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A dyadic multiple mediation model of patient and spouse stressors predicting patient dietary and exercise adherence via depression symptoms and diabetes self-efficacy

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Abstract

Using dyadic data from 117 married couples in which one partner was diagnosed with Type 2 diabetes, the purpose of this study was to determine whether a number of specific patient and spouse stressors (chronic life stress, diabetes-specific stress, and physical health stress in the form of the number of comorbidities) were associated with Type 2 diabetes patients' dietary and exercise adherence through two potentially modifiable patient and spouse factors—depression symptoms and diabetes self-efficacy. We found that patient and spouse stressors, particularly patient and spouse diabetes stress and the number of patient comorbidities, were related to patient dietary and exercise adherence through patient depression symptoms and both patient and spouse diabetes self-efficacy. These conclusions were strengthened by incorporating a number of relevant control variables in our models and by testing four alternative models which supported our proposed model. These results are important because they provide further evidence of the significant role spouses' play in managing diabetes and they provide diabetes educators and clinicians with specific targets for intervention programming.

Keywords

Dietary and exercise adherence; Type 2 diabetes; Couples; Stress; Diabetes self-efficacy; Dyadic data

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Compliance with ethical standards

Conflict of interest Jared R. Anderson, Joshua R. Novak, Matthew D. Johnson, Sharon L. Deitz, Ann Walker, Allison Wilcox, Virginia L. Lewis and David Robbins declares that they have no conflict of interest.

Human and animal rights and Informed consent All procedures followed were in accordance with ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients for being included in the study.

Introduction

Type 2 diabetes is a health concern that is becoming more prominent worldwide, with increasing prevalence rates observed across countries regardless of socioeconomic prosperity (Seuring et al., 2015). Recent estimates by the International Diabetes Federation indicated roughly 382 million people around the globe were living with diabetes in 2013, with that number expected to grow to almost 600 million by 2035. Type 2 diabetes comprises nearly 90 % of these diabetes cases and leads to increased health risks, including kidney disease, stroke, heart disease, blindness, and lower limb amputations at a cost of nearly 250 billion dollars per annum in the United States alone (American Diabetes Association, 2014). Despite the potential for such adverse health outcomes, Type 2 diabetes can often be successfully managed through strict adherence to a dietary and exercise regimen (Wing et al., 2001). Unfortunately, such adherence has proven a very difficult task for many patients (August & Sorkin, 2010).

Patient stress is one factor found to impact blood glucose levels via engagement (or not) in diabetes self-care behaviors (i.e., diet and exercise; Landel-Graham et al., 2003). Additionally, programs aimed at improving stress management were found to increase long-term glycemic control in Type 2 diabetes (Surwit et al., 2002). Despite these initial findings, it is unclear whether different types of stressors have similar associations with patient diabetes self-care behaviors and we know little about the pathways through which these stressors are related to diabetes self-care behaviors. Research also suggests that spouses play an integral role in patient dietary and exercise adherence (August et al., 2013; Beverly & Wray, 2010; Khan et al., 2013), thus any models linking contextual factors, such as stress, to patient self-care behaviors are likely to be stronger when incorporating spouse perceptions. Thus, the purpose of this study is to identify potentially modifiable patient and spouse factors related to patient dietary and exercise adherence. This study specifically examines associations between several distinct stressors (chronic life stress, diabetes-specific stress, and physical health stress in the form of the number of comorbidities) and patient dietary and exercise adherence via patient and spouse depression symptoms and patient and spouse diabetes self-efficacy. The dyadic multiple mediation model is tested using data from 117 married couples in which one partner was diagnosed with Type 2 diabetes (patients).

Stress and Type 2 diabetes management

Researchers have long postulated that stress affects the management of Type 2 diabetes (e.g., Fisher et al., 1982). For example, several types of stress were found to be negatively associated with both diet and exercise regimens, including personal life stress (Albright et al., 2001; Cox & GonderFrederick, 1992), diabetes-specific stress (Fisher et al., 2009), chronic life stress (Landel-Graham et al., 2003), and daily stressors (Goetsch et al., 1990). Other studies, however, have not found associations between stress and adherence (for a review see Morris et al., 2011). Finally, a recent study found that an accumulation of multiple stressors was associated with dietary adherence, but this relationship became non-significant when they controlled for depression (Osborn et al., 2014).

Given these findings, there are a number of important considerations to address related to stress and diabetes management. First, studies have not examined multiple types of stress concurrently, which may provide unique insight into specific stressors to target for improving adherence. Next, researchers identified mediators of stress (such as social support and coping) on psychological health (Aneshensel et al., 1995), and mediators of stress on physical health (such as cognitive appraisals; Lazarus & Folkman, 1984), but there is little understanding of the pathways that might link the association between stress and diabetes management. Finally, prior studies failed to take into account the stressors experienced by spouses, as theorists suggest that understanding chronic illness management must be considered in the context of the healthy partner and the intimate relationship (Berg & Upchurch, 2007). This paper attempts to address these limitations in the literature by including several types of stressors (i.e., chronic life stress, diabetes-specific stress, and the number of physical health comorbidities), identifying depression symptoms and diabetes self-efficacy as pathways that might link stress to Type 2 diabetes dietary and exercise adherence, and by including both patient and spouse perceptions of stressors.

