Relating Self-Reported and Objective Health Indicators to Adult Mortality in Bangladesh

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I. Introduction

The costs and difficulties associated with assessing the health of a population have led to an ongoing search for indicators of health status that can be readily collected from large numbers of individuals with minimal expenditure of resources (time, money and logistics). Health measurement can demand a wide range of commitments in terms of interviewer time and skill, respondent comprehension, and logistic and analytic complexity. Set against the potentially higher costs and returns of physical health testing or collection of biomarkers, a simple self-reported health indicator (SRH), whereby respondents are asked to classify their current health status on some form of hierarchical scale (e.g. good fair poor), has proven particularly valuable. In addition, objective health measures such as observed ability to carry out activities of daily living and body mass index as an indicator of nutritional status are relatively easy and inexpensive to collect.

Studies, primarily in more developed countries or countries with highly literate populations, have demonstrated that SRH is a good predictor of mortality and functional ability even after controlling for objective health measurements (Appels, Bosma, Grabauskas, Gostautas & Sturman, 1996; Borawski, Kinney, & Kahana, 1996; Idler & Benyamini, 1997; Idler & Kasl, 1995; Idler & Kasl, 1991; Kaplan & Camacho, 1983; Mossey & Shapiro, 1982; Schoenfeld, Malmrose, Blazer, Gold, & Seeman, 1994; Sugisawa, Liang, & Liu, 1992; Wolinksy & Johnson, 1992). It has been hypothesized that the strong predictive value of SRH even after appropriate controls have been instituted is related to its multifaceted nuanced nature, whereby it incorporates multiple dimensions of health (physical disability, functional or activity limitations, chronic and acute morbidity), self-assessment of severity, awareness of co-morbidity, and past health trajectory (Idler & Benyamini, 1997).

International explorations of SRH are particularly valuable, since there may be important differences in the association of SRH with other health indicators (Angel & Guarnaccia, 1989; Ferraro & Kelley-Moore, 2001; Jylhä , Guralnik, Ferrucci, Jokela, & Heikkinen, 1998; Rahman, Strauss, Gertler, Ashley, & Fox, 1994; Zimmer, Natividad, Lin & Chayovan, 2000). More specifically one might hypothesize that due to lower levels of education and formal contact with the health care system in the developing world compared to the developed world, individuals in the developing world would have less knowledge about acute and chronic morbidity and consequently, the relationship between acute and chronic morbidity and other subjective and objective health measures would be weaker in the developing world than in the developed world. In a similar vein, because of high levels of family support and lower expectations of independence of movement in the developing world vs. the developed world, one might expect physical disability and functional limitations to have a weaker association with SRH in the former compared to the latter.

International explorations of SRH measures have further found important differences by social setting in environmental, behavioral and normative influences on SRH and their relationship to objective health or mortality measures. Inconsistent gender differences have been reported with some showing a female disadvantage (Gijsbers van Wijk, van Vliet, Kolk & Everaerd, 1991; Rahman, Strauss, Gertler, Ashley, & Fox, 1994; Zimmer, Natividad, Lin & Chayovan, 2000) and others no disadvantage (Jylhä , Guralnik, Ferrucci, Jokela, & Heikkinen, 1998; Leinonen, Heikkinen, & Jylhä, 1998; McDonough & Walters, 2001; Zimmer, Natividad, Lin & Chayovan, 2000). More importantly, several studies in the developed world show gender differences in the association between SRH and mortality, with a stronger association for men. Rather than reflecting a health disadvantage for women, these studies suggest, women’s higher reports may reflect their “greater sensitivity” to health conditions (Bath 2003; Deeg and Bath 2003; Deeg and Kriegsman 2003; Idler 2003).

Very few analyses, however, have been published using data from developing countries (Rahman, Strauss, Gertler, Ashley, & Fox, 1994; Yu et al., 1998; Zimmer, Natividad, Lin & Chayovan, 2000; Frankenberg and Jones 2003), largely due to the absence of information on potentially key determinants of SRH such as acute and chronic morbidity, limitations in activities of daily living, and most importantly measured physical performance. In many nations with a perceived allocation sex bias, previous work has demonstrated sex differences in the reporting of poor SRH, typically favoring men, while adult mortality rates tend to suggest lower women’s mortality. While these sex differences might lead to sex differences in the explanatory power of SRH measures in predicting mortality, most have found that women’s higher poor SRH reports actually reflect measurable sex differences in morbidity and disability. From a methodological standpoint, the combination of poorer health and higher survival for women compared to men, rather than reflecting over-reporting of poor health by women, may reflect lower baseline mortality rates for women than for men. If so, it is possible that poor SRH reports may have the same multiplicative effect on both women’s and men’s survival, with women’s poorer health status serving to narrow or even erase women’s survival advantage.

