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Marriage, gender and obesity in later life

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ABSTRACT

A large body of literature argues that marriage promotes health and increases longevity. But do these benefits extend to maintaining a healthy body weight, as the economic theory of health investment suggests they should? They do not. Using the Health and Retirement Study (HRS), I find that entry into marriage among both men and women aged 51–70 is associated with weight gain and exit from marriage with weight loss. I evaluate three additional theories with respect to the cross-sectional and longitudinal variation in the data. First, it may be that a broader set of shared risk factors (such as social obligations regarding meals) raises body mass for married couples. However, the shared risk factor model predicts that the intra-couple correlation should increase with respect to marital duration. Instead, it declines. Second, scholars have recently promoted a "crisis" model of marriage in which marital transitions, not marital status, determine differences in body mass. The crisis model is consistent with short-term effects seen for divorce, but not for the persistent weight gains associated with marriage or the persistent weight loss following widowhood. And transition models, in general, cannot explain significant cross-sectional differences across marital states in a population that is no longer experiencing many transitions, nor can it account for the prominent gender differences (in late middle-age, the heaviest group is unmarried women and the lightest are unmarried men). Third, I argue that pressures of the marriage market, in combination with gendered preferences regarding partner BMI, can account for all the longitudinal and cross-sectional patterns found in the data.

1. Introduction

When the scientific literature[1] on marriage and health took off in the 1960s and 1970s, obesity was not widely seen as an important public health issue. But the persistent increase in body mass index (BMI) over recent decades (Ogden et al., 2006) has forced obesity to the forefront of public health concerns in developed countries.[2] Given that survey respondents around the globe report family relationships and health as the most important things in life (Spogard and James, 1999), a continuing research focus on how personal relationships interact with body weight seems an obvious way to better understand the nature of the obesity epidemic and its associated health problems.

But connecting body weight to relationships is not a simple empirical task. Common experience and research

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[1] This literature is vast. See Wood et al. (2007) for a review of some of the more recent evidence. With respect to marriage and mortality, Rendell et al. (2011) find a consistent survival advantage for married over unmarried men and women, though the effect for women is smaller. A recent meta-analysis of published studies shows a relative risk of mortality of 0.88 (95% CI: [0.85–.91]) for the married compared to the unmarried (Manzoli et al., 2007).

[2] Not all scholars view obesity as a central public health problem. Campos et al. (2006), for instance, argue that the obesity epidemic is a "moral panic" more than a public health crisis and that high body mass is a very weak predictor of mortality.

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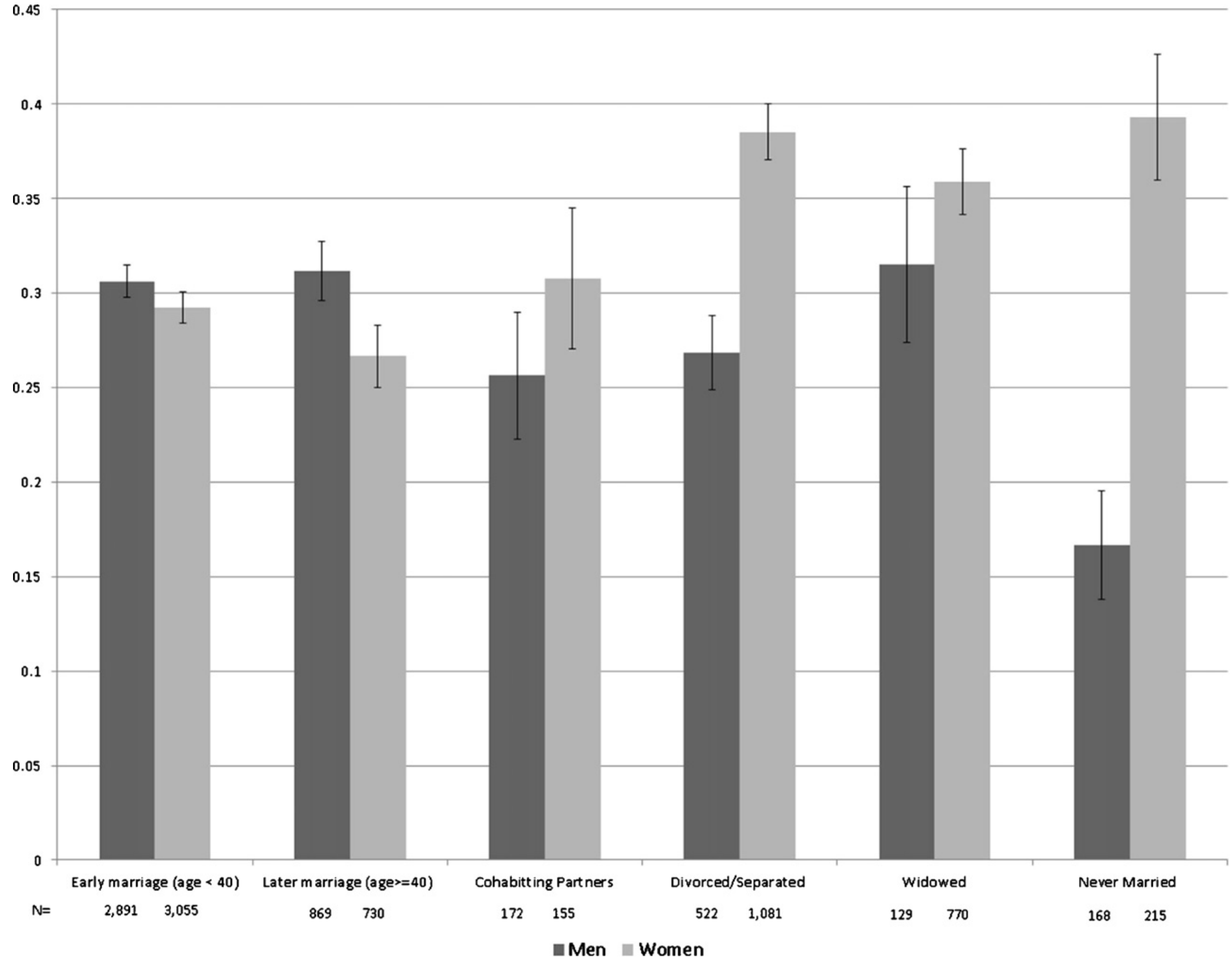

Fig. 1. Obesity prevalence and marital status, age 51–70, 2004.

dictate that body characteristics such as weight, shape, adiposity, and musculature are valuable in the marriage market (Buss et al., 2001), and prior research has shown that overweight and obese individuals are considered less attractive than those of normal weight, holding other factors constant (Maisey et al., 1999; Tovée et al., 1998). The consequences of obesity also include stigma and discrimination (Sobal, 2005), as well as lower earnings (Cawley, 2004; Finkelstein et al., 2005). These social consequences of obesity affect all the other numerous psychological, social and economic variables that influence health. In short, understanding how key features of intimate relationships—how and why they form, what makes them successful, rewarding, and enduring, and why they often fail—influence body weight is very challenging because each of those features is potentially affected, directly and indirectly, by people's body characteristics. In statistical terms, the identification problems are immense.

That body mass contributes not only to health but also attractiveness raises the prospect that gender is not an innocent bystander in the marriage–body mass nexus. To illustrate, Fig. 1 represents age-adjusted obesity rates from the 2004 wave of the HRS data for Americans aged 51–70 (see Section 3).[3] These estimates suggest that the cross-sectional patterns related to body mass are strongly gendered. Women in relationships are obese at a rate 7–12 percentage points lower than single women. But no such pattern exists for men. Indeed, married men (and widowed) are heavier than cohabiters, divorced/separated and, most notably, the never married. Most strikingly, the divorced/separated women have an obesity prevalence 1.4 times that of divorced/separated men (38.3% compared to 26.8%), and the never married women are obese at a rate 2.3 times the rate for similar men (49.0% compared to 16.7%), differences which are highly significant statistically (note the 95% confidence bands).

The empirical literature on marriage and body weight to date has used longitudinal studies of young adults, which is useful since that period is critical for marital formation as well as a period in which significant weight gain often occurs. But what is happening in later life? From

[3] Estimates are based on linear probability models and incorporate survey weights.

studying older adults, especially using data that covers a long time span, we can potentially learn more about the *cumulative* effects of living in different marital states and observe the consequences of transitions that are more common in mid to late life—namely divorce and, primarily, widowhood. In this age group, marriage formation is mostly about re-marriage rather than first marriage, and the empirical patterns observed among older adults may be fundamentally different from those in earlier life because of physiological, psychological, economic and social differences that occur over the life course. For instance, the influence of body weight on attractiveness discussed above may be quite different for older adults than for younger ones. This study is the first longitudinal analysis to look in detail at the marriage–body weight relationships for older adults.

The empirical analysis to follow will extract evidence related to four theoretical propositions that connect marriage to body mass. The first proposition argues that because marriage creates a better household production technology, married people will exploit these advantages to obtain a healthier body mass. Empirical work to date[4] does not support this health investment theory since prior research indicates that most marriages are associated with weight gain while marital dissolution is associated with weight loss. The second theoretical proposition broadens the first, which I call the shared risk factor model. Sharing a life means sharing a variety of risk factors for health conditions, including obesity. These risk factors not only include potential results of investment behavior, but also include culturally influenced behavioral patterns (particularly changes in eating habits) that do not promote a healthy body weight, as well as common risks not chosen (or even observed) by the couple. The third theoretical proposition is the crisis model (Williams, 2003; Williams and Umberson, 2004; Umberson et al., 2009), which argues against any long-term effects of marriage on health. This model assumes that transitions into and out of marriage produce stress which causes temporary changes in weight. The fourth proposition is that marriage–body mass correlations are driven by the forces of the marriage market—both selection into and out of marital states and assortative matching *within* the married group.

In short, this essay asks what are the effects of participating in marriage and the marriage market on body mass in later life? In looking at a large sample of Americans aged 51–70 from the Health and Retirement Study (HRS), we can see a picture of important life-course patterns related to that question. The analysis would be different if the sample contained younger couples. Because the sample contains data on older couples and does not contain data on BMI during the initial spousal search or for any age prior to the time of survey, I cannot address, for instance, the importance of BMI during one's reproductive years in the selection of a partner or how the importance of BMI in the marriage market changes over the life course. Despite these shortcomings, however, analyzing the HRS data can shed light on the relationship between BMI and marriage. First, cross-sectional patterns reveal the accumulated history of the marriage–body mass interaction, and, second, longitudinal patterns reveal the changes still occurring in later life. Both of these analytical windows will be used to evaluate the theoretical propositions outlined above.

2. Conceptual background

2.1. Theoretical models of marriage and body mass

2.1.1. The investment model

The first theoretical model regarding marriage and body mass involves bringing together two central theories in modern economic thought. The first theory is the health capital model, which goes back to the seminal work by Grossman (1972). That model views health as a stock of human capital that people augment by directing time, money and other resources towards health-promotion, including the purchase of medical care. At any point in time, a person's health capital is a function of an initial endowment, the investments the person has made over his/her life, and depreciation of the health capital stock. The second theory is the economic model of marriage in which goods purchased in the market and time inputs are used by the husband and wife to produce what Becker (1991) has called "household commodities"—love and companionship, meals, recreation, entertainment, housing, sex, children, leisure, housing, home décor—according to a household production function.[5] In producing commodities, two people can do better than one because a partnership allows for specialization and trade (both between the spouses and in the larger market) and economies of scale (such as lower per person housing, utility, and meal costs). Furthermore, many key aspects of a successful marriage, such as companionship, sex, and the care of children, are much more efficiently produced by couples who are in a committed partnership, rather than by disconnected singles. In other words, formation of a partnership represents an augmentation of the household production technology that is not available to single persons.[6] The natural connection point between these two economic theories—the production of health and the production of household commodities—come by treating

[4] Kahn and Williamson (1990), Umberson (1992), Sobal et al. (2003), Eng et al. (2005), Lee et al. (2005), The and Gordon-Larsen (2009), Shafer (2010), Klein (2011).

