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The physiology of marriage: pathways to health

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Abstract

Marriage is the central relationship for most adults and has beneficial effects for health. At the same time, troubled marriages have negative health consequences. This review outlines the physiological pathways through which marital relationships influence health based on a stress/social support model. In addition, we review recent findings suggesting that unhappy marriages are associated with morbidity and mortality. We then turn to studies of marital interaction that include assessment of physiological pathways through which marital functioning influences health: the cardiovascular, endocrine, and immune systems. Across these studies, negative and hostile behaviors during marital conflict discussions are related to elevations in cardiovascular activity, alterations in hormones related to stress, and dysregulation of immune function. Using recent conceptualizations of the physiological impact of chronic stress, we illustrate how physiological changes associated with marital functioning in these studies have long-term implications for health outcomes. Finally, we discuss future implications of current research for understanding the relationships among marital functioning, physiology, and health.

Keywords: Marriage; Interpersonal behavior; Health; Cardiovascular system; Endocrine system; Immune system; Stress

1. Introduction

For humans and a wide variety of animal species, social relationships have important physiological consequences, often with implications for health [1,2]. Social relationships are also important contributors to health and well-being. Epidemiological studies suggest that social isolation is a major risk factor for morbidity and mortality, comparable to well-established health risk factors such as cigarette smoking, blood pressure, blood lipids, obesity, and physical activity [3]. Although both the quality and quantity of social ties have been related to morbidity and mortality, the support provided by certain relationships may be more important than others. The central relationship for most adults is marriage; 56% of adults in the United States are married and living with their spouse [4].

Across a number of surveys, married individuals report greater happiness and life satisfaction [5] and have a lower risk of depression [6] than their unmarried counterparts. Moreover, findings from the National Longitudinal Mortality Study illustrate the scope of impact that marital status has on mortality [7]. Across all causes of mortality and across different nonmarried populations (never married, divorced/separated, and widowed), nonmarried individuals had elevated rates of mortality compared to married individuals. Although elevated risk was observed for cardiovascular disease and cancer, significant risk was also observed for other causes, notably pneumonia and influenza, chronic obstructive pulmonary disease, and liver disease and cirrhosis. The relationship between marital status and mortality exhibits a generally consistent pattern in longitudinal studies, with marital status affording greater protection from mortality for men compared to women (50% higher among women, 250% higher among men [8–10]).

What are the processes by which marriage promotes health and well-being? Several explanations have been proposed, including cohabitation, economic well-being, and social support [10]. Research supports the two latter explanations, as cohabiting adults are more likely to report poorer health than married adults [11], and are as likely to report distress as adults living alone [12]. In terms of economic well-being, married persons have higher median household incomes than the nonmarried (US$54,300 vs.

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US$23,400 [13]), but after controlling for income, married persons still have lower rates of mortality than nonmarried persons [7].

The prevailing explanatory framework proposed to account for the protective benefits of marriage is the *stress/social support hypothesis*, which accounts for both protective and deleterious health correlates of marriage [14]. Stress and support in the marital relationship influence health status through a number of pathways. These include influences on the marital relationship itself, on the individual's cognitions, emotions or affect, health-related behaviors, coping behaviors, and physiology [14,15].

This paper focuses on physiological pathways through which marital relationships influence health. In addition to informing marriage and health research, studies of marriage and physiology offer important insights into biobehavioral aspects of human social relationships. We briefly review recent evidence of the health consequences of marital relationships, with a focus on consequences of distressed and unhappy marriages, as negative aspects of marital functioning have traditionally received greater emphasis compared to positive aspects. We then turn to physiological pathways through which marital functioning influences health: the cardiovascular, endocrine, and immune systems [2]. Evidence for the influence of marital functioning on physiological pathways is primarily derived from paradigms used by marital interaction researchers. Finally, we discuss future implications of current research for understanding the relationships among marital functioning, physiology, and health.

2. Marital strain and health outcomes

Burman and Margolin [14] termed their explanatory framework as the stress/social support hypothesis, noting that marital factors may be a source of stress. Distressed marriages are a major source of stress, and in general, unhappily married persons are worse off in well-being than unmarried persons [16]. Given the centrality of the marital relationship for most adults, it is likely that marital stress would have consequences for physical health as well.