Depression symptoms and diabetes self-efficacy as potential mediators

Depression symptoms as a mediator—Stress, in its many forms, is linked with depression. For example, depending on the measure used, studies have found at least a moderate correlation between general life stress and depression symptoms ($r = .25-.40$; Lin & Ensel, 1989) and general life stress contributes to higher depression symptoms in both patients with Type 2 diabetes (Golden et al., 2008) and the caregiving spouse (Pruchno et al., 2009). Additionally, diabetes-specific stress, or stress that stems directly from managing diabetes, has also been found to increase depression symptoms (Fisher et al., 2009). Stress related to concerns about one's overall physical health (and having more physical health problems) is also associated with depression symptoms and is approximately two to three times more common in people with a chronic physical health problem than in people who are in good physical health (National Collaborating Centre for Mental Health, 2009).

These findings support a key theoretical model in the stress literature linking stress and depression symptoms—the stress exposure model (e.g., Brown & Harris, 1978). The stress exposure model proposes that more exposure to aversive, stressful, or negative events precedes and increases the risk for depression and depression symptoms (Cole et al., 2006). Given that Type 2 diabetes requires lifestyle changes in order to avoid or decrease complications (e.g., strict adherence to taking medications, physical exercise, dietary requirements, doctor visits), stress from managing the illness can lead to higher depression symptoms (Fisher et al., 2009). This is further evidenced by higher rates of depression in diabetes patients than the general population (Anderson et al., 2001). This is not to say that depression symptoms cannot also exacerbate or create stress in patient's lives (see Johnson et al., 2014b)—the impact of stress on depression symptoms is most certainly bidirectional—but there is strong empirical and theoretical support for depression symptoms as one possible pathway through which stress is associated with dietary and exercise adherence. But are depression symptoms the only pathway through which stress is associated with patient dietary and exercise adherence, or is there another important factor? We believe there is evidence for another important link in this pathway—diabetes self-efficacy.

Diabetes self-efficacy as a mediator—One of the most significant factors associated with patient dietary and exercise adherence is diabetes self-efficacy, or the confidence one has in their ability to manage their disease. This link between patient diabetes self-efficacy and dietary and exercise adherence holds in cross-sectional (King et al., 2010) and longitudinal research (e.g., Nakahara et al., 2006), and has proven one of the strongest predictors of adherence—even when including a host of other related variables (e.g., diabetes risk awareness). In addition, research has shown that diabetes self-care is improved from interventions that directly target diabetes self-efficacy (Trief et al., 2009). The link between diabetes self-efficacy and patient dietary and exercise adherence has also been found for spouses. Johnson et al. (2013) used reports of both patient and spouse diabetes self-efficacy and found both were related to better patient dietary and exercise adherence. Our study extends the work of Johnson and colleagues by including multiple patient and spouse factors that could be related to patient dietary and exercise adherence through patient and spouse diabetes self-efficacy.

How might depression symptoms be linked to diabetes self-efficacy? For some time, theorists have thought mood states were the lens or filter *through* which people view self-efficacy expectations (Kanfer & Zeiss, 1983; Kavanagh & Bower, 1985), meaning that when individuals experience sadness or depression, they feel less capable of carrying out a behavior. To our knowledge, this important theoretical link has not been tested in the diabetes literature, as researchers using path analysis only included adherence and self-efficacy as predictors of depression (Sacco et al., 2005, 2007). These studies used depression and self-discrepancy theories of emotion, which emphasized the causal role self-perceived failure has on negative emotion (Sacco & Beck, 1995; Sacco et al., 2005). Relatively few studies, if any, have reversed this pathway with depression symptoms predicting diabetes self-efficacy, despite Bandura's postulation that physiological states such as anxiety/depression symptoms can inhibit higher self-efficacy (Bandura, 1997). We believe our ordering of this theoretical link is important, as underlying psychological distress can affect the confidence in one's ability to engage in important diabetes self-care behaviors.

The present study

Informed by relevant empirical literature and theory related to the stress exposure model (Brown & Harris, 1978) and self-efficacy theory (Bandura, 1997), the current study tested a model linking patient and spouse stressors to patient dietary and exercise adherence through both patient and spouse depression symptoms and diabetes self-efficacy. We hypothesized that higher levels of chronic life stress, physical health stress (i.e., a higher number of patient comorbidities), and diabetes-specific stress would be indirectly associated with worse patient dietary and exercise adherence via the pathways of patient and spouse depression symptoms and diabetes self-efficacy. These indirect effects were tested using bootstrapping procedures (Preacher & Hayes, 2008). Finally, to increase the confidence in our model, several control variables were added to the model—age and gender of patient and spouse and the number of years since the patient was diagnosed with Type 2 diabetes—and the model was also empirically tested against four alternative models. First, this study assumed that patient and spouse depression symptoms were related to patient dietary and exercise adherence through patient and spouse diabetes self-efficacy. Past research found depression

symptoms directly predict adherence (Gonzalez et al., 2011), so partial mediation is possible, therefore, we also tested direct paths from patient and spouse depression symptoms to patient dietary and exercise adherence. Second, given previous links between stress and adherence (Albright, et al., 2001; Morris et al., 2011; Osborn et al., 2014), stressors may be linked to dietary and exercise adherence directly, as well as the proposed indirect pathway through depression symptoms and diabetes self-efficacy. A third alternative model was considered where patient and spouse diabetes self-efficacy predicted patient dietary and exercise adherence indirectly through patient and spouse depression symptoms. This model was also plausible, as previous studies have found self-efficacy to predict depression (Sacco et al., 2005, 2007) and this relationship is assumed to be bidirectional (Bandura, 1997). Finally, we tested whether dietary and exercise adherence mediates the relationship between patient and spouse stressors and patient and spouse depression symptoms and diabetes self-efficacy.

