HHS Public Access

Author manuscript

Ann Behav Med. Author manuscript; available in PMC 2016 October 01.

Published in final edited form as:

Ann Behav Med. 2015 October ; 49(5): 704–714. doi:10.1007/s12160-015-9705-4.

Husbands' and Wives' Physical Activity and Depressive Symptoms: Longitudinal Findings from the Cardiovascular Health Study

Joan K. Monin, Ph.D.[1], **Becca Levy, Ph.D.**[1], **Baibing Chen, MPH**[1], **Terri Fried, M.D.**[2], **Sarah T. Stahl, Ph.D.**[3], **Richard Schulz, Ph.D.**[3], **Margaret Doyle, MPH**[1], and **Trace Kershaw, Ph.D.**[1]

[1]Social and Behavioral Sciences, Yale School of Public Health

[2]VA Connecticut Healthcare System; Geriatrics, Yale School of Medicine

[3]University Center for Social and Urban Research, University of Pittsburgh

Abstract

Background—When examining older adults' health behaviors and psychological health it is important to consider the social context.

Purpose—To examine in older adult marriages whether each spouse's physical activity predicted changes in their own (actor effects) and their partner's (partner effects) depressive symptoms. Gender differences were also examined.

Method—Each spouse within 1,260 married couples (at baseline) in the Cardiovascular Health Study completed self-report measures at wave 1 (1989–1990), wave 3 (1992–1993), and wave 7 (1996–1997). Dyadic path analyses were performed.

Results—Husbands' physical activity significantly predicted own decreased depressive symptoms (actor effect). For both spouses, own physical activity did not significantly predict the spouse's depressive symptoms (partner effects). However, husbands' physical activity and depressive symptoms predicted wives' physical activity and depressive symptoms (partner effects), respectively. Depressive symptoms did not predict physical activity.

Conclusion—Findings suggest that husbands' physical activity is particularly influential for older married couples' psychological health.

Keywords

depression; marriage; exercise; personal relationships; physical fitness; gender

There is considerable evidence that physical activity protects the psychological and physical health of older adults [1]. Prospective studies and clinical trials show that regular physical activity significantly decreases the risk for developing depression [2], alleviates depressive symptoms within individuals [3], and can even reduce depressive symptoms in older patients

Corresponding author: Joan K. Monin, Yale School of Public Health, 60 College Street, New Haven, CT, 06520, telephone: 203 785 2895, fax: 203 785 6980, joan.monin@yale.edu.

Conflicts of Interest There are no conflicts of interest relevant to this work.

with major depressive disorder [4]. A variety of mechanisms have been proposed for why physical activity prevents depressive symptoms including that physical activity increases brain neurotransmitters (i.e., monoamines and endorphins) [5], prevents chronic conditions [6], and increases self-esteem [7]. At the same time it is important to understand how these processes are influenced by the social environment, especially marriage in which spouses tend to be similar to one another, engage in many shared activities, and live in the same place [8,9]. For this reason there has been growing interest in research that addresses spousal dynamics and mutual influences in health behaviors and psychological health in late life marriage [10–14]. Also, as physical activity interventions targeted towards older adults are quite common [15] and many older married individuals participate in them, it is important to understand spousal associations in physical activity and psychological health to inform the design of these interventions [16,17]. However, research that takes into account the interdependency of close relationship partners' health behaviors and psychological health is still relatively scarce. Drawing from multiple theories of interpersonal dynamics and health, this study examines how physical activity relates to depressive symptoms longitudinally among older married couples.

Past studies have shown that older spouses' physical activity levels are positively associated [9,18] and that spouses' depressive symptoms are highly related [19]. What is not known is the extent to which one spouse's physical activity influences the other spouse's psychological health. It is also unknown whether husbands' or wives' physical activity is more influential for their partners' psychological health. Thus, the aim of this study was to examine dyadic associations between physical activity (e.g., walking, gardening, household tasks, and general exercise) and depressive symptoms, utilizing a large cohort of older married couples from the Cardiovascular Health Study (CHS).

How might one spouse's physical activity impact the other spouse's depressive symptoms?

Several theories of interpersonal dynamics and health suggest multiple pathways through which one spouse's physical activity may influence changes in the other spouse's subsequent depressive symptoms. One *indirect* pathway may be that change in an individual's physical activity is dependent on his or her partner's physical activity, which has implications for both partners' depressive symptoms. A partner's physical activity level may be related to changes in an individual's physical activity for a number of reasons. For example, spouses often exert social control on one another, directly or indirectly attempting to monitor or shape their partner's health behaviors, often to align with their own behaviors [20]. Preliminary research suggests this occurs with physical activity, with women particularly motivated to increase their exercise activity to comply with their husbands' exercise activity [21]. Another reason one spouse's physical activity may impact the other spouse's physical activity is that interdependence between couple members can transform a person-centered motivation to a relationship-centered motivation [22]. When one partner is physically active, increasing physical activity may become the goal of both partners.

One spouse's physical activity may also *directly* lead to changes in the other spouse's depressive symptoms. For example, an individual's high level of physical activity may

prevent future chronic illness and depressive symptoms, making the individual less of a potential burden or source of negative emotional contagion for the spouse [23]. Another example is relational identity. The Inclusion of the Other in the Self theory suggests that in close relationships individuals often incorporate the characteristics of their partners into their own sense of well-being [24]. Having a partner who is physically active or inactive may be psychologically meaningful to the self. It may also be the case that when both partners engage in physical activity together, this has an exponential influence on closeness, marital satisfaction, and in turn psychological health [25].

Potential differences between husbands and wives

First, little is known about gender differences in how physical activity relates to depressive symptoms within individuals. Some studies suggest that physical activity in general, which includes both exercise and domestic work, is related to lower depressive symptoms among both men and women [2]. Other studies suggest there may be differences in the types of activities husbands and wives perform that have implications for the effects of psychological health. For example, studies have shown that, among older adults, men are more likely to engage in sport activities whereas women are more likely to engage in household chores [26], and there tends to be a weaker association between domestic work and depressive symptoms than other leisure time physical activities [2]. Thus, physical activity may be more important for increasing husbands' compared to wives' psychological health.

