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How health behaviors link romantic relationship dysfunction and physical health across 20 years for middle-aged and older adults

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ABSTRACT

Rationale: There has been substantial research linking marital quality to physical health outcomes; however, the mechanisms linking marital quality and physical health have been studied less extensively, especially with longitudinal data. Of the hypothesized mechanisms, only psychological distress (anxiety/depression) and physiological mechanisms (inflammation) have been tested and confirmed. Health behaviors such as diet, exercise, smoking, drinking, and sleeping have not previously been examined as mechanisms linking marital quality and physical health.

Objective: The present study tests how the emotional influence of the marital relationship is linked to subsequent health outcomes through behavioral mechanisms. A biopsychosocial theoretical model, the Biobehavioral Family Model (BBFM), is used to hypothesize the mediating paths between marital dysfunction and physical health.

Method: The study hypotheses are tested with publicly accessible survey data, Midlife in the United States (MIDUS). We examined married or cohabiting participants ($N = 5023$) across the three time points of MIDUS, or 20 years. Specifically, we tested whether five health behaviors at Time 2 (smoking, alcohol, sleep, food to cope, and physical activity) function as mechanisms linking marital dysfunction (Time 1) to subsequent physical health (Time 3). We tested each health behavior as a mechanism in a series of mediating Structural Equation Models.

Results: Two health behaviors were significant mechanisms (food to cope and physical activity), while three were not (smoking, alcohol, and sleep).

Conclusion: Diet and exercise are mechanisms linking marital dysfunction and health across 20 years because they may be linked to the emotional influence and not functional influence of the marriage context. According to the BBFM, diet and exercise may be part of the mediating construct of the model (i.e., biobehavioral reactivity), which explains how emotional stress from a marriage may produce declines in physical health over time. Implications for biopsychosocial healthcare interventions are discussed.

1. Introduction

Close, supportive marriages are consistently linked to improved health outcomes including healthier (risk-reducing) behaviors, reduced morbidity and mortality, and improved physical and emotional health (House et al., 1988; Kiecolt-Glaser and Newton, 2001; Umberson et al., 2010). Conversely, poor marital quality is linked to worse health outcomes including earlier all-cause mortality, increases in morbidity, and worse mental health (e.g., Carr and Springer, 2010; Woods et al., 2014). Despite the repeated substantiation of these marriage-health associations, the mechanisms of effect linking marital quality and health remain unclear (Carr and Springer, 2010). There is evidence that psychophysiological reactions to marital stress are one critical link (Priest et al., 2015). However, health behaviors have only been proposed as a mechanism linking marital quality and health (Beverly et al., 2008; Chopik and O'Brien, 2016; Kiecolt-Glaser and Newton, 2001; Weihs et al., 2002) and have not yet been tested in a full mediating model. The aim of the current study is to add health behaviors to the literature on social models of health promotion through the expansion of an existing biopsychosocial model of health to adults: the Biobehavioral Family Model (BBFM; Wood, 1993). The BBFM models the effects of broader relationship functioning (including marital and other family relationships) on physical health outcomes, through individual family members' stress reactivity (Wood et al., 2008). The original specification of this mediating stress pathway included individuals' *behavioral* reactivity (Wood, 1993), but behavior as an operationalization has yet to be

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tested. Therefore, we will examine health behaviors (i.e., physical activity, diet, sleep, alcohol use, and smoking) as a component of the BBFM's mediating pathway. Results of this study will point to the role that health behaviors play in the biopsychosocial unfolding of health outcomes during adulthood, and work to further uncover why marriage and physical health are so closely linked (e.g., Kiecolt-Glaser et al., 2010; Umberson et al., 2010).

1.1. Health behaviors

Marital relationships play a critical role in shaping health behavior and lifestyle changes over time (Beverly et al., 2008; Chopik and O'Brien, 2016; Kiecolt-Glaser and Newton, 2001). As such, there is a growing emphasis in the extant literature on the dyad, situating individual's health behaviors and outcomes within the broader context of social relationships, rather than examining these factors in isolation (Chopik and O'Brien, 2016; Hoppmann and Gerstorf, 2014; Lewis et al., 2006; Troxel, 2010). Health behaviors have been proposed as a potential mediator, or indirect pathway, through which the marital relationship may negatively or positively affect health outcomes (Kiecolt-Glaser et al., 2010; Umberson et al., 2010). Broadly, the literature offers two explanations for the link between marital quality and health behaviors: (a) Health behaviors can result from socially promoted, encouraged, or learned behaviors, with reciprocal influence between individual spouses, which is labeled *functional influence* here. Functional influence can potentially manifest as effective communication patterns (Weihs et al., 2002). In addition, (b) health behaviors can develop as a means of coping with perceived marital stress (Krueger and Chang, 2008), which is labeled *emotional influence* here. Therefore, some health behaviors may be a result of functional influence, such as a spouse's reminder to take medication or spousal food preparation and other health behaviors may be a result of emotional influence such as a conflictual marriage that results in eating as a stress-reducing coping strategy. While there is evidence that the marital context is linked to health behaviors, it is not clear which health behaviors, if any, mediate the association between marital distress and general health outcomes.

Smoking, namely the persistence to smoke and failure to quit, is linked to marital stress (Slopen et al., 2013). In fact, psychosocial stressors more broadly are risk factors for smoking (e.g., Slopen et al., 2013; Stein et al., 2008), while smoking cessation is linked to relationship satisfaction (Foulstone et al., 2017). Among married individuals who reported more emotional intimacy with their partner, they were more likely to smoke fewer cigarettes 9 years later (Derrick et al., 2013). In fact, satisfaction with a marriage does not appear to be enough to reduce smoking in its entirety, as multiple marital characteristics, including emotional intimacy, partner cohesion (i.e., how well the partners get a long), and partner consensus (i.e., the amount of agreement shared between the spouses about major life domains), are also linked to reduced smoking (Derrick et al., 2013; Scholz et al., 2013). Therefore, poorer marital quality may be linked to health outcomes through smoking (a) if individuals use smoking as a coping mechanism or (b) if support from the marital relationship can help the individual overcome barriers to smoking cessation.

