PERGAMON

Social Science & Medicine 55 (2002) 1157–1172

SOCIAL SCIENCE & MEDICINE

www.elsevier.com/locate/socscimed

The health capital of families: an investigation of the inter-spousal correlation in health status

Sven E. Wilson*

Departments of Political Science and Economics, Brigham Young University, 732 SWKT, Provo, UT 84602, USA

Abstract

This study documents and analyzes the inter-spousal correlation in health status (ISCIHS) among married couples in later life. A simple economic theory is developed that integrates standard theories of marriage markets and health capital formation. This theory implies that several causal factors will lead to a positive correlation in the health status of spouses. These include assortative matching in the marriage market along dimensions related to health (such as education); a tendency to share common life-style behaviors such as diet, smoking and exercise; shared environmental risk factors for disease; and a potential for direct effects of the health of one spouse on the health of the other. Empirical estimates using the 1992 Health and Retirement study in the USA demonstrate that ISCIHS is large in magnitude, highly statistically significant, and robust to alternative measures of health status. ISCIHS exists even after controlling for age, education, income, and other socioeconomic and demographic determinants of health status, including behavioral risk factors. These covariates reduce the overall correlation coefficient by 33% to 57%, depending on the health measure, which suggests both that marriage formation and decision making processes systematically affect health in later life and that heretofore unidentified risk factors for disease and disability exist at the household level.

Keywords: Health production; Economics of the family; Marriage markets; Shared risks; USA

Introduction

A frequently studied topic across the various disciplines of social science is the robust empirical relationship between health and marital status. But while we know that health varies significantly across martial status categories, we know little about how the characteristics of marriage influence health *within* the married category. In other words, how does the formation, structure and maintenance of marital relationships affect the various human physiological processes that occur across the life cycle? Just as individuals are heterogenous, couples also differ markedly from each other. Surely only a very limited answer to the question posed above can be obtained simply by comparing the married to the unmarried.

While health economists have typically incorporated marital status as part of the health production function, they have largely left theorizing about the health-marriage relationship to sociologists, who have emphasized that marriage provides, among other things, health-improving "social-support." The lack of economic research in this area is surprising because economists can bring two major branches of theory to bear upon this question. The first is the notion of health capital investment, as pioneered by Grossman (1972). The second is Becker's (1973, 1974) theory of marriage, which posits that marriages are created in marriage markets that reveal the value of individual characteristics such as education or attractiveness.

The objective of this paper is to take a few modest steps in integrating these theoretical strands, thereby working towards a health economics of the family. I propose a simple model that integrates the health capital and marriage market theories and argue that a central

*Fax: +1-801-378-9018.
E-mail address: sven_wilson@byu.edu (S.E. Wilson).

0277-9536/02/$ - see front matter © 2002 Elsevier Science Ltd. All rights reserved.
PII: S0277-9536(01)00253-2

implication of this theory is that the health of spouses should be positively correlated (meaning that the health status of a married individual tends to mirror the health status of his or her spouse). I will then document that the inter-spousal correlation in health status (or ISCIHS) does indeed exist and is robust to a variety of different health measures. Finally, I will evaluate the evidence for and against 3 different theoretical reasons why ISCIHS exists, outline the implications of these findings, and suggest directions for future research.

Health capital and the family: theoretical and empirical foundations

Except for those who live alone, the food we eat, the air we breathe, the recreational activities we perform, the neighborhood we live in, and the type of medical care we receive are all influenced by relationships within the household. Since all of these factors contribute to health, it makes eminent sense to model health production as occurring in a social context, in which the family is a central feature. Parsons (1977) argued that the family is an "informal health service organization," but this insight, while obviously true, is still much too narrow a conception of how families influence health. Families determine health outcomes not only because they help individuals cope with the burdens of poor health, but also because they are intrinsically involved in the creation of health capital across the life cycle. Furthermore, it is plausible that the demand for health is fundamentally related to the process of marriage and family formation.

The starting point for modern studies of health demand is the seminal work of Grossman (1972), who argued that health can be treated as a stock of human capital that can be utilized both in earning wages in the labor market and in producing household commodities. Consequently, rational individuals will invest in their health capital through the purchase of medical care or through behaviors such as diet and exercise in such a manner that the present value of expected net benefits of health investment is maximized. As individuals age, the depreciation rises and eventually the health capital stock is allowed to decline until it falls below the subsistence level and the agent dies.

A simple extension of the health capital framework is to consider a household which invests in the health of all members to maximize total household utility. Of course the immediate weakness of this approach is that *households* do not make investment and consumption decisions, *individuals* do. Therefore, a bargaining mechanism by which individuals agree on the allocation of resources across household members is necessary. Although many bargaining models of marriage exist, a natural place to begin the analysis is with Becker's marriage market model mentioned previously. In the Becker model, the competitive market is the mechanism that allocates resources across partners. Each agent has a set of observable characteristics which can be combined with the characteristics of potential partners to produce household commodities. Characteristics which are complementary will result in positive assortative matching—the matching of likes.[1]

What is largely missing from the economic literature is that these two theories can be integrated to build a theory of health capital formation within the family.[2] There are several key points of intersection between the theories. First, health capital is a vital input in the household production process since it affects both wage income (which is used to buy market goods) and productivity within the household. Indeed, household production theory is grounded in human capital, which is the central resource in producing household commodities.[3] Second, consumption decisions over the course of the marriage can affect the health of the married couple. Third, many factors which affect health (both observable and unobservable), are shared by the couple. And finally, the same characteristics which are traded in the marriage market (education, religion, family background, etc.) are also characteristics that affect health. Indeed, it may even be that the health capital of individuals is one of the characteristics that determines marriage matches.

Appendix A to this paper formalizes the ideas mentioned here in a simple two-period model of health capital formation within a marriage, using the marriage market as the allocative mechanism. The essential features of this model are that men and women match together according to a vector of characteristics, X^{f} and X^{m}, respectively, that are present and observable at the time of marriage. These are assumed to include factors such as family background, education, religion, occupation and social class. Over the course of their lives they also choose a set of health-related behaviors, R^{f} and R^{m}. These include choices concerning diet, exercise, work habits, smoking, or other investments in health. Furthermore, there are other risk-factors, Θ_{f} and Θ_{m}, which are not observable to the agents in the model, nor to the econometrician. The first order conditions derived in the model can be solved, in principle, to produce

[1] Sociologists typically explain these correlations as functions of relationship networks or socialization, both of which result in "endogomay" or "homophily." See Laumann, Gagnon, Michael, and Michaels (1994) for a thorough discussion of the theoretical debate.

[2] The recent work of Jacobson (2000) extends the Grossman model slightly in that a single decision maker makes health-investements for a multi-member household, but this model does try to address marrige market literature or assortative mating.

[3] A seminal paper in this vein is Michael (1973), who argues that education augments productivity in the household.

health demand equations as functions of the X and Θ variables and demand, as well as optimal equations for R^{f} and R^{m}.

Hypotheses

Of course the health demand equations in this model will depend on the specification of the individual utility functions, household production functions, characteristics of marriage and commodity markets, and the health production functions. Exploring the implications of different assumptions should be an important topic for future theoretical research in this area. For the purpose of this analysis, however, I argue that a central implication of the theoretical model discussed above is that the health status of spouses should be positively correlated. This overarching hypothesis is derived from four sub-hypotheses, all of which lead to ISCIHS, and none of which are mutually exclusive. These sub-hypotheses are stated below:

H1: Assortative mating*. Two types of sorting are likely to occur in the marriage market. First, marriage markets sort couples according to the variables that affect health over the life cycle, including education, religion and social class. Thus marital selection has an indirect impact on the correlation in partners' health in later life. Second, health status may be traded directly in the market. In short, ones's value on the marriage market increases with one's health.[4] Although health may be difficult for potential mates to observe and to verify, indicators of health such as weight, diet, smoking, and exercise are observable in the market. Furthermore, evolutionary theory strongly implies that individuals will seek to find mates who are in robust health and can produce and care for offspring.

H2*: Common life-style risk factors*. Married couples have several life-style risk factors in common.[5] In the context of the present model, we expect that R^{f} and R^{m} will be positively correlated because they are likely complementary in the production of household commodities, such as leisure activities. Although life-style risk factors are, to a degree, a direct product of marital selection, two couples who are observationally equivalent at marriage will make a variety of different choices and have different experiences that affect their risk of illness in later life.