Several prospective longitudinal studies strongly suggest that marital strain is related to self-reported and objective health outcomes. One of the most intensive assessments involved 364 wives and husbands who provided data on marital quality and illness symptoms annually for 4 years [17]. Participants with higher initial levels of marital quality reported fewer physical illness symptoms at study entry. Moreover, improvements in marital quality over the 4-year period were accompanied by decreases in self-reports of physical illness symptoms. Among 174 patients with end-stage renal disease treated with hemodialysis, greater dyadic satisfaction was associated with a 29% decrease in risk for mortality, and an increase in relationship negativity was associated with a 46% increase in risk for mortality at a 3-year follow-up [18]. The relationship between marital strain and mortality was significant even after controlling for demographics and disease-related variables (e.g. severity, treatment).

Several recent studies have provided compelling evidence for a relationship between marital strain and morbidity and mortality from cardiovascular disease. At a 5-year follow-up of 292 female patients admitted for an acute coronary event from 1991 to 1994, marital status was not associated with increased risk of recurrent coronary events (including cardiac death, acute myocardial infarction, and revascularization procedures [19]). However, women who reported moderate to severe marital strain at baseline were almost three times more likely to experience a recurrent coronary event, even after controlling for demographic, health behavior, and disease status variables. The risk of recurrent events was twice as high for marital stress compared to work stress. In terms of mortality, marital quality in 189 congestive heart failure patients predicted 4-year survival rates [20]. Moreover, the effect size for marital quality predicting mortality was similar to the effect size for disease severity, and controlling for disease severity did not attenuate the effect of marital quality. Patients with the highest disease severity and poorer marriages had the highest risk for mortality, with a 4-year survival rate of 42%, compared to 78% among patients with mild severity and good marriages.

These studies provide strong and compelling evidence of a relationship between marital strain and health outcomes. A broad range of outcomes was encompassed in these studies, including self-reported symptoms, verified coronary events, and actual mortality. Indeed, across a number of health domains, marital strain is related to health [15]. Importantly, several studies found that marital strain afforded risk for negative outcomes equivalent to health-related variables such as disease severity. As such, marital strain joins social isolation as a psychosocial risk factor for negative health outcomes that is similar in magnitude to more "traditional" risk factors, such as physical activity and smoking [21].

3. Physiological pathways

In their stress/social support framework, Burman and Margolin [14] proposed several interrelated pathways from marital status to health, including interpersonal mediators, intraindividual variables, psychological processes, coping strategies, and physiological consequences. In their review of more recent research on marriage and health, Kiecolt-Glaser and Newton [15] refined this model, focusing on affective, behavioral, and physiological pathways from marital factors to health outcomes. There is ample evidence that intimate relationships can impact illness processes or outcomes indirectly through alterations in mood and through their influence on health habits. Our focus is on the three primary physiological pathways that mediate the

relationship between stress, social relationships, and health: cardiovascular function, neuroendocrine function, and immune function [2]. In particular, evidence for the role of these pathways comes from marital interaction studies that include physiological assessments.

Marital interaction studies describe the relationships between behavior during spouse or partner interactions and marriage-related outcomes, including satisfaction and distress [22]. Interactions are typically 10–15 min discussions of areas of conflict within the relationship. Such discussions occur with regular frequency among married couples, with community samples reporting an average of one to two conflict discussions per month [23]. Although the majority of studies observes interaction in a clinic or research setting, the external validity of this paradigm has been well established [22], and if anything, such interactions underestimate negativity during problem-solving/conflict interactions in natural settings, such as the home [24]. In these studies, behavior is recorded through systematic observation using behavioral coding systems [22].

Of primary interest in these studies are the physiological concomitants and consequences of marital conflict interactions. Marital conflict is a primary source of marital distress [25] and is linked with increased psychological distress and depressive symptoms [26]. In addition, marital conflict is associated with poorer health, including objective indicators of health, such as symptomatology or degree of recovery, self-reported health, and pain [15]. Specifically, negative behaviors (e.g. hostility and criticism) during marital conflict have been linked to underlying physiological mechanisms related to health. The next sections consider evidence for the influence of marital interaction on the three physiological pathways.