The links between heavy alcohol consumption and marital quality are mixed. Increases in binge drinking among older adults as been linked bi-directionally to poorer marital quality for women, but, for men, only poor marital quality was linked to increased binge drinking in a unidirectional fashion (Roberson et al., in press). In a younger population, high relationship satisfaction was linked to lower alcohol consumption *and* a greater willingness to decrease alcohol consumption among those who were engaged in drinking behaviors (Khaddouma et al., 2016). Conversely, for men occupying multiple caregiving roles, increases in marital support was linked to more drinking in a cross-sectional model (DePasquale et al., 2016). It is clear that there *is* a link between marital quality and drinking; however, the direction of this association and the type of marital influence (emotional vs functional) is unclear based on the existing research.

Poor sleep appears to be linked to poor marital quality bi-directionally (Lee et al., 2017; Troxel et al., 2007). However, in a longitudinal intervention, increases in relationship quality were linked with a 36% decrease in the risk of insomnia (Troxel et al., 2017). For men, a cross-sectional model showed that the impact of marital quality on poor sleep is particularly noticeable when they have multiple caretaking roles (e.g., caring for children and elderly parents) and their marital strain is high (DePasquale et al., 2016). But, it is difficult to determine the directionality of this association as poor sleep is also linked to greater conflict the next day (Gordon and Chen, 2014). Marital quality and sleep appear to have a cyclical association, however, it is unclear how their interaction operates over time to influence health outcomes. Because sleep deprivation can increase agitation and one's ability to communicate effectively, and stress from poor marital quality can disrupt sleep, both the functional and emotional influence of marital quality may impact health through sleep.

When considering eating habits, greater partner support increases healthy eating while greater partner strain increases unhealthy eating behaviors (Kiecolt-Glaser and Newton, 2001). One form of unhealthy eating is consuming fast-food, which may be linked to an effort to save time and reduce stress especially among those who occupy numerous social roles simultaneously (Hamrick and Okrent, 2014; DePasquale et al., 2016). Further, when examining diabetes-specific populations, functional influence from a spouse appears to influence eating habits (Nicklett et al., 2013; Strom and Egede, 2012). Therefore, marital quality could influence health through both afunctional and emotional influence.

The direct link between physical activity and marital quality has not been examined extensively; what has been examined focuses on a diabetic population. In couples, the experienced stress linked to diabetes from both the spouse and patient are negatively linked to the patients' physical activity frequency (Anderson et al., 2016). Also, a couple's shared beliefs about how to manage a disease may improve physical activity maintenance (Beverly and Wray, 2008). The link between marital context and physical activity is complex, as spousal support and control over health behaviors can independently and jointly influence partners' physical activity (Khan et al., 2013). There appears to be some evidence that the intense negative emotions in the social context of marriage influences physical activity, which are predictive of health outcomes.

In general, health behaviors appear to precede physical health outcomes which are preceded by relationship quality, although this temporal ordering is not always clear (Kearns-Bodkin and Leonard, 2005). Evidence supports the need to include health behaviors as mediators in research to aid in the development of public health interventions to improve health behavior and lifestyle change (Robles, 2014; Robles et al., 2014). We propose that health behaviors triggered by the emotional influences of marriages will link marital dysfunction and physical health outcomes.

1.2. The biobehavioral family model (BBFM)

In addition to empirical evidence, theoretical models hypothesize that health behaviors link marital quality and health outcomes. The BBFM is a biopsychosocial approach (Engel, 1977) and multi-level interactive systems model (Wood et al., 2015) that explores the ways in which family functioning interacts with psychophysiological factors to affect the physical health outcomes of individual family members. Developed from a general systems paradigm (von Bertalanffy, 1969), the BBFM is a reformulation of the “psychosomatic family model” (Minuchin et al., 1975) that theorizes a model about the reciprocal influence of social, emotional, behavioral, and physiological factors at both the individual and the interpersonal (family) level. The BBFM incorporates family functioning, psychological health, and physical health into one comprehensive model and postulates that close

relationships (familial and intimate partner) may buffer or activate psychophysiological processes associated with poor physical health, or disease activity (Priest and Woods, 2015; Wood, 1993). In other words, the model hypothesizes that a stressful close relationship context, such as marriage, may contribute to the development of illness through psychophysiological stress reactivity and that a positive and supportive environment may buffer against environmental stress promoting positive health outcomes. (Wood et al., 2008).

The BBFM examines three specific variables – family emotional climate, biobehavioral reactivity, and disease activity – and theorizes biobehavioral reactivity to play a mediating role in the association between family emotional climate and physical health outcomes (Priest et al., 2015; Priest and Woods, 2015; Wood, 1993). The *family emotional climate* includes multiple relational factors within the family environment, such as relationship quality, positive and negative emotional processes, the relative intensity of the emotional processes, and interpersonal responsivity and reactivity (Priest et al., 2015; Wood et al., 2008). The valence and intensity of the family emotional climate, positive (warm, receptive, caring) or negative (hostile, critical, nonresponsive), in turn resonates and reverberates for individual family members, who react to this family environment emotionally, behaviorally, and physiologically. In the present study, we specifically focus on one aspect of the family emotional climate, the marital relationship, and target dysfunction or negativity in that relationship.