H3: Shared environmental risk factors*. Beyond observable life-style variables, which are predominantly endogenous, married couples share a variety of exogenous risk factors, many of which may be unobservable to them. They breathe the same air, come in contact with many of the same people, and, in general, are exposed to the same disease environment. Of course the difficulty of confirming this hypothesis empirically is that it is not possible for the econometrician to distinguish between environmental risk factors and life-cycle risk factors not observed in the data.

H4: Direct health effects*. H2–H3 both depend on shared risk factors to explain ISCIHS. But it is possible that the health of a spouse has a direct effect on one's own health. An obvious example would be infectious diseases, including sexually transmitted disease. Other direct effects stem from the burden imposed on the spouse such as financial stress or fatigue from providing care to an unhealthy partner. Studies of caregivers have shown that the stress of caring for a spouse can reduce one's own health (Schulz, O'Brien, Bookwala, & Fleissner, 1995).

Empirical background

There is a large scientific literature comparing the health of married people to unmarried. In the 1970s and 80s a flurry of studies appeared that established a strong relationship between marital status and health. In addition to highlighting this empirical regularity, seminal papers by Cobb (1976) and Cassell (1976) introduced the concept of "social support," which in various forms has dominated the sociological literature related to health and epidemiology, though the mechanisms by which health is affected are still not well understood. The studies reviewed by Cobb and Cassell were primarily cross-sectional, but the marital status effects were confirmed in prospective community studies of mortality risk in Alameda County, California; Tecumsah, Michigan; and Evans County, Georgia, as well as several studies in Europe.[6]

It is in the area of mortality that a positive role for marriage finds its strongest support. Recent work has confirmed the results of the community studies and

[4] Behrman, Birdsall, and Deolalikar (1995) find evidence from south–central India that unobserved determinants of success in marriage and in labor markets are positively correlated, indicating that the marriage market equilibrium utilizes types of human capital in addition to observed education measures. Lillard and Panis (1996) discover two kinds of marital selection: adverse selection, where unhealthy males are more likely to remarry because they have high benefits from marriage (and high benefits from hiding their health status from potential mates); and positive selection on unobservables that promote health. Contrary evidence is found in a recent study in the Netherlands (Joung, Vand De Mheen, Stronks, Van Poppel, & Mackenbach, 1997), which finds no statistically significant effect of the presence of chronic conditions on the odds of marriage.

[5] The term "life-style" is broadly defined here to include all socioeconomic (health insurance, occupation, etc.), behavioral (smoking, diet, etc.) and other risk factors which the agents choose after the onset of marriage.

[6] See House, Umberson, and Landis (1988a, b) for reviews of the theory and evidence relating social support to health.

offered additional exploration of the causal pathways through which marriage affects mortality, with somewhat contradictory results. Hu and Goldman (1990) perform extensive international comparisons to show that the mortality risk is highest for divorced persons (especially men) and that the excess mortality of unmarried persons, as of the date of their study, has been increasing over recent decades. Zick and Smith (1991) find that the "protective effect" of marriage works predominantly for men, and that married women do better because of improved economic status. They find no support for the hypothesis that healthier people are selected into marriage (though they actually have no health data other than subsequent mortality in the study), though Goldman (1993) notes that valid inferences about marital selection cannot be drawn from differential mortality across marital status groups. Lillard and Waite (1995) demonstrate that the mortality hazard for men drops immediately upon marriage and returns to the unmarried rate upon marital dissolution, while women experience a steady decline in the hazard with each year of marriage. Their research indicates that men gain from marriage by a change to a more "settled" life-style, whereas women gain predominantly through access to increased financial resources.

As noted above, most of the existing research makes inferences about the role of marriage by making comparisons across marital status categories. A limited amount of research, however, does try to look to see what is happening within marriage that might affect health.[7] Recent work of Wickrama, Lorenz, Conger, and Elder (1997), for instance, tries to capture the role of marital quality on health using a model of latent marital quality to examine illness patterns in a small ($N = 364$) sample of Midwestern couples. In an important study very similar in spirit to the analysis presented in this paper, Smith and Zick (1994) show a correlation in mortality between spouses and conclude that shared risk factors of household smoking, risk avoidance behavior, poverty and children affect husbands' and wives' mortality in similar ways.

Methods

Health data and health measurement

This study exploits data from the 1992 Health and Retirement Survey. This is a nationally representative sample of the US population aged 51–61 in 1992. Information was obtained from face-to-face interviews of all age-eligible respondents and their spouses. The analysis presented here uses all married couples living together at the time of the survey in 1992. When the couple is considered the unit of observation, this sub-sample is representative, of co-habiting married couples with at least one spouse in the target age range. HRS-supplied sampling weights are applied throughout.

This study attempts to support the robustness of the conclusions by using three different health measures. The first is self-assessed general health status (SAGHS). Respondents are asked to rate their overall health as either excellent, very good, good, fair or poor. SAGHS is a strong correlate of more "objective" health measures, and in many cases, subjectivity is actually an asset for economic questions, particularly when the task at hand is understanding the myriad human choices that rely on individual perceptions of health more than they depend on an objective measure of health status.[8]

The second measure of health employed is disability as captured by an index of functional limitations and activity restrictions (IFLAR).[9] The index was calculated following the methodology of McClellan (1998) and Smith and Kington (1997), where an overall score is obtained by adding 1 point for a minor difficulty and 2 points for a major difficulty. The scores are then scaled from 0 to 100.

The final health measure employed is the weighted chronic disease index (WCDI). This index incorporates physician-diagnosed chronic conditions, as reported by the respondent. Rather than simply counting the number of conditions, a method which treats all conditions as having equal impacts on health, the WCDI is obtained by regressing the IFLAR on the set of binary disease variables (and age) and using the regression coefficients as weights in counting the number of conditions.[10] In theory, this index is designed to remove the subjective portion of IFLAR that varies across individuals, though WCDI, based on binary indicators of disease, loses information about the severity of conditions as reflected in the IFLAR. Another shortcoming is that WCDI captures only the effect of disease upon physical functioning, even though

[7] See Ross, Mirowsky, and Goldsteen (1990) for a review of many of the demographic and socioeconomic patterns relating to health.

[8] Potential problems in using self-reported health measures, such as SAGHS, are discussed in Bound (1991) and Dwyer and Mitchell (1999).

[9] The functional limitations represent how difficult it is to perform the following tasks: walk several blocks; climb a flight of stairs; climb several flights of stairs; lift 10 lb; pull or push large objects; pick up a dime from a table; stoop, kneel or crouch; sit for long periods of time; get up from a chair; get in/out of bed without help; bathe or shower without help; extend arms above shoulders; eat without help; or dress without help.

[10] The chronic conditions are: hypertension, diabetes, cancer, lung disease, heart disease, stroke, psychological disorders, arthritis, asthma, back trouble, feet and leg trouble, kidney disease, ulcers, broken bones, and head injury.

chronic disease may have other serious impacts such as reductions in life-expectancy or an increased risk of subsequent disease.

Covariates

In addition to the health variables discussed above, various socioeconomic and demographic variables can be exploited in the HRS including three of the most important correlates of health—age, education and income. Education is measured here with years of schooling, and income is measured by the total household income in 1991, the year before the survey. Additional socioeconomic and demographic controls include race, nativity, religious activity (whether the individual attends church services at least once per month), parent's education, duration of marriage (in years) and presence of health insurance.

A variety of health behaviors are also present. Daily cigarette consumption is classified as light (1–10), moderate (11–20), heavy (21–30) or very heavy (31+), with a distinction made between current and previous smoking. Drinking is number of drinks per day with categories including non-drinker, light (less than 1), moderate (1–2), heavy (3–4), very heavy (5 or more). The physical exercise variable is calculated from two separate questions on regular exercise, one focusing on vigorous exercise such as running, and light exercise, such as walking. The five exercise categories are based on the author's categorization of responses to both these questions. "Very heavy" exercise constitutes regular rigorous exercise, "light" exercise consists only of intermittent non-rigorous exercise, while moderate and heavy exercise constitute a combination of rigorous and non-rigorous exercise.[11] Finally, obesity, which is influenced by diet, is proxied with body mass index (BMI), which is a commonly used metric defined as weight in kilograms divided by the square of height in meters.