[5] The basic economics of marriage comes from the seminal work of Gary Becker. Much of his analysis on the family is pulled together in the volume *A Treatise on the Family* (Becker, 1991).

[6] Many of the benefits to marriage discussed here could be applied equally as well to committed relationships more generally. Musick and Bumpass (2012) argue that for most indicators of well-being, the benefits of marriage are not different from cohabiting unions, though they do find marriage is more beneficial than cohabitation with respect to physical health. To keep the argument parsimonious, however, I am not going to address here whether marriage produces more benefits than long-term cohabitation or differences between heterosexual and homosexual unions. These are, of course, important questions that deserve additional attention.

health as a capital stock invested in *by the household*.[7] Both partners contribute to health, and both draw upon their own health and the health of their spouses to generate utility.[8]

There are compelling theoretical reasons to think that the gains from marriage include better health. First, health is a highly desired commodity, and married people are able to purchase better medical care and, in other ways, invest more effectively in producing better health. Increased household efficiency gained through marriage works much like an increase in real income, and the couples, on average, will use that income to buy better health. Second, marriage raises expected utility far into the future, which gives individuals a greater incentive to invest more in health today so they can realize those future gains. Put another way, people in high quality marriage relationships have more to live for. Third, a spouse helps in this investment process by providing valuable *informal* health care, especially in later life. Parsons (1977) referred to the family as "an informal health service organization" (711). Indeed, this informal care may prove as important over the life-cycle as formal health care. A spouse may provide many hours of nursing care for those who need it, and a spouse also informs, educates, monitors, encourages, reminds, and, yes, nags (Waite and Gallagher, 2000) his/her partner in the pursuit of better health throughout married life.[9] A spouse might also encourage and facilitate maintaining a healthier diet[10] and provide companionship for physical exercise. Single people living alone usually lack ready access to this important informal health care. Fourth, a spouse provides social support, both in terms of providing emotional support directly but also in terms of expanding a partner's social network, thereby increasing the support available. Taken together, these hypothesized health-promoting aspects of marriage are often referred to in both economic and sociological studies as the "marriage protection hypothesis." [11]

The question of whether marital benefits accrue to both men and women has received much attention by scholars. Liu and Umberson (2008) observe that "A long-standing sociological tenet is that marriage enhances the health of men more than women... (242)." This idea goes back to the early work of Gove (1972, 1973). The most convincing evidence comes from studies on mortality.[12] An influential review by Ross et al. (1990) found lower mortality among married persons, but the gains to men were much higher than for women. Similar findings by Hu and Goldman (1990), Rogers (1995), Liu (2009), and Rendell et al. (2011) have reinforced this basic tenet. Yet this conventional wisdom has been challenged, at least for the elderly. A recent meta-analysis of studies on the elderly (Manzoli et al., 2007) shows the relative mortality risk for married women was only slightly higher than for married men (.90 compared to .88). Goldman et al. (1995) find that marriage effects are modest for both men and women, but statistically significant only for widowed males. And in their review, Kaplan and Kronick (2006) argue that the gain from marriage is higher for men under the age of 65 but higher for women aged 65 and older, suggesting that the gender-basis of marital gains may shift with age.[13]

Previous research has also investigated the many sources of gender differences in health outcomes related to marriage, such as mortality. According to Waite and Gallagher, the primary explanation is that single men "... often lead unhealthy and risk-filled lives, but single women rarely do" (2000, 62).[14] Umberson (1992) found that wives are much more likely to monitor the health of their spouses than husbands are, and that monitoring has significant effects on health behaviors. The oft-cited benefit of social support also seems stronger for men, since they receive less emotional support outside of marriage. Women, on the other hand, tend to gain health advantages not through behavior or social support, but through the financial resources attendant to marriage (Lillard and Waite, 1995).[15] The role of gender-based psychological difference is potentially important as well. Gove's (1972) sex-role theory that marriage is advantageous to men's mental health but disadvantageous to women's has had a significant impact on psychological studies of gender differences related to marriage and marital transitions. By the close of the 20th century, however, the theory was still problematic because of the mixed empirical evidence. Simon (2002) argues that the empirical evidence shows that the research has consistently demonstrated that marriage is beneficial to the mental health of both men *and* women, and his longitudinal analysis finds that the emotional benefits of

[7] A more extensive and formal treatment of this idea that includes the formation of households in the marriage market is found in Wilson (2002).

[8] Health is thus both a *final* good (producing utility directly) and an *intermediate* good (used in the production of other household commodities, such as recreation or sex).

[9] In an analysis of over 127,000 patients with colon cancer, for instance, Wang et al. (2011) find that the presence of a spouse leads to earlier diagnosis and to more aggressive treatment (which is also more effective on average, though riskier).

[10] Spouses also monitor diet and the level of monitoring increases with the level of body mass (Markey et al., 2008).

[11] Sociologists use the term "marital resource model" (Williams and Umberson, 2004; Umberson et al., 2009). The sociological approach emphasizes marital factors such as access to a confidant, which may reduce stress but also may lead to eating at more frequent intervals. The economic theory is more about *choosing* health-related behaviors, but the presence of a confidant can be thought of as part of the household technology associated with marriage.

[12] There is also a large literature on physical health, but in a review of the literature, Wood et al. (2007) argue that no conclusive gender patterns exist with respect to physical health. In a recent longitudinal study with the National Survey of Families and Households, Musick and Bumpass (2012) find gains in physical health associated with marriage, but the marital effects do not differ significantly by gender.

[13] Exceptions to these results do exist. For instance, Lund et al. (2002) find strong effects of living with someone on mortality, but no differences in those effects with respect to either age or gender.

[14] Umberson's (1987) analysis showed that divorced and widowed persons exhibited much higher levels of risky behavior than the married, but there were no significant gender differences, except for the case of alcohol abuse.

[15] These differences are reflected in health care outcomes as well. In surveying this evidence, Wood et al. (2007) conclude that men gain from marriage for outcomes related to informal care and social support, but for outcomes related to health insurance coverage, the effect of marriage is stronger for women.

marriage apply equally to both genders, though the *type* of emotional problems experienced as a result of transitions differ by gender. Similarly, earlier work by Umberson et al. (1992) showed that gender differences in widowhood strain affected both men and women, but in different ways: for women, the strain is financial; for men, the critical strain was household management.

The idea that some individuals have their health worsened by marriage leads to a more general point about marital quality and health. Marital conflict has negative healthy consequences for both men and women, but Kiecolt-Glaser and Newton (2001) conclude that women's physiological changes following marital conflict show greater persistence than men's. Additionally, Umberson et al. (2006) show that the effects of marital strain are *cumulative* over the life course and that the negative aspects of marriage are more consequential at later ages.[16] Marital conflict can also have cross-spousal effects. Recently, Whisman and Uebelacker (2011) showed that when men have poor "marital adjustment" it raises the risk of metabolic syndrome (of which obesity is a prominent indicator) among their wives. Together this evidence suggests that since most of the literature on marriage and health treats all marriages equally, the benefits of high quality marriage (and the costs of low quality ones) may be understated by simple married/unmarried dichotomies. It also suggests that attention to gender and length of marriage are key components to any analysis of the health consequences of marriage.

In sum, the investment theory and evidence for it suggest that marriage promotes health, but can these claims be extended to the case of healthy body mass? Health is a multi-faceted concept, with body mass being just one characteristic of health. Married individuals may have an unhealthy body mass even as, on balance, marriage promotes their health and longevity. Body mass has a strong genetic component, and individuals who have relatively healthy habits concerning diet and exercise may still be overweight or obese. Furthermore, as individuals age the relative importance of body mass may change: other health issues develop, and people may become less concerned with physical attractiveness, in general. However, when age, gender, and other health conditions are held constant, the investment model clearly predicts that marriage should promote a lower body mass.[17]

2.1.2. The shared risk factor model

Almost any factor that affects BMI could be related to intimate relationships (or lack thereof) in some way. Empirical studies investigating the role of marriage try to control for as many of the observable socio-demographic and economic influences as possible. But the large body of literature on the spousal concordance in BMI suggests a possibility that unobserved factors common to the married couple contribute to BMI. These common factors may include exogenous factors that are common to the couple's environment, but they also may include behavioral factors, such as the health investment incentive just discussed. Thus, the shared risk factor model can be thought of as a generalization of the health investment model.

Marriage comes with a host of cultural forces and expectations that are powerful and may override investment incentives. Some (Sobal et al., 2003; Averett et al., 2008) argue that the various "social obligations" of marriage induce frequent eating and a higher consumption of calorie-dense foods. This may be the case, but couples may compensate in some ways. Having a partner for exercise programs, for instance, would be a shared behavioral force counteracting such obligations. Thus it is not theoretically clear in which direction the common risk factors should influence body mass.

What the shared risk factor model does bring to the table is a broader emphasis on what the couple shares. Intra-couple correlation can be adequately accounted for by assortative mating. But *changes* in the intra-couple correlation over the course of the marriage indicate marital effects beyond sorting. They suggest something shared by the couple. These shared factors might include employment stress, problems with kids, locational risk factors, new friends or neighbors or any number of things couples share in common. Previous research indicates that changes in weight are small and hard to explain but that intra-couple correlation coefficients are very large. We want to avoid post hoc story telling about unobserved factors, but empirical evidence of such factors would suggest a value in going beyond the simple selection story.

2.1.3. The crisis model

The two previous models focus on marital states and their implications. But it may be that marital transitions are more important than marital states. The first of these is the use of the "crisis" model of marriage recently explored by Umberson et al. (2009),[18] who use growth curve analysis to argue that changes in body mass trajectories are due mostly to transitions in marriage, not marital status. This stress may have a direct effect on weight change but may also have indirect effects through worsening health.

The previously debate over gender differences is also relevant to crisis theory. Zick and Smith (1991) find that recent marital transitions raise mortality risk, but only for men, and Umberson et al. (1992) find that marital dissolution is particularly harmful to men. Other studies, however, show that women are more distressed following a marital dissolution (Aseltine and Kessler, 1993; Menaghan and Lieberman, 1986; Simon and Marcussen, 1999), while Strohschein et al. (2005) find that the short-term

[16] Umberson and Williams (2005) show that even though the impact of poor marital quality is roughly the same for men and women, women experience lower levels of marital quality, which translates into a sustained disadvantage for the health of women over the life course compared to married men.

[17] In terms of health, some research suggests that overweight is actually protective of health beyond age 70 (Himes, 2000; Krueger et al., 2004; Reynolds et al., 2005; Flegal et al., 2005). It may also be the case that in the period 1992–2008, people aged 51–70 were less aware than later cohorts of the negative consequences of obesity when they were younger and making health-related investments.