Second, in regards to spousal influences, a large literature shows that men tend to benefit from marriage more than women do in terms of physical health [27]. One possible mechanism is that husbands receive more social support from wives than vice versa [28,29]. Less work has examined gender differences in how one spouse's health behaviors (physical activity) and psychological health (depressive symptoms) affect the other spouse's health behaviors and psychological health. That said, past research shows that wives' psychological health tends to be more affected by relationship quality, or both partner's emotional states, than husbands' health [30]. It has been theorized that this is because women are more interdependent than men and are more likely to incorporate their husband's characteristics in their own self-construal (the interdependent construal perspective [30]). Less is known about whether husbands' physical activity also influences wives' physical activity in older adult marriages. As noted earlier, preliminary research suggests that wives are more likely to comply with their husbands' exercise activity [21]; however, it unclear whether this applies to physical activity in general, which includes other activities such as housework.

The Present Study

The primary aims of the study were to examine longitudinally: (1) the association between each individual's physical activity level and changes in their own depressive symptoms (actor effect; Hypothesis 1), and (2) the association between each individual's physical activity level and changes in their spouse's depressive symptoms (partner effect; Hypothesis 2). However, we were also interested in actor and partner effects in regards to physical activity (Hypothesis 3 and 4) and depressive symptoms (Hypotheses 5 and 6), separately.

We examine these associations across a time period spanning ~8 years, utilizing data at three time points. Our specific hypotheses are as follows:

Hypothesis 1

An individual's greater physical activity will be associated with reduced depressive symptoms, and this association will be greater for husbands than wives.

Hypothesis 2

An individual's greater physical activity levels will be associated with reduced depressive symptoms in the spouse, with wives' depressive symptoms more likely to be influenced by their husbands' physical activity than husbands' depressive symptoms influenced by wives' physical activity.

Hypothesis 3 and 4

An individual's greater physical activity will predict increases in his or her own subsequent physical activity. Greater physical activity in an individual will be associated with increased physical activity in the spouse, with wives' physical activity more affected by their husbands' physical activity.

Hypothesis 5 and 6

An individual's greater depressive symptoms will predict increases in his or her own subsequent depressive symptoms. Greater depressive symptoms in an individual will be associated with increased depressive symptoms in the spouse, with wives' depressive symptoms more affected by their husbands' depressive symptoms.

Finally, because a theoretical case can also be made that depressive symptoms influence changes in physical activity levels [31,32], we tested an alternate model with depressive symptoms predicting changes in physical activity, including all associations described in the hypotheses. We compare this alternative model with the hypothesized model in terms of statistical fit.

Method

Design

Data for this study came from the Cardiovascular Health Study (CHS), a population-based longitudinal study designed to determine the risk factors for cardiovascular disease in adults 65 years or older. Participants were recruited from four communities in the United States: Forsyth County, NC; Sacramento County, CA; Washington County, MD; and Pittsburgh, PA. Participants underwent annual clinical examinations and structured interviews. Further details of the design are described elsewhere [33]. The present study includes data from three waves of the CHS that collected information on respondent physical activity and depressive symptoms: baseline/wave 1 (W1; 1989/1990), wave 3 (W3; 1992/1993), and wave 7 (W7; 1996/1997).

Participants

The CHS sample included 5,201 individuals who were enrolled in 1989/1990, with an additional cohort of 687 African Americans enrolled in 1992/1993. Eligible participants were sampled from Medicare eligibility lists. Those eligible included all persons living in the household of each individual sampled from the Health Care Financing Administration (HCFA) sampling frame, who were 65 years or older at the time of examination, were non-institutionalized, were expected to remain in the area for the next three years, and were able to give informed consent and did not require a proxy respondent at baseline. Potentially eligible individuals who were wheelchair-bound in the home at baseline or were receiving hospice treatment, radiation therapy or chemotherapy for cancer were excluded. See Fried et al. (1991) for complete information about the CHS sample [33]. Of the original sample, 2,524 reported being married and had spousal data available (n = 1,262 couples). Because data from the African American cohort were not available at the same time points as the overall CHS sample, these data were not included in the present analysis. Table 1 presents descriptive information for the married couples at the time of CHS enrollment. Table 2 shows the sample sizes for each variable at each wave and the extent of missing data over time. Some couples were missing data at W3 and/or W7 because of the death of one or both partners. One hundred and sixteen husbands and 39 wives were deceased at W3, and 351 husbands and 132 wives were deceased at W7. Only 2 husbands and 2 wives indicated that they were caregivers over the three waves. One wife indicated she was divorced at W3. Two husbands and four wives indicated they were divorced at W7. Couples were evenly distributed among the CHS sites (Forsyth County, NC: n=306; Sacramento County, CA: n=334; Washington County, MD: n=348; Pittsburgh, PA: n=272). 599 (49.6%) couples reported an annual income of less than $25,000; 397 (33.2%) reported between $25,000 and $4,9999, and 206 (17.2%) reported greater than $50,000.

Measures

Depressive symptomatology—Symptoms of depression were measured with the modified version of the Center for Epidemiology Studies Depression Scale (CES-D [34]). The scale assessed self-reported depressive symptoms experienced during the preceding 7 days of the CHS clinic visit. The scale consists of 10 symptoms, each scored 0–3, for a maximum of 30 points. Higher scores indicate greater frequency of depressive symptoms and correlate with an increased risk of clinical depression.

Physical activity—Energy in kilocalories expended weekly (kcal/week) in leisure-time activities was measured using information from the following activity items in the CHS surveys at each wave: walking, mowing, raking, gardening, hiking, jogging, biking, cycling, dance, aerobics, bowling, golf, general exercise, household tasks, and swimming. Energy in kilocalories was calculated by (METS intensity score from Ainsworth et al., 1993 [35]) x (duration per session) x (number of sessions in the last 2 weeks/2). The mean METS score for husbands was 1.53 (*SD*=.78) which was significantly higher than the mean for wives (*M*=1.45, *SD*=.78; *t* (1258)=3.06,*p*=.002). Higher kcal/week scores indicate greater energy expenditure. Also, it should be noted that CHS included tennis and racquet ball as activities at baseline only. Therefore, we recalculated the baseline score for the 21 husbands and the 6 wives who played tennis to be consistent with the other time points. No participants

indicated playing racquet ball. Results were unchanged when repeating the analysis with the revised score. See Table 3 for the mean frequencies of activities at baseline for husbands and wives.