An empirical framework

The model sketched above and discussed more formally in the appendix implies that health status at a point in time for husbands and wives (H^{f} and H^{m}, respectively) is a function of behavioral risk factors, R, and other observable characteristics, X determined early in life:

$$
\begin{aligned}
H_i^{\mathrm{f}} &= \alpha_0^{\mathrm{f}} + \alpha_1^{\mathrm{f}} X_i + \alpha_2^{\mathrm{f}} R_i + \varepsilon_i^{\mathrm{f}}, \\
H_i^{\mathrm{m}} &= \alpha_0^{\mathrm{m}} + \alpha_1^{\mathrm{m}} X_i + \alpha_2^{\mathrm{m}} R_i + \varepsilon_i^{\mathrm{m}}.
\end{aligned} \tag{1}
$$

In this specification, i indexes each married couple, and the X_i and R_i vectors contain both the husband's and the wife's variables. For ease of exposition, the i subscripts will be suppressed hereafter.

As noted above, three different measures for H are employed. IFLAR and WCDI are continuous measures, and SAGHS will be treated as a continuous measure with values ranging from 1–5, even though the data is reported as categorical. The X vector represents the variables, such as education, that are either present at time of marriage or determined early within the marriage. These include age, nativity, religiosity, education, parent's education and marital duration. In discussing the results, the R covariates are divided into two types: R_{E} represents the economic variables, income and health insurance, while R_{H} includes the health behavior variables outlined above: smoking, drinking, exercise and diet.

Since the regression equations estimated above contain the same variables on the right-hand-side of the equation, no efficiency gains are possible from bivarate regression, such as the method of seemingly unrelated regressions (SUR), which was introduced by Zellner (1962). The "full model" therefore is obtained with OLS regression. Restricted models which are used to explore the impact of different sets of covariates will, however, be estimated with the SUR technique, since it provides a convenient and efficient way to estimate the residual correlation, σ_{fm}; which is the unexplained component of ISCIHS.

Estimating health status always raises serious questions about the potential endogeneity of the regressors. One type of endogeneity results from the fact that R is technically an endogenous variable: it is chosen by the agent as a solution to the optimization problem. However, in this case R is assumed to depend on X, but not the other way around. In other words, the system is fully recursive. Given the recursive structure assumption, both α_1 and α_2 are identified and can be estimated consistently.[12] However, the α_1 coefficients do not reflect the full effect of X on H (unless $\alpha_2 = 0$) because the effect of the X variables also works through R: Estimates of $\mathrm{d}H/\mathrm{d}X$ can be obtained through combining $\hat{\alpha}_1, \hat{\alpha}_2$ with coefficients from a regression of R on X.

A more serious form of endogeneity results from ignoring the possible dependence of R on H. For instance, physical exercise may promote good health, but the exercise may also be a response of the individual to negative health indicators such as hypertension or diabetes. Two approaches for addressing this type of endogeneity exist. The first is to find appropriate instruments for R. The problem with this approach is that identification of (1) requires finding instruments that are highly correlated with R but not with H, which

[11] A complete classification scheme is available from the author upon request.

[12] This is well-established. See, e.g., Greene (1997), pp. 732–733.

is typically not possible.[13] The second approach is to drop R from the equation and estimate the reduced-form equation for H. When there are no omitted exogenous variables, reduced-form estimates are unbiased. But if there are omitted variables whose effect is mostly captured in the R variables, the reduced form estimates may actually be more biased than the full-equation estimates. Furthermore, knowledge of α_2 is interesting in itself and important for understanding the sources of ISCIHS. Given these potential problems with endogeneity, the cross-sectional regression results reported here need to be interpreted cautiously.

Results

Preliminary evidence

Table 1 provides clear evidence for the strong presence of ISCIHS.[14] For instance, a man aged 51–55 who is in excellent health has only a 4.8% chance of being married to a woman in fair health and a 2.3% chance of being married to a woman in poor health. On the other hand, 23.6% of men in poor health have a wife who is only in fair health, and 13.2% of the same group are married to women in poor health. Correlation coefficients tell the same story. For men aged 51–55, the simple correlation coefficient between spouses' health is 0.249 for SAGHS, 0.227 for IFLAR and 0.179 for WCDI; for those aged 56–61, the corresponding coefficients are 0.260, 0.245, and 0.211. In each case the correlation coefficients are statistically significant with p-values virtually equal to zero.

At first glance, cross-sectional correlation coefficients in the neighborhood of 0.2 may not seem to be substantial. But note that the correlation coefficients for ISCIHS are in the same range as probably the most important socioeconomic predictors of health status, namely education and income. For men, simple correlation coefficients in the 1992 cross-section for years of schooling correlated with own health status are −0.324 (SAGHS), −0.215 (IFLAR) and −0.1823 (WCDI). For household income in 1991, the coefficients are −0.2517 (SAGHS), −0.189 (IFLAR) and −0.169 (WCDI).

In addition to health status, evidence also exists that health-related behaviors between spouses are highly correlated. Evidence for this association is given in Table 2. The values for smoking, drinking and exercise are collapsed to three categories: none, moderate and high. For smoking, the moderate category consists of 1–20 cigarettes to day; moderate drinking is 1–2 drinks per day; and moderate exercise consists of the two lowest levels of exercise above no exercise, as described above. BMI is categorized by quartiles, calculated separately for men and women. For each table, Kendall's tau-b test of association between ordinal variables rejects the null hypothesis of no association ($p<0.05$).

Regression estimates

Tables 3 and 4 present the regression results for each of the three health variables for men and women, respectively. As discussed above, the SAGHS measure uses a simple linear index of values from 1 to 5 representing the categories of excellent, very good, good, fair and poor.[15] Thus all the dependent variables are *decreasing* in health (thus a negative coefficient represents a variable that improves health). All regressions are estimated with STATA 6.0, and t-stats are based on robust (heteroskedasticity-consistent) standard errors. Coefficient estimates are reported in standardized form where units are presented in terms of standard deviations of the dependent and independent variables, thus allowing greater comparability across the equations.

For men, age, education, income and insurance coverage have strong effects on health. The strongest age effect, not surprisingly, is found for chronic conditions. Education has its greatest impact on SAGHS. This implies that education improves one's ability to accommodate disease and disability in terms of their effect on overall well-being. In the case of SAGHS, religiosity is associated with better health, but native birth is inversely related to health. These effects are not found for the other health measures (though the signs are the same). Parental education and marital duration also improve health, but not to a significant degree.

Health-related behaviors are also significantly correlated with health status. Not surprisingly, smoking is inversely related to health, with an increasing gradient for SAGHS and WCDI. Interestingly, the greatest estimated effect is for those who smoked over 30 cigarettes per day some time in the past (but are not current smokers). Consistent with previous research, moderate alcohol consumption is associated with good health, and the results here are robust across all health measures. Those who drink less than one drink per day are healthiest, but health declines as the number of drinks rises. Those who drink 5 or more drinks per day are statistically indistinguishable from teetotalers.

[13] Furthermore, recent research suggests that poor instruments tend to produce more problems than they solve. See Staiger and Stock (1997) and Bound, Jaeger, and Baker (1995) for example.

[14] Similar analysis for wives and for the other health measures yield qualitatively similar results.

[15] SAGHS estimates were also performed using ordered probit and multinomial logit techniques, but the qualitative results are unchanged. The OLS results are reported here because of their ease in presentation and interpretation.

Table 1
Inter-spousal correlation in health status[a]

Health in 1992	Wife					
	Excellent (%)	Very good (%)	Good (%)	Fair (%)	Poor (%)	
Husband (Age 51–55)						
Excellent (27.0%)	43.0	28.8	21.1	4.8	2.3	100
Very good (32.0%)	35.5	31.0	22.2	7.9	3.5	100
Good (26.4%)	22.9	33.2	28.2	12.7	3.0	100
Fair (9.5%)	15.8	24.3	39.0	14.7	6.2	100
Poor (5.1%)	17.5	24.2	21.6	23.6	13.2	100
$N = 1659$						
Husband (Age 56–61)						
Excellent (23.1)	38.5	33.6	19.0	6.1	2.9	100
Very good (28.0%)	25.9	36.6	25.9	8.2	3.5	100
Good (29.8%)	21.2	32.3	30.4	11.7	4.5	100
Fair (11.8%)	13.0	32.8	29.6	15.4	9.2	100
Poor (7.3%)	12.1	24.8	24.7	22.5	16.0	100
$N = 1867$						

[a] *Notes*: Data are restricted to married couples living together in 1992. Similar results are obtained when sorting the data by age of the wife. Health measures used is SAGHS, self-assessed global health status. Based on Kendall's tau-b test statistic, husband and wife health measured are not independent ($p < 0.0001$).