Methods

Procedures

Participants in this study were recruited through a patient registry at a large, Midwestern United States medical center. From the several thousand patients included in the registry, we selected those diagnosed with Type 2 diabetes mellitus between the ages of 18–74 who had not experienced any of the following severe diabetes outcomes: amputation, blindness or low vision, chronic kidney disease, or renal failure. A total of 525 patients met these criteria. These patients were then contacted via phone by a research assistant to screen for further eligibility: they had to be married to a spouse *not* diagnosed with Type 2 diabetes and both they and their spouse had to agree to participate in the study. Of the 525 patients contacted, 105 were unable to be reached and 180 did not qualify based on the screening criteria, leaving a total of 240 eligible participants. A total of 155 patients consented (85 declined) to participate in the study.

Separate e-mails were sent to the consenting patient and his or her spouse and each were provided a unique link to complete the online survey. Informed consent was obtained from all individual participants included in the study. Data from the couples were collected using REDCap electronic data capture tools (Harris et al., 2009). If requested, participants were provided a paper version of the survey, which was mailed to them with a self-addressed envelope for return upon their completion. Thirty-eight of the 155 consenting couples did not complete the study, despite several follow-up attempts. The final sample included 75 % of consenting patients, resulting in a sample of 117 patients and their spouses. Each couple received \$30 compensation for completing the survey. All procedures performed in involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Participants

The sample included 117 couples in which one partner was diagnosed with Type 2 diabetes mellitus. On average, the length of diagnosis with Type 2 diabetes was 10.98 years (SD =

9.19) and there were slightly more male (57.3 %) than female (42.7 %) patients. A majority of the couples were in their first marriage (61.5 %), with an average length of relationship of 29.40 years ($SD = 13.88$). The average age of patients was 57.44 years ($SD = 9.83$) and was 57.38 years ($SD = 10.15$) for spouses. The majority of the sample was European American (patients = 87.0 % and spouses = 83.3 %, respectively), highly educated (87.1 % of patients and 80.9 % of spouses having completed at least some college or more), and financially well-off (with only 18.5 % of couples making <\$50,000 annually).

Measures

Patient dietary and exercise adherence—Patient dietary and exercise adherence was measured using an average of the two general diet items and the two exercise items in the revised Summary of Diabetes Self-Care Activities (SDSCA; Toobert et al., 2000). Previous research demonstrated that patient self-report of dietary and exercise adherence significantly predicted levels of HbA_{1c} , a biological indicator of glycemic control (Heisler responded to the following questions about dietary adherence: “How many of the last 7 days have you followed a healthful eating plan?” and “On average, over the past month, how many days per week have you followed your eating plan?” The inter-correlation of these items was $r = .83$ ($p < .001$). For exercise adherence, patients responded to the following items: “On how many of the last 7 days did you participate in at least 30 min of physical activity?” and “On how many of the last 7 days did you participate in a specific exercise session (such as swimming, walking, biking) other than what you do around the house or as part of your work?” The inter-correlation of these items was $r = .70$ ($p < .001$) and responses ranged from 0 = 0 days to 7 = 7 days.

Diabetes self-efficacy—Diabetes self-efficacy was measured using the seven-item self-efficacy subscale of the Multidimensional Diabetes Questionnaire (MDQ; Talbot et al., 1997). Patients reported their own self-efficacy and spouses reported their level of confidence in the patient’s ability to adhere to their prescribed treatment regimen, including following the recommended diet, testing blood sugar levels, and exercising regularly, with specific examples including, “How confident are you in your ability (or your partner’s ability) to keep your (his/her) blood sugar level under control?” and “How confident are you in your ability (or your partner’s ability) to exercise regularly?” Responses ranged from 0 = *not at all confident* to 5 = *completely confident* and mean scores were computed, with higher scores indicating greater self-efficacy. Cronbach’s alpha reliability in the current study for patients was .87 and .91 for spouses.

Depression symptoms—Depression symptoms were measured using the nine-item Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001). Both patients and their spouses were asked how often they have been bothered by any of the nine-items over the last 2 weeks. Responses ranged from 0 = *not at all* to 3 = *nearly every day*. Example items include: “Little interest or pleasure in doing things,” “Feeling down, depressed, or hopeless,” and “Thoughts that you would be better off dead or hurting yourself in some way.” Responses were summed, and higher scores indicated higher depression symptoms. Cronbach’s alpha reliability estimates were calculated for both patients ($\alpha = .88$) and spouses ($\alpha = .88$).

Diabetes-specific stress—Diabetes stress was measured using the 20-item Problem Areas in Diabetes Scale (PAID; Polonsky et al., 1995). This scale measures the degree of stress the respondent experienced as a result of diabetes. This study evaluated both the patient's and spouse's stress and respondents were asked to indicate whether each item is a problem for him or her. Responses ranged from 0 = *not a problem* to 5 = *a serious problem*. Examples of questions include: "Feeling overwhelmed by your (or your spouses') diabetes regimen," and "Feeling guilty or anxious when you get off track with your diabetes management (when your partner gets off track with his/ her diabetes management)." The mean of all items were calculated, and higher scores indicated more diabetes stress. The Cronbach's alpha reliability for patients was .96 and was .94 for spouses.

