Vol. 183, No. 5
DOI: 10.1093/aje/kwv104
Advance Access publication:
September 2, 2015

Spousal Influence on Physical Activity in Middle-Aged and Older Adults

The ARIC Study

Laura K. Cobb, Job G. Godino, Elizabeth Selvin, Anna Kucharska-Newton, Josef Coresh, and Silvia Koton*

* Correspondence to Dr. Silvia Koton, Department of Nursing, The Stanley Steyer School of Health Professions, Tel Aviv University, Tel Aviv 69978, Israel (e-mail: koton@tauex.tau.ac.il).

Initially submitted October 31, 2014; accepted for publication April 14, 2015.

Low physical activity levels are a public health concern. Few studies have assessed the concordance of physical activity change among spouses. We studied this concordance during a 6-year period (baseline: 1987–1989; follow-up: 1993–1995) in 3,261 spousal pairs from the US-based Atherosclerosis Risk in Communities (ARIC) Study. Linear regression was used to examine the association between change in individuals' sport/exercise and leisure physical activity indices (ranging from 1 (low) to 5 (high)) and change in his or her spouse's indices. The association between individual and spousal changes in meeting physical activity recommendations was assessed with logistic regression. Individual changes in the sport/exercise and leisure indices were positively associated with spousal changes. For every standard deviation increase in their wives' sport/exercise index, men's exercise index increased by 0.09 (95% confidence interval: 0.05, 0.12) standard deviation; for every standard deviation increase in their wives' leisure index, men's leisure index increased by 0.08 standard deviation. Results were similar for women. Individuals had higher odds of meeting physical activity recommendations if their spouse met recommendations at both visits or just follow-up. In conclusion, changes in an individual's physical activity are positively associated with changes in his or her spouse's physical activity. Physical activity promotion efforts should consider targeting couples.

change; cohort study; concordance; determinants; physical activity; population-based study; prospective study; spouses

Abbreviations: ARIC, Atherosclerosis Risk in Communities; CI, confidence interval; SD, standard deviation.

Regular physical activity is associated with many health benefits (1, 2). However, the vast majority of adults in the United States do not achieve the recommended amount of physical activity (3, 4), and there is evidence that the global burden of noncommunicable disease attributable to physical inactivity is now similar to that of smoking (2). For development of effective physical activity promotion efforts to occur, an improved understanding of the determinants of physical activity is needed (5, 6). The social or family unit, which often comprises spouses, has been identified as a potentially important target for physical activity interventions (7–9).

A substantial body of research has shown that marriage and cohabitation are associated with a decreased risk of morbidity and mortality related to multiple noncommunicable diseases in both sexes (10–12). Furthermore, spouses have been shown to exhibit similar health-seeking and risky behaviors (13, 14). These similarities may be partially explained by the fact that people often choose spouses who are similar to them (assortative mating). However, theories suggest that spouses may also become more similar over time because their shared environment leads to a high level of concordance in behavior (the shared resource hypothesis), the behavior of 1 spouse influences the behavior of the other spouse (the social control hypothesis), or spouses simultaneously influence each other and their behavior converges (convergence theory) (10–15). Previous research has found that changes by 1 spouse in a variety of behaviors associated with risk of noncommunicable disease (e.g., smoking, drinking, and medical screening) can promote similar changes (both positive and negative) in the other spouse (13, 14, 16). Current research is unclear, however, as to how an individual's level of physical activity is influenced by changes in his or her spouse's level of physical activity.

The majority of studies that have examined the concordance of physical activity in spouses have used cross-sectional data, and they consistently report that levels of physical activity are positively correlated (17–20). The few studies that have examined the spousal influence on physical activity longitudinally report that changes in both the absolute level and trajectories of physical activity in spouses are concordant over time (14, 21–23). A substantial limitation of these reports is that they are based on measures of physical activity with low validity or reliability (24, 25) that rely on either a single question (14, 21) or multiple questions on the frequency of "exercise" or "vigorous," "moderate," and "mild" activities with a ceiling response of "nearly every day" or "more than once a week" (22, 23).

The aim of the present study was to quantify the extent to which change in an individual's physical activity is influenced by changes in his or her spouse's physical activity in the community-based Atherosclerosis Risk in Communities (ARIC) Study. In the ARIC Study, physical activity was measured by using the Baecke Questionnaire, a highly reliable tool for the assessment of physical activity among adults (24–27). Additionally, the study sample includes more than 3,000 spousal pairs, aged 45–64 years at baseline, who completed 2 measurements approximately 6 years apart. A better understanding of how spouses in this population influence each other's physical activity behavior could provide important information for the design and targeting of future interventions among middle-aged and older adults (28).