[18] This builds on earlier work of Williams (2003) and Williams and Umberson (2004).

health effects of moving into and out of marriage on psychological distress are similar for men and women. Because the consequences of marital dissolution often begin before the transition occurs, gender-based differences may occur both before and after the martial transition occurs. Wives are much more likely to be caregivers to dying spouses, and Smith and Christakis (2008) conclude from their analysis of the literature that the attendant strains of caregiving are greater for women than for men, including greater fatigue and depression. Earlier work by Umberson et al. (1992) also found differences.

A central weakness in this theory is that the theoretical direction of the effect is ambiguous. For some people "change" means weight gain and others it means weight loss. The conditions resulting in a given direction of change are not known. Booth and Amato (1991) and Williams et al. (1992) show negative psychological consequences from separation and divorce, and these consequences might result in changes in body mass. Torres and Nowson (2007) argue that chronic stress leads to consuming foods high in sugar and fat, and a meta-analysis of longitudinal studies shows that depression generally leads to weight gain (Blaine, 2008). Using the Whitehall II data, others (Kouvonen et al., 2011) have shown that the negative aspects of marriage result in weight gain. All of this suggests that spousal lost should raise BMI. However, Lee et al. (2005) show that divorce leads to a decrease in BMI, which is consistent with observed increases in physical activity and increase in smoking. In sum, marital transitions are seen by advocates of the crisis model as a socio-psychological alternative to marriage protection hypothesis, but the model still needs more development in terms of explaining the direction of estimated effects, since either gain or loss would be consistent with the model. The key feature of the crisis model is that it accounts only for transitory changes in body mass, not persistent ones. This is consistent with the physiological concept of homeostasis, in which the body attempts to return to the previous equilibrium following a shock.[19] Because marital transitions lead to temporary effects, crisis theory has little to say about why strong cross-sectional differences across marital status categories exist in a population with few transitions.

2.1.4. The market sorting model

The three models above all focus on body mass as a biological construct. But body mass (particularly how body mass is distributed across the human frame) affects physical attractiveness and, hence, is a trait that has value in the marriage market. Though health status, history and behaviors may influence marriage market sorting, health variables do not typically have the association with attractiveness that body mass does. Two essential features of this market will play a role here: (1) people face competitive *pressure* from the market to increase their attractiveness as a potential partner; (2) the marriage market is characterized by strong assortative mating or homogamy. I refer here to the "market sorting" model to capture both the notions of market pressure and assortative mating.

As part of marriage market sorting, personal traits that are complementary[20] in household production will be characterized by positive assortative mating. Complementary traits, such as education, religion and lifestyle are also correlated with better health, implying that the intra-couple correlation in health should be strong and positive whether or not health itself is complementary. Similarly, we also expect observable health behaviors, such as diet and exercise, to exhibit positive intra-couple correlation at marriage. A large body of empirical evidence supports the concordance in spousal BMIs in many countries, though the literature is divided on the question of whether spousal concordance is due entirely to sorting in the market (Knuiman et al., 1996; Silventoinen et al., 2003; Klein, 2011) or whether a shared environment and behavior contribute to the correlation (The and Gordon-Larsen, 2009).[21] Of course in real marriage markets, perfect sorting does not occur because of limited information, the high costs involved with forming and dissolving marriages, and, especially, uncertainty about the future. Many thin people are happily married to heavy ones because physical attractiveness is only one of many traits that people weigh in their marital decisions.

One important factor driving marital sorting is a gender difference in preferences concerning body mass. Previous research indicates that men have stronger preference for thinness in their partners than women do (Carmalt et al., 2008). Earlier, Fu and Goldman (1996) argued that "men perceive heavy women to be physically unattractive to a considerably greater degree than women find overweight men to be unappealing." Men also place a greater emphasis on attractiveness—in general—when selecting a mate (Fisman et al., 2006). These generalities, however, are largely derived from studies of young adults, and the marginal value of thinness is likely to decrease with age and with the length of the relationship. A universal feature of romantic attachments is that the intensity and frequency of sexual activity fades over time. The physical characteristics that influence sexual attractiveness become relatively less important over time compared to a variety of other factors that determine marital success, such as the problems with children or juggling finances. Thus, thinness is likely a less valuable trait among the older adults in this study than among younger adults, and there are likely important gender differences with respect to body weight

[19] Recent research is shedding more light on how homeostasis occurs with respect to weight change. For instance, a study by Sumithran et al. (2011) show that a full year after weight loss has occurred, circulating hormones that encourage weight regain are still at levels higher than before weight loss occurred.

[20] A trait is *complementary* when an increase in the amount of a trait for one partner is worth more the higher the amount of the partner's trait; mathematically, this is when the cross-partial derivative of household production is positive with respect to the trait.

[21] See also Jacobson et al. (2007), Brown et al. (2010), and Oreffice and Qiuntana-Domeque (2010). See Meyler et al. (2007) and Monden (2007) for a review of spousal concordance in health conditions beyond body mass.

Table 1
Summary of theoretical predictions.

Prediction	Investment	Market sorting	Crisis	Shared risk factors
Cross-sectional differences across marital states				
Advantage (lower BMI) for married	Y		N	
Gender differences		Y*		N
Marital transitions				
Transition into marriage				
→weight gain	N	Y		
→weight loss				
→weight change			Y	
Transition out of marriage				
→weight gain				
→weight loss	N	Y		
→weight change			Y	
Duration of effects				
Temporary			Y	
Increasing in magnitude over time	Y		N	
Positive intra-couple correlation				
Exists at time of marriage		Y		
Grows over time	Y			Y
Co-movement of BMI across time	Y			Y

Notes: Predictions are for population in later adulthood (ages 51–70). "Y" indicates what should occur; "N" indicates what should not occur. Blank cells indicate no prediction.
* Assuming men have stronger preferences regarding partner BMI, married men will be heavier than single men and married women will be lighter.

and perceptions of attractiveness at older ages as well. Nonetheless, the empirical patterns we observe among older persons are heavily influenced by market forces at play in young adulthood. We, therefore, expect to see the residual effects of those forces persisting into later life, but we cannot observe life-cycle comparisons in this analysis because we lack data on younger adults.

In a market search, people incorporate what they know about themselves, what they observe in others, and their assumptions about the condition of the market to determine what they will accept from a prospective mate—meaning they marry and stop the search process.[22] Given the preference for thinness, thin men will reject many of the heavy women they meet, preferring to keep searching for a thin companion. Heavy men, though they also prefer to marry a thin woman, have lower value in the market and will be more likely to accept the heavier women. Similarly, heavy women should be more likely to get divorced, and heavy men will be less likely, holding other factors constant.[23] Thus over time, the market selects in favor of heavier men and thinner women, meaning that the average weight of the unmarried women is higher than married women, while the average weight of the unmarried men is lower than married men. The beginnings of this pattern are seen empirically in early adulthood, where high BMI significantly reduces the marriage rate for women (Averett and Korenmann, 1996; Fu and Goldman, 1996; Conley and Glauber, 2005).

Because physical attractiveness is important in the marriage market, many people will try, often with considerable effort, but only occasionally with success, to lower their body mass. This may occur among both single people wanting to get married and among married people who want to maintain their market value in the case of divorce or spousal death.[24] In other words, the weight loss or weight maintenance is *strategic* rather than health related (though of course both aims can be present).

2.2. Empirical implications

Different dimensions of marriage yield insights into how marriage affects body mass according to the theoretical models discussed above. I highlight three marital dimensions here, and I summarize the predictions of each theory in Table 1. Remember, however, that these predictions apply only to marriages for people in the age range under study, namely people aged 51–70 and, thus, the empirical implications of the theory may not apply in the same fashion when looking at younger ages. Additionally, this study contains no information on sample participants' body weight earlier in life.

The first empirically relevant dimension is marital status. Marital status categories are rich in information, representing both a *state* (where one is) and a *history* (where one has been). Under the investment theory, the long-term married should have considerable advantages over those who have married more recently (especially when later first marriages) and over the divorced—both because of lower cumulative time in marriage and because

[22] This is not to say that marriage partners will stop assessing their value on the market or that they will stop seeking potential new partners in the market, though, assuming their partners value fidelity, the cost of doing so rises considerably.

[23] This does not mean, however, that body weight is the *proximate* cause of dissolution or that men will be the one's initiating divorce proceedings. Brinig and Allen (2000) review evidence that about two-thirds of US divorce filings in recent decades have been initiated by women.

[24] See Lundborg et al. (2007) for cross-national evidence in Europe.

divorce is an indicator of the quality of the marriage match. In brief, bad matches in the marriage market produce harm and dissolve, whereas good matches produce benefits and thrive. Thus the divorced, holding other factors constant, should be less healthy (higher body mass) than those in their initial marriages. Those who have widowed, on the other hand, should be much like the long-term married. And, by the same logic, the never married should be the worst of group of all, holding other factors constant, since they have never benefited from the more productive household technology that married persons have access to. A more nuanced analysis would include factors such as time spent in each state, time since the most recent transition, and the quality of marriage and other factors. But even with these simple generalizations, the health investment model implies that there should be relatively pronounced differences across marital states once the individuals reach middle-age.

The marriage market, on the other hand, induces offsetting effects on the cross-sectional distribution. If thinner people marry at a higher rate, then those who have remarried (or who form other relationships) will be thinner than those who do not experience success on the marriage market. On the other hand, once people marry, they have less of an incentive to maintain a low body weight, driving down the gap between the remarried and the divorced. Thus it is ambiguous what the net effects of market sorting will be. However, if preferences regarding spousal BMI and preferences for marriage in general are differentiated by gender, then the cross-sectional patterns in the data across marital states may be very different for men and women, as discussed above. The data we saw in Fig. 1 illustrates these significant gender differences.

The other theories are also distinct from the health investment model. In a population where few marital transitions are occurring, the effects of past transitions should have mostly run their course. Thus, according to the crisis theory, few cross-sectional differences should exist, either for men or for women. The shared risk factor model, on the other hand, would allow cross-sectional differences, depending on the balance of these risk factors in the population. However, the essence of the shared risk factor model is that there is a strong couple-level component to body mass. Thus the model speaks *against* gender patterns in the cross-sectional relationship. The married may be either worse or better off than other groups, but the patterns that are driving the effects are common to men and women.

The second important dimension of marriage is marital transition. In the data discussed in Section 3, we can observe individuals for up to 16 years in some cases. Thus we have ample opportunity to observe the implications of marital transition. Under the investment model, we do not know the rate of return on marital productivity, so we cannot say how fast the gains to marriage or the costs of dissolution should be realized. Thus there is no short-term prediction. However, over the long term, we should see benefits from investment and those benefits grow over time. Indeed, it is the accumulation over time of those benefits and costs that lead to the cross-sectional differences discussed above. Under the market sorting model, on the other hand, we would see the opposite effects of marriage transition than are seen under the investment model. As discussed earlier, entry into marriage reduces the incentive to have a low body weight, while exit from marriage raises that incentive.

Transitions are the heart and soul of the marital crisis. Unfortunately, we can say little about the expected direction of such changes, nor can we investigate here the role played by various stressors in the transition process. The main feature of the crisis model is that the transition effects are temporary and individuals return over time to their pre-transition state. Thus, both non-effects and permanent effects are evidence against the theory. Under the shared risk factor model there are no immediate effects of marital transitions and any long-term effects are ambiguous in direction.