Individual family members' responses to the family emotional climate are captured in the *biobehavioral reactivity (BBR)* construct of the BBFM. BBR is operationalized as the degree to which an individual reacts emotionally, physiologically, and behaviorally to their family environment, and their ability to regulate stress and arousal (emotional and physiological) (Wood et al., 2008, 2015). This construct represents the mediating pathway linking family emotional climate and disease activity, and includes psychophysiological stress reactivity reflected in autonomic nervous system and neuroendocrine system activation (Wood et al., 2015). Within an emotionally positive and supportive family emotional climate, an individual's BBR is more likely to be regulated, which can buffer against the negative impact external stress has on individual health outcomes. However, in an emotionally stressful family environment characterized by hostility, invalidation, and conflict, an individual is chronically reacting to stress and may therefore become physiologically and emotionally dysregulated. Dysregulated BBR, and activated physiological stress pathways, transfers the impact of family stress on disease activity.

Past research has confirmed emotional (i.e., depression and anxiety) and physiological (i.e., allostatic load) components of a dysregulated BBR (Priest et al., 2015; Priest and Woods, 2015; Roberson et al., in press; Wood et al., 2008; Woods and Denton, 2014). Although these conceptualizations are unique, it is important to note that depression and anxiety are, in and of themselves, psychophysiological, inclusive of physical symptoms (e.g., somnolence, psychomotor retardation, pain) that convey the effects of family stress within an individual family member. Despite advances in testing the BBFM in full, the *behavioral* aspect of BBR has yet to be examined. Therefore, we will test specific health behaviors as operationalizations of BBR, in response to marital dysfunction.

Lastly, the *disease activity* construct of the BBFM represents the chronic activation of psychobiological processes involved in illness, which, over time, contribute to disease and worsening illness symptoms. Disease activity is typically measured by self-reported physical health or by the presence (or absence) of a chronic health condition (Priest and Woods, 2015; Wood et al., 2007; Woods and Denton, 2014).

The BBFM has been repetitively substantiated. Due to its emphasis on stress-related health outcomes, much of the research using the model has been conducted with families of pediatric asthma patients (e.g., Wood et al., 2007, 2008, 2015). More recently, the BBFM has been expanded beyond stress-related illnesses and tested on culturally, ethnically, and socioeconomically diverse groups, as well as adult patients (Priest and Woods, 2015; Woods and Denton, 2014; Woods and McWey, 2012). While the BBFM has been supported as a useful model for theorizing the effects of close relationships on physical health outcomes across developmental and cultural groups (Priest and Woods, 2015; Woods et al., 2014), tests of its pathways have yet to incorporate a consideration of health behaviors, despite overwhelming evidence of the importance of health-related behaviors for health outcomes, as well as the link between marital quality and health behaviors.

1.2.1. Present study

The purpose of the present study was to expand the BBFM via an examination of health behaviors as part of the biobehavioral reactivity (mediating) construct. In particular, the health behaviors linking marital dysfunction to health outcomes will be considered an indicator of a *dysregulated* BBR, resulting from the emotional influence of the marriage. More specifically, based on the assumptions of the BBFM, we hypothesized that a significant, indirect (or mediating) pathway exists between family emotional climate and disease activity through the health behaviors of physical activity, diet, sleep, alcohol use, and smoking. We hypothesize that all other pathways endemic to the BBFM would remain intact such as anxiety or depression (see Priest et al., 2015) and that health behaviors would explain an additional mechanism by which marriage quality influence physical health.

2. Method

2.1. Participants and procedures

Data for this study are from the Midlife in the United States (MIDUS) study; the current study was exempt from IRB approval because it uses publicly accessible data. MIDUS began in 1995 (MIDUS 1; $N = 7108$) with the goal of examining the role of psychological, behavioral and social factors associated with health and well-being for adults in the United States. A follow up of the original MIDUS participants began in 2002 (MIDUS 2; $N = 4963$); the third time point of data collection (MIDUS 3; $N = 3294$) with these same participants began in 2011. For each time point of data, respondents were asked about their mental and physical health, the quality of their marriages, and their health behaviors.

MIDUS included a random digit dialing sample ($n = 3487$), an oversampling of five metropolitan areas ($n = 757$), a sample of siblings of the random digit dialing sample ($n = 950$), and a random digit dialing sample of twin pairs ($n = 1914$). To be eligible, participants had to live in the coterminous United States, speak English, and be between the ages of 25–74. MIDUS 2 was comprised of the MIDUS 1 participants; about 70% of those in MIDUS 1 also completed MIDUS 2. MIDUS 3 was comprised of n = 3294 respondents from MIDUS 1; in other words, about 46% of those who completed MIDUS 1 also completed MIDUS 3, while about 66% of those who completed MIDUS 2 also completed MIDUS 3 (Ryff et al., 2013). For a complete description of the MIDUS attrition rates and reason for attrition, see Ryff et al. (2013).

The present study included participants who reported being married or in a marriage-like relationship (e.g., cohabiting) during MIDUS 1 and completed the MIDUS 1 marital dysfunction measures. We did not remove people if they were divorced or separated at subsequent time points. Individuals who are divorced at time 1 and 2 are likely to have poorer functioning marriages at time 1 and we did not want to truncate the range of the predictor variable by eliminating these participants. Demographic information for the present sample appears in Table 1 as well as descriptive statistics for all variables of interest.

2.2. Measurement

2.2.1. Marital dysfunction

The latent construct of marital dysfunction is measured by three variables developed by MIDUS: *Marital Strain* (6-items; e.g., “How often

Table 1
Demographic information for the sample (N = 5032).