Covariates—The first potential set of covariates was socio-demographic information, including age, sex, race, education, and annual income. Second, we examined physical functioning as potential covariate, as we were interested in the unique effects of physical activity on depressive symptoms above and beyond its association with disability [36]. Physical functioning was assessed using the Health Interview Survey Supplement (HISS) on aging questionnaire [36], specifically the items that asked if, due to health problems, a person had difficulty performing 10 activities of daily living (ADLs; e.g., walking, dressing, or bathing). ADL items were coded as 0 (no difficulty) and 1 (any difficulty) and summed to create a functional impairment index. Higher values indicate greater difficulty to function independently. Third, we included perceived social support as a potential covariate because of its theoretical relevance to gender, physical activity, and depressive symptoms and the empirical evidence that physical activity is related to available support [37]. Five items from the 6-item version of the Interpersonal Support Evaluation List (ISEL) [38] was used to assess the perceived availability of belonging (emotional), appraisal (informational), and tangible (instrumental) support [39]. Examples of items assessing belonging support (2 items; a range=.60–.63) and appraisal support (2 items; a range=.66–.71) respectively are: “When I feel lonely, there are several people I can talk to,” and “When I need suggestions on how to deal with a personal problem, I know someone I can turn to.” Tangible support was measured with the item: “If I were sick I could easily find someone to help me with my daily chores” (only one item used for tangible support because of low reliability with the two items). All items were rated on a 4 point scale from 1 (definitely false) to 4 (definitely true). Scores were averaged for each participant.

Analysis

In preliminary analyses, we first examined differences in baseline variables between participants who had data from all three waves, two waves, or one wave using ANOVAs. Second, we examined correlations among physical activity, depressive symptoms, and potential covariates at baseline (age, education, disability, social support). Covariates were included in the model if they were theoretically and significantly related to both physical activity and depressive symptoms for either husbands or wives. Next, to describe how husbands and wives changed in their physical and psychological health and potential covariates (physical activity, depressive symptoms, disability, and social support) over the three waves, we used repeated measures ANOVAs with couple as the unit of analysis and time and gender as within-couple factors.

To test the primary hypotheses, path analyses were conducted using structural equation modeling (SEM) software (AMOS 22.0). The analysis of dyadic data is often problematic because of non-independence among responses (e.g., depressive symptoms of one spouse often relates to depressive symptoms of the other spouse due to shared characteristics and experiences). Analyzing members of the dyad separately is one way to avoid statistical problems due to non-independence. However, this approach fails to incorporate the

interdependence of dyad members. One approach to incorporating this interdependence is the Actor-Partner Interdependence Model (APIM) [40]. The APIM incorporates responses from both members of a dyad into a single analysis. APIM allows assessment of whether wives influence husbands or husbands influence wives. To incorporate the interdependence of dyadic data, correlations of all pairs of variables (e.g., age of wife is correlated with age of husband) and error disturbances (e.g., error term for wife's depressive symptoms is correlated with the error term for husband's depressive symptoms) were used in the model.

Path analysis, using covariances and maximum likelihood estimation, was used to assess models that included both husbands and wives. In the proposed model, physical activity levels of both spouses was set to predict changes in both partner's depressive symptoms at W3 and W7 (controlling for W1 age, disability, and social support for each spouse and physical activity and depressive symptoms at each time point). Our focus was on the influence of one's physical activity on changes in his or her subsequent depression. We did not hypothesize that these relationships would be different at specific time periods. For this reason all like effects (Wl to W3; W3 to W7) were set to be equal, giving us an overall test of whether previous scores influenced subsequent scores. We also tested an alternative model with depressive symptoms as the predictor and physical activity as the outcome. In addition, to examine the extent to which there were significant differences in each pair of effects for husbands and wives, we performed chi-square difference tests comparing the fit of the models with husbands and wives paths constrained to be equal with the original models in which the paths were unconstrained.

The AMOS software uses Bayesian data imputation, an algorithm that adjusts parameter estimations to account for missing outcomes, allowing for data from all participants to be used [40]. R-square values were calculated to determine the amount of variance that the predictors accounted for in the outcomes. Similar to Kim and colleagues (2008) we report three model fit indices: Bollen's incremental fit index (IFI), the confirmatory fit index (CFI), and the root mean squared error of approximation (RMSEA)[41]. For IFI values of >.90 [42], for the CFI values of >.95, and for the RMSEA values of >.60 [43] reflect adequate fit of a specified model to the data. In addition, we examined the fit indices for the fully constrained models, the unconstrained model, and the models in between in which we progressively constrain each set effects corresponding to each hypothesis.

Results

Preliminary analyses

First, the ANOVAs examining differences in baseline variables between participants who had data from all three waves, two waves, or one wave showed that for both husbands and wives, participants who had more missing data were older (husbands: F(2, 1334.57)=51.90,*P*=.000; wives: F(2,850.99)=40.10,*P*=000), less educated (husbands: F(2, 499.69)=20.95,*P*=000; wives: F(2, 285.95)=16.59,*P*=000), had lower income (husbands: F(2, 52.40)= 19.35, *p*=.000; wives: F(2, 50.68)=18.44, *p*=000), more disabled (husbands: F(2, .76)=5.67, *p*=004; wives: F(2, 1.37)=6.27, *p*=002), less physically active (husbands: F(2, 64017487.53)= 12.46, *p*=.000; wives: F(2,12974182.54)= 2.67, p=.07), and more depressed (husbands: F(2,145.40)=10.44, *p*=000; wives: F(2, 103.47)= 5A9,*p*=.004) at

baseline. AMOS 22.0 accounts for missing data and takes these differences into account when calculating the hypothesized effects.