These conditions characterize the nature of sex differences in health and mortality in rural Bangladesh, at least for adults over 50 (Rahman and Liu,2000; Rahman and Barsky, 2003). While adult survival for both sexes is substantially lower than in More Developed Countries (MDCs), women are at a particular disadvantage. While women tend to outlive men by between 6 and 8 years in most MDCs, women’s life expectancy in Bangladesh have only recently surpassed men’s, and had not done so through the follow-up period, 1996 to 2001 (US Census

2004; Bangladesh Bureau of Statistics 2002). As presented in greater detail below, female respondents to the Matlab Health and Socioeconomic Survey (MHSS), a comprehensive 1996 survey linking health and socioeconomic data in a rural area of Bangladesh, were 50% more likely to report poor general health than men. Women also reported greater disability and morbidity on more detailed self-reports, and were observed to have higher levels of physical dysfunction than males. Rahman and Barsky (2003) found that, controlling for observed disability and self-reports of disability and morbidity, there was no sex difference in SRH.

This analysis seeks to further investigate the of SRH reports in the MHSS, with particular emphasis on gender differences, by linking MHSS data to five years of prospective mortality reports from the Demographic Surveillance System in Matlab, which has been run by the International Centre for Health and Population Research (ICDDR,B) for over 40 years. In particular, we investigate the following questions:

i) To what extent does SRH predict subsequent survival?

ii) Does SRH still contribute to the prediction of mortality when more detailed self-reports and objective measures of health are available and included as predictors?

iii) Are there differences by gender in the explanatory power of SRH in predicting mortality?

iv) How would longitudinal mortality models be affected by depending exclusively on self-reported health data?

II. Setting, Data and Methods

Setting: --- The population under study comes from rural Bangladesh, a society where environmental hazards are high and community health and educational infrastructure is poorly developed. The overwhelming majority of older individuals live with adult children (mostly sons) and alternative sources of support--financial and otherwise--outside the family are scarce.

Per capita income is $370/year. The predominant occupation for rural males is agriculture, with labor force participation rates remaining very high even for older males. Women are largely restricted by convention to activities within the home with relatively little opportunity to venture outside the homestead. Given the high level of poverty and the scarcity of health providers (4071 persons/physician, 17446 persons/registered nurse), contact with the formal health care system is thought to be relatively infrequent. Nationwide, life expectancy for 1996 was 59.3 for men and 58.9 for women (US Census 2004). The population over age 50 constitutes approximately 10% of the population as a whole and Life expectancy at age 50 is approximately 30 years with no significant gender difference (Bangladesh Bureau of Statistics, 2002; Rahman, Menken, Foster, Peterson et al, 1999; Makhlisur Rahman, 1986; Aziz, 1979).

The Matlab Health and Socioeconomic Survey (MHSS) --- is a large-scale survey of adult health and was conducted in a rural area of Bangladesh in 1996. In addition to detailed data on social networks, life histories and economic activity, the survey collected self-reports on global health trajectory, activities of daily living (ADLs), and chronic and acute morbidity, and objective measures that include observed ability to carry out ADLs and basic anthropometry. The MHSS is a multistage multisample household survey that collected information from 11,150 individuals aged 15 and over in 4,538 households.

While designed for comparability to similar nationally representative family life surveys such as the Indonesian and Malaysian Family Life Surveys (IFLS, MFLS), MHSS eschewed a nationally representative sample in favor of a sample based entirely in Matlab, where the ICDDR,B has operated the Demographic Surveillance System (DSS) since 1966 (Rahman, Menken, Foster, Peterson et al, 1999). Matlab DSS data have been used extensively in the demographic literature and the DSS is considered to be one of the few high quality (i.e.

complete, accurate and up-to-date) demographic data sources in the developing world (Fauveau 1994). In particular, age reporting is considered to be highly accurate, a feature not found in other South Asian data sources (Menken and Phillips, 1990).

As part of a collaborative study by investigators at the Harvard School of Public Health , the University of Colorado at Boulder, ICDDR,B, and Independent University, Bangladesh, MHSS respondents were tracked through the DSS from 1996 through 2000. The resulting match produced an event history database which identifies whether a respondent died in a particular calendar year and whether they were censored from the DSS population through migration. The technique of matching survey data to mortality surveillance data, often employed using Current Population Survey data in the United States, offers some advantages over a panel survey. Foremost among these is cost, since longitudinal analysis only requires matching the survey to existing data rather than fielding a followup study. Furthermore, a study of this type offers greater reliability in terms of identifying accurately the date of death or censoring, and effectively distinguishing between these two types of exits from the sample. In contrast, panel surveys collected in other LDCs have typically faced attrition rates of 10% or more, leading to uncertainty about the cause of attrition and potential bias. In addition, survey costs can rise considerably as followup efforts intensify (Frankenberg and Thomas, 2000). These followup surveys offer far more detailed data on longitudinal changes in health status, nutrition and morbidity. However, longitudinal mortality followup offers a crucial opportunity to study the effects of health. The complementarity of these approaches is obvious. We plan a 10-year followup of the MHSS households.

Sampling: --- The MHSS multi-stage sampling was conducted as follows (Rahman, Menken, Foster, Peterson et al, 1999). The Matab surveillance area consists of 8640 baris or residential compounds, of which roughly one third (31.1%) or 2687 baris were randomly sampled. The bari is the basic unit of social organization in rural Bangladesh and in Matlab in particular (Aziz, 1979; Makhlisur Rahman, 1986). Baris usually consist of a cluster of households linked in many instances in a kin network-(note however that about 16% of baris consist only of a single household and even in multi-household baris, kin networks may exist only for sub-clusters of households). Sampling baris rather than households provides a better representation of family networks, a major focus of the MHSS survey. Within each bari, up to two households were selected for detailed interviews. Within each selected household, all individuals aged 50 years and over were interviewed. For those below the age of 50, certain criteria were followed to reduce the interviewing load vis-à-vis large households.