METHODS

Study design and population

The ARIC Study is a community-based prospective cohort study of 15,792 primarily black and white adults designed to examine risk factors for cardiovascular disease and its related morbidity and mortality. Participants were recruited by using probability sampling from 4 US communities: Forsyth County, North Carolina; Jackson, Mississippi; Minneapolis, Minnesota; and Washington County, Maryland. During recruitment, all adults between the ages of 45 and 65 years in sampled households were invited to participate, resulting in the inclusion of spousal pairs. Data were collected at a baseline visit (visit 1) and 4 follow-up visits (visits 2 through 5) through interviews, physical examination, and blood collection. Details of the study design have been published previously (29). These analyses focus on ARIC Study visits 1 and 3, where comparable physical activity data were available (no physical activity information was collected at visits 2 and 4; information collected at visit 5 differed substantially from that collected at visits 1 and 3).

The method used to identify spousal pairs in the ARIC Study has been described previously (16, 30). Those who agreed to participate were asked to report their marital status (i.e., married, never married, divorced, separated, or widowed) and, if applicable, to identify their spouse. In cases where this information was not available, participants were considered spouses if exactly 2 adults lived in their household and both participants reported being married. These analyses included participants who enrolled along with their spouse, completed visit 1 (which took place from 1987 to 1989), and remained married until completing visit 3 (which took place from 1993 to 1995).

The institutional review boards of all participating institutions (i.e., Johns Hopkins University, University of Minnesota, University of Mississippi, University of North Carolina, Wake Forest University, and Baylor College of Medicine) approved the study protocol, and all participants provided written, informed consent.

Outcome, exposure, and covariates

Self-reported physical activity was measured by using the Baecke Questionnaire, which was designed to study habitual physical activity and to distinguish between different domains of physical activity (26). Details of the questionnaire have been published previously (26, 27). In brief, the questionnaire was interviewer administered and resulted in indices for sport/exercise and leisure physical activity that ranged from 1 (low) to 5 (high). The sport/exercise index was derived from 4 items: the frequency of participation in sport/exercise in general; the frequency of sweating during sport/exercise; a subjective rating of the frequency of participation in sport/exercise compared with others in the same age group; and the sum of the frequency, duration, and intensity of up to 4 sport/exercise activities. The leisure index was also derived from 4 items: the frequency of television viewing, walking, and cycling; and the time spent walking or cycling to and from work or shopping. The questionnaire has been found to be both reliable and valid among diverse populations of young, middle-aged, and older adults (31–34).

We also utilized data collected with the Baecke Questionnaire to create a binary variable that identifies participants whose physical activity levels met the American Heart Association physical activity recommendations. In line with previous research, this research utilizes the frequency, duration, and intensity of up to 4 sport/exercise activities and the frequency of walking for leisure to determine whether participants completed ≥150 minutes of moderate or ≥75 minutes of vigorous physical activity per week (35, 36).

The primary outcomes of interest were the change from visit 1 to visit 3 in participants' sport/exercise and leisure indices, as well as incident high physical activity. The exposure was the concurrent change in the spouses' respective physical activity measures. Change in the physical activity indices was calculated as the index value at visit 3 minus the value at visit 1. For the binary measure of high physical activity, change was classified into the following categories: low at visit 1 only, low at both visits, low at visit 3 only, and high at both visits.

Sociodemographic, behavioral, and health risk factors and illnesses assessed at visit 1 that we hypothesized might be associated with physical activity were treated as covariates.

These included age, race, study center, education (<high school, high school/college, graduate school), and employment status (employed, retired, homemaker, unemployed). Smoking status was measured as never, former, or current smoker. Health risk factors and illnesses included the following: body mass index (weight (kg)/height (m)^2); hypertension (measured systolic blood pressure ≥140 mm Hg, diastolic blood pressure ≥90 mm Hg, or taking hypertension medication; diabetes (self-reported, diabetes medications, a fasting glucose level above 126 mg/dL, or a nonfasting glucose level above 200 mg/dL); self-reported cardiovascular disease; self-reported lung disease; self-reported cancer; and self-reported health status (excellent, good, fair, poor). Because of high levels of missing data on self-reported cardiovascular disease, we included a missing indicator for this variable.

Statistical analysis

All analyses were conducted by using Stata, version 12, statistical software (StataCorp LP, College Station, Texas). Mean changes in sport/exercise and leisure indices from visit 1 to visit 3 and the values at each visit in spouses were compared by using paired *t* tests and Spearman correlations. Descriptive statistics by sex were also calculated at each visit for meeting physical activity recommendations and compared by using McNemar's test. Similar calculations were made for covariates.