Demographic Variable	*M* (*SD*) or %
Age	46.43 (12.60)
Relationship Status	
Married	92.9%
Cohabitating	7.1%
Gender	
Men	51.6%
Women	47.4%
Race	
White	92.6%
African American	3.9%
Other	< 3.0%

Model Variables	*M* (*SD*)	Median	Minimum observed	Maximum observed
T1 Relationship - Strain	2.21 (.61)	2.17	1.00	4.00
T1 Relationship - Trouble	1.85 (1.04)	1.00	1.00	5.00
T1 Relationship - Separate	3.52 (.72)	4.00	1.00	4.00
T1 Physical Health - Self	7.51 (1.56)	8.00	0.00	10.00
T1 Physical Health - Chronic Conditions	2.28 (2.39)	2.00	0	27
T1 Physical health - Prescriptions	0.47 (.86)	0	0	8
T2 BBR - Depressed Affect	0.50 (1.60)	0.00	0.00	7.00
T2 BBR - Anxiety Disorder	0.11 (.82)	0.00	0.00	10.00
T3 Physical Health - overall	7.36 (1.58)	8.00	0.00	10.00
T3 Physical Health - Chronic Conditions	3.15 (3.08)	2	0	20
T3 Physical health - Prescriptions	1.49 (1.51)	1	0	9
T2 Smoking	5.53 (12.59)	0	0	96
T2 Drink Alcohol	0.42 (2.33)	0	0	31
T2 Sleep	2.52 (1.12)	2.00	1.00	5.00
T2 Food Cope	3.68 (1.83)	3.00	2.00	8.00
T2 Physical Activity	4.15 (1.44)	4.33	1.00	6.00

does he or she criticize you?" 1 = Never to 4 = Often; α = .88), *Marital Trouble* (1 item; "During the past year, how often have you thought your relationship might be in trouble?" 1 = Never to 5 = All the time), and *Ever Separate* (1 item; "It is always difficult to predict what will happen in a relationship, but realistically, what do you think the chances are that you and your partner will eventually separate?" 4 = not likely at all to 1 = very likely). Variables were measured at Time 1.

2.2.2. Physical health

Physical health was measured as a latent construct with three variables: *Number of Symptoms and Chronic Conditions*, *Number of Prescriptions*, and *Self-Reported Health* ("How would you rate your health these days?" 0 = Worst to 5 = Best). All items were recoded so that higher scores indicated worse health. These questions (and data) have been used in previous tests of the BBFM (Priest and Woods, 2015; Priest et al., 2015; Woods et al., 2015) so we replicate that method here. Variables were measured at Time 1 and 3.

2.2.3. Biobehavioral reactivity

The emotional aspect of biobehavioral reactivity was measured with *Depression and Anxiety* as a latent construct using Anxiety Disorder and Depression scales from MIDUS 2. The Anxiety Disorder scale was measured with 10 items (e.g., "How often were you restless because of worry?") and response options ranged from 1 – most days to 4 - never. The scale was computed by adding together the number of "most days" responses, for scores ranging from 0 to 10. The Depression scale was measured with responses to 7 items. These items asked respondents to indicate if during two weeks in the past 12 months when they felt blue if they had symptoms of depression, such as losing interest in most things or feeling worthless. Participants answered "yes" or "no" to each of the 7 items. This scale was computed by adding the number of yes responses together, for scores ranging from 0 to 7. These variables were measured at Time 2 and have shown to be reliable for MIDUS respondents (Ryff et al., 2012).

The behavioral aspect of biobehavioral reactivity was measured with a series of individual *Health Behaviors* at Time 2. We measured behaviors that were current during the Time 2 survey in an effort to reduce confounding temporal precedence: *Smoking* ("For current smokers: On average, about how many cigarettes did you smoke per day during the one year in your life when you smoked most heavily?"; 0 = never smoked); *Alcohol* ("Number of times had 5 + drinks on the same occasion in the past month?"; 0 = never drank or have not binged in the past month); *Sleep* ("How often do you feel unrested during the day?" 1 = never to 5 = almost always); *Food Cope* (2 items were averaged; e.g., "I eat more of my favorite foods to make myself feel better"); and *Physical Activity* (6 items were averaged; e.g., "How often do you engage in vigorous physical activity …. during your leisure or free time in the summer?"; "… during your leisure or free time in the winter?" 1 = several times a week to 6 = never).

2.3. Analytic strategy

To determine how each type of health behavior mediated the link between relationship quality and physical health, we test a series of mediation structural equation models (SEMs) in Mplus. First, we determine if the latent constructs are appropriate measures by testing the measurement model with Confirmatory Factor Analysis (CFA). To determine if the overall CFA is appropriate we will examine common indicators of model fit (RMSEA < .08, TLI > .90, CFI > .90; Kline, 2015). Additionally, to determine if individual variables of the latent construct all fit together appropriately, we will examine the factor loadings; a factor loading of < .40 will indicate that the individual variable should be removed from the latent construct. The next step to take prior to estimating the mediation of health behaviors is confirming the baseline BBFM SEM model. Using the same model fit indicators as the CFA, we will determine if the SEM model is appropriate. The baseline model will examine relationship quality (T1) predicting later physical health (T3) directly and indirectly through biobehavioral reactivity (T2) while controlling for initial physical health (T1).