The third dimension of marriage is spousal concordance, or the degree to which spouses match each other in their characteristics. The market sorting model says that couples form *because* of those characteristics and that the force of the market can be measure by the degree of similarity (measured here as the simple intra-couple correlation in body mass). But that is not the end of the story. Suppose, for instance, that a couple has one obese spouse and one spouse of recommended weight. Under the investment model, the heavy spouse loses weight as a product of better household technology. Under the shared risk factor model, couples become more alike because they adopt similar, though not necessarily more healthy behaviors, particularly related to diet and exercise. Thus the investment model predicts that spouses become more alike and healthier, while the shared risk factor model implies they become more alike but not necessarily healthier. Under the crisis model, there are no behavioral forces involved so the model predicts neither convergence nor divergence of BMI.

Finally, the strategic implications of market sorting are not assessed here. As noted above and in Table 1, strategic response to market pressure can explain weight loss following exit from marriage and weight gain following entry into marriage. However, it would require a much more fully specified model—not to mention data on people's expectations—to understand the full range of strategic behavior induced by the marriage market. The claims made here about market sorting are fairly modest. I do not pursue other possible claims about long-term effects of market sorting other than those suggested above.

3. Data and methods

3.1. Data

All data used for this study come from the HRS dataset. The first wave of the study began in 1992 and was a multistage probability sample of Americans born between the years of 1931 and 1941, making them approximately 51–61 at the time of the survey. Spouses of any age are also surveyed. Together, the first wave of the HRS consisted of 12,652 participants, with oversamples of African–Americans, Hispanics, and Floridians. In the following year, 1993, the first wave of the Asset and Health Dynamics (AHEAD) survey was taken using a sample of residential households with at least one respondent born in 1923 or earlier. Follow-up samples occurred for the HRS in 1994 and 1996 and for the AHEAD sample in 1995. In 1998, the two surveys became one and the combined data is now typically referred to simply as the HRS. Also, at that time a new cohort was added to the sample. With the appropriate sample weights, the 1998 HRS study was then representative of the entire residential population of the US aged 51 and over. Since that point, respondents have been surveyed every 2 years, and a new cohort was used to refresh the sample in 2004. The data used in this study are for all participants in the HRS during the survey years 1992–2008 when they are between the ages of 50 and 71.[25] (Therefore, I do not use any individuals from the original AHEAD cohort).

This study uses a version of the HRS created by RAND. This effort by RAND is extremely valuable for researchers because it takes a large subset of variables from the study and standardizes names and definitions across all waves of the data.

3.2. Variable definitions

The dependent variable here is body mass as captured by the body mass index, BMI, which is calculated as weight (in kilograms) over height (in meters squared). Mean BMI begins to decline quite rapidly after age 70, and, as noted earlier, some studies even suggest that high body mass may have protective effects among that age.[26] Some scholars even suggest that weight loss among those over age 65 is a greater health concern than weight gain (Locher et al., 2007). In the analyses below, I treat body mass in two ways: (1) continuously, using ln(BMI) as the dependent variable and (2) dichotomously, following the common practice of defining obesity as $BMI > 30$. A change in ln(BMI) approximates the percentage change in BMI given a unit change in an explanatory variable. The HRS height and weight data are self-reported rather than measured objectively, which may affect reliability.[27]

Finally, BMI is often a poor measure of both adiposity and attractiveness. From a health perspective, BMI can be a poor proxy for fat body mass, which is (likely) the principle variable of interest (Burkhauser and Cawley, 2008; Burkhauser et al., 2009), at least with respect to health. BMI is also less than ideal as an indicator of physical attractiveness, since it is not a perfect measure of adiposity and because attractiveness is less a function of adiposity than of body shape.

For this analysis, the primary variables of interest are marital status and transitions into and out of different variable states. Defining a survey respondent's marital trajectory over the course of the survey is complicated by several factors. Perhaps the primary limiting factor is that the HRS only surveys people at 2-year intervals, and some people will go through two or more transitions within a 2-year period (marriage → widowed → cohabitation → re-marriage, for example). Furthermore, respondent-provided information is not always consistent over time. For instance, they report marriages in later waves that they did not mention in previous ones, or they claim that a previously reported marriage was not in fact a marriage. There are also changes in question wording and coding by the HRS researchers. The timing of marital transitions can be measured retrospectively down to the month. A serious limitation of this analysis, however, is that body mass is only measured at time of interview, meaning we cannot observe body mass at the time the marital transition occurs.[28]

Fortunately, extensive work was done by researchers at RAND to make the data as useable as possible in terms of consistently mapping out the respondents' marital states across time. Granting that there are a huge variety of marital histories that might be captured in marital status definitions, the following six-category definition is used:

1. Married before age 40
2. Married after age 40
3. Cohabiting
4. Separated/divorced
5. Widowed
6. Never married.

These categories are exhaustive and mutually exclusive. Dividing the married group by length of marriage is done to facilitate identification of marital duration among the married.[29] An alternative would be to subdivide the married by first marriages and re-marriages. In practice, however, only 9.1% of those in the married after age 40 are first marriages, and 82.4% of those married before age 40 are in their first marriage. Thus, later marriages are, in large part, the same set of people as re-marriages. Qualitatively, the results that follow do not hinge on whether an early/late or first/second categorization of marriage type is used, and in both cases the distinction between the two married groups does not influence that ubiquitous result to follow that the two marriage types look very much the same with respect to body mass.

In contrast, the never married and remarried cohabiters end up looking quite different from one another in terms of body mass. 89.3% of cohabiters are previously married, but moving the never married cohabiters from the cohabiting category (3) to the never married group (6) does not qualitatively affect the estimates for these groups, and

[25] And, thus, the do *not* enter the analysis in survey years when they are outside of that age range.

[26] Though Fontaine et al. (2003) find the opposite.

[27] See Kuskowska-Wolk et al. (1992), Nieto-Garcia et al. (1990), and Black et al. (1998) for discussions of the self-reporting issue.

[28] Because marital transition dates are known, it is possible to subdivide the 2-year interval. For instance, we could look at body mass as a function of spousal death in the past 0–1 years or 1–2 years. Explorations of this type did not yield substantial differences in the estimated patterns and are unsatisfying because of lack of data on the timing of weight changes. The lack of inter-survey weight trajectories is a problem that plagues most of the other research attempting to understand the consequences of marital transitions.

[29] Looking at the effects of duration in different states, such as divorced or widowed would be an interesting topic for future analysis.

Table 2a
Sample statistics by marital status, men.

	Mean or percentage:					
Marital status:	Early mar.	Later mar.	Cohabit.	Div/Sep	Widowed	Never mar.
N=	24,619	6445	1320	4051	1078	1239
Body mass						
% Obese	29.1%	30.1%	27.1%	24.3%	30.6%	19.0%
BMI	28.28	28.44	27.95	27.42	28.09	26.81
	(*4.71*)	(*4.70*)	(*4.82*)	(*5.17*)	(*5.48*)	(*4.95*)
ln(BMI)	3.33	3.34	3.32	3.30	3.32	3.28
	(*0.16*)	(*0.16*)	(*0.16*)	(*0.18*)	(*0.19*)	(*0.17*)
Health						
# of chronic	1.36	1.47	1.58	1.52	1.82	1.62
Conditions	(*1.25*)	(*1.32*)	(*1.44*)	(*1.41*)	(*1.52*)	(*1.27*)
Health: excellent	17.5%	17.3%	13.7%	15.4%	11.4%	13.9%
Health: very good	33.6%	31.0%	28.0%	26.1%	26.9%	31.6%
Health: good	30.2%	29.7%	27.8%	28.8%	29.3%	28.3%
Health: fair	13.5%	14.9%	20.3%	18.9%	20.2%	16.5%
Health: poor	5.3%	7.2%	10.2%	10.8%	12.3%	9.8%
Non-smoker	33.2%	26.7%	23.7%	24.2%	22.3%	39.9%
Previous smoker	49.0%	51.8%	40.5%	37.8%	46.1%	34.2%
Current smoker	17.4%	20.8%	35.3%	38.0%	30.4%	25.9%
Uncertain	13.4%	0.7%	0.5%	0.0%	1.2%	0.0%
Demographics/assets						
Age	59.64	60.02	58.77	59.16	62.50	58.94
	(*4.83*)	(*4.84*)	(*4.61*)	(*4.75*)	(*4.77*)	(*4.83*)
Race: white	84.0%	82.3%	70.5%	73.9%	71.9%	78.5%
Race: black	6.3%	8.4%	17.6%	16.0%	17.5%	14.7%
Race: other	9.7%	9.4%	12.0%	10.1%	10.6%	6.8%
Education	13.16	13.18	12.35	12.69	11.88	13.36
	(*3.09*)	(*3.03*)	(*3.32*)	(*3.06*)	(*3.49*)	(*3.33*)
ln(assets)	12.21	11.95	11.25	10.75	11.03	11.33
	(*1.52*)	(*1.75*)	(*2.03*)	(*2.31*)	(*2.15*)	(*2.22*)

Notes: Standard deviations in parentheses; all values are weighted with individual-level sample weights; sample sizes include multiple observations on each sample individual from waves 1 to 9 (1992–2008), where present. Additional variables not shown here include: parent's education, religion in childhood, region of birth.

there are not enough individuals who are never married cohabiters to distinguish them statistically from the previously married cohabiters (and we cannot identify in the data who among those category 6 might have *previously* cohabited).

A variety of other variables are included in the analysis. I divide them into two broad groups. The first variable group contains only ''early-life'' demographic variables, meaning variables determined either at birth (age, race, etc.) or early in life (education). Survey wave is used to control for within-sample changes that occur over time and is included in the first group of variables. Because of the relationship *birth year = survey year − age*, year of birth is not included in the model, nor is it a focus of this study to disentangle age, period and cohort effects.[30] Other demographic variables include years of own education, father's education, mother's education, region of birth, religious affiliation (since this is usually determined in early life), race and ethnicity. All these variables are measured categorically. Race and ethnicity are divided into three categories: non-Hispanic whites, other non-Hispanics (mostly blacks), and Hispanics.

The third category includes variables that are contemporaneous with current-period body mass. These include wealth and health status. Wealth is used instead of income because it captures previous economic experiences of respondents and is thus likely to be less endogenous with respect to changes in health than income. The wealth measure is the log of total household assets. Health variables include self-assessed health status (measured as categories: excellent, very good, good, fair, poor), number of major chronic conditions, and smoking status (categories: non-smoker, previous smoker, and current smoker).

Tables 2a and 2b provide detailed descriptive statistics for all the variables used in the analysis broken out by sex and marital status. These statistics include all waves of data and thus contain multiple observations per person. All reported estimates in this and other tables employ sample weights provided by the HRS.

[30] This is not to say that cohort effects are unimportant. Of particular interest is the shifting relationship between body mass and attractiveness from the 1950s through the 1970s, with increasing importance place on thinness, especially for women. Further research on these types of cohort effects could prove very fruitful.

Table 2b
Sample statistics by marital status, women.

