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THE IMPACT OF RURAL MUTUAL HEALTH CARE ON HEALTH STATUS: EVALUATION OF A SOCIAL EXPERIMENT IN RURAL CHINA

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SUMMARY

Despite widespread efforts to expand health insurance in developing countries, there is scant evidence as to whether doing so actually improves people's health. This paper aims to fill this gap by evaluating the impact of Rural Mutual Health Care (RMHC), a community-based health insurance scheme, on enrollees' health outcomes. RMHC is a social experiment that was conducted in one of China's western provinces from 2003 to 2006. The RMHC experiment adopted a pre–post treatment-control study design. This study used panel data collected in 2002, 1 year prior to the intervention, and followed up in 2005, 2 years after the intervention, both in the intervention and control sites. We measured health status using both a 5-point Categorical Rating Scale and the EQ-5D instruments. The estimation method used here is difference-in-difference combined propensity score matching. The results show that RMHC has a positive effect on the health status of participants. Among the five dimensions of EQ-5D, RMHC significantly reduces pain/discomfort and anxiety/depression for the general population, and has a positive impact on mobility and usual activity for those over 55-years old. Our study provides useful policy information on the development of health insurance in developing countries, and also identifies areas where further research is needed.

KEY WORDS: community-based health insurance; health outcomes; EQ-5D; propensity score matching; social experiment; difference-in-difference estimation; developing country; rural China

1. INTRODUCTION

There are growing efforts to expand health insurance coverage in developing countries, with one of the primary objectives being an improvement in health outcomes. Little is known, however, about whether expanded coverage actually has any effect on health status. This study aims to fill this gap by investigating the effects of a community-based health insurance scheme in rural China, Rural Mutual Health Care (RMHC), on participants' health status as measured by a 5-point Categorical Rating Scale (CRS) of self-perceived health and the EQ-5D instruments.

Before 1978, community-based health insurance, rural doctors (known as 'barefoot doctors'), and a three-tier network of health care delivery were the three pillars of rural China's health care system. Together, they provided financial risk protection and the basic health services needed for rural residents to maintain their health. This system collapsed, however, when the rural economy transformed from a collective economic system to a mainly market-based one in 1978. The

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community-based health insurance scheme, the Cooperative Medical System (CMS), lost its funding base and disintegrated, leaving rural residents without financial risk protection and forcing them to pay out-of-pocket for health care services (Hsiao, 1984; Gu *et al.*, 1993; Feng *et al.*, 1995; Ministry of Health PRC, 1999). Rural doctors became private practitioners, earning money on a fee-for-service basis. The government permitted doctors earn a 15–25% profit on drugs that they sold to their patients (Hsiao, 1984). This policy created strong incentives for rural doctors to prescribe not only more drugs but also more expensive drugs. It is not uncommon for doctors to purchase fraudulent or expired drugs at below-market prices, then sell them to unsuspecting patients at the full price, so as to further increase their profits. Moreover, the previous referral system within the three-tier network was all but destroyed, as providers at all levels want to keep patients at their own practices (Yip *et al.*, 1998). Owing to these changes, the financial burden on patients has increased, the accessibility of services has declined, the quality of services has been compromised, and health improvements have stagnated (Liu *et al.*, 1995; Ministry of Health PRC, 1999).

In an effort to solve the problems that exist in rural China's current health care system, the Chinese government announced in 2002 a new health care financing policy to re-establish CMS. This revamped model of CMS is called the New Cooperative Medical System (NCMS). For the program's initial waves, the government subsidized each farmer 20 RMB (1 RMB = US$ 0.125), shared equally between the central and local governments, if the farmer paid an annual premium of at least 10 RMB to enroll (Liu, 2004). In addition, the NCMS incorporated two important policy guidelines: voluntary enrollment and coverage of catastrophic illnesses (defined by acute illness associated with hospitalization). Apart from this, the design of the program was left to the local governments, turning China into a laboratory of health insurance experiments. This new scheme was to be phased in over 5 years, targeted to reach full coverage by the end of 2008.

To assist China in developing a rural health care system that is tailored to Chinese conditions and sustainable in the long run, we designed and implemented a community-based prepayment scheme – RMHC. The primary goals of RMHC were to improve villagers' access to cost-effective basic health care, provide them with greater protection from financial risk associated with medical costs, and improve their health status. The project simulated the government subsidy of 20 RMB for each villager who prepaid a premium to enroll in RMHC. We adhered to one of the government guidelines – voluntary enrollment – and added a number of other features.

Unlike the NCMS, which mainly covers hospital services with a large deductible, the benefit package of RMHC includes both outpatient services and hospital services with no deductible. We also augmented RMHC with a number of measures aimed to improve the health care delivery system. The Fund Office of RMHC acted as a single purchaser and selected the best-qualified village doctors on a competitive basis. Contracted doctors were compensated with a salary plus a bonus based on selected health outcomes and performance measurements. This de-linked village doctors' incomes from their drug dispensing activities, and aimed to reduce the problem of over-prescription and sale of fraudulent drugs. This in turn would help reduce patients' financial burden and improve the quality of services. In addition, village doctors were no longer allowed to purchase drugs directly. Instead, township health centers purchased drugs in bulk through competitive bidding and distributed them directly to village doctors through a central distribution system. This helped to assure drug safety at a minimum cost. Finally, a prescription review system was introduced to review the cost of services.

The objective of this paper is to investigate the impact of the RMHC scheme on participants' health status, as measured by the CRS and EQ-5D instruments. This paper is organized into five sections. The next section provides a brief review of the literature on the effects of health insurance on health outcomes. Section 3 describes the study design, data sources, and variables used in the study, as well as the method of estimation. The results of the study are contained in Section 4. The major findings and

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interpretations are contained in Section 5, along with policy implications, limitations, and directions for future research.