All analyses were conducted separately for men and women, which ensured that individuals were not included more than once in any of our models and which allowed us to determine if associations were similar across men and women. We determined the cross-sectional association of individuals' sport/exercise and leisure indices, as well as their spouses' respective indices, at visit 1 by using linear regression. We then examined the relationship between change in each index and concurrent spousal change, also with linear regression. For each analysis, we considered 4 models: 1) unadjusted; 2) adjusted for individual's age, race, study center, and education; 3) additionally adjusted for the individual health risk factors and illnesses; and 4) additionally adjusted for spousal characteristics. Because the indices are difficult to interpret, we standardized both the sport/exercise and leisure indices, as well as the change in the sport/exercise and leisure indices, to their respective standard deviations.

We also assessed whether or not the relationship between physical activity change across spouses was modified by the following factors: 1) concordance in baseline physical activity levels and 2) concordance in baseline health status (excellent or good vs. fair or poor).We considered interactions to be significant if $P < 0.05$.

A secondary analysis assessed the association between meeting physical activity recommendations across spouses. We first examined the cross-sectional association between individuals meeting physical activity recommendations at visit 1 and their spouses meeting recommendations at visit 1 using logistic regression. We then looked at the longitudinal associations between changes in a spouse's meeting recommendations (i.e., a spouse continues to meet recommendations, a spouse no longer meets recommendations, a spouse continues to not meet recommendations, or a spouse begins to meet recommendations) and participants' meeting recommendations. We limited our analysis to individuals who did not meet physical activity recommendations at visit 1 and used logistic regression to determine whether changes in a spouse's meeting recommendations influenced the odds of the individual's meeting recommendations at visit 3, given that they had not met recommendations at visit 1. The models for this analysis were the same as those for the continuous analysis above.

RESULTS

Of the 4,505 spousal pairs who completed visit 1, a total of 3,537 also completed visit 3. Of those, 3,467 remained married. Spousal pairs that were missing information on physical activity ($n = 132$), a critical covariate ($n = 113$), and whose race was not black or white ($n = 54$) were excluded. The final sample included 3,261 spousal pairs and 6,522 individuals. At visit 1, men were, on average, 55 (standard deviation (SD), 5.3) years of age compared with 53 (SD, 5.2) years of age for women. The sample as a whole was 89.3% white, with only 1 interracial marriage. At visit 1, 83.5% of men and 64.9% of women were employed outside the home. Men had higher prevalence rates of all risk factors and illnesses with the exception of cancer, which was more common in women, and lung disease, which was evenly distributed (Table 1).

At visit 1, men had a mean sport/exercise index of 2.6 (SD, 0.8), slightly higher than women's sport/exercise index of 2.4 (SD, 0.8). Women, however, had a higher mean leisure index of 2.5 (SD, 0.6) versus 2.4 (SD, 0.5). Correlations between spouses were 0.20 for the sport/exercise index and 0.22 for the leisure index. On average, men and women had a slight increase in their sport/exercise index between visit 1 and visit 3. Leisure indices declined in both men and women, although this was larger for women (0.09 vs. 0.02). More men than women met physical activity recommendations at both visits (visit 1: 45.3% vs. 33.4%; visit 3: 40.3% vs. 30.0%), although this declined over time for both sexes (Table 1).

In cross-sectional analyses at visit 1, we found a statistically significant, positive association between both an individual's sport/exercise index and leisure index and that of his or her spouse, regardless of the model used (Table 2). In models fully adjusted for individual and spousal characteristics, a 1 standard deviation increase in a woman's sport/exercise index (0.8 units on the point Baecke scale) was associated with a 0.15 (95% confidence interval (CI): 0.12, 0.19) standard deviation increase in her spouse's index. Similarly, a 1 standard deviation increase in a woman's leisure index (0.5 units on the 5-point Baecke scale) was associated with a 0.17 (95% CI: 0.14, 0.20) standard deviation increase in her spouse's index. Relationships were symmetrical across sexes.

Results for physical activity change were similar. Changes in a woman's sport/exercise index and leisure index were positively associated with change in her spouse's index and vice versa, regardless of the model used. A 1 standard deviation increase in women's leisure index (0.6 units on the 5-point Baecke scale) was associated with a 0.08 (95% CI: 0.05, 0.11) standard deviation increase in husbands' leisure

Table 1. Characteristics of Participants by Sex, Correlations, and Concordance Between Spousal Pairs at Visit 1 (1987–1989) and Visit 3 (1993–1995) ($n = 3{,}261$), Atherosclerosis Risk in Communities Study