	Mean or percentage:					
	Early mar.	Later mar.	Cohabit.	Div/Sep	Widowed	Never mar.
N=	25,754	4877	1069	8230	6097	1590
Body mass						
% Obese	27.5%	24.3%	27.0%	35.6%	33.7%	37.6%
BMI	27.54	27.05	27.52	28.78	28.41	29.15
	(5.84)	(5.30)	(6.06)	(6.92)	(6.37)	(6.89)
ln(BMI)	3.29	3.28	3.29	3.33	3.32	3.35
	(0.20)	(0.19)	(0.21)	(0.23)	(0.22)	(0.23)
Health						
# of chronic	1.42	1.55	1.63	1.86	1.81	1.77
Conditions	(1.25)	(1.34)	(1.57)	(1.50)	(1.45)	(1.48)
Health: excellent	18.1%	17.1%	14.1%	12.9%	12.3%	14.7%
Health: very good	34.9%	32.9%	30.9%	26.2%	27.9%	24.4%
Health: good	28.6%	28.4%	28.7%	27.3%	29.9%	30.9%
Health: fair	13.4%	15.4%	17.8%	20.9%	20.4%	21.5%
Health: poor	5.0%	6.1%	8.2%	12.8%	9.5%	8.6%
Non-smoker	52.9%	42.3%	35.0%	37.4%	44.1%	49.2%
Previous smoker	32.6%	35.7%	36.7%	36.0%	31.4%	31.5%
Current smoker	14.3%	21.1%	28.1%	26.5%	24.5%	19.2%
Uncertain	0.2%	0.9%	0.2%	0.1%	0.1%	0.0%
Demographics/assets						
Age	59.51	59.50	58.46	59.48	62.14	29.21
	(4.83)	(4.77)	(4.59)	(4.77)	(4.92)	(4.80)
White	84.6%	86.0%	75.9%	67.8%	72.2%	59.3%
Black	6.0%	7.2%	13.7%	19.4%	17.0%	25.7%
Other	9.4%	6.8%	10.4%	12.8%	10.8%	14.9%
Education	12.81	13.03	12.32	12.69	11.84	13.06
	(2.76)	(2.71)	(2.68)	(2.91)	(2.93)	(3.31)
ln(assets)	12.26	12.03	11.27	10.36	10.88	10.46
	(1.53)	(1.70)	(2.28)	(2.48)	(2.32)	(2.53)

Notes: Standard deviations in parentheses; all values are weighted with individual-level sample weights; sample sizes include multiple observations on each sample individual from waves 1 to 9 (1992–2008), where present. Additional variables not shown here include: parent's education, religion in childhood, region of birth.

3.3. Analytical methods

Transitions from one marital state to another, as well as from one health state to another, are functions of underlying and usually unobserved processes that can take decades to develop. In Section 2, I outlined four possible theoretical reasons why we might expect body mass to be related to marriage. In this section I specify the estimating equations used to draw conclusions from those theories.

3.3.1. Cross-sectional analyses

I start out with simple cross-sectional OLS models (using all waves of the data in which sample members are in the 51–70 age range and adjusting appropriately the standard errors to account for repeated observations on the same individuals).[31] The basic model is the following:

$$\ln(\mathrm{BMI}_{it}) = X_{it}B_x + M_{it}B_m + e_{it}, \quad (1)$$

where B_x is a vector of fixed regression coefficients, X_{it} a vector of explanatory variables, M_{it} is the vector of marital state variables, with associated coefficients B_m, and e_{it} is an *i.i.d.* residual. In all cases, I estimate and compare the models separately for men and for women.

3.3.2. Longitudinal analyses

The next step is to employ longitudinal analysis of two types. First, I estimate simple fixed effects models of the form:

$$\ln(\mathrm{BMI}_{it}) = X_{it}B + M_{it}B_m + u_i + e_{it} \quad (2)$$

This model adds an unobserved, person-specific component, u_i, to the specification in model (1) that is assumed to be constant across time. Averett et al. (2008) use this approach and claim that the fixed effects model will "net out the selection effect of marriage p. 333," but this claim is overly ambitious. Selection can still be due to correlation of marital status with the residual e_{it}, but the fixed effects model does provide a partial solution to the endogeneity of marital status and body mass by allowing us to account for the person-specific unobservables that are fixed over time and are likely highly correlated with other explanatory

[31] The time trends evident from these models show a steady and substantial increase in both mean BMI and obesity prevalence at all ages. This is consistent with Ogden et al. (2006) and other research on obesity trends. But both the age and time variables here are treated merely as controls; the interesting trends, as well as possible cohort effects, are not a focus of this study.

variables. In sum, the fixed effects model measures how longitudinal changes in X are correlated with longitudinal changes in BMI. Any fixed factor, observed or unobserved, is removed, leaving only longitudinal factors.

The second approach is to model transitions directly. Specific transitions (married → divorced, for instance) are modeled explicitly, allowing us to see the *direction* of the effects, which is not possible with the fixed effects estimates. The model is:

$$\Delta_s \ln(\text{BMI}_{i(t+s)}) = X_{it} B + \Delta M_{i(t+1)} B_m + e_{it} \quad (3)$$

where $\Delta_s \ln(\text{BMI}_{i(t+s)}) = \ln(\text{BMI}_{i(t+s)}) - \ln(\text{BMI}_{it})$, and $\Delta M_{i(t+1)} = M_{i(t+1)} - M_{it}$. In words, if marital status shifts from period t to period $t+1$, how does BMI shift in the same and in subsequent periods? Setting $s = 1$ means the shift in BMI occurs in the same period as the shift in marital status, and $s > 1$ means looking into the future. I estimate separate models for $s = 1, 2, 3$ holding all X variables constant at their values in time t. This approach lets us examine both short-term and longer-term consequences of marital status transitions.

Though there are numerous possible transitions that could be addressed, small numbers of people making particular transitions prohibit this. For instance, almost all of the transitions into marriage are for people previously married; only a small percentage of the sample is never married and, of that group, only about 1.2% of men and 0.5% of women enter marriage between any two waves. Thus, there simply are not enough cases to reliably compare transition into marriage between the never married and the previously married. Transitions into divorce and separation are treated distinctly from transitions into widowhood. I do not, however, subdivide these marital dissolutions by whether the marriage was an early or recent marriage. Thus, I study six transitions/non-transitions:

(1) Married → married (no transition)
(2) Married → divorced/separated
(3) Married → widowed
(4) Unmarried → married
(5) Unmarried → unmarried (no transition)
(6) Multiple changes or uncertain.

An additional complication is that theory suggests that weight changes associated with marital transitions do not coincide sharply with transition dates. For instance, I discussed earlier how changes in BMI are likely to come *before* the actual change in marital status. Thus even if we observed BMI at the time of divorce or widowhood, we would still not have the optimal timing of observations. And in the HRS, dates of divorce are recorded between the survey waves but dates of separation are not. Separation is a key indicator of marital dissolution and can occur quickly. Divorce, on the other hand, usually takes time to occur after the decision is made. I implicitly assume that separation indicates a "failure" of marriage and divorce is a final marker of that failure (though there are clear exceptions to this pattern).

3.3.3. Spousal concordance analyses

The final set of models is used to investigate the intra-couple correlation in BMI within married couples. As cited earlier, a growing body of research has shown a strong spousal concordance in BMI. Estimating the intra-couple correlation shows the extent of assortative mating. Market-based sorting will be present at time of marriage. Sorting due to shared risk factors may occur at marriage but the correlation will grow over time.

The intra-couple correlation in body mass is based on estimated residuals. To estimate the correlation, I first estimate the BMI of husbands and wives as follows using OLS:

$$\ln(\text{BMI}^h_{it}) = X^h_{it} B^h + M^h_{it} B^h_m + e^h_{it} \quad (4)$$

$$\ln(\text{BMI}^w_{it}) = X^w_{it} B^w + M^{w\,w}_{it\,m} + e^w_{it} \quad (5)$$

where h refers to husbands and w to wives. Of key interest is whether the intra-couple correlation is growing over time. I examine this issue by breaking out the correlation estimates with respect to marriage duration. It is important to note, however, that such an approach is looking *retrospectively* at marriage duration. There is the possibility of survivorship bias here because couples who split up before they are at risk for inclusion in the data are not included in the analysis. However, if couples are more likely to split up because of a failure to match with complementary characteristics, we should see that the survivorship bias would cause the observed correlations to be overstated. And, since the results to be presented in Section 4 find that the intra-couple correlation *declines* with respect to duration, removing survivorship bias would actually cause that decline to be sharper, thereby further infirming the hypothesis that shared risk factors cause couples to grow more alike over time.

Finally, the last analysis with couples looks at how spousal BMIs move together over time, meaning they are likely to gain or lose weight together. Using the same residuals from Eqs. (4) and (5), I will calculate *between–period* correlations in the body mass of husbands and wives. This is done by taking the estimated residuals from each model and differencing them ($e_t - e_{t-1}$) for both husbands and wives and then calculating the intra-couple correlation of those differenced residuals. I refer to this as the intertemporal–intra-couple correlation coefficient. In simplest terms, it measures the co-movement of body mass over time for couples, netting out the effect of other observed factors which vary over time.

4. Results

An important starting point for any analysis using panel data is to understand the nature of the variation to be explained. Three characteristics are most salient: first, most variation in BMI is due to differences across people, not changes over time. A simple random effects *ANOVA* model gives an intraclass correlation coefficient of .117, meaning that 11.7% of the total variation in ln(BMI) in the sample is longitudinal (*within* variance) and 88.3% is cross-sectional (*between* variance).

Second, the BMI distribution for older adults both shifted and widened between 1992 and 2008. Over this period, mean BMI for men rose from 26.73 to 28.72 (7.4%) and women from 26.22 to 28.62 (9.2%). Additionally, the variance of BMI increased significantly: from 17.5 to 29.1 for men and from 30.3 to 42.4 for women (after standardizing for age).[32] It is the combination of these two factors that has led to the much publicized increase in obesity, though increases in the mean have received much more attention than increases in the variance. The prevalence of obesity, holding age constant, for this age group increased from .179 to .337 (88.3%) for men and from .202 to .338 (67.3%) for women.

Third, even though this shift is significant, adding time to the simple ANOVA model accounts for virtually none of the longitudinal variation in the data decreasing the percentage of total variation explained by the longitudinal component from 11.7% to 11.5%. In other words, the portion of the variation in BMI that is due to longitudinal factors is *not* due to the population shift of the BMI distribution between 1992 and 2008. It is, instead, variation over time at the person-level. It is this person-level variation that the longitudinal analyses and intra-couple correlation analyses below seeks to explain.

In this analysis, all nine waves of the data set are used.[33] As noted earlier, it is essential to include time controls in each specification. Each specification also includes both a linear and quadratic term for age (different specifications for age have little consequence). Finally, using repeated observations on each individual also necessitates adjustment of the standard errors to avoid over-confidence in the estimates. The appropriate cluster-robust standard errors are shown for each specification.[34]

4.1. Cross-sectional models

Given space restrictions, I report in table form only the results related to marital status, but other covariates not shown in Table 3 deserve some initial discussion.[35] The age and time effects are still present after accounting for additional variables. Indeed, the rise in obesity cannot be accounted for by changes in any demographic variables, including marital status. Those demographic variables are significant determinants, however, in explaining the cross-sectional variation of BMI. Education is negatively related to body mass, particularly for those with college degrees or higher. Father's education also shows the same pattern, probably indicating the influence of father's education on the socioeconomic status of the respondent's early life. Mother's education has little impact. For men, race and ethnicity are unimportant predictors of body mass, but for women, they are extremely important. Black women and, to a lesser extent, Hispanic women are *much* heavier than white women; the effect of being black relative to white is double the effect of moving from no high school to college graduate, for instance. Body mass is strongly related to health and smoking in the ways we would predict. Current smokers (though not previous smokers) weigh considerably less than non-smokers. Indeed the cross-sectional models reveal that the difference between the current smokers and non-smokers is roughly as large as the entire increase in obesity between 1992 and 2008. Body mass is also positively correlated with the number of chronic conditions and poor self-reported health and negatively correlated with household financial assets.