For baris with two or fewer households, all households were chosen. For baris with greater than two households, the first household was chosen at random; the second household was selected from the bari in order of preference as follows: (i) The household of the father and/or mother of the head of the first sampled household; (ii) A household containing a son of the head of the first sampled household (chosen at random if there are multiple sons in separate households in the bari); (iii) A household containing a brother of the head of the first sampled household -(chosen at random if there are multiple brothers in separate households in the bari) and (iv) A second randomly selected household.

There were 11,150 individuals aged 15 years and over in the MHSS bari samples. People were eliminated from this analysis (see Table 1) if the individual probability weight could not be calculated (54) or the MHSS identification number was erroneous and could not be matched in the DSS (165). Thus we begin with 10931 respondents in the MHSS bari sample who could be followed in the DSS. An additional 13 had missing self-reported activities of daily living. A further 1,382 were eliminated due to missing observed health indicators – 1,001 had missing information on physical disability (measured physical performance limitations) and 1,304 were missing within-range measures of body mass index. Most non-responses stem from the fact that there were special teams for collection of observed health indicators and for anthropometric measurement. They visited only subsets of all MHSS households. Very few respondents refused to participate. Thus for the purposes of this study, we focus on 9,536 respondents aged 15 years and older (4,399 males, and 5,137 females) for whom we have complete information. Rahman and Barsky (2003) found little difference between individuals who had complete information on health indicators and all respondents.

Data Analytic Plan: --- Longitudinal models of mortality subsequent to MHSS fieldwork offer an opportunity to investigate the predictive power of the health measures. Each respondent contributes an observation for each person year from 1996 to 2000 unless they are censored by death or out-migration. As shown at the bottom of Table 1, 356 individuals died during the followup period, and another 1,098 were censored due to out-migration, eliminating 569 and 1,979 person years, respectively, subsequent to censoring. A logistic hazards model of mortality is tested for the remaining 45,132 person-years according to the following form:

$$Log\left(\frac{\mu_{ik}}{1-\mu_{ik}}\right) = \beta_0 + \beta_1 Female + \beta_2 Age_{ik} + \beta_{3j} SR_{3j} + ... + \beta_{4m} OBS_{4m} + ... + \varepsilon$$

μ_{ik} is the risk that person i dies in followup year k, where *Female* is 1 for women and 0 for men, *Age* is respondent's age at the start of year k, SR_j is the jth self-reported health indicator and OBS_m is the mth observed health indicator. Additional models include interaction terms between sex and the health indicators. The latter were recorded once – in the MHSS. Therefore, the only time-varying variable is *Age*.

Estimation of models incorporates a Huber-White correction for intra-cluster correlation in the distribution of the probability or mortality across observation years for a given respondent. Because of the multistage nature of the sample, individual observations have been weighted appropriately to reflect population representation (Rahman et al., 1999). Results presented in the tables display the relative odds associated with a variable, or the relative change in $\frac{\mu_t}{1-\mu_t}$ resulting from a one-unit change in a variable. Summary results are presented in Figures 1 in the Discussion in terms of predicted age and sex differences over the five years subsequent to the MHSS in person years lived with and without health problems.

Table 2 presents the number of person years and deaths and death rates for the full person-year sample and for subsamples of those under and over age 50 at the start of the person year. Deaths of 10.7% of the over-50 subsample were recorded in the DSS within the followup period, compared to only 0.7% of the young subsample and 3.7% overall. Shifting to person-years, we see that deaths of just 0.62% of respondents were recorded in any person year. While there was a relatively high annual frequency in the older group (1.95%), death is a quite rare event in the younger subsample (0.12%). For this reason, all models were replicated using the Rare Events Logistic Regression package for STATA (King and Zeng 2001). In all cases, rare event models resulted in higher coefficient estimates and lower standard errors, so we choose to report the more conservative logistic regression results. Table 2 also shows lower mortality rates for women than for men, particularly at younger ages. However, as will be shown later, controlling for age, these differences are not significant.

Variables: --- We use five health indicators including three self reported measures: (self-reported health; self reported functional limitations (activities of daily living—ADLs); and self-reported chronic morbidity) and two objectively assessed indicators (physical disability (assessed as measured performance of ADLs) and body mass index (weight in kg/ (height in meters)^2)), For the purposes of this paper, each measure is dichotomous, with the higher score indicating poorer health. All of the indices with the exception of BMI were originally developed by Rahman and Barsky (2003) or are adapted from their work.