Table 2
Inter-spousal correlation in health behaviors[a]

	Husband		Wife				
			None	Moderate	High		
Smoking	None (%)	75.2	84.9	6.4	8.8	100.0	
	Moderate (%)	6.6	65.2	17.7	17.2	100.0	
	High (%)	18.3	50.6	13.2	36.2	100.0	
		100.0					
Drinking	None (%)	30.9	74.6	24.8	0.6	100.0	
	Moderate (%)	61.0	27.0	71.8	1.3	100.0	
	High (%)	8.2	25.2	60.2	14.6	100.0	
		100.0					
Exercise	None (%)	22.6	37.2	50.9	11.9	100.0	
	Moderate (%)	56.0	25.1	59.8	15.1	100.0	
	High (%)	21.4	18.8	47.9	33.4	100.0	
		100.0					
			First	Second	Third	Fourth	
Body mass (Quartiles)	First (%)	25.3	33.6	26.1	22.8	17.6	100.0
	Second (%)	25.0	25.9	27.2	25.6	21.3	100.0
	Third (%)	24.9	22.8	24.1	26.6	26.5	100.0
	Fourth (%)	24.9	17.5	22.7	26.1	33.7	100.0
		100.0					

[a] *Notes*: $N = 4746$ married couples living together in 1992. Based on Kendall's tau-b test statistic, the null hypotheses of independence is rejected for each variable ($p < 0.05$). Smoking:Moderate = 1–20 cigarettes/day; High = 21 + /day; Drinking: Moderate = less than 2 drinks/day; High = 3 + /day; Exercise: See text.

Table 3
OLS regression results (men)[a]

	Health measure:		SAGHS		IFLAR		WCDI	
	Dependent variable mean:		2.503		9.004		10.045	
	Dependent variable Std. Dev.:		1.167		13.090		7.656	
	Mean	Std. Dev.	Std. Coeff.	*t*-stat	Std. Coeff.	*t*-stat	Std. Coeff.	*t*-stat
Individual characteristics (X_M)								
Age	57.68	5.47	0.099	5.93	0.104	5.63	0.142	8.06
Education	12.43	3.28	−0.146	−7.40	−0.070	−3.19	−0.069	−3.39
Race: white	0.85	0.36	0.001	0.03	−0.025	−0.79	0.024	0.94
Native born	0.91	0.28	0.040	2.16	0.024	0.99	0.019	1.07
Religiously active	0.45	0.50	−0.055	−3.16	−0.028	−1.55	−0.022	−1.21
Mother's education	9.49	3.33	−0.012	−0.64	−0.003	−0.13	−0.011	−0.53
Father's education	9.13	3.66	−0.020	−1.08	−0.027	−1.40	−0.032	−1.61
Years of marriage	27.54	11.03	−0.001	−0.06	−0.002	−0.14	−0.008	−0.49
Economic variables (R_E)								
Log(income)	10.69	1.00	−0.098	−5.02	−0.115	−5.93	−0.079	−4.85
Health insurance	0.86	0.35	−0.076	−4.72	−0.099	−5.18	−0.091	−5.14
Health behaviors (R_{MH})								
Curr. smoking: light	0.03	0.17	0.023	1.65	0.041	2.69	0.029	2.04
Curr. smoking: moderate	0.04	0.19	0.044	2.99	0.032	2.34	0.028	1.78
Curr. smoking: heavy	0.09	0.29	0.046	2.85	0.036	2.10	0.046	2.67
Curr. smoking: very heavy	0.09	0.28	0.054	3.09	0.044	2.44	0.054	2.94
Prev. smoking: light	0.05	0.22	0.012	0.89	0.035	2.42	0.033	2.27
Prev. smoking: moderate	0.06	0.23	0.002	0.11	0.001	0.06	0.008	0.59
Prev. smoking: heavy	0.14	0.35	0.026	1.65	0.014	0.91	0.023	1.41
Prev. smoking: very heavy	0.24	0.42	0.075	4.40	0.077	4.32	0.100	5.64
Daily drinks: <1	0.47	0.50	−0.105	−5.72	−0.094	−5.02	−0.109	−5.77
Daily drinks: 1–2	0.14	0.35	−0.078	−4.58	−0.078	−4.47	−0.094	−5.38
Daily drinks: 3–4	0.06	0.24	−0.047	−2.94	−0.044	−2.87	−0.049	−3.02
Daily drinks: 5+	0.02	0.15	−0.005	−0.37	−0.012	−0.80	0.009	0.57
Exercise: light	0.48	0.50	−0.090	−4.84	−0.176	−7.67	−0.062	−3.11
Exercise: moderate	0.08	0.27	−0.098	−6.65	−0.136	−9.42	−0.078	−5.16
Exercise: heavy	0.09	0.29	−0.128	−8.44	−0.169	−11.37	−0.093	−6.17
Exercise: very heavy	0.12	0.33	−0.162	−9.82	−0.186	−11.31	−0.120	−7.15
Body mass index	27.25	4.15	0.082	5.65	0.078	4.64	0.103	6.22
Wife's characterisitics (X_F)								
Age	53.58	5.67	0.007	0.37	−0.000	−0.02	0.002	0.08
Education	12.38	2.70	0.013	0.70	0.023	1.15	0.041	2.06
Race: white	0.85	0.36	−0.048	−1.82	0.042	1.35	0.007	0.27
Native born	0.90	0.30	0.018	0.94	0.002	0.07	0.026	1.41
Religiously active	0.55	0.50	0.017	0.93	−0.013	−0.71	−0.002	−0.12
Mother's education	9.63	3.36	−0.024	−1.30	−0.014	−0.72	0.017	0.87
Father's education	9.49	3.63	−0.008	−0.45	0.028	1.51	0.000	0.02
Wife's health behaviors (R_{FH})								
Curr. smoking: light	0.03	0.18	0.004	0.31	−0.008	−0.66	−0.018	−1.21
Curr. smoking: moderate	0.05	0.22	0.028	1.86	0.024	1.55	0.015	1.02
Curr. smoking: heavy	0.10	0.29	0.030	1.88	0.040	2.25	0.031	1.80
Curr. Smoking: very heavy	0.05	0.21	0.013	0.82	0.001	0.09	0.006	0.34
Prev. smoking: light	0.07	0.25	0.004	0.31	0.006	0.50	0.001	0.07
Prev. smoking: moderate	0.05	0.23	0.002	0.15	0.023	1.55	−0.024	−1.80

Table 3 (*continued*)

	Health measure:		SAGHS		IFLAR		WCDI	
	Dependent variable mean:		2.503		9.004		10.045	
	Dependent variable Std. Dev.:		1.167		13.090		7.656	
	Mean	Std. Dev.	Std. Coeff.	*t*-stat	Std. Coeff.	*t*-stat	Std. Coeff.	*t*-stat
Prev. smoking: heavy	0.09	0.28	−0.015	−1.07	0.015	0.92	0.007	0.44
Prev. smoking: very heavy	0.08	0.27	0.012	0.82	0.010	0.64	0.017	1.14
Daily drinks: <1	0.32	0.47	0.001	0.07	0.007	0.41	0.028	1.66
Daily drinks: 1–2	0.05	0.22	−0.031	−1.97	0.004	0.26	−0.007	−0.44
Daily drinks: 3–4	0.01	0.12	−0.036	−2.40	−0.018	−1.17	−0.022	−1.49
Daily drinks: 5+	0.00	0.05	−0.005	−0.37	0.003	0.23	0.012	0.69
Exercise: light	0.47	0.50	−0.025	−1.46	−0.016	−0.92	−0.033	−1.81
Exercise: moderate	0.08	0.27	−0.029	−1.88	−0.011	−0.74	−0.012	−0.80
Exercise: heavy	0.08	0.27	−0.030	−2.03	−0.012	−0.81	−0.030	−1.91
Exercise: very heavy	0.10	0.30	−0.019	−1.21	−0.010	−0.71	−0.007	−0.42
Body mass index	26.51	5.46	0.027	1.68	0.040	2.51	0.032	1.98
R^2			0.22		0.17		0.14	

[a] *Notes*: Sample size is 4746 for each regression. All regression coefficents are in standardized form (in terms of Std. Dev.). *T*-stats are based on heteroskedasticity-consistent standard errors. All estimates calculated with STATA 6. For further variable definitions, see text.