3.1. Cardiovascular function

Marital quality has consequences for cardiovascular disease outcomes, with poorer marital quality associated with increased morbidity and mortality. Psychosocial research on cardiovascular disease has been guided by the "reactivity hypothesis," the premise that excessive cardiovascular reactivity to stress is a risk factor for the development of hypertension and cardiovascular disease, particularly if responses occur more frequently and at high intensity [21]. Marital conflict is reliably associated with heightened blood pressure and heart rates [27–34]. For instance, in 43 hypertensive patients, a marital problem-solving task produced clinically significant increases in blood pressure that were specifically associated with hostile marital interactions; neither supportive nor neutral behaviors were significantly associated with change [35]. Indeed, the effects were sizable; hostile interactions and marital dissatisfaction accounted for 50% of the variance in women's systolic blood pressure. Similarly, behaviorally coded negative affect accounted for 20% of the variance in women's systolic blood pressure during a 10-min marital conflict discussion and 53% of the variance in self-reported marital distress [27]. Differences in cardiovascular arousal during conflict discriminated wives (but not husbands) in physically violent marriages from those in distressed but nonviolent marriages [36].

Other studies involving married couples and cardiovascular physiology have involved impersonal topics, not relationship issues [37–39]. In these studies, parameters of the marital discussions are manipulated, such as inducement to influence the other spouse [37,38], agreement versus disagreement [39], and evaluative threat [39]. In general, interpersonal demands, such as discussions where couples are asked to disagree, elicited heightened heart rates and blood pressure among wives, but not husbands [39]. In contrast, evaluative threat and incentive to influence the spouse had no effects on women's cardiovascular responses, while men under the same conditions displayed larger heart rate and blood pressure compared to low-threat or no incentive conditions [38,39]. Moreover, when there was an inducement to influence the spouse, husbands' elevations in systolic blood pressure were correlated with husbands' hostile and controlling behavior [38]. Importantly, these differences were also observed while couples were preparing for the discussion, not just during the time when they were actually talking.

In addition to parameters of the discussion, individual differences play an important role in moderating cardiovascular responses. Higher cynical hostility in husbands was associated with greater blood pressure reactivity in their wives, while wives' hostility was not related to either their own or their husbands' reactivity [37]. Among husbands, only their own hostility predicted their blood pressure changes. Under conditions of evaluative threat, high levels of hostility were associated with greater systolic blood pressure reactivity in husbands [40]. Moreover, although hostility was not associated with wives' cardiovascular reactivity, wives disagreeing with high hostile husbands exhibited greater cardiovascular reactivity.

These data suggest that qualitatively different interpersonal demands may differentially activate husbands' and wives' cardiovascular responses. Studies in which spouses discuss areas of marital disagreement showed that negative or hostile behavior during conflict was clearly associated with physiological alterations, with larger differences among women than men. The fact that wives respond to spousal disagreements, even on impersonal topics, with larger cardiovascular responses than husbands [39] is consistent with those studies.

3.2. Endocrine function

Catecholamines and glucocorticoids have a wide range of effects on homeostatic processes, including metabolic regulation and stress responses. These hormones are also important in regulating cardiovascular, metabolic, and immune functions [41,42]. Moreover, these hormones are

influenced by the presence and quality of social relationships [2,43].

Studies from our laboratory have shown consistent relationships between marital conflict and endocrine function. We assessed autonomic, endocrine, and immune functions over a 24-h period in 90 newlywed couples who met stringent mental and physical health criteria [30]. Couples also engaged in a 30-min conflict resolution task in which they discussed current marital problems. Newlywed couples exhibiting higher levels of hostile and negative behavior during conflict showed elevated levels of epinephrine, norepinephrine, adenocorticotropin hormone (ACTH) and growth hormone, and lower levels of prolactin [44]. More negative and hostile couples showed elevations in epinephrine, norepinephrine, ACTH, and growth hormone during the conflict discussion, which persisted for 15 min after the discussion had ended. In addition, these elevations were more pronounced in women compared to men.

Behavior during marital conflict also accounted for a significant proportion of variance in endocrine measures pooled over 24 h, accounting for 24% of the variance in changes in epinephrine and cortisol, 29% of the variance in norepinephrine, and 37% of the variance in prolactin [45]. For wives, higher probabilities of husbands' withdrawal in response to wives' negative behavior were associated with higher norepinephrine and cortisol levels over 24 h. The "wife demand/husband withdraw" sequence has been associated with greater marital distress in a number of marital studies [46,47]. In addition, wives who showed higher frequencies of positive behaviors during conflict had lower epinephrine levels.