Characteristics	Men		Women		*P* Value[a]	Correlation, *r*	95% CI	Concordance, %
	Mean (SD)	%	Mean (SD)	%				
Visit 1 (1987–1989)								
Age, years	55.3 (5.3)		53.0 (5.2)		<0.001	0.81	0.80, 0.82	
BMI[b]	27.5 (4.0)		26.8 (5.5)		<0.001	0.19	0.15, 0.22	
Sport/exercise index[c,d]	2.64 (0.80)		2.40 (0.77)		<0.001	0.20	0.17, 0.24	
Leisure index[c,d]	2.39 (0.52)		2.49 (0.55)		<0.001	0.22	0.19, 0.26	
White		89.3		89.3	1			100
Less than high school education		18.2		13.2	<0.001			83.3
Employed		83.5		64.9	<0.001			66.4
Meets physical activity recommendations		45.3		33.4	<0.001			57.6
Current smoker		20.7		18.4	0.006			76.1
Fair/poor health status		13.2		11.1	0.002			84.2
Diabetes		10.1		7.5	<0.001			84.8
CVD		8.4		2.3	<0.001			90.6
High blood pressure		30.9		27.2	<0.001			63.5
Lung disease		4.1		4.1	1			92.4
Cancer		4.1		6.3	<0.001			90.6
Visit 3 (1993–1995)								
Sport/exercise index[c,d]	2.68 (0.83)		2.45 (0.78)		<0.001	0.21	0.17, 0.24	
Leisure index[c,d]	2.38 (0.54)		2.40 (0.56)		0.084	0.17	0.13, 0.20	
Meets physical activity recommendations		40.3		30.0	<0.001			60.7
Change Over the 6-Year Period From Visit 1 to Visit 3								
Change in sport/exercise physical activity[d]	0.04 (0.79)		0.05 (0.76)		0.609	0.08	0.05, 0.12	
Change in leisure physical activity[d]	−0.02 (0.56)		−0.09 (0.59)		<0.001	0.09	0.05, 0.12	

Abbreviations: BMI, body mass index; CI, confidence interval; CVD, cardiovascular disease; SD, standard deviation.
[a] *P* values from paired *t* tests for continuous variables and from McNemar χ^2 for categorical variables.
[b] Weight (kg)/height (m)^2.
[c] Physical activity measures on a scale from 1 to 5, with 5 being most active.
[d] Spearman correlation to account for nonlinear nature of score.

index; similarly, a 1 standard deviation increase in her sport/exercise index (0.8 units on the 5-point Baecke scale) was associated with a 0.09 (95% CI: 0.05, 0.12) standard deviation increase in her husband's sport/exercise index. Complete results from fully adjusted models are shown in Web Table 1, available at http://aje.oxfordjournals.org/. As in the cross-sectional analysis, results were symmetrical across sexes (Table 3). We did not find any significant interactions between concordance on either baseline health status or meeting physical activity recommendations at baseline and the change in either sport/exercise or leisure physical activity (data not shown).

At visit 1, having one's spouse meet physical activity recommendations was significantly associated with meeting recommendations oneself. In fully adjusted models, men and women whose spouses met recommendations at visit 1 had 1.56 (men, 95% CI: 1.34, 1.83; women, 95% CI: 1.33, 1.82) times the odds of meeting recommendations themselves (Web Table 2).

Results for changes in meeting physical activity recommendations similarly showed associations across spouses. Among men who did not meet physical activity recommendations at visit 1, those whose wife met recommendations at both visits were most likely to meet recommendations at visit 3 (compared with wives who never met recommendations, odds ratio = 1.70, 95% CI: 1.23, 2.36), followed by those whose wife met recommendations at visit 3 but not at visit 1 (odds ratio = 1.42, 95% CI: 1.05, 1.92). Results were similar in women, except that women whose spouses stopped meeting recommendations between visit 1 and visit 3 were actually less likely than those whose spouses never met recommendations to begin meeting recommendations themselves by visit 3 (odds ratio = 0.71, 95% CI: 0.51, 0.99) (Figure 1; Web Table 2).

Table 2. Cross-Sectional Analysis of the Association Between Participants' Physical Activity and Their Spouse's Physical Activity at Visit 1 (1987–1989), the Atherosclerosis Risk in Communities Study[a]

Physical Activity Model	Men		Women	
	Physical Activity[b]	95% CI	Physical Activity[b]	95% CI
Physical Activity From Sport/Exercise[c] (3,261 Pairs)				
Unadjusted	0.21	0.18, 0.25	0.19	0.16, 0.23
Unadjusted and demographic characteristics[d]	0.17	0.13, 0.20	0.16	0.13, 0.19
Unadjusted, demographic characteristics, illness, and behavior characteristics[e]	0.15	0.12, 0.19	0.15	0.12, 0.18
Unadjusted, demographic characteristics, illness, behavior characteristics, and spousal characteristics[f]	0.15	0.12, 0.19	0.15	0.11, 0.18
Leisure Physical Activity[c] (3,261 Pairs)				
Unadjusted	0.21	0.18, 0.24	0.24	0.21, 0.28
Unadjusted and demographic characteristics[d]	0.18	0.15, 0.21	0.20	0.16, 0.23
Unadjusted, demographic characteristics, illness, and behavior characteristics[e]	0.17	0.13, 0.20	0.19	0.16, 0.23
Unadjusted, demographic characteristics, illness, behavior characteristics, and spousal characteristics[f]	0.17	0.14, 0.20	0.19	0.16, 0.23

Abbreviation: CI, confidence interval.