Exercise also has substantial impacts on health, with the impact growing stronger (for SAGHS and WCDI) as the amount of exercise increases, though even moderate exercise has beneficial effects. The strong impact on disability (IFLAR) is likely due, in part, to reverse causality, since some people with disabilities won't be able to exercise. Finally, diet, as proxied by body mass index, has a strong association with health status across all measures.

In general, the impact of the wife's characteristics and health behaviors on the health of the husband are small and statistically insignificant. Still, two points deserve some attention here. First, smoking by the spouse is a variable that we might expect to affect one's health, but these estimates show only a modest and statistically insignificant impact. Overall, the evidence in this study is slight that second-hand smoke has negative health consequences. Even when we restrict the analysis to only those men who have never smoked, the wife's smoking behavior has no discernible negative effect (results not shown here). Second, there is some evidence that the BMI of the wife is correlated with the husband's health. The obesity of the wife may predict her husband's health if it reflects characteristics of the husband's diet, such as high intake of saturated fats, that are not reflected in his own weight due to a high metabolic rate.

The findings concerning the health of the wife closely parallel those of the husband, including the effects for age, education, income and health behaviors, though there are a few notable differences. First, white women are much more likely to report better health than their non-white counterparts when looking at SAGHS, but the same is not true for the other health measures. Next, women who have been married a longer period of time report significantly better health across health categories, though the effect of marital duration on their husband's health is non-existent. Since the majority of recent marriages within this sample are second marriages, this suggests that second marriages for women are less advantageous (for health) than women of similar characteristics who are still in their first marriages. Lastly, exercise is a more powerful correlate of health for men, while the effects of body mass for women are roughly twice those for men.

As is the case with men, characteristics and behaviors of the spouse are small and generally not statistically significant. Some of the estimates do differ between husbands and wives, however. Most notable is that the education of the husband is positively associated with the health of the wife, though it is only significant in the case of SAGHS. For husbands, the wife's education is associated with lower health status. This pattern is different than what we might expect given the notion that education is an input to household production (Michael, 1973), at least as far as women in this cohort are the primary producers of household commodities. Further investigation may reveal that this gender pattern is primarily due to the husband's education being a more powerful determinant of the household's socioeconomic status than the wife's. An additional anomaly is that, for women, having a white husband improves health, but

Table 4
OLS regression results (women)[a]

	Mean	Std. Dev.	Std. Coeff.	t-stat	Std. Coeff.	t-stat	Std. Coeff.	t-stat
Health measure:			SAGHS		IFLAR		WCDI	
Dependent variable mean:			2.371		11.440		10.101	
Dependent variable Std. Dev:			1.129		13.008		7.929	
Individual characteristics (X_F)								
Age	53.58	5.67	0.098	5.42	0.091	5.10	0.161	8.55
Education	12.38	2.70	−0.121	−6.30	−0.054	−2.66	−0.061	−3.04
Race: white	0.85	0.36	−0.096	−3.69	−0.031	−1.35	0.028	1.11
Native born	0.90	0.30	−0.010	−0.54	0.043	2.36	0.038	1.93
Religiously active	0.55	0.50	−0.049	−2.72	−0.022	−1.26	−0.008	−0.42
Mother's education	9.63	3.36	−0.029	−1.51	−0.014	−0.71	−0.020	−0.99
Father's education	9.49	3.63	0.010	0.54	−0.010	−0.54	0.017	0.84
Years of marriage	27.52	11.03	−0.052	−3.18	−0.034	−1.97	−0.062	−3.45
Economic variables (R_E)								
Log(income)	10.69	1.00	−0.091	−4.79	−0.103	−4.33	−0.060	−3.18
Health insurance	0.86	0.35	−0.062	−3.81	−0.078	−4.27	−0.041	−2.44
Health behaviors (R_{FH})								
Curr. smoking: light	0.03	0.18	0.001	0.12	0.005	0.37	0.026	1.77
Curr. smoking: moderate	0.05	0.22	0.041	2.62	0.017	1.12	0.021	1.40
Curr. smoking: heavy	0.10	0.29	0.053	3.28	0.030	1.78	0.043	2.59
Curr. smoking: very heavy	0.05	0.21	0.052	3.40	0.028	1.68	0.069	3.83
Prev. smoking: light	0.07	0.25	0.027	1.95	0.041	2.70	0.054	3.70
Prev. smoking: moderate	0.05	0.23	−0.000	−0.03	0.004	0.27	0.004	0.25
Prev. smoking: heavy	0.09	0.28	0.012	0.80	0.022	1.61	0.038	2.60
Prev. smoking: very heavy	0.08	0.27	0.044	2.98	0.042	2.79	0.090	5.30
Daily drinks: <1	0.49	0.50	−0.108	−6.38	−0.053	−3.09	−0.057	−3.28
Daily drinks: 1–2	0.07	0.26	−0.071	−4.53	−0.033	−2.10	−0.043	−2.79
Daily drinks: 3–4	0.02	0.14	−0.034	−2.23	−0.005	−0.27	−0.002	−0.11
Daily drinks: 5+	0.00	0.05	0.016	0.89	0.006	0.46	0.002	0.18
Exercise: light	0.47	0.50	−0.072	−4.07	−0.159	−8.31	−0.041	−2.28
Exercise: moderate	0.08	0.27	−0.080	−5.51	−0.115	−8.61	−0.048	−3.11
Exercise: heavy	0.08	0.27	−0.074	−4.79	−0.147	−11.02	−0.061	−4.10
Exercise: very heavy	0.10	0.30	−0.129	−8.54	−0.156	−11.25	−0.062	−3.91
Body mass index	26.51	5.46	0.152	10.22	0.194	11.63	0.197	12.40
Husband's characterisitics (X_M)								
Age	57.68	5.47	0.017	1.05	0.001	0.07	−0.014	−0.78
Education	12.43	3.28	−0.057	−2.95	−0.031	−1.46	−0.024	−1.16
Race: white	0.85	0.36	0.047	1.88	0.084	3.71	0.035	1.41
Native born	0.91	0.28	−0.004	−0.22	−0.000	−0.01	0.006	0.29
Religiously active	0.45	0.50	0.014	0.78	0.010	0.55	−0.022	−1.20
Mother's education	9.49	3.33	−0.007	−0.37	−0.013	−0.68	−0.029	−1.53
Father's education	9.13	3.66	−0.001	−0.08	0.006	0.31	−0.001	−0.08
Husband's health behaviors (R_{MH})								
Curr. smoking: light	0.03	0.17	−0.007	−0.50	−0.009	−0.71	−0.008	−0.58
Curr. smoking: moderate	0.04	0.19	0.024	1.68	0.001	0.05	0.007	0.47
Curr. smoking: heavy	0.09	0.29	0.033	1.91	0.046	2.50	0.017	0.95
Curr. smoking: very heavy	0.09	0.28	0.020	1.13	0.031	1.59	0.017	0.94
Prev. smoking: light	0.05	0.22	0.003	0.21	0.021	1.52	0.010	0.68
Prev. smoking: moderate	0.06	0.23	0.030	2.12	0.016	1.21	0.012	0.77

Table 4 (*continued*)