2. LITERATURE REVIEW

There are many studies that examine the relationship between health insurance and health status in developed countries. These studies have been well summarized elsewhere (Levy and Meltzer, 2001; Hadley, 2003). The literature has continued to expand in recent years due to continuing efforts to study existing and newly developed insurance schemes. Most of these studies find that health insurance has positive effects on participants' health status. Mortality studies suggest that health insurance could reduce the mortality rate of those who were previously uninsured (Hadley, 2003; McWilliams *et al.*, 2004; Hadley and Waidmann, 2006). Existing literature has also suggested that there are significant positive effects of health insurance on self-reported health status (Franks *et al.*, 1993; Hadley, 2003; Card *et al.*, 2004; McWilliams *et al.*, 2004; Hadley and Waidmann, 2006). Although much of the existing literature demonstrates the positive relationship between health insurance and health status, several studies have found that health insurance coverage is not associated with health status, and some have even found it to be associated with worse health status (Hadley, 2003). Most of these results are from observational studies – very few of them are from natural experiments or randomized trials. As a result, very few studies have been able to draw conclusions about the causal relationship between health insurance and health status (Levy and Meltzer, 2001; Hadley, 2003; Chen *et al.*, 2007).

Although many developing countries attempt to reform their health care systems and expand or develop their own health insurance schemes, the effects of these attempts on the health status of the population are rarely examined (Ekman, 2004). Existing literature has yielded conflicting results. In a cross-sectional study, Russel (2005) examined the relationship between several measures of health status and the National Health Insurance (NHI) in Iran (Russel, 2005). The results show that there is a strong association between the amount of NHI reimbursement and years of life lost and mortality. Wagstaff and Pradham examined the effects of Vietnam's social health insurance program on health utilization and health outcomes (Wagstaff and Pradhan, 2005). Their results suggest that Vietnam's health insurance program has a favorable impact on height-for-age and weight-for-age of young school children, and on body mass index among adults. John A. Nyman and Nathan Barleen examined the effect of supplemental private health insurance on health care purchases and health in Brazil and found that supplemental private health insurance leads to significant improvements in quality of life (Nyman and Barleen, 2005). Wagstaff and Yu examine the effects of the World Bank Health VIII project in China – an intervention that targets the demand side by expanding health insurance and providing financial aid to the poor and targets the supply side by improving effectiveness and quality of health service delivery – on health utilization and health outcomes (Wagstaff and Yu, 2007). They find that the impact of these efforts on health outcomes is mixed. The results indicate that the project may reduce days of sickness, especially among the poor. However, there is no robust evidence that other health indicators are favorably impacted by the project.

3. METHOD

3.1. Conceptual framework

The economic model of health production is adopted as the theoretical framework for this study. This model is largely derived from the human capital model of demand for health (Grossman, 1972). The core concept of the model is that health is a durable commodity. The individual has an initial stock of

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health that depreciates over time and can be augmented by investment. Health service utilization is considered one of the most important investments in health.

We hypothesize that the reduced price of services faced by consumers and the improvements in quality of health care delivery will improve enrollees' health status by increasing their utilization of higher quality health care services. We also expect that the effects of RMHC on health will be stronger in low-income groups than in high-income groups if health and health care are normal goods and have diminishing marginal returns (Folland *et al.*, 2001). In addition, we expect that the elderly, the unhealthy, and females will obtain more benefits from RMHC than the young, the healthy, and males since the elderly, unhealthy, and female groups are more likely to use health care services than those in the young, healthy, and male groups.

3.2. Study design and data

RMHC was implemented with a quasi-experimental design in a western province in China. One township was randomly selected to be the intervention site, and another was selected as a control site. The control site was selected to match the RMHC intervention sites in terms of socioeconomic conditions, availability of health facilities, and distance to city centers, based on available official statistics. RMHC began its first-time enrollment in the intervention site in December 2003, and went into full operation immediately thereafter. There was no health insurance scheme or other new policy introduced in the control site throughout the study period.

The data for this analysis are based on longitudinal household and individual surveys conducted 1 year prior to the intervention (December 2002) and followed up 2 years after the intervention in 2005. We randomly selected 10 villages (6 in the intervention site and 4 in the control site, in proportion to population size of the intervention and control towns). Within each village, we randomly selected one out of three households in the village, yielding a total sample of 1925 households (1173 in the intervention site and 752 in the control site) and 7025 individuals (4160 in the intervention site and 2865 in the control site) in the pre-intervention year. This analysis only includes those aged 15 and above because children under 15 were not asked to self-rate their health status, the primary dependent variable. This results in a sample size of 3062 in the intervention site and 2189 in control site.

To measure health status, we used two instruments, both of which are self-perceived measures. The first one is a 5-point CRS to represent overall health status (excellent, very good, good, fair, or poor). This simple instrument has been shown to successfully predict mortality (Idler and Benyamini, 1997; Burstrom and Fredlund, 2001) and disability (Goldstein *et al.*, 1984). For convenience, we created a dichotomized variable 'Poorh' (1 = fair or poor; 0 = excellent, very good, or good). The definition and descriptive statistics for this variable are listed in Table I.

The second instrument that we used is the EQ-5D instrument (EuroQol Group, 1990). This instrument defines health in terms of five dimensions: mobility, self-care, usual activities (work, study, housework, family, or leisure), pain/discomfort, and anxiety/depression. For each dimension, respondents were asked to rate whether there is no problem, a moderate problem, or an extreme problem (Kind *et al.*, 1998). Because this study was conducted in the general population rather than a population with illnesses, it is expected that the results will be skewed toward the no problem category. We, therefore, combined the moderate and extreme problem categories into one (Roset *et al.*, 1999). Five variables that represent five dimensions of EQ-5D were dichotomized (1 = any problem; 0 = no problem). In addition, a dichotomized variable 'EQ-5D any dimension' (1 = any problem in any of the five dimensions and 0 = no problem in any of the five dimensions) was also formulated to represent overall health status. The definitions and descriptive statistics of these variables are also listed in Table I.