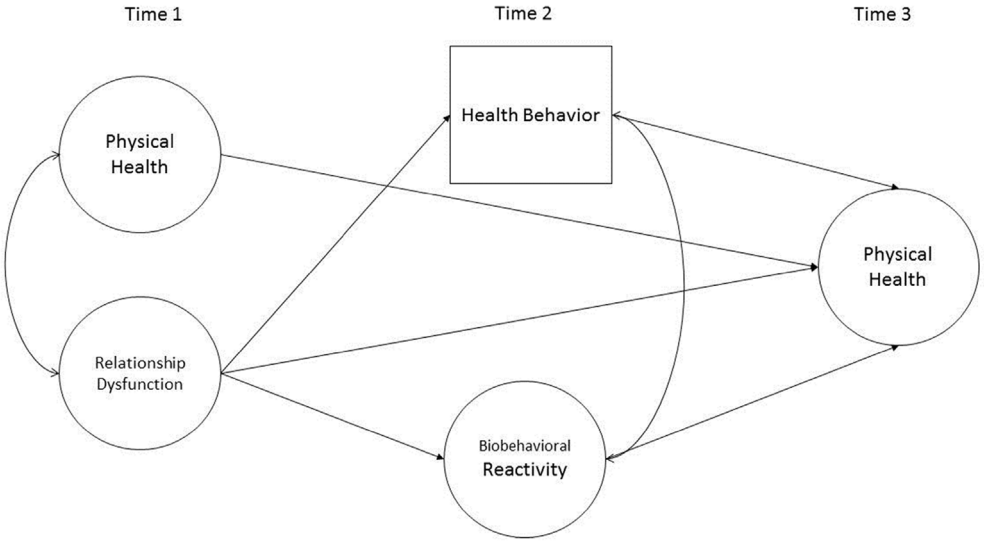

Fig. 1. The theoretical model of biobehavioral family model with the inclusion of health behaviors.

When examining the mediation of each of the health behavior variables, we will build on the established BBFM baseline model above by including the health behavior as an additional mediator at Time 2 (Fig. 1). A model with adequate fit (Kline, 2015) and a statistically significant path from relationship quality and to physical health will indicate a mediation. This mediation will be confirmed in the "model indirect" statement within Mplus that produces a parameter estimate for the entire mediating path (e.g., T1 marital dysfunction →T2 smoking → T3 health). This technique will provide a combined parameter estimate of the regression path from relationship quality to the specific health behavior to physical health. A significant indirect path will indicate that the tested health behavior links relationship dysfunction to health outcome above and beyond anxiety and depression.

In each statistical model, we use maximum likelihood estimation –robust because some of the indicators of health were skewed. This robust estimator corrects biased estimates typically observed with skewed data (Muthén and Muthén, 1998-2017). To handle missing data, we use full information maximum likelihood, which is preferred to reduce biased estimates when missing data is missing at random and covariates are included. We included three control variables: gender, age, and baseline health status.

3. Results

First, the correlation matrix of all variables of interest across the three time points (not shown) revealed that variables were related in expected directions with absolute values of the correlations (*r*) ranging from .01 to .60.

3.1. BBFM baseline model

The Confirmatory Factor Analysis (CFA) for the measurement model examined the latent variables T1 marital dysfunction, T2 anxiety/depression, and T1 and T3 physical health. This model fit the data well: χ^2 (38) = 421.05, $p < .001$, RMSEA = .045 (90% *CI* = .041, .049), CFI = .94, TLI = .91. Factor loadings for each construct were in acceptable ranges and correlations among the latent variables were significant (Table 2).

For the baseline model, we tested the originally conceptualized BBFM model, without the health behavior variables. This model also fit the data: χ^2 (39) = 469.68, $p < .001$, RMSEA = .047 (90% *CI* = .043, .051), CFI = .93, TLI = .90. As expected, T2 emotional biobehavioral reactivity (BBR) mediated the link between T1 marital dysfunction and T3 physical health (T1 marital dysfunction → T2 anxiety/depression → T3 physical health: $\beta = .056$, $SE = .020$, $p < .001$).

Table 2
Standardized factor loadings, Unstandardized path estimates, Standardized path estimates for baseline model ($N = 5023$).

	CFA		BBFM Longitudinal Model		
	β	*SE*	*B*	*SE*	β
Factor Loadings					
T1 Health					
Chronic illnesses	.76**	.02	–	.02	.78**
Prescription medication	.64**	.02	–	.02	.60**
Self-reported health	.59**	.02	–	.02	.54**
T1 Relationship quality					
Relationship strain	.70**	.01	–	.01	.70**
Relationship troubles	.83**	.01	–	.01	.83**
Chance of separation	.69**	.01	–	.01	.69**
T2 Biobehavioral reactivity					
Anxiety	.43**	.05	–	.06	.41**
Depression	.53**	.06	–	.08	.56**
T3 Health					
Chronic illnesses	.78**	.02	–	.02	.76**
Prescription medication	.60**	.02	–	.02	.64**
Self-reported health	.54**	.02	–	.02	.58**
Correlations					
T1 Health					
T1 Relationship quality	.16**	.02	–		
T2 Biobehavioral reactivity	.33**	.06	–		
T3 Health	.86**	.02	–		
T1 Relationship quality					
T2 Biobehavioral reactivity	.24**	.04	–		
T3 Health	.10**	.03	–		
T2 Biobehavioral reactivity					
T3 Health	.40**	.061	–		
Path Estimates					
T1 Health →					
T3 Health	–		.95	.05	.86**
T1 Relationship quality →					
T2 Biobehavioral reactivity	–		.53	.10	.25**
T3 Health	–		-.19	.07	-.09*
T2 Biobehavioral reactivity →					
T3 Health	–		.23	.09	.22*
T1 Health corr. T1 Relationship quality	–		.06	.01	.16**

3.2. BBFM with T2 smoking

To test how T2 smoking, as an indicator of the behavioral component of biobehavioral reactivity (BBR), mediated the link between

Table 3
Standardized factor loadings, Unstandardized path estimates, Standardized path estimates for all health behavior mediating models (N = 5032).