	Health measure:		SAGHS		IFLAR		WCDI	
	Dependent variable mean:		2.371		11.440		10.101	
	Dependent variable Std. Dev:		1.129		13.008		7.929	
	Mean	Std. Dev.	Std. Coeff.	*t*-stat	Std. Coeff.	*t*-stat	Std. Coeff.	*t*-stat
Prev. smoking: heavy	0.14	0.35	−0.024	−1.59	−0.006	−0.45	−0.012	−0.76
Prev. Smoking: very heavy	0.24	0.42	−0.001	−0.04	0.014	0.87	−0.000	−0.01
Daily drinks: <1	0.17	0.37	−0.023	−1.29	−0.025	−1.37	−0.016	−0.87
Daily drinks: 1–2	0.05	0.22	0.006	0.35	−0.024	−1.33	−0.031	−1.77
Daily drinks: 3–4	0.03	0.16	−0.005	−0.32	−0.035	−2.40	−0.021	−1.30
Daily drinks: 5+	0.01	0.10	0.016	1.19	−0.011	−0.79	−0.014	−0.97
Exercise: light	0.48	0.50	−0.013	−0.74	−0.017	−0.90	0.002	0.08
Exercise: moderate	0.08	0.27	−0.019	−1.28	−0.021	−1.43	−0.019	−1.23
Exercise: heavy	0.09	0.29	−0.014	−0.89	−0.012	−0.82	−0.018	−1.12
Exercise: very heavy	0.12	0.33	−0.024	−1.44	−0.013	−0.84	−0.012	−0.72
Body mass index	27.25	4.15	−0.011	−0.76	−0.008	−0.56	−0.016	−1.08
R^2			0.23		0.19		0.14	

[a] *Notes*: Sample size is 4746 for each regression. All regression coefficents are in standardized form (in terms of Std. Dev.). T-stats are based on heteroskedasticity-consistent standard errors. All estimates calculated with STATA 6. For further variable definitions, see text.

being white herself tends to lower health (in terms of SAGHS). Given the high assortative matching along racial lines, these coefficients need further interpretation that more fully incorporates the inter-spousal racial correlations.

Residual correlation

A central finding of this research is that ISCIHS exists even after controlling for all other covariates Evidence for this is shown in Table 5, which estimates the residual correlation, $\hat{\sigma}_{\mathrm{fm}}$, for the husband and wife health equations for the full model (Tables 3 and 4), noted as Model 10, as well as several restricted models including a model with no controls, Model 1. For each restricted model, the percent of the residual correlation explained (relative to Model 1) is calculated. The estimates of residual correlation in Model 10, therefore, represent the ISCIHS coefficient after all variables in the model have been accounted for. It should be emphasized that the focus here is on the ability of covariates to explain the residual correlation, σ_{fm}, not health status itself. Furthermore, the coefficients for each of the restricted models are not consistently estimated, due to omitted variables. The purpose of these estimates is not to obtain coefficient estimates, but to explore which types of variables can explain the presence of ISCIHS.

Table 5 reveals that a relatively large percentage of ISCIHS can be explained by the variables in the full model (57% for SAGHS, 41% for IFLAR, and 33% for WCDI). Furthermore, selectively adding variables provides some information on the importance of different groups of variables. Since the explanatory power of different groups depends on the order in which they are added to the analysis, the differences between the models in Table 5 should be interpreted cautiously. Models 3–6 reveal the high degree of colinearity between the different groups of covariates, since X and R both explain (when included invidually) a significant portion of the overall correlation. In general, the variables in R alone can account for nearly all of the explained correlation of the full model (compare Models 6 and 10). Across all health measures, adding the health variables to the reduced form has a slightly greater effect than the economic variables, as noted by the differences between Models 4 and 5. These results suggests that the impact of the X variables works through R (primarily R_{H}), which is not surprising given the well-known association between education, economic status and health behavior. Tables 3 and 4 show that X has a strong independent effect on individual health status, but it does not seem to have an independent impact on the inter-spousal correlation. All the estimated correlation coefficients in Table 5 are statistically significant ($p<0.0001$).

Table 5 also incorporates the effects of proxy respondents, households where one spouse provides information on the health of the other spouse, which is the case with 11.6% of couples. Proxy respondents may affect ISCIHS if the assessments of the health of one's spouse are correlated with one's own health simply because the same person is providing the information for both spouses. Table 5 shows estimates of Models 1–10 with and without proxy respondents. Since the rate of

Table 5
Residual correlation coefficients[a,b]

Model	Health measure: SAGHS Corr.	SAGHS Percent explained	IFLAR Corr.	IFLAR Percent explained	WCDI Corr.	WCDI Percent explained
All couples $N = 4746$						
Model 1: no controls	0.263		0.232		0.206	
Model 2: age alone	0.252	4.0	0.225	2.9	0.198	4.1
Model 3: age + X	0.157	40.4	0.182	21.7	0.166	19.6
Model 4: age + R_E	0.188	28.5	0.175	24.6	0.171	17.2
Model 5: age + R_H	0.158	39.7	0.162	30.0	0.152	26.3
Model 6: age + R_E + R_H	0.128	51.5	0.137	40.9	0.141	31.6
Model 7: age + X + R_E	0.141	46.3	0.159	31.5	0.155	24.8
Model 8: age + X + R_H	0.122	53.5	0.152	34.3	0.145	29.9
Model 9: age + X + R_H + R_E	0.110	58.0	0.134	42.2	0.137	33.6
Model 10: age + X + R_H + R_E + (X_S + R_S)	0.112	57.3	0.136	41.3	0.138	33.1
Cases with no proxy respondents $N = 4196$						
Model 1: no controls	0.260		0.241		0.201	
Model 2: age alone	0.250	3.7	0.236	2.1	0.193	4.1
Model 3: age + X	0.145	44.1	0.187	22.4	0.160	20.6
Model 4: age + R_E	0.183	29.6	0.185	23.0	0.165	18.2
Model 5: age + R_H	0.153	41.2	0.172	28.4	0.146	27.6
Model 6: age + R_E + R_H	0.120	53.9	0.147	38.9	0.134	33.6
Model 7: age + X + R_E	0.129	50.5	0.165	31.5	0.149	26.1
Model 8: age + X + R_H	0.111	57.4	0.159	34.0	0.138	31.5
Model 9: age + X + R_H + R_E	0.099	62.0	0.141	41.4	0.130	35.5
Model 10: age + X + R_H + R_E + (X_S + R_S)	0.101	61.1	0.143	40.6	0.131	35.0

[a] *Definitions*: X: Individual characteristics (education, race, nativity, religiousity, parents' education, marriage duration); R_E: Household economic variables (log of income, health insurance); R_H: Health behaviors (current and previous smoking, drinking, exercise, body mass index); $X_S + R_S$: All spousal variables (characterisitcs and health behaviors).

[b] *Notes*: Correlation coeffiecients are the residual correlation between the partners' health status after controlling for the variables given in each model. Regressions for men and women estimated jointly with SUR regression. All the correlations above are significantly different from zero ($p < .00001$), based on the Breusch–Pagan test of independence. Estimation performed with STATA 6. Further model and variable description is given in text.

proxy responding is low, the estimates where proxy respondents have been excluded are essentially the same as the full sample. Furthermore, additional analysis comparing the differences between the cases with proxies and those without yield only modest differences.

Discussion

Interpreting the results

What do the regression results have to say about the four hypotheses concerning ISCIHS discussed earlier? First, assortative mating (H1) clearly plays an important role. For IFLAR and WCDI, individual characteristics likely to be determined by the time of marriage (the X variables) reduce the residual correlation about 20%; in the case of SAGHS, the reduction is over 40%. Given that the data analyzed represent but a small portion of the variables actually observed by the agents at the time of marriage formation, these estimates seem quite high. Moreover, the X variables by themselves can account for about half the total reduction in estimated correlation in the full model for IFLAR and WCDI, and 70% for SAGHS.

The results shown in Table 5 clearly suggest that endogenous risk factors, primarily health behaviors, are the channel through which a large share of ISCIHS occurs. Even after controlling for those variables present in early life, the economic and health behaviors of the couples, which have been shown to be highly correlated themselves (Table 2), explain an additional portion of the ISCIHS coefficient. Thus couples apparently make joint life-style choices, some predictable at the time of marriage, that affect the joint occurrence of health outcomes in later life, which is consistent with H2.

The importance of H3 (environmental risks) and H4 (direct health effects) are captured in the unexplained portion of the residual correlation coefficient, which has shown to be substantial (Model 10 in Table 5). Not much, however, can be said about environmental factors, since they are not observed in the data, and it is not possible to know whether the unexplained residual correlation is due to missing variables in X or R or due to other factors. Direct health effects may exist, but there is only limited evidence of the effect of second-hand smoke. Data to capture other possible direct effects, such as sexually transmitted disease or fatigue due to caregiving, is not available.