The observable socioeconomic and demographic variables of our sample included age, gender, marital status, household size, income, level of education, migrant status, and the distance from the

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Table I. Descriptive statistics of outcome variables

		Pre-intervention				Post-intervention						
		RMHC enrolled ($N = 1665$)		Control ($N = 1745$)		RMHC enrolled ($N = 1665$)		Control ($N = 1745$)				
Variables	Definition	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Dif-in-Diff	S.E.	Sig
Poorh	1 if self-rated health status is 'poor' or 'fair', 0 otherwise	0.34	0.48	0.19	0.39	0.19	0.39	0.21	0.40	−0.17	0.018	**
EQ-5D any dimension	1 if having problem on EQ-5D any of five dimensions, 0 otherwise	0.49	0.50	0.37	0.48	0.20	0.40	0.30	0.46	−0.22	0.020	**
EQ-5D dimensions												
Mobility	1 if having problem on EQ-5D mobility dimension, 0 otherwise	0.08	0.27	0.06	0.24	0.04	0.20	0.05	0.22	−0.03	0.011	
Self-care	1 if having problem on EQ-5D self-care dimension, 0 otherwise	0.05	0.21	0.04	0.19	0.04	0.20	0.03	0.16	0.00	0.009	
Usual activity	1 if having problem on EQ-5D usual activity dimension, 0 otherwise	0.11	0.32	0.10	0.30	0.06	0.23	0.05	0.22	−0.01	0.012	
Pain/discomfort	1 if having problem on EQ-5D pain/discomfort dimension, 0 otherwise	0.31	0.46	0.23	0.42	0.17	0.37	0.22	0.41	−0.12	0.019	**
Anxiety/depression	1 if having problem on EQ-5D anxiety/depression dimension, 0 otherwise	0.40	0.49	0.30	0.46	0.12	0.33	0.26	0.44	−0.24	0.020	**

**$p < 0.01$; *$p < 0.05$.

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respondent's home to village health facility. The income variable used in this study was self-reported, post-direct tax consumption expenditure rather than self-reported income, as income is more likely to be misreported and actual expenditure is a better proxy for resources available for spending (Meyer and Sullivan, 2003). Instead of using a continuous variable, we created categorical income variables in order to capture nonlinear effects. In addition, the 'type of house' variable was included in the analyses since current earned income is often an incomplete measure of wealth status, and the value of the house represents long-term cumulative earning, which may have more important effects on health than current income. Table II describes these variables and provides summary statistics for each. The same survey instruments were used for both the intervention and control sites, and for the pre-intervention and post-intervention surveys.

3.3. Estimation method

Our goal is to estimate the impact of RMHC on the health status of individuals who were exposed to the program (the enrolled) – that is, the average treatment effect (ATT). To do so, we adopted the differences-in-differences (DD) method together with propensity score matching (PSM), a method that is increasingly used for impact evaluations (Imbens, 2004; Blundell *et al.*, 2005; Ravallion, 2005; Wagstaff and Yu, 2007). Since enrollment in RMHC was voluntary, the enrolled are likely to be different from those who are not enrolled in both observable and unobservable ways. A comparison of the enrolled and non-enrolled would therefore lead to biased estimates. The DD method applied to panel data removes any time-invariant unobservables that may correlate with RMHC enrollment and bias the impact estimates. A DD estimate without PSM may still be biased if the initial conditions of the treatment and control groups differ in a significant way. The basic idea behind PSM is to create a counterfactual group who are 'similar' to the treatment group as measured by the propensity score. PSM thus helps to remove selection on observables and reduces selection on unobservables that are highly correlated with the observables.

Formally,

$$\text{ATT} = E(Y^1_{i,t1} - Y^0_{i,t0}|D_i = 1) - E(Y^0_{i,t1} - Y^0_{i,t0}|D_i = 1)$$

where Y^1_i represents health outcome for individual 'i' if exposed to RMHC intervention and Y^0_i represents health outcome for individual 'i' if not exposed to RMHC intervention. $D_i = 1$ if the individual enrolled in RMHC and '0' otherwise. The subscripts, '$t0$' and '$t1$', stand for pre- and post-intervention periods, respectively. $E(Y^0_{i,t1}|D_i = 1)$ is not observed, however.

If the conditional mean independence condition is satisfied,

$E(Y^0_i|Z, D_i = 1) = E(Y^0_i|Z, D_i = 0) = E(Y^0_i|Z)$, that is, conditional on a set of observed characteristics, Z, enrollment in RMHC can be treated as random; and if $\Pr(D = 1|Z) = 1$, that is, for each treated individual, there exists a matched control analogue, then, $E(Y^0_{i,t1} - Y^0_{i,t0}|D_i = 1)$ can be replaced by $E(Y^0_{i,t1} - Y^0_{i,t0}|Z, D_i = 0)$.

The average treatment effect can be written as

$$ATT = E(Y^1_{i,t1} - Y^0_{i,t0}|D_i = 1) - E(Y^0_{i,t1} - Y^0_{i,t0}|Z, D_i = 0)$$

where the first term can be estimated from the treatment group and the second term from the outcomes of the matched (on Z) comparison group (Smith and Todd, 2005). The more variables used for matching, the more likely that differences between the treated and control samples are reduced. Rosenbaum and Rubin (1983) show that if outcomes are independent of participation conditional on Z, they are also independent of participation conditional on the propensity score, $\Pr(D = 1|Z)$. The propensity score can be estimated by a logit or probit. As a result,

$$ATT = E(Y^1_{i,t1} - Y^0_{i,t0}|D_i = 1) - E(Y^0_{i,t1} - Y^0_{i,t0}|(\Pr(D = 1|Z), D_i = 0)$$

Our treatment group consists of those who enrolled in RMHC and who are 15 years and older ($N = 1812$). There are two potential candidates for comparison groups: the non-enrolled in the

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Table II. Descriptive statistics of control variables at the pre-intervention with follow up sample