According to the correlational analysis testing for potential covariates, age was associated with physical activity for husbands (r(1257)=−.12,p<.01) and wives (r(1257)=−.11, p<.01). The association between social support and physical activity was only significant for wives (r(1253)=−.06,p<.05), with less physical activity associated with more support. Age, disability, and social support were significantly related to depressive symptoms for husbands (r(1260)=.07, p<.05; r(1256)=06, p<.05; and r(1256)=29,p<.01, respectively). Only disability (r(1257)=22, p<.01) and social support (r(1257)=.32, p<.01) were related to depressive symptoms for wives. Thus, in our proposed model we included age, disability, and social support as covariates. In each model we set each of these variables to covary between spouses, along with W1 physical activity (r=.24, p<.001) and depressive symptoms (r=.21, p<.001).

For descriptive purposes, in terms of changes in the variables of interest over time, Table 2 shows that for both husbands and wives there were significant increases in depressive symptoms, disability, and social support. There was also a significant decrease in physical activity for both husbands and wives. There was also a significant increase in perceived social support, and this increase was larger for husbands than for wives.

Main hypothesis testing

The model for physical activity predicting depressive symptoms showed adequate fit (IFI=0.91; CFI=908; RMSEA=05, RMSEA 90% CI=.047–057). The model accounted for 28% and 33%) of the variance in wives' wave 3 and wave 7 depressive symptoms, respectively; 15% and 11% for wives' physical activity; 30% and 31% for husbands' depressive symptoms; and 24%) and 22% for husbands' physical activity. We re-ran the model excluding couples where one or both partners died at W3 or W7 and also excluding couples with any missing data with listwise deletion. The results of these models did not significantly differ from the main model presented. See Table 4 for the fit indices for the constrained, progressively unconstrained, and unconstrained models. In addition, we also compared the fit indices when constraining and unconstraining the autoregressive actor effects of the two lags in the models to be equal for each hypothesized association, and there were no substantial differences in the model fit. Model estimates are presented in Table 5 addressing each of the hypothesized associations, and Figure 1 depicts which of these associations were significant.

Hypothesis 1—As shown in Table 5, there was a significant actor effect such that husbands' greater physical activity predicted husbands' own decreased depressive symptoms. The actor effect for wives was not significant. However, according to the chi squared difference tests, the paths did not significantly differ between husbands and wives ($\Delta\chi^2$ =1.48, Δdf=1, *ns*). Thus, hypothesis 1 was partially supported.

Hypothesis 2—As shown in Table 5, the partner effects for husbands' and wives' physical activity predicting changes in their partners' depressive symptoms were not significant.

Hypothesis 2 was not supported. Again, paths for husbands and wives were not significantly different from each other ($\Delta\chi^2$ =.614, Δdf=1, *ns*).

Hypothesis 3 and 4—As shown in Table 5, supporting hypothesis 3, for both husbands and wives, greater physical activity at W1 predicted increased physical activity at W7. The paths for husbands and wives were significantly different ($\Delta\chi^2$ =138.95, Δdf=l, p<.001). Also, supporting hypothesis 4, husbands' greater physical activity predicted increases in wives' physical activity, but wives' physical activity did not predict changes in husbands' subsequent physical activity. However, the paths did not significantly differ for husbands and wives ($\Delta\chi^2$=1.92, Δdf=1,*ns*).

Hypothesis 5 and 6—As shown in Table 5, for both husbands and wives, depressive symptoms at Wl predicted increases in depressive symptoms at W7. The paths did not significantly differ for husbands wives ($\Delta\chi^2$ =1.34, Δdf=1, *ns*). Supporting hypothesis 6, husbands' greater depressive symptoms predicted increases in wives' depressive symptoms. Wives' depressive symptoms did not significantly predict changes in husbands' depressive symptoms. However, the paths did not significantly differ for husbands wives ($\Delta\chi^2$=1.74, Δdf=1, *ns*).

Did depressive symptoms predict physical activity?

The model for depressive symptoms predicting physical activity showed less than adequate fit on the three criteria (IFI=728; CFI=724; RMSEA =.09, RMSEA 90% CI=.087– .096). Thus, we did not find evidence in our models that depressive symptoms predicted changes in physical activity for individuals or partners.

Discussion

In this study we examined the associations between partners' physical activity and changes in subsequent depressive symptoms in a large, longitudinal sample of older married couples. Consistent with past research and supporting our first hypothesis we found that greater physical activity in an individual was related to decreased depressive symptoms within that individual [1,2]. However, we found that this association was only significant for husbands, and not for wives. A potential reason for why the effect was only significant for husbands may be that husbands and wives tend to engage in different types of physical activities. Wives are more likely to perform household chores than husbands, and husbands are more likely to engage in exercise and group sports activities. Engaging in household chores may not enhance psychological health to the same degree as exercise or sports activities [2,44–46], activities that may be particularly linked with positive social encounters and greater psychological health [47]. Also, because husbands' activities may be more vigorously intense (compared to women's activities, which may be less intense), these activities may decline more rapidly and have a greater impact on psychological well-being. That husbands and wives' physical activity were differentially associated with psychological health is an important finding that deserves further investigation to identify mechanisms. It is possible that different types and intensities of physical activity have different psychological meaning due to gender roles of older married adults [48]. In addition to assessing types and intensity

of physical activity, future research would benefit from assessing the meaning of different activities for husbands' and wives' well-being.

Consistent with past research and as hypothesized, we found that husbands' physical activity and depressive symptoms predicted changes in wives' physical activity and depressive symptoms respectively. These effects were robust controlling for age, disability, and perceived social support, providing further evidence that older spouses' health behaviors and psychological health are intertwined and perhaps contagious in close relationships [49,50]. This finding is consistent with relational interdependence theory, which states that women are more likely to incorporate their spouses' attitudes and behaviors into their own identity than men are [30].

Importantly, we also found that husbands' physical activity was related to increases in wives' physical activity, which suggests that intervening with husbands to increase physical activity may also have benefits for their wives. It is consistent with preliminary research showing that wives are particularly likely to comply with their husband's exercise [21], but it extends past research by showing this applies to physical activity in general, including household chores. However, as our results for hypothesis 1 suggest, increasing physical activity in wives may not be as beneficial for their psychological health compared to husbands. It may be the case that when husbands engage in more group sports activities or exercise, wives engage in more household tasks. Future research should investigate how husbands and wives influence one another in terms of specific physical activities to help elucidate this process.