Chronic life stress—Life stress was measured using the eight-item chronic stress subscale of the Couples Stress Index (Bodenmann et al., 2008). Chronic stress refers to experiences of ongoing stress over the past 12 months, compared to acute stress which is experienced within the past 7 days. Participants were asked how stressful or straining they felt a series of situations were, with response options ranging from 1 = *not at all* to 4 = *strong*. Sample items of chronic life stress included: "job/education," "living situation," "social contacts (conflicts with)," "free time (too little time for)," "children," "family of origin," "finances," and "daily hassles." Item responses were averaged to develop the total scale score. Cronbach's alpha reliability in the current study was $\alpha = .77$ for patients and $\alpha = .76$ for spouses.

Physical health stress—Physical health stress was measured using the Charlson comorbidity index (Charlson et al., 1987). This index assesses the presence of a wide range of potential comorbid health conditions, such as heart disease, asthma, ulcers, and stroke. Respondents reported whether they experienced the health condition (1 = *yes*) or not (0 = *no*). Items were summed to produce a total score reflecting the total number of comorbid health problems. On average, patients reported 2.09 comorbid health problems ($SD = 1.82$), while spouses reported 1.14 ($SD = 1.43$). In hemodialysis patients, a higher number of comorbidities is associated with higher stress scores (Yeh et al., 2009). Although more comorbid medical issues may be an outcome of diabetes, these may add to and create additional stress on top of diabetes management—as they can require separate medical procedures, seeing separate specialists, and even taking separate medications. Therefore, we conceptualized more medical comorbidities as additional physical health stress separate from disease specific stress (i.e., diabetes stress).

Covariates—Gender, age, and time since diagnosis of Type 2 diabetes were considered potential covariates in the present analyses. Research has demonstrated differences between men and women in experiences of chronic health management and support, with spousal health impacting wives more than husbands, and women having both higher levels of depression symptoms and higher levels of social contact (August & Sorkin, 2010; Denton et al., 2004). Likewise, researchers have highlighted the importance of considering age when examining chronic illness as older adults are more likely to have multiple chronic illnesses and increased likelihood of developing age-related chronic conditions (e.g., Roper &

Yorgason, 2009). Finally, a longer time since diagnosis of Type 2 diabetes was found to be associated with lower patient diabetes self-efficacy (Johnson et al., 2013).

Analytic plan

The data were first explored with descriptive statistics and correlations. Missing data were low, ranging from 2.4 % for dietary adherence to 14.5 % for patient and spouse comorbidities. Full-information maximum likelihood estimation (FIML) was used to account for missingness as it provides less biased parameter estimates than listwise deletion or pairwise deletion and mean substitution, and comparable estimates to multiple imputation (Johnson & Young, 2011). Path analysis in Mplus 7.0 (Muthén & Muthén, 2012) was used to answer the research questions following dyadic data analysis procedures (Kenny et al., 2006). Model fit was evaluated with the model Chi-square (χ^2), the comparative fit index (CFI), Tucker-Lewis Index (TLI), the root mean square error approximation (RMSEA), and the standardized root mean square residual (SRMR) with a non-significant Chi-square, values >.95 for CFI and TLI and smaller than .06 and .08 for RMSEA and SRMR suggesting good fit (Hu & Bentler, 1999). The alternative models were tested using nested model comparison through the Chi-square difference test and non-nested model comparison with the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), where smaller values of the AIC and BIC indicate less discrepancy between the hypothesized model and the true model (West et al., 2012). The indirect paths were tested with bootstrapping procedures (Preacher & Hayes, 2008).

Results

Correlations analysis

The correlation results revealed important information about the bivariate associations among the study variables (see Table 1). Patient dietary and exercise adherence were positively correlated with patient and spouse diabetes self-efficacy. Patient dietary adherence was negatively correlated with patient and spouse diabetes-specific stress and depression symptoms and negatively correlated with patient chronic stress and comorbidities. Patient exercise adherence was negatively correlated with patient depression symptoms and comorbidities and spouse diabetes specific stress. Patient and spouse diabetes self-efficacy was negatively correlated with their own depression symptoms, chronic stress, and diabetes-specific stress. Patient and spouse depression symptoms were positively correlated with their own chronic stress, diabetes-specific stress, and comorbidities. Positive correlations were found between patient and spouse reports of diabetes self-efficacy, depression symptoms, and diabetes-specific stress while patient and spouse reports of chronic stress and comorbidities were not associated. With the results of the correlations generally preceding as anticipated, we turned to the main analyses.

Path analysis results

The final path model results can be viewed in Fig. 1. Initially, all the variables in the model were regressed on each control variable. None of the control variables—patient and spouse gender and age and number of years the patient was diagnosed with Type 2 diabetes—were associated with patient and spouse depression symptoms and patient and spouse diabetes

self-efficacy, so they were trimmed one at a time to ensure model fit was not significantly reduced and were omitted from the final model for the sake of parsimony. The final model proved to fit the data well: $\chi^2(36) = 34.021$, $p = .563$; RMSEA = .000 (CI .000, .061); CFI = 1.000; TLI = 1.0014; SRMR = .029, and 44 % of the variance in dietary adherence and 32 % of the variance in exercise adherence was explained by this model.