Though many of the model estimates mentioned above merit further discussion, the focus here is on marital status, and estimates for each cross-sectional model are found in Table 3. The top panels are OLS estimates using ln(BMI) as the dependent variable. The bottom panels contain coefficient estimates from a simple linear probability model with obesity as the binary dependent variable. Though not shown, marginal effects calculated from logit coefficients yield highly similar values to the linear probability estimates.

Probably the most striking feature of Table 3 is the difference between men and women. When we control for early life demographics (model 1), women who are divorced/separated, widowed or never married are significantly heavier and more likely to be obese than are currently married women. Conversely, men in the divorced/separated and never married categories have significantly lower BMIs and are much less likely to be obese than the married. Sobal et al. (2009) also find no marital status differences among women (after controlling for other factors) using the NHANES data, but they do not find the high rate of obesity among the never married women that is found here. The difference between their findings and the ones presented here are that they do not show higher BMIs for never married women—which is the category showing the biggest discrepancy in Table 3.[36]

The estimates from model 1, which account for fixed demographics, largely confirm the patterns shown early in Fig. 1. The estimates tend to be smaller in magnitude at the mean than in the tails of the distribution, and both measures of body mass tell essentially the same story. Women who have succeeded in the market for remarriages (and cohabiting relationships) are lighter than early marriages, while women who remain on the market are significantly heavier. This is particularly pronounced for the never married. Indeed, the obesity prevalence for the never married is 10 points higher than for women who are cohabiting or who have married (remarried, in most cases) after age 40. A very different pattern holds for men. Later marriage is not different from early marriage, and the divorced/separated groups have lower body mass than

[32] As an example, Helmchen and Henderson (2004) find a similar widening of the BMI distribution for US in the NHANES data between the late 1970s and the late 1990s, suggesting that this trend has been going on for a few decades at least. Because women are shorter, on average, the variance of their BMIs is greater than for men largely because of how BMI is constructed.

[33] Panels are not balanced, meaning that observations not present for the full 9 years are still used in the years for which data exists.

[34] These were obtained with the vce(cluster id) option in STATA 11.

[35] Again, all estimates are available in the Appendix.

[36] In separate analysis, the differences in obesity between the long-term married and the long-term unmarried show a very similar gender pattern.

Table 3
Cross-sectional OLS estimates.

Dependent variable: ln(BMI)	Men		Women	
Model:	(1)	(2)	(1)	(2)
Marital status	Coeff.	Coeff.	Coeff.	
Early marriage (age <40)	Reference		Reference	
Later marriage (age ≥40)	.005	.005	−.018**	−.018***
	(.005)	(.005)	(.007)	(.006)
Cohabiting partners	−.022**	−.017*	−.023*	−.025**
	(.010)	(.009)	(.014)	(.011)
Divorced/Separated	−.039***	−.031***	.019***	.002
	(.007)	(.007)	(.007)	(.007)
Widowed	−.012	−.010	.011*	.005
	(.014)	(.012)	(.074)	(.007)
Never married	−.058***	−.054***	.031**	.009
	(.012)	(.011)	(.015)	(.014)
R^2	0.039	0.122	0.077	0.190
Dependent variable: obesity	**Men**		**Women**	
Model	(1)	(2)	(1)	(2)
Marital status	Coeff.	Coeff.	Coeff.	Coeff.
Early marriage (age <40)	Reference		Reference	
Later marriage (age ≥40)	.005	.004	−.038***	−.042***
	(.015)	(.014)	(.015)	(.014)
Cohabiting partners	−.045*	−.042*	−.046	−.053**
	(.027)	(.025)	(.029)	(.024)
Divorced/Separated	−.063***	−.057***	.047***	.008*
	(.017)	(.017)	(.014)	(.014)
Widowed	.007	.001	.035**	.020
	(.029)	(.028)	(.015)	(.015)
Never married	−.105***	−.106***	.061**	.016
	(.026)	(.025)	(.030)	(.027)
R^2	0.025	0.083	0.055	0.065
NT	38,752	38,752	47,617	47,617
N (individuals)	8255	8255	9955	9955
T (periods per individual)	4.69	4.69	4.78	4.78

Models: (1) Base model adjusts for age, survey wave, and early life demographics including, race/ethnicity, education, parents' education, religion and region of birth. (2) Model with contemporaneous covariates, including household assets and health variables (see text).
Estimation notes: cluster-robust standard errors are in parentheses; estimates based on individuals aged 51–70 from all nine waves of the HRS/AHEAD data, 1992–2008, where present; all estimates weighted using person-level sample weights.
* $p < .1$
** $p < .05$
*** $p < .01$.

married men. Unmarried men in this age cohort are, by far, the lightest group.

We also see important gender differences in the estimates of model 2, but here a different gender pattern emerges. The inclusion of wealth and health variables has very little effect on the estimates of marital status for men, indicating that the cross-sectional marital patterns for men are largely independent of the contemporaneous variables in model 2. For women, however, controlling for the contemporaneous variables reduces the magnitude of the coefficients substantially. This suggests that the greater weight for unmarried women may be a function of the reduced financial assets and reduced health associated with being unmarried. Consistent with these findings, previous research has shown that obese women face stiff penalties in terms of wages and earnings that obese men do not (Fu and Goldman, 1996; Cawley, 2004; Sario-Lahteenkorva et al., 2004).

4.2. Longitudinal models

I now move to longitudinal models, beginning with standard fixed effects models.[37] Before discussing the marriage results, I note that in the fixed effects models, all

[37] I'm using the term "fixed effects" not in the way that researchers experienced with multi-level or mixed models use it, but as it is typically used in panel data econometrics, meaning varying (but not random) intercept terms.

Table 4
Fixed effects models.

Dependent variable: ln(BMI)	Men		Women	
Model:	(1)	(2)	(1)	(2)
Marital status	Coeff.	Coeff.	Coeff.	
Early marriage (age <40)	Reference		Reference	
Later marriage (age ≥40)	−.007	−.007	.006	.006
	(.006)	(.006)	(.006)	(.005)
Cohabiting partners	−.004	−.004	−.008	−.008
	(.007)	(.007)	(.008)	(.008)
Divorced/Separated	−.014**	−.013**	−.008*	−.008
	(.006)	(.006)	(.005)	(.005)
Widowed	−.017**	−.017**	−.018***	−.018***
	(.008)	(.008)	(.004)	(.004)
Never married	.005	.003	−.001	.000
	(.015)	(.015)	(.017)	(.016)
R^2	0.012	0.021	0.007	0.028
Dependent variable: obesity	**Men**		**Women**	
Model:	(1)	(2)	(1)	(2)
Marital status	Coeff.	Coeff.	Coeff.	Coeff.
Early marriage (age <40)	Reference		Reference	
Later marriage (age ≥40)	−.009	−.008	.018	.019
	(.022)	(.023)	(.018)	(.017)
Cohabiting partners	−.010	−.010	−.006	−.007
	(.029)	(.029)	(.026)	(.026)
Divorced/Separated	−.017	−.017	−.006	−.009
	(.022)	(.022)	(.019)	(.019)
Widowed	−.029	−.028	−.007	−.006
	(.024)	(.024)	(.012)	(.012)
Never married	.005	.000	.018	.020
	(.048)	(.048)	(.030)	(.029)
R^2	0.009	0.026	0.000	0.035
NT=	38,752	38,752	47,617	47,617
N (individuals)=	8255	8255	9955	9955
T (periods per individual)	4.69	4.69	4.78	4.78

Models: (1) base model adjusts for age, survey wave (early life demographics are time-invariant and, hence, dropped). (2) Model with contemporaneous covariates, including household assets and health variables (see text).
Estimation notes: cluster-robust standard errors are in parentheses; estimates based on individuals aged 51–70 from all nine waves of the HRS/AHEAD data, 1992–2008, where present; all estimates weighted using person-level sample weights.
* $p < .1$.
** $p < .05$.
*** $p < .01$.

the early demographic variables are deleted since they are time-invariant (see model 1). Contemporaneous changes in health and assets are included in model 2. In that specification, deterioration in self-reported health status is associated with a statistically significant *increase* in BMI. However, changes in smoking status have little effect (in sharp contrast to the cross-sectional models). Assets and BMI are also negatively correlated, but not significantly.

Table 4 shows the fixed effects estimates for marital status changes. The strongest effects are due to widowhood, which has a negative effect on body mass for both men and women. Of course we cannot tell with the fixed effects estimates whether the effect is primarily due to gaining weight upon moving from widowhood to re-marriage or losing weight following spousal loss (though since the latter is a more common event in the data). In the cross-sectional analysis, those who were widowed differed little from the married groups, but these results suggest that widowhood has significant (and similar) effects for both men and women. Furthermore, that this effect shows up for ln(BMI) but not for obesity suggests that widowhood is affecting people across the distribution rather than just in the upper tail. Though less than half the size as observed in the cross-sectional models, the coefficients on separation and divorce are, for men, negative and statistically significant. For women, the sign is negative, but the effect is smaller and only marginally significant. For both men and women, the widowhood coefficient is larger than the divorced/separated coefficient, but the differences are not statistically significant.

Finally, perhaps the most striking difference between the cross-sectional and the fixed effects estimates is that the never married group in the fixed effects model has, after controlling for other factors, essentially the same body mass as the married (whether talking about early marriages or later marriages); in contrast, the cross-sectional estimates were very large. How can this difference be interpreted? Some might quickly dismiss the cross-sectional results as not being robust due to the inclusion of fixed effects. However, it is important to remember that when looking at changes over time and removing fixed characteristics, there is virtually no change in the never married category. By this age, those who have never married, rarely marry, and it is categorically impossible to move into the never married category from another marital state. So, by construction, the fixed effects model can tell us nothing about the never married compared to the continuously married—even though such differences are very large in the cross-section.

The transition models tell us more about the direction of the effects suggested by the fixed effects models above, though they can account only for baseline characteristics and do not account for unobserved heterogeneity, since there is no fixed effect term in the specification. Results from the transition models are shown in Table 5. In these models, the full complement of variables (both early life and contemporaneous covariates) are included since they can be treated as pre-determined variables held constant at their values *before* the marital transitions occur.

These models tell virtually the same story for widowhood as do the fixed effects estimates (though the estimated effects are even stronger in the transition models). Spousal loss is associated with a significant negative effect on body mass. Again, the effect on ln(BMI) is estimated with more precision than is the effect on obesity, though both are negative and non-trivial in magnitude. The effect is particularly strong for men. Furthermore, the effect seems to persist and even grow over time. With women, the estimated effect is smaller and tends to diminish over time.

These estimates also provide evidence that the differences in body mass between divorce and marriage are more a function of remarried people gaining than weight loss following divorce. Both men and women in this age group gain weight after marriage, with some evidence that the weight continues to grow (compared to those who didn't transition into marriage). Men who get divorced experience no weight loss, but men who marry have significant weight gain. This suggests that the significantly negative sign on the fixed effects coefficient for divorce/separation reflects not stress from spousal loss but, rather, weight gain associated with obtaining a spouse.