[a] All P values < 0.001.

[b] Difference (per standard deviation) in participant's estimated physical activity associated with a 1–standard deviation increase in his or her spouse's physical activity.

[c] Physical activity measured by Baecke physical activity indices (26) for sport/exercise and leisure physical activity.

[d] Demographic characteristics include age, race, study center, education, and employment status.

[e] Illness and behavioral characteristics include smoking status, health status, body mass index, diabetes, hypertension, coronary heart disease, and cancer.

[f] Spousal characteristics include age, race, study center, education, employment status, smoking status, health status, body mass index, diabetes, hypertension, coronary heart disease, and cancer.

Table 3. Longitudinal Analysis of the Association Between Change in Participants' Physical Activity From Visit 1 (1987–1989) to Visit 3 (1993–1995) and Their Spouses' Physical Activity Change, the Atherosclerosis Risk in Communities Study[a]

Physical Activity Model	Men		Women	
	Change in Physical Activity[b]	95% CI	Change in Physical Activity[b]	95% CI
Physical Activity from Sport/Exercise[c] (3,261 Pairs)				
Unadjusted	0.09	0.05, 0.13	0.08	0.05, 0.12
Unadjusted and demographic characteristics[d]	0.08	0.05, 0.12	0.08	0.05, 0.11
Unadjusted, demographic characteristics, illness, and behavior characteristics[e]	0.08	0.05, 0.12	0.08	0.05, 0.11
Unadjusted, demographic characteristics, illness, behavior characteristics, and spousal characteristics[f]	0.09	0.05, 0.12	0.08	0.05, 0.11
Leisure Physical Activity[c] (3,261 Pairs)				
Unadjusted	0.08	0.05, 0.11	0.09	0.05, 0.13
Unadjusted and demographic characteristics[d]	0.08	0.04, 0.11	0.08	0.05, 0.12
Unadjusted, demographic characteristics, illness, and behavior characteristics[e]	0.08	0.04, 0.11	0.08	0.05, 0.12
Unadjusted, demographic characteristics, illness, behavior characteristics, and spousal characteristics[f]	0.08	0.05, 0.11	0.09	0.05, 0.12

Abbreviation: CI, confidence interval.

[a] All P values < 0.001.

[b] Participant's estimated change in physical activity per standard deviation associated with 1–standard deviation increase in his or her spouse's physical activity.

[c] Physical activity measured by Baecke physical activity indices (26) for sport/exercise and leisure physical activity.

[d] Demographic characteristics include age, race, study center, education, and employment status.

[e] Illness and behavioral characteristics include smoking status, health status, body mass index, diabetes, hypertension, coronary heart disease, and cancer.

[f] Spousal characteristics include age, race, study center, education, employment status, smoking status, health status, body mass index, diabetes, hypertension, coronary heart disease, and cancer.

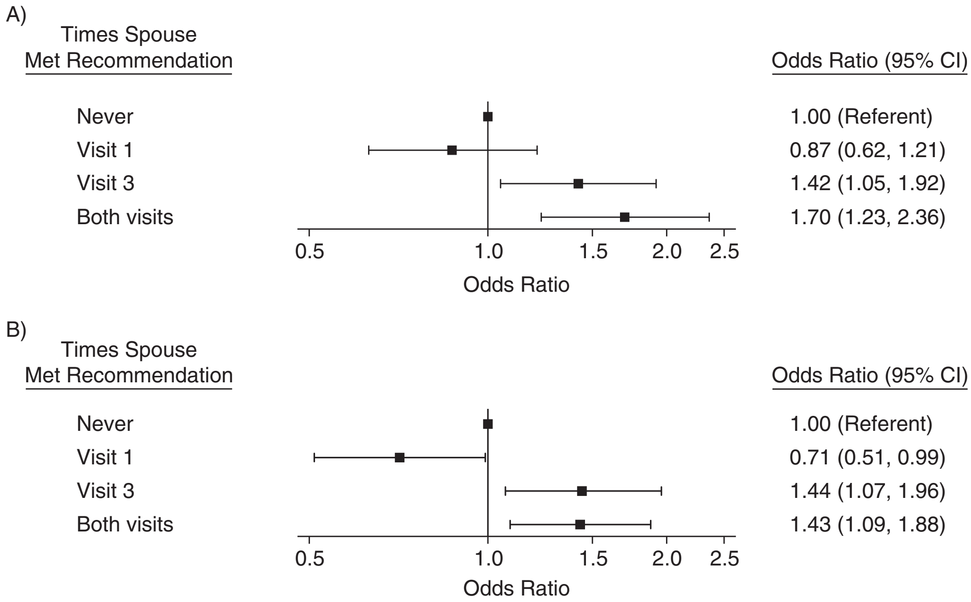

Figure 1. Longitudinal associations between meeting physical activity recommendations at visit 3 (1993–1995) by spousal change in meeting physical activity recommendations from visit 1 (1987–1989) to visit 3, among men (A) and women (B) not meeting recommendations at baseline in the Atherosclerosis Risk in Communities Study. Models controlled for individual and spousal characteristics (age, race, study center, education, employment status, smoking status, health status, body mass index, diabetes, hypertension, coronary heart disease, and cancer). Bars, 95% confidence intervals (CIs).