Starting with the exogenous variables predicting patient depression symptoms, as anticipated, higher levels of patient chronic life stress ($\beta = .17$, $p = .055$), diabetes specific stress ($\beta = .58$, $p < .001$), and a greater number of comorbidities ($\beta = .19$, $p = .007$) were associated with higher levels of patient depression symptoms and one spouse stressor, diabetes-specific stress, was related to patient depression symptoms ($\beta = -.21$, $p = .008$). Turning to variables associated with patient diabetes self-efficacy, higher levels of patient depression symptoms ($\beta = -.44$, $p < .001$) and spouse diabetes-specific stress ($\beta = .26$, $p = .006$) were significantly associated with lower levels of patient diabetes self-efficacy. Finally, higher levels of patient ($\beta = .48$, $p < .001$) and spouse ($\beta = .22$, $p = .015$) diabetes self-efficacy were related to greater patient dietary adherence as well as higher levels of patient ($\beta = .21$, $p = .054$) and spouse ($\beta = .34$, $p < .001$) diabetes self-efficacy were related to greater patient exercise adherence. To test whether the associations between patient and spouse diabetes self-efficacy and patient dietary and exercise adherence were significantly different, corresponding parameter estimates were constrained to be equal and the Chi-square difference test was conducted. None of these associations significantly differed—i.e., the associations between patient diabetes self-efficacy and patient dietary adherence and exercise adherence, $\chi^2_{\text{diff}}(1) = 2.147$, $p = .143$; the association between spouse diabetes self-efficacy and patient dietary adherence and exercise adherence, $\chi^2_{\text{diff}}(1) = 1.806$, $p = .179$; the association between patient and spouse diabetes self-efficacy and patient dietary adherence, $\chi^2_{\text{diff}}(1) = 2.978$, $p = .084$; and finally, the association between patient and spouse diabetes self-efficacy and patient exercise adherence, $\chi^2_{\text{diff}}(1) = .304$, $p = .581$.

Regarding exogenous variables predicting spouse depression symptoms, higher levels of spouse comorbidities ($\beta = .23$, $p = .009$) and chronic stress ($\beta = .39$, $p < .001$) and a greater number of patient comorbidities ($\beta = .21$, $p = .010$) were associated with higher levels of spouse depression symptoms. Spouse diabetes stress ($\beta = -.40$, $p < .001$) and .17, $p = .038$) and patient comorbidities ($\beta = .31$, $p < .001$) and depression symptoms ($\beta = -.48$, $p < .001$) were all significantly associated with spouse diabetes self-efficacy. Spouse depression symptoms were not significantly associated with spouse diabetes self-efficacy. Patient and spouse depression symptoms were not associated, although patient and spouse diabetes self-efficacy were linked ($\beta = .53$, $p < .001$).

Model comparison

We compared our final trimmed model to four theoretically plausible alternatives. First, a nested model comparison was conducted to evaluate whether the indirect link between patient and spouse depression symptoms and patient dietary and exercise adherence was best represented as fully mediated by diabetes self-efficacy (the proposed model) or partially mediated (direct paths from patient and spouse depression symptoms to patient dietary and

exercise adherence). Each model was estimated and the Chi-square difference test indicated adding these direct paths did not improve model fit [$\chi^2_{\text{diff}}(4) = 3.339, p = .503$], indicating patient and spouse diabetes self-efficacy fully mediated the association between depression symptoms and patient dietary and exercise adherence. Second, a nested model comparison was conducted to evaluate whether patient and spouse stressors were directly and indirectly linked to patient dietary and exercise adherence, rather than only indirectly linked (proposed model). Each model was estimated and the Chi-square difference test indicated adding these direct paths did not improve model fit [$\chi^2_{\text{diff}}(12) = 14.888, p = .386$], indicating patient and spouse depression symptoms and diabetes self-efficacy fully mediated the association between stressors and patient dietary and exercise adherence. Next, our proposed model waste model in which patient and spouse diabetes self-efficacy were modeled to predict patient and spouse depression symptoms, which ultimately predicted dietary and exercise adherence. The AIC and BIC values were smaller for the proposed model (AIC = 5960.675; BIC = 6330.806 versus AIC = 6010.048; BIC = 6380.180), signifying our proposed model as a better fit to the data. Finally, our proposed model was tested against a model in which patient dietary and exercise adherence served as the mediators between patient and spouse stressors and patient and spouse depression symptoms and diabetes self-efficacy. The AIC and BIC values were smaller for the proposed model (AIC = 5960.675; BIC = 6330.806 versus AIC = 6043.245; BIC = 6413.376), signifying our proposed model as a better fit to the data.