Finally, the possibility still exists that ISCIHS is present in the data only because of the potential tendency for reporting errors to be correlated between the spouses. The fact that ISCIHS is robust to all three measures of health, however, casts some doubt on this assertion. It is noteworthy, nonetheless, that the estimate of ISCIHS falls as the measure becomes more "objective." For SAGHS it is 0.263, for IFLAR, 0.232 and for WCDI, 0.206. This suggests that the extent to which one interprets underlying health conditions in making an overall health assessment is correlated across spouses, but this "correlation in subjective interpretation" is entirely accounted for by the variables in the model, since the residual correlation for the complete model is notably similar across the three measures (0.112 for SAGHS and 0.136 for IFLAR and 0.138 for WCDI).

Implications

Over recent centuries, humans have made tremendous progress in changing the environment in which they live. These changes have included improvements in public sanitation and the widespread use of antibiotics and immunizations to curb the spread of infectious disease. Currently, public health institutions in the developed world are primarily focused on encouraging healthy behaviors such as eating right, not smoking and getting exercise. The results here imply that these behavioral components of health are important, but that there are also household-specific risk factors for illness that are not related to the observable characteristics and behaviors of household members. This suggests that increased attention should be given to the household in epidemiological research.

The results here also suggest that social insurance programs should be designed to account for the concentration of poor health within households. Disability benefits, for instance, should not be based on the losses in individual income that disabled people typically incur, but the loss of household income. Furthermore, if the disabled need personal assistance in performing the activities of daily living, policy should be sensitive to the fact that a disabled person's spouse is much less likely to assist in these tasks than the average spouse in the population because he or she is much more likely also to be disabled. It may be that the total cost of disability within a household with two disabled spouses is much greater than the sum of the individual costs would be when only one spouse is disabled. In general, policy should be made and administered with an eye to the concentration of poor health within households, particularly those households with poor socioeconomic status.

Extensions

The analysis here is intended to document the existence of ISCIHS and to take a preliminary step in explaining the economics of the household that would lead to its occurrence. Many extensions ought to be made. The most obvious extension is the need to study families longitudinally. The problems in making life-cycle inferences from cross-sectional data are well known. Of course longitudinal analysis, while being able to better control for the endogeneity problems discussed earlier, has its own problems. Dynamic specifications need to be made that appropriately account for the relationship between risk factors and health outcomes. For instance, it is not necessarily the period-to-period variation in variables such as income, occupation or diet that will change health, but the accumulation of risk factors over the life course.

Additional health indicators, such as the use of specific chronic conditions or multi–dimensional health measures, also will increase the reliability of the results. Looking further at different types of household relationships, such as cohabiting unions and extended families, should also be a fruitful research area. This study also ignored how marital transitions and multiple marriages affect the health status of individuals and couples. A central idea driving this research is that marriages differ in quality. Developing and employing measures of marital quality will further augment our understanding of health processes within the household. Additionally, exploring ISCIHS across different marriage types, including classifications based on race and ethnicity, may reveal important aspects of the factors behind the observed correlation.

Conclusion

The general conclusion of this study is that household matters in determining health status. Sick people are not randomly distributed across the population: they tend to be married to other sick people. The economic theory of marriage provides a natural starting point for investigating how the matching of individuals at marriage impacts health across the life-cycle. We know that couples who marry share several characteristics, such as similar educational levels. This selection at marriage will naturally cause a correlation in their health to develop. It is also reasonable to think that over the course of their marriage, couples will develop several common life-style variables (including health behaviors), and, simply by living together, they will share many of the same environmental risk factors that lead to disease. Furthermore, poor health in one spouse may influence directly the health of the other, either through infectious disease agents or through the stress (and economic burden) of having a spouse who is ill. Though the cross-sectional results presented here must be considered tentative, they suggest support for all of these hypotheses. Clearly the joint determination of health status within a marriage exists, and it is characterized by a complex, multi-causal process.

Whether we are trying to understand labor supply, consumption, savings, the demand for medical care or a variety of other economic choices, ISCIHS should not be ignored. So far economists have been largely unsuccessful in getting empirical estimates of joint behavior in households to align with theoretical predictions. Consequently, most research has ignored these household links. The presence of ISCIHS is one more argument for taking the hard road and looking at economic behavior in the context that it actually takes place—the family and the household.

Acknowledgements

Research support has been provided by Grants from Brigham Young University and from the National Institute on Aging (AG10120). I thank Robert Fogel, Jay Goodliffe, John Kim, David Meltzer, Tomas Philipson, and Tyler Shumway and two anonymous referees for helpful suggestions and Brigham Cannon, Lauren Cundick, Greg Gamette, and Patrick Wightman for research assistance.

Appendix A. Simple life-cycle model of marriage and health

Consider a simple economy with an equal number of men and women who each live for two periods. At the beginning of the first period all the men and women enter the marriage market, which has a market-clearing equilibrium characterized by complete monogamous pairings between the men and the women. This assumes that gains to marriage for all equilibrium matches are sufficiently high to exceed the "reservation price" individuals must receive to get married rather than remain single. As part of the marriage market equilibrium, individuals make agreements on how to divide the "output" from marriage. Income is combined with the exogenous household time endowment to produce household commodities $Z = Z^{f} + Z^{m}$. For simplicity, a linear household production function is assumed; Z is treated as unidimensional; and the shadow price of a unit of Z is normalized to unity.

The observable characteristics of potential partners are given as the vector X_{m}, for men, and X_{f}, for women. These characteristics are assumed to be determined prior to entry into the marriage market and include variables such as education and education of parents, as well as the *history* of health-related behaviors. Additional vectors of variables, Θ^{f} and Θ^{m}, are unobservable either to the individual or to potential partners and is viewed by the decision maker as random. Although Θ does not determine selection in the marriage market, it can affect health in later life, possibly through genetic forces or unobserved environmental health hazards in childhood. Over the course of the first period, individuals choose a level for a set of behavioral risk factors, R^{f} and R^{m}. In general, there are utility gains from "unhealthy" behavior in the first period, but higher levels of R decrease expected health in the second period. Thus health status in the second period is given as

$$\begin{aligned} H^{f} &= H^{f}(R^{f}, R^{m}; X^{f}, \Theta^{f}), \\ H^{m} &= H^{m}(R^{f}, R^{m}; X^{m}, \Theta^{m}) \end{aligned} \tag{A1}$$

and the above health functions are assumed to be twice-differentiable in R^{f} and R^{m}.

In the marriage market, individuals contract to divide the output of the household. Household labor income in the first period, Y_1, is a deterministic function of X^{f} and X^{m}. In the second period, labor income Y_2 is a function of X^{f} and X^{m} as well as the level of health status of each spouse, H^{m} and H^{f}, even though individuals do not know what H^{m} and H^{f} will be in the second period.[16] This implies that the household intertemporal budget constraint is

$$Z_1^{f} + Z_1^{m} + \frac{Z_2^{f}}{(1+r)} + \frac{Z_2^{m}}{(1+r)} \leqslant Y_1 + \frac{Y_2(H^{f}, H^{m})}{(1+r)}, \tag{A2}$$

where r is the rate of interest between the periods. In the preceding equation, the dependence of Y_2 on H^{f} and H^{m} is noted explicitly, though both labor income and the productivity of the household in producing Z depends on X^{f} and X^{m} as well.

Three assumptions should be made explicit concerning how the marriage market conditions the health-related behaviors of marital partners. The first is that the market determines a range of output that is consistent with equilibrium and negotiation determine the exact terms of trade, or the proportion of marital output each party will get. The percentages of output that women get

[16] Note that all persons are assumed to be healthy in the first period.

in the first and second period are denoted, respectively, as ρ_1^{f} and ρ_2^{f} (with ρ_1^{m} and ρ_2^{m} defined similarly for men), with ρ values determined solely by X^{f} and X^{m}. Second, women treat R^{m} as fixed, and men treat R^{f} as fixed. In choosing their own values of R, each spouse, consequently, ignores the effect of his or her behavior on the behavior of the spouse. Finally, the utility maximization problem is solved after the marriage market equilibrium has been obtained and marital contracts negotiated. These assumptions allow a separation of the decision processes of each spouse, particularly the intertemporal budget constraints. The effective allocation of household output in period t is $Z_t^{\mathrm{f}} = \rho_t^{\mathrm{f}} Y_t$ and $Z_t^{\mathrm{m}} = \rho_t^{\mathrm{m}} Y_t$. Household output in the first period can be consumed, Ct, or saved (or borrowed in the competitive market), and the balance is consumed in the second period. Thus the budget constraints for women and men, respectively, are:

$$C_1^{\mathrm{f}} + \frac{C_2^{\mathrm{f}}}{(1+r)} \leqslant \rho_1^{\mathrm{f}} Y_1 + \frac{\rho_1^{\mathrm{f}} Y_2(H^{\mathrm{f}}, H^{\mathrm{m}})}{(1+r)}, \tag{A3}$$

$$C_1^{\mathrm{m}} + \frac{C_2^{\mathrm{m}}}{(1+r)} \leqslant \rho_1^{\mathrm{m}} Y_1 + \frac{\rho_1^{\mathrm{m}} Y_2(H^{\mathrm{f}}, H^{\mathrm{m}})}{(1+r)}.$$