DISCUSSION

This study suggests that an individual's level of physical activity may be influenced by his or her spouse's level of physical activity. We found that, on average, middle-aged and older spouses had concordant levels of physical activity. More importantly, when 1 spouse increased his or her physical activity level (especially to the point of meeting recommendations), the physical activity level of the other spouse also increased, although the association size was small. The spousal influence on physical activity did not appear to be different by sex.

Several theories, including assortative mating, the shared resource hypothesis, social control theory, and convergence theory, have been proposed to explain why this is the case. Assortative mating suggests that individuals tend to choose spouses with similar demographic characteristics, attitudes, personalities, and behaviors. Thus, the concordance in spousal levels of physical activity may have been established before spouses even met (13, 14). The shared resource hypothesis posits that concordance may be due to sharing physical and social environments as well as access to resources, whereas the social control theory suggests that 1 spouse may influence the behavior for both spouses (13). Convergence theory suggests that each spouse becomes more like the other over time (15). Although our data are insufficient to test these theories explicitly, the fact that we saw associations between physical activity change indicates that assortative mating alone is not a sufficient explanation. Future research on spousal pairs could look to explain the specific underlying mechanisms by which spouses influence one another.

Our findings are in line with the small amount of research that has previously reported positive associations between spousal levels of physical activity (17–20). Additionally, these findings add to the evidence suggesting that an individual's physical activity behavior has the potential to be positively influenced by healthy changes in his or her spouse's behavior (14, 21, 23). Taken together, this research has at least 2 important implications for physical activity promotion efforts. First, interventions and policies targeting couples may be more effective than those simply targeting the individual. Relatively few intervention studies to date have explicitly targeted couples, and those that have targeted couples reported mixed results (9, 37, 38). Randomized controlled trials that enroll large numbers of spouses and include objective assessment of physical activity would greatly advance research in this area. Second, intervention studies that target the individual should include an assessment of the intervention effects on an individual's spouse in order to establish the presence of spillover effects (14). Previous studies have found evidence of these effects with weight loss and diet, but not physical activity (39). An accurate assessment of spillover effects would allow for a more complete determination of the impact of physical activity interventions.

This study has several important strengths and adds significantly to existing research on this topic. First, our analyses included a large population-based sample of black and white spousal pairs who were middle-aged or older and had a low divorce rate. As the population ages, understanding the determinants of physical activity in this demographic is critical for the development of effective physical activity promotion efforts.

Additionally, we assessed changes in the physical activity of both spouses over an average of 6 years. Most studies that examine spousal influences on health behaviors focus on the change in 1 spouse and treat the other spouse's behavior as fixed, and very few have longitudinal data over an extended period of time (14). Finally, participants underwent precise phenotyping, which allowed us to control for several potential confounding factors.

The findings of this study should be considered within its limitations. First, spousal pairs were limited to legally married heterosexual couples and may not be generalizable to unmarried or same-sex couples. Future research should include a definition of "spousal pair" that reflects the diversity of couples who are cohabiting in today's society. Furthermore, our study did not take into account the quality or duration of relationships, nor did we examine the influence of divorce or widowhood. An additional limitation of the study includes the use of a self-reported questionnaire to assess physical activity. Although the Baecke Questionnaire is highly reliable, has acceptable validity, and has been widely used in large population-based cohort studies (31–34), future studies should utilize objective measures from accelerometers, heart rate monitors, or combined sensors (24, 25). Furthermore, although we have little reason to believe that the social dynamics of spouses have substantially changed, some items in the Baecke Questionnaire do not accurately reflect modern influences on physical activity; for example, television viewing in leisure time is being replaced by use of computers, tablets, and smartphones. Moreover, there was a substantial period of time between visit 1 and visit 3 during which physical activity levels could have changed because of factors other than spousal influence (e.g., changes in health status, environment, or age). Finally, among spousal pairs in which both individuals changed their behavior, it is not possible for us to determine which spouse initiated the change or if changes occurred simultaneously.