Self reported general health (SRH) was assessed with the item "What is your current health status?" Responses were scored as good, fair or bad. SRH was coded as 1 if the respondent reported his or her health was bad; good or fair health was coded as 0. In the cultural context of this study population , individuals even when they are in good health are reluctant to classify themselves as being in good health (because of the sense that 'it might attract the attention of "the gods") and the tendency is to say that one is in fair health. Thus the fair health category in all likelihood is comprised of a substantial proportion of people in good health, and it seemed reasonable to combine the fair and the good categories, so that the dichotomy of poor vs. fair-good would provide the sharpest contrast. Moreover, the dichotomous coding of poor vs. fair or good has been used in other published studies (Wu and Rudkin, 2000). It is important to note however, that a different coding scheme (i.e. poor or fair vs. good) would probably result in a less sharp contrast and some attenuation in our results.

Following Merrill, Seeman, Kasl, & Berkman (1997), Rahman & Liu (2000) and Rahman and Barsky (2003), we constructed a series of measures for functional limitations in self-reported activities of daily living. We used self-report information on 10 ADL items, which were divided into two clusters: (I) limitations in personal care—four items-- ability to: (a) bathe; (b) dress; (c) get up and out of bed; and (d) use the toilet; and (II) limitations in range of motion —six items-- ability to: (a) carry a 10 kg weight for twenty yards; (b) use a hand-pump to draw water; (c) stand up from a squatting position on the floor; (d) sit in a squatting position on the floor; (e) get up from a sitting position on a chair or stool without help; (f) crouch or stoop. Because men and women appear to have different norms regarding personal care, in this paper we consider only the second cluster. The variable SR-ADL was scored as 0 (can easily do all the activities in the cluster) or 1 (have trouble with one or more activities in the cluster).

Self-reported chronic morbidity (Rahman et al., 1999) was assessed with a checklist of 14 sentinel conditions (anemia, arthritis, broken bones, cataracts, vision problems, asthma, other breathing difficulty, diabetes, pain or burning on urination; paralysis, tuberculosis, gastric/ulcer problems, edema, and a residual category called other conditions). For each condition, respondents were asked to report whether they had experienced it in the three months prior to the survey, and if so whether it had caused them no difficulty, some difficulty, a great deal of difficulty, or an inability to carry out their day-to-day activities. Those who had experienced one or more of the 13 sentinel conditions which had caused a great deal of difficulty/inability to carry out their day to day activities were labeled as having severe chronic disease and scored as 1 on SR-chronic disease. Those who had none of the sentinel conditions or who experienced only minor chronic disease were scored as 0.

Physical disability was assessed objectively as in prior studies (Merrill, Seeman, Kasl, & Berkman, 1997; Rahman & Liu, 2000, Rahman & Barsky, 2003) by asking respondents to perform four timed physical tasks: maintaining side by side, semi tandem and tandem positions (balance); walking 8 feet twice (gait); chair-rises (lower extremity movement); and shoulder rotation (upper extremity movement). Each task had a three level score: 0 (unable to do the activity); 1 (had some difficulty doing the activity); and 2 (could do the activity easily), assigned by an independent observer. The four individual sub-scales were added to form a scale ranging in value from 0-8, with higher scores indicating better performance. Those with scores in the 0-5 range were labeled as having poor physical performance and scored 1 on OBS-ADL, while the reference group (those with scores 6 and above) was scored as 0.

Height and weight were measured and BMI calculated. Those with BMI<16 were considered to have poor nutritional status and scored 1 on OBS-BMI<16, with the reference group (those with BMI 16 or above) scored as 0.

It is worth noting that for self-reported chronic disease, the summary measure is comprised of heterogeneous categories of symptoms and disease labels which reflect the prevailing morbid conditions in rural Bangladesh. As such they are locally specific and cross-country comparisons using these summary measures would be difficult to interpret.

III. Description of Health Measures

Table 3 presents the weighted percent, by sex and for each sample (all adults, adults under 50 years of age, and adults 50 and older), estimated by each indicator to be in poor health. Poor health is more likely among the older group no matter how measured, but substantial differences exist among measures. Poor SRH is about four times more common among the older group (36% vs. 9%). The most health indicator with the highest frequency of poor health is SR-ADL, with 18.5% reported substantial mobility limitations, but it is heavily concentrated in elders, who are over seven times more likely to report poor SR-ADL (53% vs. 7%). Observed physical dysfunction (OBS-ADL) is less common than reported dysfunction (5.5% poor versus 18.5%), particular for the older sub-group, which is four to five times more likely than the younger sub-group to have an observed limitation (OBS-ADL poor = 13% vs. 3%). Since BMI combines deprivation and physical well-being, it is unsurprising that OBS–BMI<16 occurs only twice as frequently among the older sample (20% vs. 9.5%).

Table 3 also depicts substantial sex differences in poor health, whether self-reported or observed, and particularly at younger ages. Younger women are more than twice as likely as men to report poor SRH, more than six times more likely to report poor SR-ADL, and almost three times more likely to report chronic disease. Moreover, younger women are five times more likely to perform poorly on observed physical tests. Fewer young women have BMI<16 than men, in part because standards differ for men and women. Taken together, 38% of women under 50 have at least one reported or observed health problem, compared to 22% of men. Looking only at the three self-reports, 31% of women have at least one problem, compared to 13% of men.