In terms of our second hypothesis that one partner's physical activity would be related to the other partner's depressive symptoms, we did not find evidence that either wives or husbands' physical activity was directly related to changes in their partner's depressive symptoms, as would be suggested by Self-expansion theory, Inclusion of the Other in the Self theory, or theories of self-construal. Although speculative, just as one's own physical activity may not be very meaningful for the psychological health of wives, their husbands' physical activity may also not be meaningful to the self. For husbands, as suggested by the interdependent self-construal perspective, their partner's physical activity may be less meaningful than one's own physical activity for well-being. Future research would benefit from investigating individuals' perceptions of the meaning of physical activities of their partners in terms of promoting their own physical activity behavior.

A major strength of this study was that we used a large sample of older couples and examined both partners' physical activity and depressive symptoms over a span of approximately eight years. No previous studies have used a dyadic approach to analyze data from the CHS. By using the APEVI, we could account for the interdependence that naturally exists between partners, something that is rarely done in health research [13]. Because CHS includes a large number of married couples, even when researchers are not interested in partner effects, it is important to statistically account for non-independent data.

There are also limitations. First, CHS does not include variables related to relationship functioning and marital quality as it was mainly designed to examine the physical health of

individuals. Second, objective assessments of physical activity were not collected. Older adults tend to engage in activities on an irregular basis, and may have problems with short- and long-term memory, each of which affects their ability to accurately recall past physical activity behaviors [51]. Future research on physical activity and depressive symptoms among older married couples should include objective assessments of physical activity and measures of relationship quality which may mediate the association between physical activity and depressive symptoms. Furthermore, physical activity and depressive symptoms data were not available at the same time points for the African American cohort in CHS. Thus, it was not possible to combine the data. Future research should examine changes over time for couples in the African American cohort separately to confirm that the present findings are replicated in more diverse samples. Finally, we were limited to three waves of physical activity data in the CHS, which did not allow for growth curve modeling, which would have provided information about how changes in one spouse's physical activity related to changes in the other spouse's depressive symptoms. This is an important direction for future research.

This study adds to a growing literature providing evidence that spouses' physical and depressive symptoms are intertwined which has potential clinical implications. For instance, during healthcare visits, it may be helpful for physicians not only to attend to the needs of individual older patients but also their spouses as they may have shared environmental or behavioral risk factors for poor physical and psychological health. It may also be particularly beneficial when clinicians are aware of the physical activity of both couple members (and especially husbands) within a marriage. Recently there has been a strong initiative to increase physical activity in older adults because of the well-known physical and mental health benefits. Such interventions should take advantage of the interdependency of physical activity and depression of older married couples and the unique ways husbands and wives influence one another [16,52]. Furthermore, it may be useful to target older married couples for physical activity interventions.

Acknowledgments

Sources of Funding: Funding sources include a career development award to Joan Monin from the National Institute on Aging, National Institutes of Health (KO1 AG042450-01A1) and an award from Yale's Pepper Center (P30AG021342). This research was also supported by contracts HHSN268201200036C, HHSN268200800007C, N01 HC55222, N01HC85079, N01HC85080, N01HC85081, N01HC85082, N01HC85083, N01HC85086, and grant HL080295 from the National Heart, Lung, and Blood Institute (NHLBI), with additional contribution from the National Institute of Neurological Disorders and Stroke (NINDS). Additional support was provided by AG023629 from the National Institute on Aging (NIA). A full list of principal CHS investigators and institutions can be found at CHS-NHLBI.org. Support was also provided to Becca Levy from the National Institute on Aging (R01AG023993), National Heart, Lung and Blood Institute (R01HL089314)

References

1. Loprinzi PD. Objectively measured light and moderate-to-vigorous physical activity is associated with lower depression levels among older US adults. Aging & Mental Health. 2013; 17(7):801–805. [PubMed: 23731057]
2. Teychenne M, Ball K, Salmon J. Physical activity and likelihood of depression in adults: a review. Preventive Medicine. 2008; 46(5):397–411. [PubMed: 18289655]

3. Kerse N, Hayman KJ, Moyes SA, et al. Home-based activity program for older people with depressive symptoms: DeLLITE-a randomized controlled trial. The Annals of Family Medicine. 2010; 8(3):214–223. [PubMed: 20458104]
4. Blumenthal JA, Babyak MA, Moore KA, et al. Effects of exercise training on older patients with major depression. Archives of Internal Medicine. 1999 Oct 25; 159(19):2349–2356. [PubMed: 10547175]
5. Phillips WT, Kiernan M, King AC. Physical Activity as a Nonpharmacological Treatment for Depression: A Review. Complementary Health Practice Review. 2003 Apr 1; 8(2):139–152. 2003.
6. Roberts RE, Kaplan GA, Shema SJ, Strawbridge WJ. Does growing old increase the risk for depression? American Journal of Psychiatry. 1997; 154(10):1384–1390. [PubMed: 9326820]
7. Stewart AL, Hays RD, Wells KB, Rogers WH, Spritzer KL, Greenfield S. Long-term functioning and well-being outcomes associated with physical activity and exercise in patients with chronic conditions in the medical outcomes study. Journal of Clinical Epidemiology. 1994; 47(7):719–730. 7//. [PubMed: 7722585]
8. Meyler D, Stimpson JP, Peek MK. Health concordance within couples: a systematic review. Social Science & Medicine. 2007; 64(11):2297–2310. [PubMed: 17374552]
9. Li K-K, Cardinal BJ, Acock AC. Concordance of Physical Activity Trajectories Among Middle-Aged and Older Married Couples: Impact of Diseases and Functional Difficulties. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2013 Sep 1; 68(5):794–806. 2013.
10. Ayotte BJ, Yang FM, Jones RN. Physical health and depression: a dyadic study of chronic health conditions and depressive symptomatology in older adult couples. The Journals of Gerontology. Series B, Psychological sciences and Social sciences. 2010 Jul; 65(4):438–448.
11. Hoppmann C, Gerstorf D. Spousal interrelations in old age-a mini-review. Gerontology. 2009; 55(4):449–459. [PubMed: 19346740]
12. Hoppmann CA, Gerstorf D, Hibbert A. Spousal associations between functional limitation and depressive symptom trajectories: Longitudinal findings from the study of Asset and Health Dynamics Among the Oldest Old (AHEAD). Health Psychology. 2011; 30(2):153. [PubMed: 21401249]
13. Ryan LH, Wan WH, Smith J. Spousal social support and strain: impacts on health in older couples. Journal of Behavioral Medicine. 2014:1–10. [PubMed: 23054178]
14. Samios C, Pakenham KI, O'Brien J. A Dyadic and Longitudinal Investigation of Adjustment in Couples Coping with Multiple Sclerosis. Annals of Behavioral Medicine. 2014:1–10.
15. Cesari M, Vellas B, Hsu F-C, et al. A Physical Activity Intervention to Treat the Frailty Syndrome in Older Persons—Results From the LIFE-P Study. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences. 2014 Nov 11.2014
16. Martire LM, Schulz R, Helgeson VS, Small BJ, Saghafi EM. Review and meta-analysis of couple-oriented interventions for chronic illness. Annals of Behavioral Medicine. 2010; 40(3):325–342. [PubMed: 20697859]
17. Conn V, Valentine J, Cooper H. Interventions to increase physical activity among aging adults: A meta-analysis. Annals of Behavioral Medicine. 2002; 24(3):190–200. 2002/08/01. [PubMed: 12173676]
18. Pettee KK, Brach JS, Kriska AM, et al. Influence of marital status on physical activity levels among older adults. Medicine and Science in Sports and Exercise. 2006; 38(3):541–546. [PubMed: 16540843]
19. Townsend AL, Miller B, Guo S. Depressive Symptomatology in Middle-Aged and Older Married Couples A Dyadic Analysis. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2001; 56(6):S352–S364.
20. Umberson D. Gender marital status the social control of health behavior. Social Science & Medicine. 1992; 34(8):907–917. 4//. [PubMed: 1604380]
21. Troped PJSRP. Gender differences in social influence on physical activity at different stages of exercise adoption. American Journal of Health Promotion. 1998; 13:112–115. [PubMed: 10346657]