Test of indirect paths

Model indirect effects (see Table 2) were tested with 5000 bootstraps and a 95 % confidence interval (Preacher & Hayes, 2008). Two significant indirect paths to patient dietary adherence emerged: patient diabetes-specific stress $\rightarrow$ patient depression symptoms $\rightarrow$ patient diabetes self-efficacy $\rightarrow$ patient dietary adherence ($\beta = -.12, p = .008, CI = -.21, -.03$) and spouse diabetes-specific stress $\rightarrow$ patient diabetes self-efficacy $\rightarrow$ patient dietary adherence ($\beta = -.12, p = .050, CI = -.25, -.001$). Using the first indirect effect as an example, this can be interpreted as follows: a one standard deviation unit increase in patient diabetes-specific stress is associated with a .12 standard deviation unit decrease in dietary adherence via the prior effect of patient diabetes-specific stress on patient depression symptoms and patient diabetes self-efficacy. Three indirect paths to patient exercise adherence were also significant: patient diabetes-specific stress $\rightarrow$ patient depression symptoms $\rightarrow$ spouse diabetes self-efficacy $\rightarrow$ patient exercise adherence ($\beta = -.09, p = .019, CI = -.17, -.02$); patient comorbidities $\rightarrow$ spouse diabetes self-efficacy $\rightarrow$ patient exercise adherence ($\beta = -.11, p = .015, CI = -.19, -.02$); and spouse diabetes-specific stress $\rightarrow$ spouse diabetes self-efficacy $\rightarrow$ patient exercise adherence ($\beta = -.14, p = .016, CI = -.25, -.03$). Finally, there were two indirect pathways to patient dietary adherence that were nearly significant, suggesting additional potentially important indirect effects. These include: patient comorbidities $\rightarrow$ spouse diabetes self-efficacy $\rightarrow$ patient dietary adherence ($\beta = -.07, p = .060, CI = -.14, .003$) and spouse diabetes-specific stress $\rightarrow$ spouse diabetes self-efficacy $\rightarrow$ patient dietary adherence ($\beta = -.09, p = .053, CI = -.18, .001$).

Discussion

The purpose of this study was to determine whether multiple stressors were associated with Type 2 diabetes patients' dietary and exercise adherence through two potentially modifiable patient and spouse factors—depression symptoms and diabetes self-efficacy. The most noteworthy finding in this study was the identification of indirect pathways through which stressors were associated with patient dietary and exercise adherence and that these pathways included both patient and spouse factors. These results were robust, as they persisted when including a number of relevant control variables and by empirically comparing our proposed model to four plausible alternatives. These findings are important because they provide further evidence for the importance of considering the role of healthy spouses in the management of Type 2 diabetes and they also provide diabetes educators and clinicians with specific targets for intervention.

For patients, stress rooted in the management of diabetes and other physical health conditions were related to their dietary and exercise adherence indirectly through their own heightened feelings of depression and both their confidence and their spouse's confidence in their ability to manage their diabetes successfully. These findings support the long postulated stress-diabetes management link for patients (Fisher et al., 1982), but add to the literature in two important ways. First, when considering several distinct types of stressors simultaneously, only diabetes-specific stress and physical health stress (i.e., number of comorbidities) were indirectly related to dietary and exercise adherence. It seems that disease specific and health related stressors are more salient to disease specific behaviors (i.e., diabetes adherence) than general life stressors. For patients, it could be that diabetes-specific stressors are highly interrelated with chronic life stressors. This seems plausible as the bivariate correlation between patient diabetes stress and patient chronic life stress was high ($r = .55$), thus leaving little *unique* predictive power for chronic life stress when considered diabetes specific stress. On the other hand, it may simply be that any disease specific stressor is going to be more salient when measuring disease specific cognitions (e.g., diabetes self-efficacy) or disease specific behaviors (e.g., diabetes adherence). Nevertheless, this study points to the importance of diabetes-specific stress and physical health stress in lower levels of patient dietary and exercise adherence.

Second, this study adds to the literature by showing that patient depression symptoms and diabetes self-efficacy are one potential pathway through which patient stress is related to lower patient dietary and exercise adherence. Rates of depression are higher in those diagnosed with Type 2 diabetes compared to the general population (Anderson et al., 2001) and previous studies found clinical depression and symptoms of depression are related to worse diabetes management (Gonzalez et al., 2008). What this study adds is the delineation of a more complex pathway, in that patients with higher levels of diabetes specific stress and a higher number of comorbidities tend to have more depression symptoms. A higher number of depression symptoms are then related to less confidence in managing one's diabetes which, in turn, is related to poorer dietary and exercise adherence. This finding supports previous theorizing that mood states, such as the presence of depression symptoms, are related to self-efficacy (Bandura, 1997; Kanfer & Zeiss, 1983; Kavanagh & Bower, 1985). Indeed, there is strong evidence to suggest depression reduces a person's feelings of

competence (Gotlib & Hammen, 2014). Of course, this relationship is likely bidirectional, in that lower levels of self-efficacy are also related to more depression symptoms. Although, when we empirically tested this alternative model (i.e., diabetes self-efficacy to depression symptoms to dietary and exercise adherence), we found that our original hypothesized model was a better fit to the data—further strengthening the hypothesized pathway that depression symptoms are related to dietary and exercise adherence through diabetes self-efficacy. Future research using longitudinal data and autoregressive cross-lagged analyses are needed to examine the temporal ordering of these relationships.

Regarding spousal factors, spouse diabetes-specific stress was related to patient dietary and exercise adherence through the diabetes self-efficacy reported by both the spouse and patient. This means that spouses who had higher levels of stress about their partner's Type 2 diabetes had less confidence that their partner could appropriately manage his or her disease, which was related to worse dietary and exercise adherence. Spouse diabetes-specific stress was also associated with lower levels of *patient* confidence to effectively manage his or her diabetes, which was then related to less dietary adherence. Finally, patient physical health comorbidities were related to patient dietary and exercise adherence through spouse diabetes self-efficacy. Patients reporting a higher number of physical health comorbidities were more likely to have spouses who were less confident in the patient's ability to effectively manage his or her diabetes, which was related to lower levels of dietary and exercise adherence. These findings also add to the literature in two important ways.