It is also noteworthy that those who remain single have essentially the same weight trajectory as those who remain married. The cross-sectional differences that are so apparent in Fig. 1 and Table 3 do not show up at all when looking at changes in weight over time, even when controlling for a variety of early demographic characteristics such as race and education.

4.3. Intra-couple correlation

The last analysis performed here relates to the correlation in body mass between spouses.

A simple random effects ANOVA model (see on-line appendix) shows that 70.0% of the total variation (including both the cross-section and longitudinal components) among this married sub-sample consists of variation at the individual-level, while 18.6% is at the couple level and 11.4% is residual variance. Across the waves of the survey, the simple correlation between husbands and wives is roughly .224, though it may not seem so at first glance, this is a very high correlation. For comparison purposes, the simple correlation between BMI and other important variables in the dataset is as follows: education, −.090; assets, −.138; and self-reported health, .178. Indeed, a spouse's BMI is a stronger predictor of one's own BMI than any of the other variables in the model. This is consistent with the growing literature on the spousal concordance of health status mentioned earlier.

Table 6 shows intra-couple correlations by length of marriage. As before, the top panel contains estimates where ln(BMI) is the dependent variable, and the bottom panel uses obesity as the dependent variable. The salient features of this analysis are the following: (1) the intra-couple correlation is declining sharply with respect to marital duration for both body mass measures; (2) strong correlation persists even after controlling for the full set of covariates; (3) the additional of covariates reduces the estimated correlation slightly, primarily for people who have been married longer; (4) the correlation for ln(BMI) is stronger than for obesity; (5) there is small but significant co-movement in BMI and obesity (though in the latter case it is *much* smaller).[38]

I interpret this evidence as strongly supporting the market sorting on the basis of BMI and opposing the shared risk factor model, at least when it comes to long-term relationships. The shared risk factor model predicts that the correlation would *increase* over time, not decrease, a finding which is consistent with Knuiman et al. (1996).[39] And recent marriages show a very high intra-couple correlation that does not change when a full set of covariates are added to the model. Thus it appears that sorting is occurring on the basis of body mass *directly*, rather than indirectly due to matching on characteristics such as education, race, religion or even health variables such as smoking and chronic conditions.

[38] To check for the robustness of these results, I also estimated residuals using first, Zellner's seemingly unrelated regression (SURE) approach (which is a feasible GLS estimator) and a latent growth curve (LGC) model that has a three part error structure: a couple-level component, a individual-level component, and an i.i.d. residual. In this analysis (not reported further here), the SURE-based correlations are extremely close to the OLS-based correlations used in Table 6. The LGC-based correlations follow, as well, a qualitatively similar pattern, though the actual estimated correlations are somewhat lower. Each of the five features just mentioned are present for both the SURE and LGC approaches.

[39] The and Gordon-Larsen (2009) find that the correlation does increase with duration, but that is for a sample of young adults in a short period immediately following marriage.

Table 5
Transition models.

Dependent variable: $\ln(BMI_{t+1}) - \ln(BMI_t)$	Time since transition					
	Men			Women		
Marital transition	0–2 years	2–4 years	4–6 years	0–2 years	2–4 years	4–6 years
Married→married	Reference			Reference		
Married→Sep./div.	.002	.003	.012	−.016***	−.002	−.006
	(.005)	(.006)	(.007)	(.005)	(.007)	(.010)
Married→Widowed	−.018***	−.019**	−.024**	−.022***	−.018***	−.012**
	(.007)	(.009)	(.012)	(.003)	(.004)	(.005)
Single→Married	.005	.014***	.013**	.011*	.020**	.015
	(.004)	(.005)	(.006)	(.006)	(.008)	(.012)
Single→Single	.001	.001	−.002	.000	.016	.003*
	(.001)	(.002)	(.003)	(.001)	(.001)	(.002)
Uncertain	−.009	−.007	.008	.001	.003	.016
	(.007)	(.013)	(.009)	(.007)	(.008)	(.011)
R^2	0.005	0.010	0.013	0.008	0.012	0.018
Dependent variable: $obesity_{t+1} - obesity_t$						
	Men			Women		
Marital transition	0–2 years	2–4 years	4–6 years	0–2 years	2–4 years	4–6 years
Married→married	Reference			Reference		
Married→sep./div.	−.017	.026	.039	−.002	.000	.004
	(.023)	(.026)	(.032)	(.024)	(.029)	(.032)
Married→widowed	−.053*	−.061**	−.045	−.027*	−.016	.004
	(.028)	(.029)	(.034)	(.015)	(.017)	(.021)
Single→married	.013	.009	.004	.019	.047**	.040
	(.019)	(.023)	(.031)	(.023)	(.024)	(.033)
Single→single	−.002	.001	−.001	−.004	−.004	−.004
	(.004)	(.006)	(.009)	(.003)	(.005)	(.006)
Uncertain	−.034	−.002	.038	−.028	−.027	.008
	(.029)	(.039)	(.057)	(.021)	(.031)	(.027)
R^2	0.003	0.004	0.004	0.008	0.002	0.003
NT=	33,073	26,573	20,537	40,696	32,980	25,734
N (individuals)=	7901	7127	5440	9617	8770	6834
T (periods)=	4.19	3.73	3.78	4.23	3.76	3.77

Estimation notes: the initial period, "0–2 years," represents the effect of a marital transition from period t to $t+1$ on the dependent variable in period $t+1$, where time is measured in 2-year increments, holding constant independent variables at their values in period t. Covariates include age, survey wave, race/ethnicity, education, parents' education, religion and region of birth, household assets and health variables. Cluster-robust standard errors are in parentheses; estimates based on individuals aged 51–70 from all nine waves of the HRS/AHEAD data, 1992–2008, where present; all estimates weighted using person-level sample weights.

* $p < .1$.
** $p < .05$.
*** $p < .01$.

Table 6 also shows a modest (and statistically significant) co-movement in BMI between periods, suggesting that some type of unobserved variable, be it coordinated behavior (a new exercise plan) or common shock (loss of a loved one), is moving body mass between periods. Co-movements in spousal BMI has been found in previous research (Jeffery and Rick, 2002; Brown et al., 2010), and Christakis and Fowler (2007) show that weight change in one spouse leads to similar changes in the other.[40] But these co-movements do not appear to be *persistent* risk factors, since the correlation does not increase with respect to marital duration (or over time, as indicated by the minimal impact of adding in time controls in model 2).

Finally, the regression estimates used to calculate the correlations in Table 6 are reported in the Appendix and are very similar to the cross-sectional estimates in Table 3 (and, hence, have the same limitations), but the sample used for Table 6 is restricted to married individuals. I also add length of marriage as an additional explanatory variable. The coefficient on marriage length (which is significant and positive for women, and trivial and negative for men) is consistent with the previously estimated cross-sectional patterns: long-term married women are heavier than recently married, but essentially no differences exist for men with respect to marriage duration.

[40] Falba and Sindelar (2008) also show significant co-movement in a variety of spousal health-related behaviors in the HRS.

Table 6
Intra-couple correlations.

Dep. var: ln(BMI)		Model			
Length of marriage	N	(1)	(2)	(3)	(4)
0–2 years	320	0.349	0.345	0.357	0.333
2–5 years	657	0.309	0.308	0.308	0.292
5–10 years	1,160	0.309	0.293	0.267	0.264
10–20 years	3,009	0.241	0.223	0.188	0.165
20–40 years	17,274	0.223	0.214	0.188	0.171
40+	11,070	0.200	0.179	0.159	0.130
All	33,490	0.224	0.212	0.188	0.167
Intertemporal correlation	25,130	0.075	0.073	0.073	0.067
Dep. var.: obesity		**Model**			
Length of marriage	N	(1)	(2)	(3)	(4)
0–2 years	320	0.268	0.271	0.267	0.231
2–5 years	657	0.260	0.262	0.258	0.203
5–10 years	1,160	0.254	0.246	0.233	0.211
10–20 years	3,009	0.189	0.182	0.151	0.121
20–40 years	17,274	0.149	0.141	0.124	0.111
40+	11,070	0.153	0.137	0.123	0.102
All	33,490	0.161	0.152	0.135	0.116
Intertemporal correlation	25,130	0.018	0.018	0.018	0.018

Models: (1): no controls; (2): age, survey wave, length of marriage; (3): model (2) + early life demographics; (4): model (3) + contemporaneous health and assets.

Notes: All correlations are based on estimated residuals from OLS estimates of Eqs. (4) and (5) in the text (see Appendix for full regression results). All estimates are weighted by the couple-specific sampling weight. The "Intertemporal Correlation" represents the simple correlation between the husband and wife with respect to the between-period change in residuals ($e_t - e_{t-1}$) calculated from the regression estimates. All estimated correlation coefficients are significant at $p < .01$.

5. Discussion

The preceding analysis casts light on four theoretical models of the marriage–body mass interaction. Two of these are economic models, the health investment model and the market sorting model; and two are sociological models, the crisis model and the shared risk factor model. These models do not yield mutually exclusive hypotheses. Indeed, they may all play some role. Additionally, some of the assumptions overlap across the models, as indicated earlier.

The theory that does most poorly in light of the evidence is the health investment model. This is particularly true for men, where both the cross-sectional and longitudinal evidence in the data suggests that marriage promotes weight gain, not weight loss, whether controlling for other demographic variables and contemporaneous health status or not. According to the model, men in long-standing marriages should have the lowest body weight and the never married the heaviest. I find the opposite. And the long-term married are heavier than the other non-married groups as well. Additionally, the more recently married have only trivially higher BMIs than those in longstanding marriages, which does not support the theory.[41] For men, especially, marriage is simply not a weight-reducing institution. The "fat and happy" moniker seems far more appropriate.

The theoretical pattern predicted by the investment model works slightly better for women than for men but still is not consistent with predicted patterns. Instead of the long-term married having the lowest body mass, women in later marriages and in cohabiting partnerships weigh significantly less in the cross-section, even with a full set of controls. The fixed effects and transition models further inform the investment model. The estimated effects in Tables 4–5 reveal that, at least with the age range under study, marriage leads to weight gain and marital dissolution to weight loss—for both men and women. In short, the only piece of evidence linking marriage to any kind of coordinating behavior consistent with health investment is that changes in weight over time (meaning those not predicted by other factors) tend to be correlated between spouses. But these changes involve both gains and losses, not a consistent movement in the same direction, and could be explained by any number of shared risk factors.

Some (Wilson, 2002; The and Gordon-Larsen, 2009) have used intra-couple correlations to argue that a shared marital environment (including shared health investment behavior) contributes to BMI. Spousal concordance with respect to body mass is, indeed, clearly evident from the results in Table 6. However, the intra-couple correlation is not related to duration of marriage in any of the models estimated, and even though observed demographic factors can explain non-trivial part of the intra-couple correlation in BMI, those demographic factors are all present at the time of marriage. These results, thus, point not to a shared

[41] Although those married after age 40 are for the most part remarriages, the fact that their previous marriages ended in divorce is used here to infer that those initial marriages were of poor quality than successful ones and should, therefore, have lower cumulative health benefits (not to mention the negative effects of the dissolution process, as suggested by the crisis model).

environment but to sorting on BMI in the marriage market. That the marriage market is sorting *directly* on BMI, rather than simply on factors correlated with it, is also supported from previous research by the relative *lack* of spousal concordance between health-related factors less salient in the market than body mass. For instance, the intra-couple correlations for cardiovascular risk factors are much lower than for BMI or smoking (Inoue et al., 1996; Di Castelnuovo et al., 2009) and is insignificant for cancer (Friedman and Quesenberry, 1999).