The utility maximization problem of males and females is assumed to be identical, though the parameters of the utility function may differ. Consider, therefore, the maximization problem of the female spouse. Subject to the model constraints, she chooses $R^{\mathrm{f}}, Z_1^{\mathrm{f}}$, and Z_2^{f} to maximize the following separable utility function (to simplify notation somewhat, assume that R^{f} and R^{m} are unidimensional):

$$U^{\mathrm{f}}(C_1^{\mathrm{f}}, R^{\mathrm{f}}) + \beta E[V^{\mathrm{f}}(C_2^{\mathrm{f}}, H^{\mathrm{f}}, H^{\mathrm{m}})], \tag{A4}$$

where E is the expectation operator. First period utility, U^{f}, is assumed to be a twice-differentiable, strictly concave function of consumption and the behavioral risk factor. Second period utility, V^{f}, is function of consumption and the health of each spouse. It is through the health of the spouse that the utility functions are linked. This linkage implies a direct effect on utility and is separate from the linkage that occurs indirectly through the budget constraint, where the health of both spouses affects household earnings. The husband's utility functions, U^{m} and V^{m} are defined similarly.

Substituting the budget constraint and health production functions into the utility maximization problem and assuming an interior solution yields the following pair of first-order conditions (similarly defined conditions exist for men):

$$\frac{\partial U^{\mathrm{f}}}{\partial C_1^{\mathrm{f}}} = \beta(1+r)E\left[\frac{\partial V^{\mathrm{f}}}{\partial C_2^{\mathrm{f}}}\right], \tag{A5}$$

$$\begin{aligned}\frac{\partial U^{\mathrm{f}}}{\partial R^{\mathrm{f}}} = & -\beta(1+r)E \\ & \times \left[\frac{\partial V^{\mathrm{f}}}{\partial C_2^{\mathrm{f}}}\rho_2^{\mathrm{f}}\left(\frac{\partial Y_2}{\partial H^{f}}\frac{\partial H^{\mathrm{f}}}{\partial R^{\mathrm{f}}} + \frac{\partial Y^2}{\partial H^{\mathrm{m}}}\frac{\partial H^{\mathrm{m}}}{\partial R^{\mathrm{f}}}\right)\right. \\ & \left. + \frac{\partial V^{\mathrm{f}}}{\partial H^{\mathrm{f}}}\frac{\partial H^{\mathrm{f}}}{\partial R^{\mathrm{f}}} + \frac{\partial V^{\mathrm{f}}}{\partial H^{\mathrm{m}}}\frac{\partial H^{\mathrm{m}}}{\partial R^{\mathrm{f}}}\right].\end{aligned} \tag{A6}$$

The first condition is the standard consumption-smoothing condition that is present in most in-tertemporal models: the marginal utility of consumption in the first period is equated to the discounted value of expected marginal utility in the second period. The second condition describes the utility trade-off between health-related behaviors in the first period and the marginal return to those behaviors in the second period. Returns to investment in healthy behavior are captured directly through the health of both spouses and indirectly through household income. The magnitude of the return also depends on the sensitivity of expected health changes in the risk factor and the percentage of household output going to the spouse.

References

Becker, G. S. (1973). A theory of marriage: Part I. *Journal of Political Economy*, *81*, 813–846.

Becker, G. S. (1974). A theory of marriage: Part II. *Journal of Political Economy*, *82*, S11–S26.

Behrman, J., Birdsall, N., & Deolalikar, A. (1995). Marriage markets, labor markets, and unobserved human capital: An empirical exploration for South–Central India. *Economic Development and Cultural Change*, *43*, 586–601.

Bound, J. (1991). Self-reported versus objective measures of health in retirement models. *Journal of Human Resources*, *26*, 106–138.

Bound, J., Jaeger, D. A., & Baker, R. (1995). Problems with instrumental variables estimation when the correlation between the instruments and the endogenous explanatory variable is weak. *Journal of the American Statistical Association*, *90*, 443–450.

Cassell, J. (1976). The contribution of the social environment to host resistance. *American Journal of Epidemiology*, *104*, 107–123.

Cobb, S. (1976). Social support as a moderator of life stress. *Psycosomatic Medicine*, *38*, 100–115.

Dwyer, D. S., & Mitchell, O. S. (1999). Health problems as determinants of retirement: Are self-rated measures endogenous? *Journal of Health Economics*, *18*, 173–194.

Goldman, N. (1993). Marriage selection and mortality patterns: Inferences and fallacies. *Demography*, *30*, 189–208.

Greene, W. H. (1997). *Econometric analysis* (3rd ed.). Upper Saddle River, New Jersey: Prentice Hall.

Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy*, *80*, 223–255.

House, J. S., Umberson, D., & Landis, K. R. (1988a). Social relationships and health. *Science*, *241*, 540–545.

House, J. S., Umberson, D., & Landis, K. R. (1988b). Structures and processes of social support. *Annual Review of Sociology*, *14*, 293–318.

Hu, Y., & Goldman, N. (1990). Mortality differentials by marital status: An international comparison. *Demography*, *27*, 233–249.

Jacobsen, L. (2000). The family as producer of health—an extended Grossman model. *Journal of Health Economics*, *19*, 611–637.

Joung, I. M. A., Vand De Mheen, H. D., Stronks, K., Van Poppel, F. W. A., & Mackenbach, J. P. (1997). A longitudinal study of health selection in marital transitions. *Social Science & Medicine*, *46*, 425–435.

Laumann, E. O., Gagnon, J. H., Michael, R. T., & Michaels, S. (1994). *The social organization of sexuality: Sexual practices in the United States*. Chicago: University of Chicago Press.

Lillard, L. A., & Panis, C. W. A. (1996). Marital status and mortality: The role of health. *Demography*, *33*, 313–327.

Lillard, L. A., & Waite, L. J. (1995). Til death do us part: Marital disruption and mortality. *American Journal of Sociology*, *100*, 1131–1156.

McClellan, M. (1998). Health events, health insurance, and labor supply: Evidence from the health and retirement survey. In D. A. Wise (Ed.), *Frontiers in the economics of aging*. Chicago: University of Chicago Press and NBER.

Michael, R. T. (1973). Education and non-market production. *Journal of Political Economy*, *81*, 306–327.

Parsons, D. O. (1977). Health, family structure, and labor supply. *American Economic Review*, *67*, 703–712.

Ross, C. E., Mirowsky, J., & Goldsteen, G. (1990). The impact of the family on health: Decade in review. *Journal of Marriage and the Family*, *52*, 1059–1078.

Schulz, R., O'Brien, A. T., Bookwala, J., & Fleissner, K. (1995). Psychiatric and physical morbidity effects of dementia caregiving: Prevalence, correlates, and causes. *The Gerontologist*, *35*, 771–791.

Smith, J. P., & Kington, R. (1997). Demographic and economic correlates of health in old age. *Demography*, *34*, 159–170.

Smith, K. R., & Zick, C. D. (1994). Linked lives, dependent demise? Survival analysis of husbands and wives. *Demography*, *31*, 81–93.

Staiger, D., & Stock, J. H. (1997). Instrumental variables regressions with weak instruments. *Econometrica*, *65*, 557–586.

Wickrama, K. A. S., Lorenz, F. O., Conger, R. D., & Elder Jr., G. H. (1997). Marital quality and physical illness: A latent growth curve analysis. *Journal of Marriage and the Family*, *59*, 143–155.

Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests of aggregation bias. *Journal of the American Statistical Association*, *57*, 500–509.

Zick, C. D., & Smith, K. R. (1991). Marital transitions, poverty, and gender differences in mortality. *Journal of Marriage and the Family*, *53*, 327–336.