In conclusion, spouses have the potential to be powerful sources of influence that may become stronger as individuals age and social units become smaller. Although this influence has the potential to be negative, if appropriately leveraged, it also has the potential to motivate healthy changes in behavior. Such changes are critical to reducing the burden of noncommunicable disease and facilitating improved functional capacity of older adults. In the present study, middle-aged and older spouses had concordant levels of physical activity, and when an individual's spouse increased his or her physical activity level, the individual's level was likely to increase as well. These findings suggest that physical activity promotion efforts targeted toward couples may be more effective than those targeted only to the individual.

ACKNOWLEDGMENTS

Author affiliations: Welch Center for Prevention, Epidemiology, and Clinical Research, Johns Hopkins University, Baltimore, Maryland (Laura K. Cobb, Job G. Godino, Elizabeth Selvin, Josef Coresh, Silvia Koton); Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland (Laura K. Cobb, Job G. Godino, Elizabeth Selvin, Josef Coresh, Silvia Koton); Department of Epidemiology, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, North Carolina (Anna Kucharska-Newton); and Department of Nursing, Stanley Steyer School of Health Professions, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel (Silvia Koton).

Laura K. Cobb and Job G. Godino contributed equally to the study and should be considered co-first authors.

The Atherosclerosis Risk in Communities Study is carried out as a collaborative study supported by National Heart, Lung, and Blood Institute contracts (HHSN268201100005C, HHSN268201100006C, HHSN268201100007C, HHSN268201100008C, HHSN268201100009C, HHSN268201100010C, HHSN268201100011C, and HHSN268201100012C). L.K.C. is supported in part by the National Heart, Lung, and Blood Institute (Cardiovascular Epidemiology Training Program, grant T32HL007024) and the National Institute for Diabetes and Digestive and Kidney Diseases (Clinical Research and Epidemiology in Diabetes and Endocrinology Training Grant 2T32DK062707-11A1). J.G.G. is supported by the National Institute of Aging (Epidemiology and Biostatistics of Aging Training Program, grant T32AG000247).

We thank the staff of the Atherosclerosis Risk in Communities Study for their important contributions.

Conflict of interest: none declared.

REFERENCES

1. Physical Activity Guidelines Advisory Committee. *2008 Physical Activity Guidelines for Americans*. Washington, DC: US Department of Health and Human Services; 2008.
2. Lee IM, Shiroma EJ, Lobelo F, et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet*. 2012;380(9838):219–229.
3. Tudor-Locke C, Brashear MM, Johnson WD, et al. Accelerometer profiles of physical activity and inactivity in normal weight, overweight, and obese U.S. men and women. *Int J Behav Nutr Phys Act*. 2010;7:60.
4. Tucker JM, Welk GJ, Beyler NK. Physical activity in U.S.: adults' compliance with the Physical Activity Guidelines for Americans. *Am J Prev Med*. 2011;40(4):454–461.
5. Bauman AE, Sallis JF, Dzewaltowski DA, et al. Toward a better understanding of the influences on physical activity: the role of determinants, correlates, causal variables, mediators, moderators, and confounders. *Am J Prev Med*. 2002;23(2 suppl):5–14.
6. Bauman AE, Reis RS, Sallis JF, et al. Correlates of physical activity: Why are some people physically active and others not? *Lancet*. 2012;380(9838):258–271.
7. McLeroy KR, Bibeau D, Steckler A, et al. An ecological perspective on health promotion programs. *Health Educ Q*. 1988;15(4):351–377.
8. Giles-Corti B. People or places: What should be the target? *J Sci Med Sport*. 2006;9(5):357–366.
9. Kahn EB, Ramsey LT, Brownson RC, et al. The effectiveness of interventions to increase physical activity. A systematic review. *Am J Prev Med*. 2002;22(4 suppl):73–107.