		RMHC site					
		Non-enrolled		Enrolled		Control site	
		($N = 610$)		($N = 1665$)		($N = 1745$)	
Variables	Definition	Mean	S.D.	Mean	S.D.	Mean	S.D.
Age							
Age 15–34	1 if age between 15- and 34-years old, 0 otherwise	0.56	0.50	0.28	0.45	0.40	0.49
Age 35–54	1 if age between 35- and 54-years old, 0 otherwise	0.29	0.46	0.45	0.50	0.40	0.49
Age 55 and up	1 if age 55 years and older, 0 otherwise	0.15	0.36	0.27	0.45	0.21	0.41
Gender							
Male	1 if male, 0 otherwise	0.58	0.49	0.49	0.50	0.51	0.50
Marriage							
Unmarried	1 if never married, 0 otherwise	0.37	0.48	0.06	0.24	0.15	0.36
Married	1 if currently married, 0 otherwise	0.58	0.49	0.86	0.35	0.80	0.40
Divorced	1 if currently divorced or separated, 0 otherwise	0.06	0.23	0.08	0.27	0.05	0.22
Household size							
Hsize-1	1 if live himself/herself, 0 otherwise	0.00	0.07	0.02	0.12	0.01	0.12
Hsize-2	1 if household size is 2 persons, 0 otherwise	0.11	0.32	0.17	0.38	0.19	0.39
Hsize-3	1 if household size is 3 persons, 0 otherwise	0.25	0.43	0.23	0.42	0.17	0.38
Hsize-4	1 if household size is 4 persons, 0 otherwise	0.31	0.46	0.28	0.45	0.32	0.47
Hsize-5	1 if household size is 5 persons, 0 otherwise	0.19	0.39	0.18	0.38	0.23	0.42
Hsize = 6 & up	1 if household size is 6 or more persons, 0 otherwise	0.13	0.33	0.13	0.33	0.07	0.26
Income							
L-income	1 if household income per capita is at bottom 25%, 0 otherwise	0.32	0.47	0.34	0.47	0.18	0.38
M-income	1 if household income per capita is in middle 50%, 0 otherwise	0.51	0.50	0.47	0.50	0.54	0.50
H-income	1 if household income per capita is in top 25%, 0 otherwise	0.17	0.37	0.19	0.39	0.29	0.45
Type of house							
H-brick	1 if house is made of brick, 0 otherwise	0.06	0.24	0.08	0.27	0.17	0.37
H-wood	1 if house is made of wood, 0 otherwise	0.13	0.34	0.10	0.30	0.23	0.42
H-mud/other	1 if house is made of mud and grass, 0 otherwise	0.80	0.40	0.82	0.39	0.61	0.49
Education							
Illiteracy	1 if education level is illiteracy, 0 otherwise	0.20	0.40	0.31	0.46	0.25	0.43
Elementary	1 if finished elementary education, 0 otherwise	0.36	0.48	0.47	0.50	0.38	0.48
Junior high	1 if finished Junior high or higher education, 0 otherwise	0.43	0.50	0.22	0.41	0.38	0.48
Rural to urban migrant							
Migrant	1 if currently is a rural to urban migrant worker, 0 otherwise	0.10	0.31	0.03	0.18	0.06	0.23
Health status							
Illness	1 if feeling unhealthy in the past month of interview, 0 otherwise	0.27	0.45	0.44	0.50	0.19	0.39
Chronic	1 if having diagnosed chronic disease(s) in the past year, 0 otherwise	0.16	0.37	0.33	0.47	0.19	0.39
Health behavior							
Smoker	1 if currently a frequent smoker, 0 otherwise	0.27	0.44	0.39	0.49	0.32	0.47
Drinker	1 if currently a frequent drinker, 0 otherwise	0.09	0.28	0.12	0.33	0.08	0.28
Distance to health facility							
Distance	The distance from home to village health post (1/2km)	2.91	2.89	2.50	2.39	2.46	2.27

intervention sites, and the control sites. Our final analyses and the results presented in this paper use the control site as the comparison group ($N = 1745$). We choose not to include the non-enrolled sample in the intervention site, since they select themselves out of enrollment, they are more likely to suffer from biases due to unobservables that are correlated with our outcome variables of interest. We further

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restrict our analytical sample to those whom we successfully interviewed in both the pre- and post-intervention periods. The follow-up rates were 91.4 and 79.7% for the treatment and control group, respectively.

For matching, we selected two of the major methods: nearest four neighbors matching and kernel matching. Under the nearest neighbor method, each individual in the treatment group is matched with the four 'closest' individuals from the control group, where 'closeness' is defined by the propensity score. Varying the number of matches from one to five neighbors resulted in very similar estimates. Observations not in the common support are excluded from the analysis. This leads to the exclusion of 8 and 12 observations from the treatment and control samples, respectively. Under kernel matching, we use all the observations in the control group to construct the counterfactual outcome for the enrolled in the interventions sites, with each observation weighted by its closeness to the intervention observation, where the weights are equal to a transformation of the absolute difference in propensity score between the treated and untreated units (Smith and Todd, 2005).

Based on the hypotheses that are listed at the end of Section 3.1, we conducted analyses with a full sample and with sub-group samples based on income, age, gender, and illness status.

4. RESULTS

4.1. Descriptive statistics

Table I provides an overview of our study sample's health status in the pre-intervention year (2002) and the post-intervention year (2005). The data show that RMHC enrollees' overall health status improved between 2002 and 2005. In the baseline, 34% of the treatment sample reported poor/fair health, compared with only 19% post-intervention. Of the EQ-5D five dimensions, the treatment group shows the greatest improvements in health status for pain/discomfort and anxiety/depression. In contrast, the rates of reporting health problems (overall or for specific dimensions) remain relatively constant in the pre- and post-intervention periods for the control sample.

Table II provides descriptive statistics of the baseline characteristics of enrollees and non-enrollees separately in the RMHC site and the sample in the control site. Within the RMHC sample, the enrolled (treatment group) are more likely to be older, female, married, in worse health and to have less healthy behavior (as measured by smoking and drinking), lower income, and a lower level of education. This is consistent with adverse selection. Comparing the RMHC-enrolled group (treatment group) and the control site sample (control group), the treatment sample is older, has lower income, more likely to live in a mud house, has lower level of education and less healthy. These major differences in baseline characteristics warrant the use of PSM in order to reduce heterogeneity that may lead to biased estimates.

4.2. Propensity score matching – balancing properties

Table III presents the balancing properties of the PSM and the resulting reductions in observable differences in baseline characteristics between the treatment and control groups. The first column indicates the pre-matching standardized difference in means for each matching variable between the intervention and control sites (Rosenbaum and Rubin, 1985). The second column provides the significance of the two-sample t-statistic. The next sets of columns compare post-matching differences in means using our two matching methods: nearest four neighbors and kernel matching. The last column for each matching method indicates the percent reduction in bias.

