrony in samples that are more representative of the general population or represent more diverse, if not at-risk population segments. Furthermore, spatial data were unavailable. Therefore, time-based synchrony needs to be distinguished from joint activities [60]. As accelerometer data only provide information about PA intensity and miss some activities (e.g., biking), future research might combine accelerometry with data on individual and joint activity types to identify target activities for intervention. Finally, change of PA synchrony over time should be investigated to examine between-couple stability and within-couple variability. To shed light on potential causal mechanisms, future studies could correlate longitudinal change in PA synchrony with change in overall physical activity levels and health-related measures.

Supplementary Material

Supplementary material is available at *Annals of Behavioral Medicine* online.

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Compliance with Ethical Standards

Authors' Statement of Conflict of Interest and Adherence to Ethical Standards The authors declare that they have no conflict of interest.

Primary Data The findings reported have not been previously published and the manuscript is not being simultaneously submitted elsewhere. These findings have not been presented in the present form previously. The authors have full control of all primary data and agree to allow the journal to review the data if requested.

Authors' Contributions: All authors were involved in the preparation of this manuscript and read and approved the final version.

Ethical Approval All procedures, including the informed consent process, were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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