10. Johnson NJ, Backlund E, Sorlie PD, et al. Marital status and mortality: the National Longitudinal Mortality Study. *Ann Epidemiol*. 2000;10(4):224–238.
11. Robards J, Evandrou M, Falkingham J, et al. Marital status, health and mortality. *Maturitas*. 2012;73(4):295–299.
12. Molloy GJ, Stamatakis E, Randall G, et al. Marital status, gender and cardiovascular mortality: behavioural, psychological distress and metabolic explanations. *Soc Sci Med*. 2009;69(2):223–228.
13. Meyler D, Stimpson JP, Peek MK. Health concordance within couples: a systematic review. *Soc Sci Med*. 2007;64(11): 2297–2310.
14. Falba TA, Sindelar JL. Spousal concordance in health behavior change. *Health Serv Res*. 2008;43(1 pt 1):96–116.
15. Kiuru N, Burk WJ, Laursen B, et al. Is depression contagious? A test of alternative peer socialization mechanisms of depressive symptoms in adolescent peer networks. *J Adolesc Health*. 2012;50(3):250–255.
16. Cobb LK, McAdams-Demarco MA, Huxley RR, et al. The association of spousal smoking status with the ability to quit smoking: the Atherosclerosis Risk in Communities Study. *Am J Epidemiol*. 2014;179(10):1182–1187.
17. Wilson SE. The health capital of families: an investigation of the inter-spousal correlation in health status. *Soc Sci Med*. 2002; 55(7):1157–1172.
18. Satariano WA, Haight TJ, Tager IB. Living arrangements and participation in leisure-time physical activities in an older population. *J Aging Health*. 2002;14(4):427–451.
19. Jurj AL, Wen W, Li H-L, et al. Spousal correlations for lifestyle factors and selected diseases in Chinese couples. *Ann Epidemiol*. 2006;16(4):285–291.
20. Pettee KK, Brach JS, Kriska AM, et al. Influence of marital status on physical activity levels among older adults. *Med Sci Sports Exerc*. 2006;38(3):541–546.
21. Homish GG, Leonard KE. Spousal influence on general health behaviors in a community sample. *Am J Health Behav*. 2008; 32(6):754–763.
22. Ask H, Rognmo K, Torvik FA, et al. Non-random mating and convergence over time for alcohol consumption, smoking, and exercise: the Nord-Trøndelag Health Study. *Behav Genet*. 2012;42(3):354–365.
23. Li KK, Cardinal BJ, Acock AC. Concordance of physical activity trajectories among middle-aged and older married couples: impact of diseases and functional difficulties. *J Gerontol B Psychol Sci Soc Sci*. 2013;68(5):794–806.
24. van Poppel MNM, Chinapaw MJM, Mokkink LB, et al. Physical activity questionnaires for adults: a systematic review of measurement properties. *Sports Med*. 2010;40(7):565–600.
25. Helmerhorst HJF, Brage S, Warren J, et al. A systematic review of reliability and objective criterion-related validity of physical activity questionnaires. *Int J Behav Nutr Phys Act*. 2012;9:103.
26. Baecke JA, Burema J, Frijters JE. A short questionnaire for the measurement of habitual physical activity in epidemiological studies. *Am J Clin Nutr*. 1982;36(5):936–942.
27. Richardson MT, Ainsworth BE, Wu HC, et al. Ability of the Atherosclerosis Risk in Communities (ARIC)/Baecke Questionnaire to assess leisure-time physical activity. *Int J Epidemiol*. 1995;24(4):685–693.
28. Barnett I, Guell C, Ogilvie D. How do couples influence each other's physical activity behaviours in retirement? An exploratory qualitative study. *BMC Public Health*. 2013;13:1197.
29. The Atherosclerosis Risk in Communities (ARIC) Study: design and objectives. The ARIC Investigators. *Am J Epidemiol*. 1989;129(4):687–702.
30. McAdams DeMarco M, Coresh J, Woodward M, et al. Hypertension status, treatment, and control among spousal pairs in a middle-aged adult cohort. *Am J Epidemiol*. 2011;174(7): 790–796.
31. Folsom AR, Arnett DK, Hutchinson RG, et al. Physical activity and incidence of coronary heart disease in middle-aged women and men. *Med Sci Sports Exerc*. 1997;29(7): 901–909.
32. Pereira MA, Folsom AR, McGovern PG, et al. Physical activity and incident hypertension in black and white adults: the Atherosclerosis Risk in Communities Study. *Prev Med*. 1999; 28(3):304–312.
33. Schmitz KH, Arnett DK, Bank A, et al. Arterial distensibility and physical activity in the ARIC Study. *Med Sci Sports Exerc*. 2001;33(12):2065–2071.
34. Meyer A-M, Evenson KR, Couper DJ, et al. Television, physical activity, diet, and body weight status: the ARIC cohort. *Int J Behav Nutr Phys Act*. 2008;5:68.
35. Folsom AR, Yatsuya H, Nettleton JA, et al. Community prevalence of ideal cardiovascular health, by the American Heart Association definition, and relationship with cardiovascular disease incidence. *J Am Coll Cardiol*. 2011; 57(16):1690–1696.
36. Lloyd-Jones DM, Hong Y, Labarthe D, et al. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic impact goal through 2020 and beyond. *Circulation*. 2010; 121(4):586–613.
37. Burke V, Giangiulio N, Gillam HF, et al. Physical activity and nutrition programs for couples: a randomized controlled trial. *J Clin Epidemiol*. 2003;56(5):421–432.
38. Gellert P, Ziegelmann JP, Warner LM, et al. Physical activity intervention in older adults: Does a participating partner make a difference? *Eur J Ageing*. 2011;8(3):211–219.
39. Gorin AA, Wing RR, Fava JL, et al. Weight loss treatment influences untreated spouses and the home environment: evidence of a ripple effect. *Int J Obes (Lond)*. 2008;32(11): 1678–1684.