	Smoking		Alcohol		Sleep		Food Cope		Physical Activity	
	B (*SE*)	β	*B* (*SE*)	β	*B* (*SE*)	β	*B* (*SE*)	β	*B* (*SE*)	β
Factor Loadings										
T1 Physical Health										
Chronic Illnesses	–	.78	–	.78	–	.78	–	.78	–	.78
Prescription Medication	–	.60	–	.60	–	.63	–	.63	–	.60
Self-reported Health	–	.53	–	.54	–	.58	–	.58	–	.53
T1 Relationship Quality										
Relationship Strain	–	.70	–	.70	–	.71	–	.71	–	.70
Relationship Troubles	–	.83	–	.83	–	.83	–	.83	–	.83
Chance of Separation	–	.69	–	.69	–	.69	–	.69	–	.69
T2 Dep/Anx										
Anxiety	–	.40	–	.41	–	.41	–	.41	–	.56
Depression	–	.56	–	.56	–	.56	–	.55	–	.41
T3 Physical Health										
Chronic Illnesses	–	.78	–	.76	–	.75	–	.75	–	.76
Prescription Medication	–	.60	–	.64	–	.63	–	.60	–	.64
Self-reported Health	–	.53	–	.54	–	.58	–	.53	–	.58
Path Estimates										
T1 Physical Health →										
T1 Relationship Quality (Corr)	.06 (.01)**	.16	.06 (.01)**	.16	.06 (.01)**	.16	.06 (.01)**	.16	.06 (.01)**	.16
T3 Physical Health	.96 (.05)**	.86	.95 (.06)**	.86	.93 (.05)**	.84	.94 (.05)**	.85	.95 (.05)**	.85
T1 Relationship Quality →										
T2 Dep/Anx	.52 (.09)**	.25	.53 (.10)**	.25	.52 (.09)**	.25	.52 (.09)**	.26	.53 (.09)**	.25
T2 Health Behaviors	1.41 (.40)**	.07	.08 (.08)	-.02	.49 (.06)	.19	.65 (.10)**	.15	-.25 (.07)**	-.08
T3 Physical Health	-.20 (.07)**	-.09	-.18 (.07)*	-.09	-.19 (.07)*	-.09	-.19 (.07)*	-.09	-.17 (.07)*	-.08
T2 Dep/Anx →										
T3 Physical Health	.22 (.08)*	.21	.23 (.09)*	.22	.22 (.08)**	.21	.22 (.09)*	.21	.23 (.09)**	.22
T2 Health Behavior (Corr)	1.52 (.30)**	.20	.005 (.05)	.002	.34 (.04)**	.36	.32 (.06)**	.21	-.05 (.04)	-.04
T2 Health Behaviors→										
T3 Physical Health	.005 (.004)	.05	-.009 (.01)	-.02	.04 (.03)	.06	.04 (.01)*	.07	.04 (.02)*	.07

marital dysfunction and physical health we included participants' reports of smoking at T2 as a mediation variable (Table 3). The model fit the data: χ^2 (47) = 499.49, $p < .001$, RMSEA = .044 (90% *CI* = .040, .047), CFI = .93, TLI = .90. Results indicated that T2 smoking was not a mediator between T1 marital dysfunction and T3 physical health (Table 2). The test of the indirect path indicated confirmed this (T1 marital dysfunction → T2 smoking → T3 physical health: $\beta = .003$, $SE = .002$, $p = .19$). However, emotional biobehavioral reactivity is a mediator according to the indirect path (T1 marital dysfunction → T2 anxiety/depression → T3 physical health: $\beta = .052$, $SE = .018$, $p \leq .05$).

3.3. BBFM with T2 alcohol

Next, we examined how T2 alcohol consumption, as a behavioral indicator of BBR, mediated the influence marital dysfunction on physical health (Table 3). This model fit the data: χ^2 (47) = 629.42, $p < .001$, RMSEA = .044 (90% *CI* = .041, .048), CFI = .93, TLI = .90. Alcohol use did not mediate the link between T1 marital dysfunction and T3 physical health and was confirmed in the test of the indirect path (T1 marital dysfunction → T2 alcohol → T3 physical health: $\beta = .000$, SE = .000, $p = .46$). Emotional BBR was a mediator (T1 marital dysfunction → T2 anxiety/depression → T3 physical health: $\beta = .056$, $SE = .020$, $p \leq .05$).

3.4. BBFM with T2 sleep

The model testing the mediation of average sleep as a behavioral indicator of biobehavioral reactivity fit the data: χ^2 (47) = 643.27, $p < .001$, RMSEA = .050 (90% *CI* = .047, .054), CFI = .91, TLI = .88 (Table 3). Feeling unrested at T2 appeared to partially mediate the link between marital dysfunction and subsequent physical health. However, this mediation was not confirmed in the test of the indirect test and only trending toward statistical significance (T1 marital dysfunction → T2 sleep → T3 physical health: $\beta = .010$, SE = .006, $p = .12$). Emotional BBR was a mediator (T1 marital dysfunction → T2 anxiety/depression → T3 physical health: $\beta = .053$, $SE = .019$, $p \leq .05$).

3.5. BBFM with T2 food cope

The next model tested using the behavioral BBR indicator of food as a coping mechanism fit the data: χ^2 (47) = 540.90, $p < .001$, RMSEA = .046 (90% *CI* = .042, .049), CFI = .92, TLI = .89 (Table 3). T2 food coping appeared to be a mechanism by which T1 marital dysfunction is linked to T3 physical health. Specifically, higher T1 marital dysfunction is linked to T2 using food to cope to poorer T3 health outcomes. The indirect path command confirmed the mediating path for T2 food coping (T1 marital dysfunction → T2 food cope → T3 physical health: $\beta = .011$, SE = .004, $p \leq .05$) and replicated the mediating path for emotional BBR (T1 marital dysfunction → T2 anxiety/depression → T3 physical health: $\beta = .055$, $SE = .019$, $p \leq .001$).