Older women are more likely than older men to suffer poor health, whichever measure is examined. Poor SRH is reported by 42% of older women compared to 31% of older men. Women are also twice as likely to report limited mobility (SR-ADL poor = 73% vs. 35%) and much more likely to report chronic disease (45% vs. 25%). Observed physical dysfunction remains the least common poor health condition, though 20% of older women performed poorly on these tests compared to 8% of men. Considering all indicators, 86% of older women have at least one observed or reported health problem compared to only 58% of men. The difference is even greater when only self-reported disability is considered, with 83% of women reporting poor health on at least one measure, compared to only 52% of men. In contrast to many more developed countries, where women over 50 are likely to be older on average than a comparable group of men, and thus appear to have more health problems, the sample of women over age 50 is actually younger than the comparable group of men. If the measures were age-adjusted, women over age 50 would have even worse relative health.

Table 4 shows the relatively high dyadic correlations among the self-reported measures, and even higher multiple correlations. The correlation between SR-ADL and OBS-ADL is also quite high (.27). OBS-BMI<16 is only modestly correlated with the other indicators.

IV. Results

Initial models predicting the odds of dying are shown in Table 5 for the three samples – full, under 50, and over 50. Model 1 includes controls only for age and sex of the respondent. For the full and over-50 samples, mortality increases significantly with age, with each additional year associated with a 10% increase in the odds of dying. Controlling for age, there is no significant difference between men and women in the odds of dying.

Model 2 introduces the principal variable of interest, self-reported health (SRH). For all three samples, poor SRH is significantly associated with increased subsequent mortality. Although a much larger coefficient is estimated for the young sample, this stems in part from the low baseline level of mortality. The yearly probability of dying for the young sample is 0.12% (Table 2). Poor SRH in the young group (OR = 5.6), when age and sex are held constant at the mean, raises the probability of death from 7 to 41 in 10,000. This is a rather large effect, especially considering it results from a single question. For the over-50 subsample, the effect of poor SRH is smaller, but highly significant (OR = 2.1) and causes probability of death, estimated at the means of age and sex, to rise from 1% to 2%. The full sample model shows that women are significantly less likely than men to die in any particular year when controls for SRH are introduced.

Model 3 begins the process of testing the robustness of the relationship between poor SRH and mortality, first by adding controls for the two more complex self-reported health measures. For the full sample and each subsample, limitation in self-reported activities of daily living (SR-ADL) has a strong positive association with mortality, but self-reported chronic disease (SR-Chronic Disease) does not significantly predict mortality. For both the full sample and the over-50 subsample, SR-Chronic Disease was positively associated with mortality in the absence of an SRH control (models not shown), so SRH appears to reflect respondents' substantial awareness of major chronic diseases affecting them.

Model 4 drops SR-Chronic Disease, which was not significant in any model, increasing the size and significance of the SRH and SR-ADL effects. For the under-50 group, when SR-ADL is included, the effect of SRH is reduced to just below the 5% significance level. For the over-50 group and the full sample, poor SRH was significantly associated with increased mortality risk. Thus, SRH appears to reflect, in part, the respondent's own assessment of mobility limitation, but also includes other factors related to subsequent mortality that, at least for the older population, are not captured by the more complex SR-ADL measure. The inclusion of SR-ADL leads to further increase in the estimate of women's mortality advantage over men. Women have substantial disadvantages in SRH and SR-ADL, but in both the full sample and over-50 subsample, at the same level of self-reported health, women are 50% less likely to die in a given year than men.

Model 5, depicted for all three samples in the columns of Table 6, adds in the two observed measures of health. Low Body Mass Index (OBS-BMI<16) is strongly associated with increased mortality for the full sample and over-50 subsample (OR=1.8 for full sample, 1.6 for over 50 subsample). Since OBS-BMI<16 is not strongly correlated with any other health measure, its inclusion has little effect on the coefficients estimated for other health measures (separate model not shown). OBS-BMI<16 is not a significant predictor of mortality for the under-50 subsample.

Observed Activities of Daily Living (OBS-ADL) is also a strongly significant predictor of mortality in both the full sample and over-50 subsample (OR = 2.3 in both samples). Holding other covariates at the mean, a shift in OBS-ADL from 0 to 1 (poor) results in a 0.2 percentage point increase in yearly death probabilities for the full sample, and a 1.3 percentage point increase for the over-50 subsample (against base rates of 0.8% and 2.0% respectively). Since OBS-ADL has only a limited correlation with SRH and SR-ADL, however, its inclusion diminishes their effects by only factors ranging from 10 to 20% and both remain statistically significant. Controlling for OBS-ADL, poorer values on both self-reported measures still result in substantial increases in mortality for both the full sample (0.1% percentage point increase for SRH, 0.2 for SR-ADL) and the over-50 subsample (0.5% percentage point increase for SRH, 0.8% for SR-ADL). O-ADL is also not a significant predictor of under-50 mortality.

The inclusion of observed health measures also leads to further increase women's adjusted mortality advantage (OR = 0.44 for full sample, 0.48 for over-50 sample). Holding all other factors at the mean, women's mortality is 0.15 percentage points lower than men's in the full sample, and 0.8 percentage points lower for the over-50 sample. Put another way, women's sizable advantage in mortality controlling for health is substantial enough that, in spite of having substantially worse health on all observed and self-reported health indicators, their unadjusted mortality is not significantly different from men's.