Older couples display less negative behavior and more affectionate behavior than younger couples during conflict [48], and might therefore be expected to display a different pattern of endocrine changes. However, effects similar to those observed in newlywed couples were found in older couples between the ages of 55 and 75, with negative behaviors and negative escalation accounting for 16–21% of the variance in rate of change in cortisol, ACTH, and epinephrine during marital conflict, in addition to the linear effects of time [49].

3.3. Immune function

In addition to cardiovascular and endocrine changes, marital conflict is linked to immune dysregulation. Similar to the cardiovascular data, immune data from our newlywed couples suggested that physiological changes were significantly related to hostile behavior, and not to avoidant, positive, or problem-solving behaviors [30]. In particular, hostile and negative behavior was associated with declines in natural killer (NK) cell lysis and blastogenic responses to two mitogens (concanavalin A and phytohemagglutinin [PHA]), and increased antibody titers to latent Epstein–Barr virus (EBV). The latter result suggested that individuals experiencing greater negative behaviors exhibited poorer control of a latent herpesvirus by the adaptive immune system. Similar to the cardiovascular and endocrine results discussed above, the magnitude of immunological change was greater for women compared to men.

In our older adult sample, individuals who demonstrated a pattern of relatively poorer immunological responses (NK cell lysis, blastogenic responses to mitogen, EBV antibody titers) displayed more negative behavior during conflict. In addition, couples with poorer immunological responses characterized their usual marital disagreements as more negative than individuals who showed better immune responses across assays [49]. In work from another lab, wives responded to marital conflict with greater increases in depression, hostility, and systolic blood pressure than husbands; in addition, women's lymphocyte proliferative responses to PHA decreased following conflict, while those of the men increased [31]. Following conflict, decreases in proliferative responses to PHA were significantly correlated with increases in self-reported hostility.

A central question throughout much literature on physiological change and health has been the extent to which stress-induced immune changes have consequences for morbidity and mortality [50]. Stress-induced immune changes have consequences for a number of health outcomes, particularly responses to infectious disease and wound healing [51]. As shown by studies in the last decade, marital conflict, which could also be classified as a social stressor, results in immune changes. Importantly, the effects of marital conflict on immune function may actually be underestimated, as studies of marriage and health typically include couples who have relatively satisfied marriages [15].

4. Behavior and physiology in marriage: longitudinal implications

4.1. Physiological responses and health

The past decade of research has yielded important evidence for the influence of behaviors during marital interaction on physiological functioning, providing solid, mechanistic evidence of how marital functioning can have direct physiological consequences. Cardiovascular, endocrine, and immune pathways are critically important for the organism's adaptation to changing environmental demands. Thus, they play a central role in the ability of the organism to maintain physiological stability through change [52]. McEwen [42] extended this conceptualization to broader health outcomes, describing the cumulative long-term effects of physiological responses to stress. In this conceptualization, these pathways play central roles in a variety of adaptive processes and deleterious physiological outcomes.

McEwen [42] described four plausible processes through which psychosocial influences on physiology can lead to detrimental health consequences. They are listed below

along with their relevance to marital functioning, and each of these processes is of interest in the context of marriage and health.

4.1.1. Repeated "hits" by novel stressors

Marital conflict is a common occurrence, with an average frequency of one to two times per month [23]. The topic of conflict discussions can vary widely (e.g. in-laws, sex, parenting, finances, etc.) over time, akin to repeated hits.

4.1.2. Lack of adaptation to the same stressor

Spouses may not readily adapt physiologically to the same conflict discussion or topic over time. That is, rather than a gradual decline in physiological activation with each conflict discussion, certain marriages could be characterized as chronic social stressors composed of repeated hits and a lack of physiological adaptation.

4.1.3. Failure to shut off physiological responses following exposure to a stressor

The ability to shut off physiological responses after exposure to a stressor is also described as "recovery." Marital interaction studies in the past decade indicate that hostile and negative conflict behaviors are related to longer recovery following exposure to the conflict stressor. Shorter recovery periods allow the organism to "demobilize" physiological resources more quickly, diminishing physiological strain that persists beyond the transient stressor [42,53].