3.6. BBFM with T2 physical activity

The model estimating the mediation of average physical activity as an indicator of behavioral BBR fit the data: χ^2 (47) = 540.64, $p < .001$, RMSEA = .046 (90% *CI* = .042, .049), CFI = .92, TLI = .89 (Table 3). The model indicates that T2 physical activity mediates the association between T1 marital dysfunction and T3 physical health. Specifically, more T1 marital dysfunction is linked to less T2 physical activity and then poorer T3 physical health. The indirect path test confirms this mediation (T1 marital dysfunction → T2 physical activity → T3 physical health: $\beta = -.005$, $SE = .002$, $p \leq .05$). Emotional BBR reactivity was a mediator (T1 marital dysfunction → T2 anxiety/depression → T3 physical health: $\beta = .057$, $SE = .020$, $p \leq .001$).

4. Discussion

Marital functioning has been linked to health outcomes, with positive and supportive marriages often fostering better health outcomes as compared to negative and unsupportive marriages (Kiecolt-Glaser and Newton, 2001; Umberson et al., 2010). However, less is known regarding the mechanisms that link marital functioning to health outcomes among older adults across time. Identifying and interpreting mechanisms is best done through the lens of a biopsychosocial model, such as the Biobehavioral Family Model (BBFM; Wood, 1993). This model proposes that biobehavioral reactivity (BBR), or the ability to regulate stress reactivity, links marital quality to physical health; particularly dysregulated BBR. In the present study, we expanded previous tests of the BBFM by incorporating health behaviors as a behavioral indicator of dysregulated BBR using the three time points of MIDUS data. Specifically, smoking, alcohol use, sleep quality, coping with food, and physical activity at T2 were examined as potential mechanisms between T1 marital dysfunction and T3 physical health. Of the five health behaviors tested, only coping with food and physical activity were mechanisms that linked T1 marital dysfunction to T3 physical health while accounting for T2 anxiety and depression; smoking, binge drinking, and sleep quality did not act as mechanisms across 20 years.

Using food to cope and physical activity are the only two health behaviors linking marital dysfunction and a change in health across this 20-year study. Through the BBFM framework, we could extrapolate that these two health behaviors are indicators of dysregulated BBR (Wood, 1993). Dysregulated BBR occurs when an individual's stress response becomes chronically activated over time; meaning that the measured relationship dysfunction at Time 1 is an indicator of a chronically poor family emotional climate impacting the individual's ability to regulate stress response which manifest as using food to cope and/or frequency of physical activity. Further, research denotes two types of influences marital quality can have on health behaviors: emotional and functional. Emotionally influenced health behaviors are ones that are linked to marital stress and necessitate a coping mechanism. Therefore, in addition to depression and anxiety linking marital dysfunction to health, individuals with poorer marriages may also employ behavioral coping mechanisms such as problematic eating and physical activity.

While T2 physical activity and problematic eating (using food to cope) are both mechanisms linking T1 marital dysfunction and T3 health outcomes, they do so in opposite directions. For example, when individuals employ more physical activity as a coping mechanism, problematic health *decreases*. However, when individuals employ problematic eating as a coping mechanism, problematic health *increases*. Therefore, while both health behaviors are utilized and associated with marital dysfunction and subsequent health, it appears that one has an adverse effect while one has a protective effect. This could indicate that while marital dysfunction has repeatedly been shown to have a deleterious effect on physical health (Robles et al., 2014), this association may not hold for everyone. Depending on the types of coping health behavior employed, individuals may be able to circumvent the negative health impact of stress linked to marital dysfunction.

There is some indication in the literature that health behaviors cluster and co-occur, and our findings are consistent with this literature as well. Some have proposed the separation of health behaviors into two classes: health-promoting behaviors (physical activity and diet) and addictive behaviors (smoking and alcohol use), based upon clustering patterns, similarities, and interactive effects (de Vries et al., 2008). The idea is that holistic or integrative interventions may benefit from targeting multiple health behaviors for preventive purposes, particularly if these health behaviors co-occur and are interactive. Within the BBFM framework, physical activity and diet behaved similarly, as indicators of a dysregulated BBR, whereas sleep, alcohol usage, and smoking did not fully mediate the influence of marital dysfunction on health outcomes. Therefore, interventions may consider targeting clusters of health behaviors, particularly diet/exercise interventions may benefit from including models which target the marital dyad and not just the individual.

Sleep quality, binge drinking, and smoking did not function as mechanisms between T1 marital dysfunction and T3 physical health, and they simply may not serve to regulate stress longitudinally. While there is evidence that marital quality and the marital context are linked to these health behaviors (e.g., Foulstone et al., 2017; Roberson et al., in press; Troxel, 2010), there are three possible explanations why they are not mechanisms between T1 marital dysfunction and T3 physical health in this study and should be further examined in future research. First, these health behaviors may not be indicators of a dysregulated BBR; meaning, these health behaviors may not evoke a stress response from marital dysfunction and influence subsequent health. The health behaviors literature suggests that there is another role of the marital context, other than emotional influence, in which behaviors are socially promoted, encouraged, or learned behaviors (Weihs et al., 2002), referred to as functional influence. Indicators of functional influence revolves around the couple being able to effectively communicate and negotiate strategies to change and maintain health behaviors; to support or encourage patterns to change or maintain health behaviors; and/or the capacity to listen to one's spouse and allow their spouse to effect change on their behavior. Therefore, the health behaviors of sleep quality, binge drinking, smoking may be better understood as an outcome of functional influences rather than emotional influences of marital quality.