This disjunction between sex differences in health and mortality introduces the possibility that, as in other studies, women may over-report poor health and greater disability. If this were the case, the inclusion of interactions between sex and each of the significant health measures in Model 6 (depicted in Table 7) would show significant negative interactions between health measures and the female main effect, indicating that the health measure was a worse predictor or health for women. Model 6 does not support a women's over-reporting effect. In the full sample and the over-50 sample, no female/health interaction terms were statistically significant. In the under-50 sample, we see a significant positive interaction between female and OBS-BMI<16. This suggests that BMI has a different meaning for men's and women's adult health, possibly relating to increased risk of malnutrition-related mortality during pregnancy. The finding in Model 6 is consistent with earlier work on women under 50 (Duffy and Menken, 1998; Menken, Duffy and Kuhn, 2003), which demonstrated a positive relationship between BMI at the start of a 20-year followup period in Bangladesh and survival during that period. The model for the under-50 sample also includes a significant negative effect for females with and limited OBS-ADL. This result could suggest two possibilities: 1) mobility impairments for younger men increase the risk of mortality due to work-related injuries; or 2) younger women's mobility impairments are overstated due to constraints on properly completing the test, such as modesty. In either case, this finding does not suggest any sex differences in the power of self-reported health measures.

The absence of any significant interactions between the respondent's sex and the predictive power of self-reported health measures is an extremely robust finding. The effects do not even approach significance, and these results do not change when insignificant interaction terms for sex and observed health measures are dropped (models not shown). The apparent disjunction between women's higher reports of poor health and no mortality disadvantage is explained by the multiplicative nature of the logistic regression model. Women's adjusted risk of mortality, controlling for other factors, is much lower than men's. Women's low baseline mortality risks are multiplied by risks due to poor health, which are more common among women; the result is overall equality in mortality of men and women. The process is not driven by a less substantial relationship between women's poor health and women's survival, but by the fact that the same poor health multiplier effect is applied to a lower baseline mortality effect. This result holds in Rare Events logistic regression models and probit regression models, both of which also apply the very realistic assumption that mortality risks are multiplicative in nature, not additive. Model 6 was also run using a linear probability model, however, in order to estimate the size of interaction effects if mortality risks were indeed additive. Interactions between sex and SRH were found to be highly insignificant in these models as well.

V. Discussion

This paper offers a number of important insights into the role of self-reported health measures in predicting mortality. By linking self-reported and observed health measures with accurate demographic data and prospective mortality data, the MHSS/DSS is a powerful tool for studying the covariates of adult mortality in a LDC context. Confirming cross-sectional research on SRH (Rahman and Barsky 2003), the results suggest first that SRH is a reliable and multifaceted indicator of subsequent mortality. SRH captures the effects of more detailed morbidity reports. It also captures many aspects of self-reported and observed ADL indexes, yet remains a significant predictor of mortality for the population as a whole and the older population even with the inclusion of ADL measures. For a younger population with only one yearly death for 1,000 respondents, SRH was a highly significant predictor of mortality, although its effects were better captured by a more detailed ADL self-report. Of the objective measures of health, only BMI offered predictive value for this younger population, and only for women.

Furthermore, the results show that women's substantially higher reporting of poor health even at relatively young ages do not reflect women's oversensitivity, but a legitimate health deficit that is reflected in the fact that self-reported health measures, including SRH, predict subsequent mortality equally well for women and men. If similar models of mortality were run without the inclusion of health measures, it would appear as if women and men in rural Bangladesh have relatively similar mortality rates. Yet with even the inclusion of a simple measure such as SRH, we see that the narrow differential between men's and women's survival observed in Bangladesh results from a process whereby women with much higher baseline survival rates, as in most societies, face a substantially greater burden of poor health.

These findings also suggest that we must be quite sensitive to sex differences when assessing current and future increases in active versus disabled life expectancy. In Matlab, although men's and women's survival rates are relatively similar for most of the life course, women likely spend a substantially higher proportion of that time in poor health. Figure 1 illustrates the magnitude of sex differences. Based on the best-fitting model for the entire adult sample (Model 5), we estimate separately for men and women at different ages the number of years they can expect to live over the next five year period (indicated by the height of the bars) and the proportion of those years spent with none, only one, or two or more of the four health conditions found to affect mortality (poor SRH, limited SR-ADL, limited O-ADL, low O-BMI). The figure offers a conservative estimate of the burden of poor health, as it does not adjust the likelihood of reporting ill health upwards as the hypothetical respondent ages; the distribution of ill health can only change over the course of the projection through mortality selection.

For younger age groups, women and men are both likely to live the entire five year followup period, yet women spend increasingly more of those five years in poor health. For the 50 year olds, 65% of women's next five years will be spent with at least one health problem compared to 28% of men. Women will spend 32% of their time with more than one health problem, compared to 6% of men. For progressively older age groups, as mortality begins to take its toll on the population and more men are in poor health, we see a slight women's survival advantage emerge, yet we also see an increasing disease burden for those who survive, and a particular burden for women. For the 70 year olds, women live .1 years longer than men on average, yet 92% of women have at least one health problem compared to 67% of men, while 73% of women have more than one compared to 39% of men. If we look off the chart, we see that for the same group of 70 year olds, women will spend 33% of their time with three or more poor health reports, compared to 11% of men (not shown).