First, this is one of the first studies to link *spouse* diabetes-specific stress to *patient* diabetes adherence. Franks et al. (2012) found a significant bivariate correlation between spouse diabetes-specific stress and patient adherence, but the relationship was not significant in their regression models. This is likely due to their very small sample size ($n = 55$) which probably limited the power to detect this relationship. Second, this study provides evidence that *spouse* diabetes self-efficacy is an important pathway through which both spouse and *patient* factors are related to *patient* dietary and exercise adherence. These results are important because they highlight the interdependence of couple relationships in managing chronic illnesses (Berg & Upchurch, 2007) and point to the need to include spouses and the patient's larger social context in diabetes education and intervention (Vassilev et al., 2011). Future research could determine whether including spouses or partners in basic diabetes education interventions is sufficient, or if directly targeting spouse diabetes-specific stress, diabetes self-efficacy, and the couple's relationship provide additional gains in improving patient adherence (Martire et al., 2010).

Given the strong link between diabetes self-efficacy and dietary and exercise adherence (King et al., 2010; Nakahara et al., 2006) our results also provide important insights into factors associated with both patient and spouse diabetes self-efficacy. For patients, higher levels of depression symptoms are directly related to lower levels of diabetes self-efficacy and higher levels of diabetes-specific stress and a greater number of comorbidities are indirectly related to their own diabetes self-efficacy through their depression symptoms. In addition, when their spouses have higher levels of diabetes-specific stress patients have lower levels of diabetes self-efficacy. For spouses, the more stress they experience related to their partner's diabetes and the higher number of their own comorbid health conditions, the

less confidence they have that their partner will adequately manage his or her diabetes. In addition, more patient depression symptoms are directly related to lower spouse confidence in their partner's ability to manage their diabetes and higher patient diabetes-specific stress and a greater number of comorbidities are also linked to lower spouse diabetes self-efficacy indirectly through patient depression symptoms. These are important findings for a number of reasons. First, as previously discussed, our findings point to a very strong link between patient depression symptoms and their own diabetes self-efficacy, supporting the idea based on self-efficacy theory (Bandura 1997) that a person's mood state is associated with their feelings of competence. Second, these findings support the notion that "depression symptoms and diabetes distress are distinct constructs with independent relationships to diabetes" (Gonzalez et al., 2011, p. 237) and it provides important evidence for *how* these constructs are related to both patient and spouse diabetes self-efficacy and patient dietary and exercise adherence. Third, our findings speak to the interconnection of spouses when managing a chronic illness (Berg & Upchurch, 2007), in that each partner's diabetes specific-stress is related to their own and their spouse's confidence that the patient can manage their disease. When spouses have greater diabetes-specific stress, see their partner stressed about their diabetes, see their partner struggling with comorbid health problems and/or experiencing depression related symptoms the spouse is likely to engage in a variety of specific support and engagement (or disengagement) patterns with their partner (Rosland et al., 2012). These patterns of interaction and their effects likely impact their own and the patient's confidence in managing their diabetes. Determining how patient and spouse disease-specific cognitions, health problems, and mood states impact couple processes that then lead to more (or less) confidence in managing diabetes and diabetes specific behaviors is an important area for future investigation.

These findings have a number of potential implications for practice. First, as described, they provide additional evidence that spouses should also be included in intervention programs. Second, these results highlight important psychological targets for intervention, namely, efforts aimed at decreasing patient and spouse diabetes-specific stress and lowering patient depression symptoms may enhance patient and spouse diabetes self-efficacy, which is associated with better patient dietary and exercise adherence. Targeting diabetes self-efficacy directly, with or without first addressing diabetes stress and depression related symptoms may also prove to be an effective strategy, though intervention studies are needed to test these approaches.

Finally, these results support the contention that diabetes management needs to include greater consideration of the family and social context factors that influence adherence (Vassilev et al., 2011), as there are likely to be other spouse and family related stressors, cognitions, behaviors, and relevant social contexts associated with patient adherence. For example, the quality of the couple's relationship might be a protective factor that decreases the impact of disease specific stress on depression symptoms or diabetes self-efficacy or, when relationship quality is poor, strengthens the negative impact of diabetes specific stress on these variables. Along these lines, it may be important to examine couple relations regarding the patient's Type 2 diabetes as a more direct couple-level factor that could moderate the link between illness stress and management (e.g., Johnson et al., 2014a).

Limitations and conclusion

This study has a number of limitations that should be considered when interpreting the results of this study. First, this study used data from a single time point. Although we used relevant empirical research and theory to guide the development of our model and we tested four plausible alternatives to strengthen our conclusions, longitudinal studies are needed to establish the temporal ordering of these variables. Second, the sample was fairly homogenous with respect to race/ethnicity, education, and geographic location, so these results may not generalize to more ethnically diverse, less educated, or same-sex couples. On the other hand, given that the sample used in this study likely had more education and higher incomes than the average diabetes patient—and therefore, more individual and social resources—the model may underestimate the negative association between stress and diabetes adherence in resource poor samples. Third, our adherence variables were each comprised of two-items each. Although these items have been used extensively in the diabetes literature, the limitations of short scales for identifying an underlying construct have been established (Little et al., 1999). Finally, all of these variables were assessed with self-report measures, thus, a portion of the associations between variables may be attributed to shared method variance. Future studies could incorporate more objective measures, such as daily diary approaches to measuring adherence, or obtaining comorbidities from patient and spouse medical charts.