22. Kelley, HH.; Thibaut, JW. Interpersonal relations: A theory of interdependence. Wiley New York: 1978.
23. Hatfield, E.; Cacioppo, JT. Emotional contagion. New York: Cambridge university press; 1994.
24. Aron A, Aron EN, Tudor M, Nelson G. Close relationships as including other in the self. Journal of Personality and Social Psychology. 1991; 60(2)
25. Graham JM. Self-expansion and flow in couples' momentary experiences: an experience sampling study. Journal of personality and social psychology. 2008; 95(3):679. [PubMed: 18729702]
26. Moschny A, Platen P, KlaaBen-Mielke R, Trampisch U, Hinrichs T. Barriers to physical activity in older adults in Germany: a cross-sectional study. Int JBehav Nutr Phys Act. 2011; 8(8):121. [PubMed: 22047024]
27. Monin JK, Clark MS. Why do men benefit more from marriage than do women? Thinking more broadly about interpersonal processes that occur within and outside of marriage. Sex Roles. 2011; 65(5–6):320–326.
28. Belle, D. Stress and coping: An anthology. 3rd ed.. New York, NY: Columbia University Press; US; 1991. Gender differences in the social moderators of stress; p. 258-274.
29. Uchino BN, Cacioppo JT, Kiecolt-Glaser JK. The relationship between social support and physiological processes: a review with emphasis on underlying mechanisms and implications for health. Psychological Bulletin. 1996; 119(3):488. [PubMed: 8668748]
30. Kiecolt-Glaser JK, Newton TL. Marriage and health: his and hers. Psychological bulletin. 2001; 127(4):472. [PubMed: 11439708]
31. Roshanaei-Moghaddam B, Katon WJ, Russo J. The longitudinal effects of depression on physical activity. General Hospital Psychiatry. 2009; 31(4):306–315. [PubMed: 19555789]
32. Weyerer S, Kupfer B. Physical exercise and psychological health. Sports Medicine. 1994; 17(2): 108–116. [PubMed: 8171221]
33. Fried LP, Borhani NO, Enright P, et al. The cardiovascular health study: design and rati onale. Annals of Epidemiology. 1991; 1(3):263–276. [PubMed: 1669507]
34. Orme JG, Reis J, Herz EJ. Factorial and discriminant validity of the center for epidemiological studies depression (CES-D) scale. Journal of Clinical Psychology. 1986; 42(1):28–33. [PubMed: 3950011]
35. Ainsworth BE, Haskell WL, Leon AS, et al. Compendium of physical activities: classification of energy costs of human physical activities. Medicine and Science in Sports and Exercise. Jan. 1993; 25(1):71–80.
36. Miller ME, Rejeski WJ, Reboussin BA, Ten Have TR, Ettinger WH. Physical activity, functional limitations, and disability in older adults. Journal of the American Geriatrics Society. 2000
37. McAuley E, Blissmer B, Marquez DX, Jerome GJ, Kramer AF, Katula J. Social relations, physical activity, and well-being in older adults. Preventive medicine. 2000; 31(5):608–617. [PubMed: 11071843]
38. Cohen S, Mermelstein R, Kamarck T, Hoberman HM. Measuring the functional components of social support. Social support: Theory, research and applications:. 1985 Springer;:73–94.
39. Newsom JT, Schulz R. Caregiving from the recipient's perspective: negative reactions to being helped. Health Psychology. 1998; 17(2):172. [PubMed: 9548708]
40. Kenny, DA.; Kashy, DA.; Cook, WL. Dyadic data analysis. New York: Guilford Press; 2006.
41. Kim Y, Kashy DA, Wellisch DK, Spillers RL, Kaw CK, Smith TG. Quality of life of couples dealing with cancer: dyadic and individual adjustment among breast and prostate cancer survivors and their spousal caregivers. Annals of Behavioral Medicine. 2008; 35(2):230–238. [PubMed: 18365297]
42. Bollen KA. A New Incremental Fit Index for General Structural Equation Models. Sociol Method Res. 1989 Feb; 17(3):303–316.
43. Hu, Lt; Bentler, PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling: A Multidisciplinary Journal. 1999; 6(1):1–55.
44. Blair, SL. Handbook of marriage and the family. 3rd ed.. New York, NY: Springer Science + Business Media; US; 2013. The division of household labor; p. 613-635.