Second, while there is extant literature linking marital quality to sleep quality (Troxel, 2010; Troxel et al., 2007), binge drinking (DePasquale et al., 2016; Roberson et al., in press), and smoking (Foulstone et al., 2017; Slopen et al., 2013), many of these studies are short-term prospective or intervention studies. As evidenced here, the impact of marital dysfunction may not have a long-term effect on some subsequent heath behaviors; rather, it may be isolated couple disagreements or situational relational tension that disrupt sleep and/or increase substance use in the short-term. Similarly, previous studies on the longitudinal effects of marital quality on alcohol consumption have found an absence of long-term effects (Kearns-Bodkin and Leonard, 2005) or suggest that alcohol consumption may vary in a dyad over time, with stronger influence occurring in the early stages of marriage and weakening over time (Homish and Leonard, 2008). Therefore, 10-year gaps between time points may not be able to capture how marital dysfunction is linked to these health behaviors and subsequent health outcomes, if at all.

Third, the direction of effect between relationship dysfunction and these three non-significant health behaviors may be reversed. There is indication in the literature that there is a bi-directional association between relationship functioning and sleeping (Lee et al., 2017; Troxel et al., 2007) and binge drinking (Roberson et al., in press). Overall, there is consensus that the relationship between health behaviors and marital quality is bound to be a reciprocal and dynamic process (Homish and Leonard, 2008; Krueger and Chang, 2008). In fact, the BBFM posits that the process of BBR and close relationship quality can interact with each other over time. It is not until one's BBR becomes dysregulated that a direct path forms between marital quality and physical health. Therefore, binge alcohol, sleep quality, and smoking may influence relationship dysfunction more than these health behaviors are influenced *by* marital dysfunction.

An additional consistent finding is that there is a direct link between marital dysfunction at T1 and physical health outcomes at T3. This suggests that there are still additional mechanisms that mediate this relationship that have not yet been measured in this model. Future research should aim to determine other potential mediators of the link between marital quality and health outcomes in order to glean other potential targets for intervention. Our findings offer preliminary support for addressing health behaviors, specifically physical activity and problematic eating, within couples-based preventive health

interventions.

Preventive interventions have been critiqued for their tendency to be individual-focused, as opposed to dyadic, as well as for their focus on individual health behaviors rather than on multiple health behavior change simultaneously. Our findings suggest that the inclusion of multiple health behaviors (physical activity and problematic eating) in integrative and preventive health programs that targets the marital dyad (not just the individual) may promote positive physical health outcomes. While further research is needed in this area, the BBFM model is consistent with the literature on social models of health promotion, as well as with other existing social and ecological theories of disease management (Bandura, 2004; Weihs et al., 2002), which emphasize the relational context and the importance of strong interpersonal connections and emotional bonds in managing health and disease (Weihs et al., 2002). Integrative and preventive health programs may benefit from combining dyadic interventions with individual-focused interventions to more comprehensively address social as well as intra-individual contributors to health behavior change, such as self-efficacy beliefs related to behavior change (Bandura, 2004).

4.1. Limitations

While the findings of this study are substantial, they should be interpreted within the context of a few limitations. The MIDUS sample is disproportionately upper income and white. Therefore, results may not be generalizable to lower income or racial/ethnic minority individuals. The sample was predominantly middle aged at Time 1 (46 years old on average) and average of 66 at time 2 (20 years later); therefore, these results may not be generalizable to a more elderly population or younger adults. Also, the measures were all self-reported, therefore social bias may cause over- or under-reporting of specific behaviors, attitudes, or feelings. It is important to note that our ability to detect effects for sleep might have been limited by measuring this health behavior in terms of duration alone, rather than capturing other important dimensions of sleep behavior, including sleep quality and maintenance (Troxel, 2010). Future research should explore this construct more thoroughly to determine if long-term effects occur within a familial or spousal context. Similarly, this study examined diet by looking at the self-reported tendency to use food to cope, but did not examine other important aspects of diet and meal-related influences on health, including intake of saturated and omega-3 fats (Kiecolt-Glaser et al., 2015). It is also important to note that there are alternate ways in which health behaviors may come to bear in close relationships, outside of the pathway explored in the BBFM model (i.e., relational stressors preceding health-risk behavior). The temporal relationship between marital/familial stressors and health behavior is often unclear, in that couples may engage in assortative mating (i.e., select one another based on similarities), or unhealthy behaviors may cause relational strain, in addition to being influenced by relational dysfunction (Kearns-Bodkin and Leonard, 2005). Nevertheless, a strong direct link exists between marital/familial stressors and physical health outcomes, with health behaviors and depression/anxiety (biobehavioral reactivity construct) mediating this relationship. As previously mentioned, further research is needed to examine other variables that may mediate the strong link between the family emotional climate and physical health outcomes, with our research indicating that other mechanisms or mediators may exist that currently remain untested.

5. Conclusion

The Biobehavioral Family Model provides a framework for understanding why marriages are linked to health outcomes - through dysregulated BBR. The present study found that problematic eating (using food to cope) and physical activity are potential indicators of dysregulated BBR linking marital dysfunction to subsequent physical health. Notably, physical activity and problematic eating had reverse effects on health outcomes. Therefore, despite the consistent findings that poor marital quality can impact subsequent health, there appears to be differences in the effect depending on the coping mechanism used. There are also several health behaviors that might not be indicative of dysregulated BBR; Smoking, binge drinking and sleep do not appear to link marital dysfunction and health across a long period of time among middle and older adulthood. These findings point to a potential difference in terms of *how* and *why* marital relationships impact health: emotional vs. functional influence. The present study focused specifically on emotional influence; however, future research should examine how both emotional and functional influence (e.g., reminding partners to be healthy) directly or in combination influence health. Health prevention and intervention programs should include dyadic interventions focused on improving marital quality and increasing effective health behavior coping.

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