In conclusion, the purpose of this study was to identify potentially modifiable patient and spouse factors related to patient dietary and exercise adherence. Results indicated that patient and spouse diabetes-specific stress and patient physical health stress in the form of a higher number of comorbidities was linked to lower patient dietary and exercise adherence through patient depression symptoms and the diabetes self-efficacy reported by both partners. These results provide additional evidence that diabetes management is an interpersonal process, and, as such, education and intervention programs that focus solely on the patient are targeting only part of the solution.

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Fig. 1.

Path analysis of patient and spouse factors associated with diabetes adherence in patients with Type 2 diabetes ($n = 117$ couples). *Note* standardized estimates shown. *Solid lines* represent significant pathways. Non-significant paths between patient stress variables and spouse depression symptoms, spouse stress variables and patient depression symptoms, patient and spouse depression symptoms, and patient and spouse stress variables and patient and spouse diabetes self-efficacy are not shown in the figure for clarity. The link between patient and spouse stress variables and patient adherence variables were conceptualized as indirect, thus, the direct associations were not tested in this model. Patient and spouse age and gender and total years patient diagnosed with Type 2 diabetes were included as control variables, but are not included in the figure for clarity. Model fit indices: $\chi^2(36) = 34.021$, $p = .563$; RMSEA = .000 (CI .000, .061); CFI = 1.000; TLI = 1.014; SRMR = .029. † $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed)

Table 1

Correlations and descriptive statistics for study variables (N = 117 couples)

Variable	1	2	3	4	5	6	7	8	9	10	Mean	SD
1. Dietary adherence	–	.41***	.54***	-.16 [†]	-.09	-.20*	-.12	-.12	-.03	.19*	–	–
2. Exercise adherence	.41***	–	.45***	-.10	.07	-.18 [†]	-.05	-.24*	.06	-.09	–	–
3. Diabetes self-efficacy	.63***	.43***	.63***	-.32***	-.18 [†]	-.37***	-.02	-.06	-.14	.10	2.71	1.20
4. Depression symptoms	-.43***	-.29**	-.48***	.20*	.45***	.29**	.38***	.02	.18	-.13	.46	.46
5. Chronic life stress	-.17 [†]	-.11	-.27**	.49***	.16	.26**	.23*	-.07	.22*	-.26**	2.12	.60
6. Diabetes stress	-.32***	-.11	-.38***	.64***	.55***	.34**	.29**	.08	-.02	-.23*	1.03	.80
7. Comorbidities	-.18 [†]	-.23*	-.15	.32**	.17 [†]	.13	.12	.00	.10	-.12	1.14	1.43
8. Patient years Dx	-.12	-.24*	-.11	.11	.06	.09	.14	–	.00	.28**	–	–
9. Gender	.04	-.05	-.02	-.02	-.01	.13	-.07	-.08	–	.02	1.58	.50
10. Age	.14	-.03	.25**	-.19*	-.36***	-.40***	.20*	.29**	-.19*	.85***	57.4	10.1
Mean	4.50	2.84	2.52	.73	2.11	1.53	2.09	11.0	1.43	57.4		
SD	1.90	2.30	1.10	.67	.63	1.05	1.82	9.19	.50	9.83		
Range	0–7	0–7	0–5	0–3	1–4	0–5	0–17	0–52	1–2	29–72		

Patients below the diagonal, partners above the diagonal, and between patients and partners along the diagonal

[†]
 $p < .10$ *
 $p < .05$ **
 $p < .01$ ***
 $p < .001$ (two-tailed).

Physical health stress in this study was operationalized as the number of patient or spouse comorbidities

Table 2

Indirect effects (standardized solution; N = 117 couples)

Predictor	Mediator(s)	Outcome	β	CI	p value
Patient diabetes stress →	Patient depression symptoms → patient diabetes self-efficacy →	Patient dietary adherence	-.12	-.21, -.03	.008
Spouse diabetes stress →	Patient diabetes self-efficacy →	Patient dietary adherence	-.12	-.25, -.001	.050
Patient comorbidities →	Spouse diabetes self-efficacy →	Patient dietary adherence	-.07	-.14, .003 *	.060
Spouse diabetes stress →	Spouse diabetes self-efficacy →	Patient dietary adherence	-.09	-.18, .001 *	.053
Patient diabetes stress →	Patient depression symptoms → spouse diabetes self-efficacy →	Patient exercise adherence	-.09	-.17, -.02	.019
Patient comorbidities →	Spouse diabetes self-efficacy →	Patient exercise adherence	-.11	-.19, -.02	.015
Spouse diabetes stress →	Spouse diabetes self-efficacy →	Patient exercise adherence	-.13	-.24, -.03	.016

Indirect paths tested with 5000 bootstraps. CI = 95 % confidence interval.

* CI = 92.5 % confidence interval

Physical health stress in this study was operationalized as the number of patient or spouse comorbidities