45. Hochschild, A.; Machung, A. The second shift: Working families and the revolution at home. Penguin; 2012.
46. Freedman VA, Cornman JC, Carr D. Is Spousal Caregiving Associated With Enhanced Well-Being? New Evidence From the Panel Study of Income Dynamics. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2014 Feb 5.2014
47. Benenson JF. Gender differences in social networks. The Journal of Early Adolescence. 1990 Nov; 10(4):472–495.
48. Graham H. Caring: a labour of love. A labour of love: Women, work and caring. 1983:13–30.
49. Fowler JH, Christakis NA. Dynamic spread of happiness in a large social network: longitudinal analysis over 20 years in the Framingham Heart Study. Bmj. 2008:337.
50. Monin Schulz R. Interpersonal effects of suffering in older adult caregiving relationships. Psychology and Aging. 2009; 24(3):681. [PubMed: 19739924]
51. Harada ND, Chiu V, King AC, Stewart AL. An evaluation of three self-report physical activity instruments for older adults. Medicine & Science in Sports & Exercise. 2001
52. Jackson S, Steptoe A, Wardle J. The influence of partner's behavior on health behavior change: The English Longitudinal Study of Ageing. JAMA: Internal Medicine. 2015

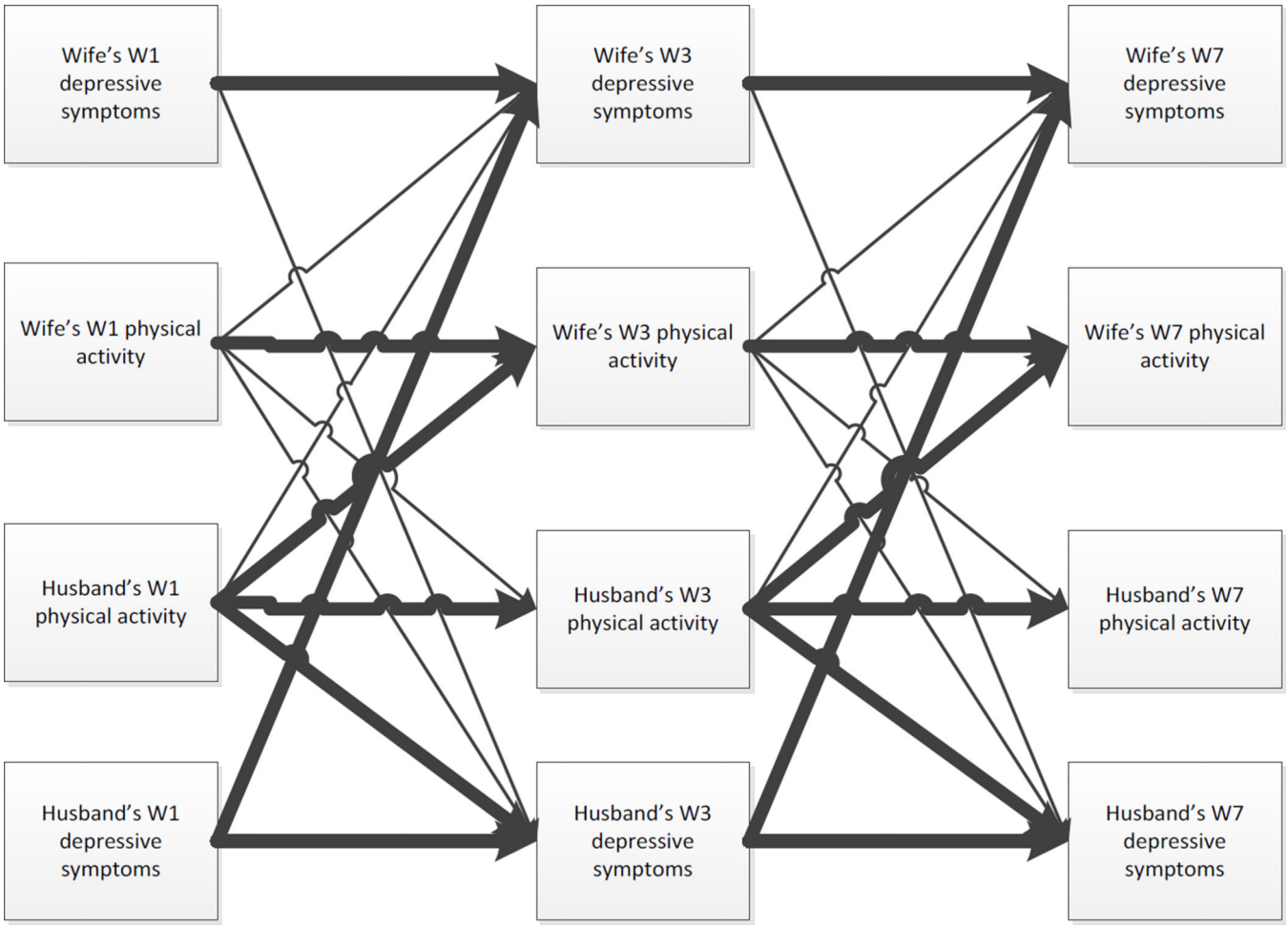

Figure 1.
Simplified SEM with significant actor and partner effects in bold
Note. W=wave.

Table 1

Participant characteristics at CHS enrollment

	Husbands	Wives	*P* value
Age in Years (SD)[a]	73.55 (5.28)	71.18(4.74)	<0.001
Race or ethnic group-no. (%)			
White	1225(92.1)	1229 (92.4)	ns*
Black	30(2.3)	27 (2.0)	
American Indian/Alaska Native	3 (0.2)	1(0.1)	
Asian	0(0)	2 (0.2)	
Other	2 (0.2)	1(0.1)	
Hispanic- no (%)[b]	13(1.0)	9 (0.7)	
Education (yrs)-mean (sd)	12.7(3.5)	12.5 (2.8)	p=.04**

Notes. All variables are W1 characteristics at the time of enrollment. Statistical analyses included analysis of variance tests for continuous variables and contingency table analysis using the χ^2 test for categorical variables.