The results in Table III show that the differences between the treatment and control groups range from 1.8% for the 'distance' variable to 55.8% for the 'Illness' variable, before matching. The differences in most of these observable variables are statistically significant, with the exceptions of

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Table III. Matching balancing properties between RMHC and control groups at the pre-intervention

	Pre-matching		Nearest neighbor matching			Kernel matching		
Variables	Std diff (%)	Sig	Std diff (%)	Sig	Bias reduction (%)	Std diff (%)	Sig	Bias reduction (%)
Age								
Age 35–54	10.6	**	4.9		53.6	3.6		66.6
Age 55 and up	15.1	**	−1.8		88.3	−1.2		92.4
Gender								
Male	−4.3		1.0		77.3	0.6		86.6
Marriage								
Married	17.3	**	−4.0		76.9	−3.0		82.4
Divorced	10.9	**	4.5		58.2	4.5		58.8
Household size								
Hsize-2	−3.8		−1.2		68.7	−1.4		61.6
Hsize-3	13.9	**	1.6		88.3	4.6		66.9
Hsize-4	−10.3	**	−2.2		78.8	−3.2		69.0
Hsize-5	−13.0	**	3.2		75.7	0.6		95.7
Hsize = 6 & up	19.3	**	−1.7		91.0	0.0		99.9
Income								
M-income	−13.4	**	2.4		82.0	−1.9		85.7
H-income	−23.6	**	−5.6		76.2	−5.8		75.5
Type of house								
H-wood	−33.5	**	1.3		96.2	0.0		99.9
H-mud/other	47.4	**	−0.6		98.8	1.9		96.0
Education								
Elementary	19.5	**	−1.8		90.7	−0.9		95.5
Junior high	−35.7	**	−1.3		96.4	−2.9		91.9
Rural to urban migrant								
Migrant	−10.3	**	−0.7		93.6	0.0		99.9
Health status								
Illness	55.8	**	−3.0		94.5	3.7		93.3
Chronic	31.5	**	4.2		86.8	5.6		82.1
Health behavior								
Smoker	12.9	**	0.1		99.3	0.6		95.7
Drinker	12.2	**	−0.1		98.8	0.9		93.0
Distance to health facility								
Distance	1.8		0.3		85.6	3.0		−69.4
Health status								
Poorh	36.2	**	6.0		83.4	6.1		83.1
EQ-5D any dimension	25.3	**	5.3		79.2	5.5		78.1
Mobility	7.7	*	2.9		62.5	1.8		76.9
Self-care	6.2		2.3		62.5	1.2		81.2
Usual activity	3.9		7.0		−80.0	4.2		−8.1
Pain/discomfort	15.9	**	3.1		80.7	2.5		84.5
Anxiety/depression	20.5	**	4.0		80.2	5.0		75.8
LR-Chi Square (29 df)	699.8	**	20.1			20.3		

**$p<0.01$; *$p<0.05$.

'male', 'Hsize-2', 'distance', and 'usual activity'. After matching, almost all of the differences in observable variables between the treatment and control groups are no longer statistically significant, except for the 'age 35–54' variable in the nearest neighbor matching and the 'H-income' variable in kernel matching. Most importantly, after matching, the differences in baseline health status between the treatment and control groups were significantly reduced.

4.3. Impact estimates – the effects of RMHC on health status

Table IV presents impact estimates of RMHC on changes in CRS and EQ-5D. We have presented two estimates, one based on kernel matching and the other based on nearest neighbor matching. The results are very similar. In terms of the CRS indicator (Poorh), the two estimated ATTs of RMHC are −0.125

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Table IV. Estimates of RMHC effects on CRS and EQ-5D

	Nearest neighbor matching			Kernel matching		
Variables	*B*	S.E.	Sig	*B*	S.E.	Sig
Poorh	−0.127	0.028	**	−0.125	0.025	**
EQ-5D any dimension	−0.246	0.028	**	−0.238	0.025	**
EQ-5D dimensions						
Mobility	−0.030	0.015	*	−0.022	0.014	
Self-care	−0.004	0.012		0.001	0.012	
Usual activity	−0.031	0.017		−0.018	0.015	
Pain/discomfort	−0.121	0.027	**	−0.117	0.023	**
Anxiety/depression	−0.220	0.028	**	−0.217	0.026	**

**$p<0.01$; *$p<0.05$. We also estimated the results using LLM. There does not seem to be major differences between the kernel estimates and LLM estimates. Our sample size is reasonably large. We therefore did not present the LLM findings.

(kernel matching) and −0.127 (nearest neighbor matching), which represent about 37.0% decrease from the pre-intervention rate of 0.34 (Table IV). In terms of EQ-5D any dimension indicator, the two estimated ATTs are −0.238 (kernel matching) and −0.246 (nearest neighbor matching), which represent a 48.4–50.0% decrease from the pre-intervention rate of 0.49 (Table IV). We also conducted estimations using local linear matching, the results of which were similar to those of kernel matching and are not reported here.

In terms of EQ-5D five dimensions indicators, the estimated ATTs of RMHC based on nearest neighbor matching and kernel matching only displayed consistent and statistically significant results on the pain/discomfort and the anxiety/depression dimensions. The two estimated ATTs of RMHC for the pain/discomfort indicator are −0.117 (kernel matching) and −0.121 (nearest neighbor matching), which represent a 38.2–39.8% decrease from the pre-intervention rate of 0.31 (Table IV). For the anxiety/depression indicator, the two estimated ATTs of RMHC are −0.217 (kernel matching) and −0.220 (nearest neighbor matching), which represent a 54.6–55.3% decrease from the pre-intervention rate of 0.40 (Table IV). We have also conducted intention to treatment (ITT) analysis and included the results of this estimation in Appendix A. As expected, the effects of RMHC on health status using ITT method are not as strong as the estimations with ATT estimations. In addition, we included the descriptive statistics of control variables at the pre- and post- intervention with follow-up sample for ATT and ITT analyses in Appendix B and Appendix C.

4.4. Impact estimates by subgroups

To examine whether the RMHC impacts differ by individual characteristics, we re-estimated the model from Table IV, including interactions with the following sets of variables, one at a time: income, gender, age, and illness status pre-intervention. The results of these analyses are shown in Table V. Across the different age groups, RMHC has the greatest impact on the middle-aged sample. The estimates show that, compared with those aged between 15 and 34, those aged between 35- and 54-years old experienced an additional reduction in the probability of reporting poor/fair health or a problem in any of the EQ-5D five dimensions by 0.123 and 0.084, respectively. The results also point to larger impacts among males and those with ill health. Surprisingly, the results indicate that there is no statistically significant difference in the effects of RMHC on health status by income group.