4.1.4. Inadequate responses to stressors

Chronic and repeated physiological activation as the result of marital stress may impair important physiological processes. For instance, chronic stress is associated with impaired responses to biological "stressors" in the form of infectious disease [50].

The studies reviewed in this paper suggest that the degree of negativity during marital conflict may be related to the persistence of physiological changes. The key implication of this conceptualization is that physiological responses to stress have cumulative, long-term effects on health, including effects on tissue and organ systems, and progression and development of disease. If abrasive interactions and relationships provoke larger and more frequent immunological, endocrinological, and cardiovascular changes in relatively healthy couples, then individuals in troubled relationships could be at greater risk for a variety of health problems over time. Distressed families experience roughly twice as many tensions per day as nondistressed families [54,55]. Moreover, distressed couples are more likely to experience continuance of tensions, particularly those that repeat in ritualized patterns at the same time on subsequent days [55].

In contrast to stressors without an interpersonal component, those that involve conflict have an increasing emotional impact as stressors occur over days, and they account for a large portion of the variance in daily mood [56]. This failure to emotionally recover following the termination of a stressor could plausibly correspond to a failure to physiologically recover. Elevated cortisol among wives throughout the course of the day following a 30-min conflict was associated with increased likelihood of husbands withdrawing from conflict [45]. This may reflect the enduring physiological and emotional impact of husbands' withdrawal during the conflict discussion on wives. Indeed, as MacLean [57] noted in his classic *The Triune Brain in Evolution*, "it deserves emphasis that, short of induced physical activity, emotional mentation represents the only psychological process that may lead to profound, and often prolonged, autonomic activity" (p. 30).

4.2. Longitudinal effects of marital functioning: preliminary evidence

Preliminary evidence for an association between marital distress and a cumulative, long-term impact on health comes from a prospective study of patients with mild essential hypertension [58]. Marital quality, ambulatory blood pressure, and left ventricular mass index (LVMI; increased LVMI reflects left ventricle hypertrophy, which is associated with poorer cardiovascular health) were assessed in 103 subjects, and cardiovascular measures were measured again at 3-year follow-up. After controlling for health variables including baseline LVMI, decreased marital quality, as measured by the Dyadic Adjustment Scale (DAS) [59], predicted increased LVMI, with a one-point decrease in the DAS total score associated with 0.3 g/m^2 increase in LVMI. Moreover, subjects who reported poor marital quality had an elevated 24-h diastolic and systolic ambulatory blood pressure at follow-up. Marital quality also moderated the relationship between spousal contact and ambulatory blood pressure, such that increased daily spousal contact was associated with lower diastolic blood pressure (DBP) in satisfied couples and elevated DBP in dissatisfied couples at follow-up.

Although the studies reviewed above suggest that marital functioning has long-term consequences for physiological function, does physiological function indicate anything about long-term outcomes for the marriage? Data from a 10-year follow-up study of our newlywed sample suggest this may be the case. We assessed marital status and satisfaction at follow-up in every couple that participated in our initial newlywed study (Time 1) and examined the extent to which marital dissolution and dissatisfaction at follow-up was associated with neuroendocrine function during the first year of marriage [60]. Levels of epinephrine were elevated during the Time 1 conflict discussion and throughout the entire day among couples who eventually divorced compared to those who remained married. Moreover, levels of epinephrine and norepinephrine were elevated among divorced couples compared to married couples. Among the couples who were still married, levels of ACTH during Time 1 conflict were twice as high among wives who reported dissatisfaction with their marriages at 10-year

follow-up, and levels of norepinephrine during Time 1 conflict were elevated in dissatisfied couples compared to satisfied couples at follow-up. In contrast to findings for endocrine function, individual difference variables such as negative affect did not distinguish between divorced and intact couples, although they were related to marital satisfaction at follow-up.

Marital interaction research incorporating cardiovascular, endocrine, and immune measures has yielded important insights into the proximal physiological consequences of marital strain. A chronic stress perspective on physiological processes points to mechanisms through which chronic marital strain can contribute to negative long-term health consequences [42]. Preliminary evidence for a long-term effect of marital strain on physiology and health was demonstrated by the relationship between baseline marital quality and LVMI at 3-year follow-up. More provocatively, physiological changes may be a harbinger of things to come, as evidenced by marital outcomes at 10-year follow-up of our newlywed sample. Overall, there is clear evidence for the importance of incorporating physiological measures in marital interaction research, and further application of this approach will be a key empirical component in understanding biobehavioral aspects of marriage and social relationships, and relationships between marital functioning and health.