Thus, our analysis provides further support for the notion that easily recorded self-reported health assessments – which have been found to incorporate many of the properties one would want in a composite health indicator including multidimensionality, co-morbidity and trajectory – are important predictors of mortality, both in the presence or absence of more detailed and costly indicators. In contrast to some other settings, in rural Bangladesh there appear to be no evidence that the relationship of SRH to mortality is different for women and men. This results reveal a situation with important epidemiological and policy implications: women in rural Bangladesh, while now living as long as or even slightly longer than their male counterparts, spend an extraordinarily high proportion of their adult lives in poor health, beginning from very early ages, compared to male Bangladeshis and to women in other nations.

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Table 1: Sample Exclusions: Source 1996 MHSS & 1996 DSS

	Persons Missing	Persons with All Indicators	Person-Years
Self-reported Health Indicators			
No sampling weight	54	11,096	55,480
No DSS Match	165	10,931	54,655
Self-reported Health Indicators			
SRH	0	10,931	54,655
SR-ADL	13	10,918	54,590
SR-Chronic Disease	0	10,918	54,590
Observed Health Indicators			
OBS-ADL	1,001	9,950	49,750
OBS-BMI<16	1,304	9,536	47,680
Observed Health Indicators			
Death	356		47,111
Migration	1098		45,132

Table 2: Person Years, Deaths, and Death Rates by Sample:
Source 1996 MHSS & 1996-2000 DSS

Males	Cases	Person-Years	Deaths*	Percent Dying in Followup Period*	Percent Dying per Year
<50	2,861	12,697	26	0.9%	0.2%
50+	1,539	7,912	197	12.8%	2.5%
Total	4,399	20,609	223	5.1%	1.1%
Females	**Cases**	**Person-Years**	**Deaths**	**Percent Ever Dying**	**Percent Dying per Year**
<50	3,765	17,136	18	0.5%	0.1%
50+	1,372	7,387	115	8.4%	1.6%
Total	5,137	24,523	133	2.6%	0.5%
Total	**Cases**	**Person-Years**	**Deaths**	**Percent Ever Dying**	**Percent Dying per Year**
<50	6,626	29,833	44	0.7%	0.1%
50+	2,910	15,299	312	10.7%	2.0%
Total	9,536	45,132	356	3.7%	0.8%

* Deaths recorded in the DSS in 1996-2000

Table 3: Percent in Poor Health according to Health Indicators and Age, by Sex: 1996 MHSS

Total Sample	Male	Female	All
Average Age	36.4	35.7	36.1
Percent SRH Poor	12.0%	19.4%	15.9%
Percent SR-ADL Poor	10.7%	25.5%	18.5%
Percent SR-Chronic Disease Yes	10.8%	21.9%	16.6%
Percent OBS-ADL Poor	2.7%	8.0%	5.5%
Percent OBS-BMI<16	12.3%	11.7%	12.0%
N	4,399	5,137	9,536

Under 50	Male	Female	All
Average Age	27.3	29.2	28.3
Percent SRH Poor	5.1%	12.9%	9.3%
Percent SR-ADL Poor	1.8%	12.0%	7.3%
Percent SR-Chronic Disease Yes	5.6%	15.3%	10.8%
Percent OBS-ADL Poor	0.9%	4.6%	2.9%
Percent OBS-BMI<16	11.0%	8.1%	9.5%
N	2,861	3,765	6,626

Over 50	Male	Female	All
Average Age	61.5	58.8	60.3
Percent SRH Poor	31.0%	42.1%	36.3%
Percent SR-ADL Poor	35.3%	72.9%	53.2%
Percent SR-Chronic Disease Yes	25.3%	45.2%	34.8%
Percent OBS-ADL Poor	7.7%	19.7%	13.4%
Percent OBS-BMI<16	15.9%	24.4%	20.0%
N	1,538	1,372	2,910

Table 4: Interrelationships between Health Measures: 1996 MHSS

	Dyadic Correlations					Multiple Correlations		
All Respondents (n=9,536)	SRH	SR-ADL	SR-CD	OBS-ADL	OBS-BMI<16	Other Self-Reported	Other Observed	All Others
SRH	--	0.441	0.329	0.181	0.158	0.474	0.229	0.483
SR-ADL	0.441	--	0.379	0.271	0.177	0.506	0.310	0.540
SR Chronic Disease	0.329	0.379	--	0.164	0.099	0.420	0.184	0.423
OBS-ADL	0.181	0.271	0.164	--	0.097	0.284	0.097	0.287
OBS-BMI<16	0.158	0.177	0.099	0.097	--	0.199	0.097	0.204

Table 5: Covariates of Mortality: Sex, Age, and Self-Reported Health Measures*; by Age Group