Table VI presents the effects of RMHC on EQ-5D five dimensions stratified by income, gender, age, and illness status at pre-intervention. Across the different income groups, there is no statistically significant difference in the impact of RMHC for any of the five dimensions, except for pain/discomfort, for which the highest income group experienced the greatest reduction in reporting a problem. Across the different age groups, consistent with expectations, RMHC has the greatest impact on the oldest group. Those who were older than 55-years old experienced a significant reduction in reporting a

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Table V. Estimates of RMHC effects on overall health status stratified by selected demographic and socioeconomic status

	Poorh			Any dimension		
Variables	*B*	S.E.	Sig	*B*	S.E.	Sig
Income						
RMHC	−0.117	0.031	**	−0.256	0.031	**
M-income × RMHC	−0.032	0.030		0.027	0.030	
Hi-income × RMHC	0.027	0.038		0.013	0.040	
Age						
RMHC	−0.058	0.029	*	−0.200	0.031	**
Age 35–54 × RMHC	−0.123	0.029	**	−0.084	0.031	**
Age 55 and up × RMHC	−0.049	0.036		−0.014	0.037	
Gender						
RMHC	−0.096	0.028	**	−0.242	0.029	**
Male × RMHC	−0.063	0.027	*	0.002	0.027	
Illness						
RMHC	−0.077	0.025	**	−0.185	0.028	**
Illness × RMHC	−0.111	0.038	**	−0.127	0.037	**

**$p<0.01$; *$p<0.05$.

Table VI. Estimates of RMHC effects on EQ-5D dimensions stratified selected demographic and socioeconomic status

	Mobility			Self-care			Usual activity			Pain/discomfort			Anxiety/depression		
Variables	*B*	S.E.	Sig	*B*	S.E.	Sig	*B*	S.E.	Sig	*B*	S.E.	Sig	*B*	S.E.	Sig
Income															
RMHC	−0.004	0.017		0.002	0.016		−0.029	0.020		−0.092	0.028	**	−0.231	0.032	**
M-income × RMHC	−0.021	0.017		0.008	0.015		0.019	0.020		−0.027	0.027		0.022	0.030	
Hi-income × RMHC	−0.038	0.020		−0.030	0.017		0.007	0.024		−0.071	0.037	*	0.010	0.039	
Age															
RMHC	0.004	0.014		0.002	0.013		0.014	0.015		−0.054	0.027	*	−0.163	0.031	*
Age 35–54 × RMHC	−0.018	0.013		−0.002	0.011		−0.015	0.015		−0.083	0.027	**	−0.104	0.031	**
Age 55 and up × RMHC	−0.060	0.023	**	−0.006	0.020		−0.094	0.026	**	−0.096	0.033	**	−0.033	0.037	
Gender															
RMHC	−0.014	0.016		−0.003	0.014		−0.008	0.017		−0.122	0.027	**	−0.218	0.030	**
Male × RMHC	−0.015	0.015		0.006	0.013		−0.021	0.017		0.010	0.025		−0.002	0.027	
Illness															
RMHC	−0.009	0.014		−0.001	0.012		0.018	0.015		−0.068	0.024	**	−0.160	0.027	**
Illness × RMHC	−0.026	0.022		0.001	0.019		−0.081	0.024	**	−0.111	0.036	**	−0.133	0.039	**

**$p<0.01$; *$p<0.05$.

problem in mobility, usual activity, pain/discomfort, and anxiety/depression. Similarly, those who were ill in the baseline experienced greater improvements in 'usual activity', 'pain/discomfort', and 'anxiety/depression' than those who were not ill in the baseline.

5. DISCUSSION AND CONCLUSION

Our results demonstrate that there is a significant potential to improve the health of the population through the expansion of health insurance and the improvement of health care delivery. The RMHC scheme that we introduced not only included a demand-side financial risk pooling intervention, which reduced the financial barriers to health care services, but also included supply-side efficiency and quality

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improvements, which increased the cost effectiveness of the delivery system. This integrated intervention approach provided benefits to the enrollees in terms of both financial access and health improvement.

In addition, RMHC adopted a first dollar coverage policy for both outpatient and inpatient services. This policy provided incentives for the enrollees to utilize health care services at the onset of their illness, which could help prevent catastrophic illnesses, thus improving the health status of the enrollees.

As we mentioned in the section 'Introduction', China has already begun to re-establish a community-based health insurance scheme in rural areas. However, the scheme that is being introduced is a catastrophic health insurance program, which only covers hospital expenditures. Since the hospitalization rate is relatively low (about 3–6% of the population), very few people will obtain direct benefits from such a scheme. In addition, if the insurance scheme does not cover outpatient services, patients might delay their health care service utilization until they are very sick and eligible for hospitalization service. Although we did not directly examine the effects of such catastrophic health insurance on health status in this analysis, we expect its effects on health would be lower than the effects of our RMHC scheme.

Based on the results of this analysis, we suggest that the Chinese government expand NCMS coverage to include outpatient services as well as hospital services, so as to maximize the impact on health outcomes. In addition, supply-side interventions to improve the efficiency and quality of service delivery should be integrated into the scheme in order to maximize health outcomes with limited resources.

Our sub-group analyses revealed that the effects of RMHC vary by age and illness, but not by income and gender. The oldest group experienced significant improvements in mobility, usual activity, pain/discomfort, and anxiety/depression, while the ill experienced greater improvements than the healthy in usual activity, pain/discomfort, and anxiety/depression. These results are consistent with our expectation that older and less healthy people would benefit more from RMHC since they are more likely to use health services than healthy people. Moreover, older individuals may suffer from more health problems than younger ones, giving them greater potential to experience health gains from RMHC.

The results from our income sub-group analysis, however, differed from our expectations. We expected that RMHC would have a larger effect on low-income groups than on high-income groups, reasoning that if low-income groups suffer from greater barriers to care, RMHC would have more of an impact on their health care utilization, and therefore on their health status. However, the results of our analysis show that the RMHC impacts do not differ across income groups, either overall or for sub-dimensions. Although low-income rural residents are able to enroll in the NCMS because the government subsidizes their premium, high co-payment rates may still pose financial barriers for them, and thus may reduce the impact of the insurance scheme (Wang *et al.*, 2005). The study results from Wagstaff and his colleagues displayed that NCMS has had no impact on out-of-pocket spending or on utilization among the poor (Wagstaff *et al.*, 2007). In order to achieve equity goals, additional financial assistance might be required to reduce or eliminate co-payments for the most vulnerable households.