Why, then, does marriage not promote a healthy BMI, even after controlling for other health factors? Other researchers (Averett et al., 2008) have recently argued that social obligations may play in important role (though they do not have direct evidence for that), particularly with respect to how eating patterns change upon marriage. In my theoretical framework, I categorize marital obligations as one of many shared risk factors that may affect body mass. In support of that view, a limited but growing body of literature explores the interaction between diet and marriage. A study (Yannakoulia et al., 2008) in Greece, for instance, finds that married couples have a healthier (Mediterranean) diet, even though they weigh more than singles. They note that, in general, being married is associated with more healthful eating habits, including eating more fruits and vegetables. Other research has shown that married people smoke less (Umberson, 1992), and also exercise less (Nomaguchi and Bianchi, 2002), both factors that will increase body weight. More research may show that increased body weight is an unfortunate side effect of marriage even as married life is associated with patterns of behavior related to weight gain that are, on balance, health-promoting. The lack of any sort of duration effect on the intra-couple correlation is a strike against the shared risk factor model, but the co-movement of BMI in couples is consistent with couple-level influences, including coordinated behavior. Thus even though there may be more going on than simple sorting, the strong intra-couple correlation present at the time of marriage is explained *only* by market sorting.

The crisis model finds some support but does not fit all the empirical patterns. A small transition effect that decreases over time is found with respect to divorce/separation, which is consistent with the theory. The significant negative effects of widowhood also suggest an important role for psychological forces, since it seems unlikely that physiological response to the loss of a spouse is merely strategic behavior to improve the likelihood of re-marriage. The greater effect for widowhood (relative to divorce) is also consistent with the idea that marital stress usually sets in long before separation occurs and widowhood in this age cohort is often quite unexpected (since the crisis with divorce starts before widowhood, we would expect the post-dissolution effect to be smaller).[42] For those cases where death is anticipated, the stress of caring for a dying spouse has a variety of negative physiological findings, particularly with respect to stress hormones and antibodies (Vitaliano et al., 2003).[43] Additionally, the findings with respect to a strong widowhood effect for men are supported by recent work on mortality (Elwert and Christakis, 2008), who show that widowed men face a elevated mortality risk that is not due to homogamy bias (or, in other words, not due to shared spousal risk factors).

The crisis model has problems, however. The changes associated with entry into marriage seem to be growing over time, and the significant negative effects of widowhood diminishes only slightly for women and actually increases for men 4–6 years after the transition. Thus a clear story of marital transitions leading to *temporary* changes in BMI is not readily seen in the HRS. Furthermore, the transition models suggest that transitions from divorce to re-marriage lead to weight gain, but transitions from marriage to divorce do not cause significant weight loss. Moreover, the crisis model cannot predict the strong gender-based cross-sectional differences in the data. As noted earlier, this is a sample containing few marital transitions, so any temporary effects occurring from transitions in the past should have mostly washed out.[44] For instance, the BMI of never married men is starkly different from never married women. But since these groups have gone through no marital transitions in their lives, how can crisis theory explain the differences? It may be that the effect of non-marital transitions, such as repeated failures of dating unions may be different for men and women, but the transition stress model is about transitory effects, not the cumulative effects of previous transitions (whether marital or non-marital). Thus, the cross-sectional patterns in the data, especially gender differences between the never married, speak against any theory of transitory effects.

I have inferred the presence of marriage market forces from the observed consequences on the distribution of BMI, particularly the cross-sectional distributions and the fact the large gender differences persist in that distribution. There is also direct evidence for market selection in the HRS, which I obtain by investigating how body weight affects selection into marriage for men and women. Factors, such as BMI, affecting transition into marriage at older ages are likely very different than the factors that influenced marital formation when this sample was younger, yet the exploratory findings among these older adults show strong gender differences consistent with the market sorting account. This analysis is summarized in Table 7. Using the same control variables discussed earlier, I find that body mass is positively associated with marriage probability for men and negatively associated with marriage probability for women. For women on the other hand, obesity is associated with a lower probability of

[42] Obviously data on BMI at each point in the transition process would be very helpful, but I know of no large data source that provides this kind of detail.

[43] These authors' review of the caregiving and physical health literature, however, shows, overall, only slight effects of caregiving on health problems.

[44] It is important, however, that in this sample, many of the widowhood transitions have occurred relatively recently.

Table 7
Entry into marriage.

	Men		Women	
BMI category	β	Prob.	β	Prob.
BMI < 25	Reference	.035	Reference	.024
25 < BMI < 30	0.517**	.057	0.013	.024
	(*.207*)		(*.179*)	
30 < BMI < 35	0.663***	.065	−0.687***	.013
	(*.236*)		(*.255*)	
BMI > 35	0.702**	.067	−0.697**	.012
	(*.340*)		(*.311*)	

Notes: The β values are logit coefficients, and "Prob." is the predicted probability of the transition. The estimated model includes age, survey wave, and early life demographics including, race/ethnicity, education, parents' education, religion, region of birth, self-reported health, smoking history, chronic conditions, and household assets. Cluster-robust standard errors are in parentheses; estimates based on individuals aged 51–70 from all nine waves of the HRS/AHEAD data, 1992–2008, where present; all estimates weighted using person-level sample weights.
** $p < .05$.
*** $p < .01$.

getting married (these effects are statistically significant, but the marriage rate in this age group is quite low for both men and women, as noted earlier).[45] Though marriage probability as a dependent variable is not the focus of this study, this exploratory evidence is consistent with the market sorting hypothesis (and its accompanying incentives for weight-related behavior).[46]

In short, the data patterns predicted by the market sorting model, both in terms of cross-sectional and longitudinal variation, are found in the HRS data. This is not to say, however, that market forces are driving all the outcomes. For instance, the analysis here finds significant declines in weight loss for both men and women following widowhood. Indeed, this is the strongest finding from the longitudinal analysis and seems much more likely to be due to psychological effects or, possibly, shared risk factors than to market forces. This speaks to the relevance of the crisis model for understanding the impact of spousal death, even though the crisis model has difficulty in explaining all the patterns in the data, especially long-term differences and sharp gender differences. It may be that the crisis model is faulty primarily in the assumption of transitory effects. A more robust theory that accounted for both transitory and persistent psychological distress—linking that distress to gender—might better account for the patterns in the data, though that theory has yet to be developed to my knowledge.

6. Conclusions

A satisfying theory needs to account for both the effects of marital transitions over time and how those effects accumulate to reflect the cross-sectional distribution in later life. The cross-sectional and longitudinal evidence here is strongly consistent with the theory that low body mass—being both highly observable and highly valued—has a profound effect in the marriage market, both shaping selection into and out of the market and, more importantly, sorting among potential mates, especially when allowing for gender-differentiated preferences about spousal weight. Incentives to do well in the market along with different preferences can explain a high spousal concordance in BMI at the time of marriage, weight gain following marriage, and weight loss following marital dissolution. Market sorting is also consistent with the cross-sectional patterns in the data as well as transitions occurring over time.

The other theoretical models do not fare as well, particularly the health investment model. Other than co-movements in BMI between spouses (which could also be predicted by other shared risk factors), there is no evidence that marriage induces healthy body weight. The crisis model, on the other hand, is consistent with the short-term transitions associated with divorce/separation but cannot account for the *persistence* of the effects of widowhood or entry into marriage. However, it is important to note that the evidence causing problems for the crisis model is even more infirming of the health investment model since the persistent marital effects are in the direction of the married being heavier, which contradicts the investment model. Finally, the shared risk factor model can explain co-movements between spouses, but the analyses fail to find any effect of marital duration on intra-couple correlation, a key prediction of the model.

The patterns uncovered here merit further inquiry. Important aspects of marriage, such as the long-term psychological effects of living in different marital states or the importance of marital quality or marital processes, have not been explored here. I have emphasized the role of the marriage market, but most of the important effects of the marriage market are likely to occur earlier in life when first marriages are formed (or fail to). I have also placed emphasis on marital transitions, but, again, this is a sample with a low transition rate. It is very possible that marital

[45] Mukhopadhyay (2008) shows the same effect for younger women. It may be that the gender-differentiated preferences regarding body weight are getting even stronger as people age—women care even less and men even more, though I don't have direct evidence for that.

[46] Even if preferences regarding partner weight might be less strong at older ages, men and women seeking partners in later life face a very imbalanced sex-ratio. The tendency of men to prefer lighter women is reinforced by the market forces created by the imbalanced sex-ratio.

transitions earlier in the life-cycle have different effects on body weight.[47] The role of other demographic variables such as education, socioeconomics, availability of partners, and race also deserve further attention. African American women, in particular, have the highest body weight and the lowest probability of being married in later life. Blacks and whites have very different body weight trajectories, which differ by gender as well (Baltus et al., 2005). Marriage may play an important role in understanding these different trajectories (Shafer, 2010).

In interpreting the empirical results, I have used gender (particularly gender-differentiated preferences for mates) as a diagnostic key to uncover the impact of market sorting. But, on a normative basis, gender is important in its own right. What the results here suggest is that the marriage market is not kind to overweight and obese women. However, the commonly repeated story that marriage confers health benefits on men but not on women finds no support in this data. The longitudinal evidence suggests that the effects of marital status transitions are roughly the same (and negative) for men and women. And in late middle-age, the groups with the highest BMIs are unmarried women and married men. Thus from this data it would be very hard to tell a story that men are taking a disproportionate share of the benefits from marriage.

Since Becker's early work, economists have heralded market sorting as an efficiency-enhancing characteristic of the marriage market: more sorting leads to higher aggregate household production in the economy. But assortative mating also leads to more inequality. Some (Hebebrand et al., 2000; Jacobson et al., 2007) have even argued that the obesity epidemic—an important part of which is the *widening* of the distribution in body weight—is due, in part, to assortative mating.[48] Wilson (2001) showed that the spousal concordance of poor health (including obesity) among married couples is primarily a phenomenon occurring among households of low socioeconomic status, whereas high SES couples are relatively untouched. Even as increases in life expectancy can be thought of as a leveling of lifetime health, marital sorting undermines those leveling trends.

In conclusion, the evidence presented here suggests that marriage has small effects on body mass that are, unfortunately, in the *opposite* direction of what marriage advocates might hope. In short, any investments in a healthier body mass that might be taking place due to coordinated investment behavior are being trumped by other forces. In particular, the imprint of powerful marriage market forces on both behavior and the distribution of body mass across the population are clearly evident.

[47] Data from the NLSY (which surveys younger adults) may show the opposite gender effects: women gaining weight after marriage and men gaining weight after divorce (Tumin and Qian, 2011). But that study cannot be seriously evaluated because the authors refuse to release it publicly, even though the paper was presented at academic meetings and discussed widely in the popular press.

[48] As age of marriage has increased, marriage market participants are better able to predict what the BMI of potential mates will be in the future. Also, individuals who marry later have more experience and may make better matches. Therefore, it is quite plausible that increasing age at marriage will result in greater assortative mating. This will, in turn, widen the distribution of BMI in the subsequent generation, thereby raising the prevalence of obesity.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ehb.2012.04.012.

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