Full Sample (n = 45,132)	Model 1		Model 2		Model 3		Model 4	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Female Respondent	-0.226	(0.161)	-0.351*	(0.161)	-0.653**	(0.166)	-0.627**	(0.165)
Respondent's Age	0.089**	(0.009)	0.081**	(0.010)	0.065**	(0.012)	0.066**	(0.012)
SRH			0.825**	(0.184)	0.484**	(0.169)	0.537**	(0.171)
SR-ADL					1.013**	(0.239)	1.063**	(0.242)
SR-Chronic Disease					0.254	(0.164)		
Constant	-9.537	(0.589)	-9.361	(0.609)	-8.829	(0.662)	-8.826	(0.658)
Log Likelihood Chi-Sq	111.43/ 2		216.35 /3		334.33 /5		329.99 /4	

Under 50 (n = 29,833)	Model 1		Model 2		Model 3		Model 4	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Female Respondent	-0.245	(0.601)	-0.427	(0.519)	-0.808	(0.424)	-0.778	(0.435)
Respondent's Age	-0.014	(0.035)	-0.029	(0.044)	-0.051	(0.049)	-0.049	(0.051)
SRH			1.718*	(0.863)	0.824	(0.497)	1.056	(0.631)
SR-ADL					1.885**	(0.591)	2.162**	(0.692)
SR-Chronic Disease					0.870	(0.502)		
Constant	-6.233**	(1.138)	-6.001	(1.190)	-5.519	(1.207)	-5.507	(1.267)
Log Likelihood Chi-Sq	0.54/ 2		22.36/ 3		45.46/ 5		32.45/ 4	

Age 50 + (n = 15,299)	Model 1		Model 2		Model 3		Model 4	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Female Respondent	-0.152	(0.164)	-0.265	(0.168)	-0.518**	(0.175)	-0.499**	(0.175)
Respondent's Age	0.099**	(0.008)	0.093**	(0.008)	0.081**	(0.009)	0.081**	(0.009)
SRH			0.731**	(0.165)	0.463**	(0.174)	0.506**	(0.171)
SR-ADL					0.818**	(0.216)	0.856**	(0.211)
SR-Chronic Disease					0.200	(0.168)		
Constant	-10.274	(0.577)	-10.182	(0.583)	-9.787	(0.619)	-9.761	(0.614)
Log Likelihood Chi-Sq	165.08/ 2		197.25 / 3		231.24 / 5		231.514	

* higher value of each health measure indicates poor health

Table 6 : Model 5 - Covariates of Mortality: Sex, Age, Self-reported and Observed Health Measures*; by Age Group

Full Sample (n = 45,132)	All		Under 50		Over 50	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Female Respondent	-0.816**	(0.165)	-0.721	(0.470)	-0.731**	(0.180)
Respondent's Age	0.059**	(0.011)	-0.037	(0.040)	0.071**	(0.009)
SRH	0.455**	(0.170)	0.919	(0.513)	0.419*	(0.171)
SR-ADL	0.950**	(0.242)	2.036**	(0.593)	0.755**	(0.213)
OBS-ADL	0.847**	(0.165)	-0.140	(0.667)	0.841**	(0.174)
OBS-BMI<16	0.564**	(0.176)	0.878	(0.566)	0.470**	(0.170)
Constant	-8.524**	(0.612)	-5.994**	(1.111)	-9.164**	(0.613)
Observations	45,132		29,833		15,299	
Pseudo – R^2						
Log Likelihood Chi-Sq	404.90/ 6		31.54 / 6		270.68 / 6	

* higher value of each health measure indicates poor health

Table 7 : Model 6 - Covariates of Mortality: Sex, Age, Self Reported and Observed Health Measures, and Sex/ Health Measure Interactions; by Age Group

	All		Under 50		Over 50	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Female Respondent	-1.130**	(0.361)	-1.428*	(0.642)	-0.973*	(0.440)
Respondent's Age	0.059**	(0.011)	-0.034	(0.033)	0.071**	(0.009)
SRH	0.422*	(0.209)	0.634	(0.444)	0.420	(0.215)
SR-ADL	0.797**	(0.270)	1.610**	(0.476)	0.615*	(0.245)
OBS-ADL	0.937**	(0.211)	1.598*	(0.699)	0.848**	(0.214)
OBS-BMI <16	0.692**	(0.200)	-0.710	(0.675)	0.765**	(0.211)
Female * SRH	0.087	(0.337)	0.248	(0.625)	-0.009	(0.353)
Female * SR-ADL	0.543	(0.393)	0.499	(0.773)	0.565	(0.489)
Female * OBS-ADL	-0.197	(0.347)	-3.329*	(1.355)	0.007	(0.333)
Female * BMI<16	-0.292	(0.396)	2.689**	(0.879)	-0.711*	(0.346)
Constant	-8.524**	(0.612)	-5.994**	(1.111)	-9.164**	(0.613)
Observations	45,132		29,833		15,299	
Pseudo – R^2						
Log Likelihood Chi-Sq	433.73 / 10		42.41 / 10		280.29 / 10	

* higher value of each health measure indicates poor health

Figure 1: Predicted Person Years Lived and Disability Status over 5-Year Followup by Age Group and Sex