There are several limitations to our study. Methodologically, while our method of combining the DD estimation and PSM effectively controls for both time-invariant unobservables and observable differences between the treatment and control groups, it does not control for unobserved factors that change between 2002 and 2005. Controlling for these factors would have required the use of instrumental variables or data on utilization trends from before the intervention, which are unavailable. While we admit that a potential bias exists, we argue that the threat it poses is limited because we have included a comprehensive set of variables in the propensity score estimation, which helps to remove time-varying unobservables that are correlated with these observable factors.

Another limitation to our study is that self-perceived health status measurements are the only health outcome measurements used in this study. This limitation is mitigated somewhat by the existence of other studies that have already demonstrated the strong correlation between self-perceived health status and other more objective measurements such as mortality and disability. Nevertheless, we are unable to directly demonstrate the effects of RMHC on these objective measurements.

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In addition, our study design prevents us from separating the effects of the health insurance from the effects of the overall intervention. As mentioned in the introduction, besides the community-based health insurance, we also introduced several supply-side interventions to improve the efficiency and quality of services. These measures are likely to have also affected participants' health status, but it is impossible to determine how much of the improvement is attributable to the insurance and how much is attributable to the supply-side interventions.

Another possible bias stems from attrition in the treatment group. This could affect our results if those who are lost to follow-up experienced a different degree of health improvement than those who participated in the survey in the evaluation year. If this is the case, our estimation might be underestimated (if the lost to follow-up received more benefit than the follow-up group) or overestimated (if the lost to follow-up group received less benefit than the follow-up group). However, this is of limited concern since the attrition rate for the treatment group is less than 9%, and although the attrition rate for the control group is higher (about 20%), we did not find any statistically significant differences in the baseline characteristics between the followed-up and the lost samples, except for marital status and whether the person has a chronic condition. To the extent that these characteristics do not change much over the 3-year period of study, they are controlled for by a DD model.

Finally, our study only compared the intervention effects between RMHC and a control group. No alternative schemes were included as comparisons. Although we demonstrate that our intervention does have the potential to improve the health status of the participants, we are not able to conclude that RMHC is the best approach.

In spite of these limitations, our study still provides useful policy information on the development of health insurance in developing countries, and also identifies areas where further research is needed. It is one of only a few studies that are attempting to examine the causal relationship between health insurance and health status in developing countries.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

APPENDIX A: ESTIMATES OF RMHC EFFECTS ON CRS AND EQ-5D (ITT ESTIMATIONS)

	Nearest neighbor matching			Kernel matching		
Variables	*B*	S.E.	Sig	*B*	S.E.	Sig
Poorh	−0.076	0.024	**	−0.084	0.021	**
EQ-5D any dimension	−0.177	0.024	**	−0.164	0.022	**
EQ-5D dimensions						
Mobility	−0.039	0.014	**	−0.023	0.013	
Self-care	−0.009	0.013		−0.007	0.011	
Usual activity	−0.026	0.016		−0.019	0.014	
Pain/discomfort	−0.087	0.022	**	−0.077	0.020	**
Anxiety/depression	−0.153	0.024	**	−0.152	0.022	**

**$p<0.01$; *$p<0.05$. $N = 3478$ (after match).

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APPENDIX B: DESCRIPTIVE STATISTICS OF CONTROL VARIABLES AT THE PRE- AND POST-INTERVENTION WITH FOLLOW-UP SAMPLE FOR ATT ANALYSIS

		Pre-intervention				Post-intervention			
		Intervention		Control		Intervention		Control	
		($N = 1665$)		($N = 1745$)		($N = 1665$)		($N = 1745$)	
Variables	Definition	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Age									
Age 15–34	1 if age between 15 and 34 years old, 0 otherwise	0.28	0.45	0.40	0.49	0.19	0.39	0.34	0.47
Age 35–54	1 if age between 35 and 54 years old, 0 otherwise	0.45	0.50	0.40	0.49	0.47	0.50	0.42	0.49
Age 55 and up	1 if age 55 years and older, 0 otherwise	0.27	0.45	0.21	0.41	0.34	0.47	0.24	0.43
Gender									
Male	1 if male, 0 otherwise	0.49	0.50	0.51	0.50	0.49	0.50	0.51	0.50
Marriage									
Unmarried	1 if never married, 0 otherwise	0.06	0.24	0.15	0.36	0.05	0.22	0.15	0.35
Married	1 if currently married, 0 otherwise	0.86	0.35	0.80	0.40	0.85	0.36	0.81	0.40
Divorced	1 if currently divorced or separated, 0 otherwise	0.08	0.27	0.05	0.22	0.10	0.30	0.05	0.22
Household size									
Hsize-1	1 if live himself/herself, 0 otherwise	0.02	0.12	0.01	0.12	0.03	0.17	0.03	0.18
Hsize-2	1 if household size is 2 persons, 0 otherwise	0.17	0.38	0.19	0.39	0.27	0.44	0.26	0.44
Hsize-3	1 if household size is 3 persons, 0 otherwise	0.23	0.42	0.17	0.38	0.22	0.42	0.23	0.42
Hsize-4	1 if household size is 4 persons, 0 otherwise	0.28	0.45	0.32	0.47	0.22	0.41	0.25	0.44
Hsize-5	1 if household size is 5 persons, 0 otherwise	0.18	0.38	0.23	0.42	0.18	0.38	0.15	0.36
Hsize = 6 and up	1 if household size is 6 or more persons, 0 otherwise	0.13	0.33	0.07	0.26	0.08	0.27	0.07	0.26
Income									
L-income	1 if household income per capita is at bottom 25%, 0 otherwise	0.34	0.47	0.18	0.38	0.30	0.46	0.17	0.38
M-income	1 if household income per capita is in middle 50%, 0 otherwise	0.47	0.50	0.54	0.50	0.52	0.50	0.47	0.50
H-income	1 if household income per capita is in top 25%, 0 otherwise	0.19	0.39	0.29	0.45	0.18	0.38	0.36	0.48
Type of house									
H-brick	1 if house is made of brick, 0 otherwise	0.08	0.27	0.17	0.37	0.18	0.38	0.21	0.41
H-wood	1 if house is made of wood, 0 otherwise	0.10	0.30	0.23	0.42	0.15	0.35	0.14	0.35