[a] n=1260,

[b] n=1252,

* ns according to McNemar's test,

** By paired t-test.

Table 2

Repeated measures ANOVA: Changes in variable of interest over time

	Husbands Means (SD) n			**Wives Means (SD) n**			**Time**	**Time X Gender**
	W1	W3	W7	W1	W3	W7	F	F
Physical activity	2066.87 (2282.49) n=1257	1794.59 (2035.06) n=1030	1490.11 (1916.73) n=754	1860.74 (2206.24) n=1257	1275.86 (1608.39) n=1077	1014.61 (1446.54) n=948	64.60**	2.02
Depressive symptoms	3.41 (3.73) n=1260	4.26(4.11) n=1042	5.09 (4.66) n=735	4.60(4.35) n=1259	5.49 (4.94) n=1095	6.09 (4.95) n=917	98.65**	2.51
ADLs	.07 (.38) n=1256	.15 (.58) n=1043	.35 (.94) n=745	.12 (.47) n=1258	.17 (.57) n=1095	.43 (1.08) N=935	104.36**	.09
Perceived social support	8.16 (2.40) n=1256	8.45 (2.52) N=1045	---	7.97 (2.34) n=1258	8.15(2.52) n=1097	---	20.37**	4.41*

Note. W=wave. F tests detect differences from the sample with complete data at all time points as the repeated measures ANOVA uses listwise deletion. ADLs= activities of daily living.

** p<.01,

* p<.05.

Table 3

Frequency of each activity in the past 2 weeks for husbands and wives at baseline

	Husbands		Wives	
Activity	**N**	**Frequency in past 2 weeks mean (sd)**	**N**	**Frequency in past 2 weeks mean (sd)**
Walk	743	8.78 (5.79)	669	7.46 (5.02)
Chores	599	3.26(3.55)	920	4.47 (4.27)
Mow	534	2.07(1.71)	74	1.74 (.92)
Rake	301	2.18(2.10)	135	2.41 (3.40)
Garden	442	5.72(4.91)	312	4.44 (4.53)
Hike	41	3.22(3.54)	20	3.15(3.27)
Jog	12	5.58(3.85)	9	7 (4.47)
Bike	49	5.10(4.48)	18	4(3.94)
Exercycle	162	6.60 (5.60)	161	5.75 (5.28)
Dancing	83	2(1.44)	91	2.52(2.12)
Aerobics	5	6.60 (4.67)	35	5.54(3.71)
Bowling	45	3.02(2.11)	42	3.12(1.92)
Golf	184	3.62(2.33)	56	3.21 (1.73)
Singles tennis	14	3.29(3.87)	1	1
Doubles tennis	17	4.65 (3.48)	9	3.44(2.30)
Racquetball	1	1	0	0
Calisthenics	231	10.53 (5.84)	250	9.41 (5.78)
Swimming	71	4.93 (3.51)	68	4.82(3.77)
Other	278	5.13 (4.65)	130	6.48 (7.60)

Table 4

Fit indices for constrained to progressively unconstrained models

	Chi square	df	IFI	CFI	RMSEA (90% CI)
Fully constrained	466.132	105	.910	.908	.054 (.047–.057)
Constrained paths H1-H5	463.234	103	.909	.908	.053 (.048–.058)
Constrained paths H1-H4	457.420	101	.910	.909	.053 (.048–.058)
Constrained paths H1-H3	450.475*	99	.912	.910	.053 (.048–.058)
Constrained paths H1-H2	441.308**	96	.913	.912	.053 (.048–.058)
Constrained paths H1	439.057**	94	.913	.912	.054 (.049–.059)
Unconstrained	438.818*	92	.913	.912	.055 (.050–.060)

Note. H= Hypothesis,

* p<.05,

** p<.01 for chi square difference test compared to fully constrained model.

Table 5

Estimates for overall APIM SEM examining in each hypothesis concerning the association between physical activity and depressive symptoms

	B	SE	β(W1_W3/W3_W7)	CR	P
Physical activity → depressive symptoms (W1_W7)					
Actor effects (Hypothesis 1)					
Wives' physical activity→ depressive symptoms	.000	.000	.000/.000	−.094	.925
Husbands' physical activity → depressive symptoms	.000*	.000	.000/.000	−2.00	.045
Partner effects (Hypothesis 2)					
Wives' physical activity → husbands depressive symptoms	.000	.000	.000/.000	−.942	.365
Husbands' physical activity → wives depressive symptoms	.000	.000	.000/.000	.184	.854
Physical activity → physical activity (W1_W7)					
Actor effects (Hypothesis 3)					
Wives' physical activity→ wives' physical activity	.277**	.017	.246/334	16.405	<001
Husbands' physical activity→ husbands' physical activity	.438**	.019	.438A439	22.710	<001
Partner effects (Hypothesis 4)					
Wives' physical activity →husbands' physical activity	−.001	.021	.010/−.030	−.062	.951
Husbands' physical activity→ wives' physical activity	.035*	.015	.012/.066	2.287	.022
Depressive symptoms → depressive symptoms (W1_W7)					
Actor effects (Hypothesis 5)					
Wives' depressive symptoms→ wives' depressive symptoms	.546**	.021	.563A529	26.083	<001
Husbands' depressive symptoms→ husbands' depressive symptoms	.585**	.023	.537A653	25.280	<001
Partner effects (Hypothesis 6)					
Wives' depressive symptoms → husbands' depressive symptoms	.024	.020	.009/.051	1.205	.228
Husbands' depressive symptoms → wives' depressive symptoms	.068**	.024	.042/.089	2.799	.005

Note. All like effects (e.g. W1 to W3; W3 to W7) were set to be equal, giving us an overall test of whether previous scores influenced subsequent scores, as shown with the unstandardized estimates (B). We also reported the standardized betas (β) for W1 to W3 and W3 to W7.

* $p<.05$,

** $p<.01$.

The following parameters were set to covary in the model; husbands and wives W1 physical activity, husbands and wives W1 depressive symptoms, husbands W1 physical activity and depressive symptoms, wives W1 physical activity and depressive symptoms, all possible combinations of husbands and wives W1 age, W1 disability, W1 perceived support, W1 physical activity, and W1 depressive symptoms. Husbands and wives error terms for W1 depressive symptoms and for W1 physical activity were also set to covary. The same was done for the W3 error terms.