5. Conclusion

This review described relationships between marital functioning and health outcomes, and the physiological pathways that may mediate these relationships. In particular, evidence from marital interaction studies suggests that marital strain has deleterious effects on cardiovascular, endocrine, and immune functions. Marital strain can be viewed as a repeated, perhaps even chronic, social stressor. As such, in spouses who fail to physiologically recover following a marital disagreement, or fail to adapt physiologically to repeated disagreements, chronic activation resulting from continual marital strain may have negative long-term consequences for health. Of the types of stressors studied in psychoneuroimmunology research, chronic social stressors show strong relationships with objective health outcomes, including responses to infectious disease and wound healing. Volunteers who reported chronic interpersonal stressors were more likely to develop a cold, following inoculation with a rhinovirus [61]. Data from several studies suggest that spousal dementia caregivers are less likely to show clinically significant responses to influenza virus vaccine [62,63], and diminished antibody titers in response to a pneumococcal vaccine compared to noncaregivers [64]. Spousal dementia caregivers also showed delayed wound healing compared to control subjects, taking 24% longer to completely heal a standardized wound [65]. At this point, assessing objective health outcomes has not been extended to marital interaction studies. As such, empirical studies have not yet directly linked cardiovascular, endocrine, and immune changes observed during marital interaction to health outcomes. This is one key challenge for future research in marriage, physiology, and health, and more broadly, future research on social relationships and health. In addition to including objective health outcome assessment, a number of important suggestions for such work can be gleaned from research to date.

Research to date considers cardiovascular, endocrine, and immune system pathways separately, without examining their influences on one another in the context of marital interaction. For example, stress-induced alterations of endocrine function are related to heightened cardiovascular reactivity and immune dysregulation [66,67]. Recent empirical work suggests that physiological responses in one pathway have important implications for other pathways (e.g. cortisol and heart rate reactivity [68], and cortisol and lymphocyte proliferation [69]). Future work should consider the effects of marital factors on interactions among different physiological pathways.

Studies of marital interaction and physiological pathways are typically conducted with relatively healthy couples. Although this limits the generalizability of research findings in this domain, it is likely that such findings underestimate the impact of marital functioning on physiology and health. However, unhappy couples are less likely to volunteer for marital research projects than those who are more satisfied with their spouse [70]. In addition, poor marital functioning may be related to poorer health habits [15], such as excessive alcohol use and smoking, which may confound physiological measurements [71]. As such, future work must strike a balance between considerations of ecological validity (including distressed couples) and internal validity (reducing potential confounds for physiological measures).

Marital interaction research clearly suggests that behavioral data enhance prediction of physiological measures [30,35,45,49]. However, a dearth of data exists on the relationship between marital support processes, physiology, and health outcomes. Recent behavioral data emphasize the importance of assessing both conflict and support behaviors in the marital relationship [72]. Incorporating positive and supportive aspects of the marital relationship into studies of marriage, physiology, and health is an important avenue for the next decade of relationship research [15,73]. Finally, studies of conflict interactions, in which real problems in the marriage are discussed, have considerably greater ecological validity compared to experimental or impersonal discussions, which have been used in studying the psychophysiology of marriage [40]. However, experimental approaches, despite decreased ecological validity, enable greater and more precise control over specific aspects of marital interaction (e.g. level of disagreement) that may be important to isolate.

Understanding the physiology of marriage and how it relates to health outcomes requires the convergence of

multiple methods at multiple levels of analysis. Describing relationships between interpersonal behavior and physiology requires sampling across the behavior spectrum, examining overt behaviors, including covert behaviors such as cognitions, evoking negative and positive behaviors, and using both systematic and ecologically valid discussions. In terms of physiology, future work requires identifying the important physiological mechanisms within the cardiovascular, endocrine, and immune systems that are relevant to health and responsive to marital functioning. Moreover, given the importance of physiological recovery, future studies must adequately and accurately delineate the parameters of physiological change affected by marital functioning and behavior. In concert with subjective and objective assessments of health outcomes, the next decade of research will provide important data on the specific physiological mechanisms through which marital functioning affects health.

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