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H-mud/ other	1 if house is made of mud and grass, 0 otherwise	0.82	0.39	0.61	0.49	0.67	0.47	0.65	0.48
Education									
Illiteracy	1 if education level is illiteracy, 0 otherwise	0.31	0.46	0.25	0.43	0.32	0.47	0.26	0.44
Elementary	1 if finished elementary education, 0 otherwise	0.47	0.50	0.38	0.48	0.45	0.50	0.37	0.48
Junior high	1 if finished Junior high or higher education, 0 otherwise	0.22	0.41	0.38	0.48	0.22	0.42	0.36	0.48
Rural to urban migrant									
Migrant	1 if currently is a rural to urban migrant worker, 0 otherwise	0.03	0.18	0.06	0.23	0.00	0.05	0.12	0.33
Health status									
Illness	1 if feeling unhealthy in the past month of interview, 0 otherwise	0.44	0.50	0.19	0.39	0.29	0.45	0.19	0.40
Chronic	1 if having diagnosed chronic disease(s) in the past year, 0 otherwise	0.33	0.47	0.19	0.39	0.31	0.46	0.18	0.38
Health behavior									
Smoker	1 if currently a frequent smoker, 0 otherwise	0.39	0.49	0.32	0.47	0.36	0.48	0.29	0.46
Drinker	1 if currently a frequent drinker, 0 otherwise	0.12	0.33	0.08	0.28	0.09	0.29	0.07	0.25
Distance to health facility									
Distance	The distance from home to village health post (1/2 km)	2.50	2.39	2.46	2.27	2.88	7.65	2.65	2.05

APPENDIX C: DESCRIPTIVE STATISTICS OF CONTROL VARIABLES AT THE PRE- AND POST-INTERVENTION WITH FOLLOW-UP SAMPLE FOR ITT ANALYSIS

		Pre-intervention				Post-intervention			
		Intervention		Control		Intervention		Control	
		($N = 2275$)		($N = 1744$)		($N = 2275$)		($N = 1744$)	
Variables	Definition	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Age									
Age 15–34	1 if age between 15 and 34 years old, 0 otherwise	0.35	0.48	0.40	0.49	0.26	0.44	0.34	0.47
Age 35–54	1 if age between 35 and 54 years old, 0 otherwise	0.41	0.49	0.40	0.49	0.43	0.50	0.42	0.49
Age 55 and up	1 if age 55 years and older, 0 otherwise	0.24	0.43	0.21	0.41	0.30	0.46	0.24	0.43
Gender									
Male	1 if male, 0 otherwise	0.51	0.50	0.51	0.50	0.51	0.50	0.51	0.50

DOI: 10.1002/hec

Marriage									
Unmarried	1 if never married, 0 otherwise	0.13	0.34	0.15	0.36	0.11	0.32	0.15	0.35
Married	1 if currently married, 0 otherwise	0.80	0.40	0.80	0.40	0.79	0.41	0.81	0.40
Divorced	1 if currently divorced or separated, 0 otherwise	0.07	0.26	0.05	0.22	0.09	0.29	0.05	0.22
Household size									
Hsize-1	1 if live himself/herself, 0 otherwise	0.01	0.12	0.01	0.12	0.04	0.20	0.03	0.18
Hsize-2	1 if household size is 2 persons, 0 otherwise	0.16	0.36	0.19	0.39	0.28	0.45	0.26	0.44
Hsize-3	1 if household size is 3 persons, 0 otherwise	0.24	0.43	0.17	0.38	0.24	0.43	0.23	0.42
Hsize-4	1 if household size is 4 persons, 0 otherwise	0.29	0.45	0.32	0.47	0.21	0.40	0.25	0.44
Hsize-5	1 if household size is 5 persons, 0 otherwise	0.18	0.39	0.23	0.42	0.16	0.37	0.15	0.36
Hsize = 6 & up	1 if household size is 6 or more persons, 0 otherwise	0.12	0.33	0.07	0.26	0.08	0.27	0.07	0.26
Income									
L-income	1 if household income per capita is at bottom 25%, 0 otherwise	0.34	0.47	0.18	0.38	0.30	0.46	0.17	0.38
M-income	1 if household income per capita is in middle 50%, 0 otherwise	0.48	0.50	0.54	0.50	0.51	0.50	0.47	0.50
H-income	1 if household income per capita is in top 25%, 0 otherwise	0.18	0.39	0.29	0.45	0.19	0.39	0.36	0.48
Type of house									
H-brick	1 if house is made of brick, 0 otherwise	0.08	0.27	0.17	0.37	0.17	0.38	0.21	0.41
H-wood	1 if house is made of wood, 0 otherwise	0.11	0.31	0.23	0.42	0.15	0.36	0.14	0.35
H-mud/ other	1 if house is made of mud and grass, 0 otherwise	0.81	0.39	0.61	0.49	0.67	0.47	0.65	0.48
Education									
Illiteracy	1 if education level is illiteracy, 0 otherwise	0.29	0.45	0.25	0.43	0.29	0.45	0.26	0.44
Elementary	1 if finished elementary education, 0 otherwise	0.45	0.50	0.38	0.48	0.44	0.50	0.37	0.48
Junior high	1 if finished Junior high or higher education, 0 otherwise	0.26	0.44	0.38	0.48	0.27	0.45	0.36	0.48
Rural to urban migrant									
Migrant	1 if currently is a rural to urban migrant worker, 0 otherwise	0.05	0.22	0.06	0.23	0.10	0.29	0.12	0.33
Health status									
Illness	1 if feeling unhealthy in the past month of interview, 0 otherwise	0.39	0.49	0.19	0.39	0.23	0.42	0.19	0.40
Chronic	1 if having diagnosed chronic disease(s) in the past year, 0 otherwise	0.28	0.45	0.19	0.39	0.27	0.44	0.18	0.38
Health behavior									
Smoker	1 if currently a frequent smoker, 0 otherwise	0.36	0.48	0.32	0.47	0.32	0.47	0.29	0.46

DOI: 10.1002/hec

Drinker	1 if currently a frequent drinker, 0 otherwise	0.12	0.32	0.08	0.28	0.09	0.28	0.07	0.25
Distance to health facility									
Distance	The distance from home to village health post (1/2 km)	2.60	2.55	2.46	2.28	2.84	6.70	2.65	2.05

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