Mate Selection Power and Female Marital Mortality Differential in China during Transition

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Abstract

This paper documents a marked sex difference of the mortality differential between the never married and the married population in China 1990. Different from existing studies made in Western societies, the female never married group is found to experience an atypically larger mortality differential from the married than do males in China. Further, the marital mortality differential of females is found to be greater in contexts of high socioeconomic background. We explain the observed abnormality with theories of mate selection power. Under the Chinese patrilineal family system, females are in part selected into marriage by health criteria and males by resources criteria. In high socioeconomic places, males' resources produce larger mate selection power, resulting in stronger selectivity on females' health.

1. INTRODUCTION

Studies on the relationship between marriage and mortality mostly find that the not married groups experience higher mortality as compared with the married, but with conflicting findings about who are the relatively most disadvantaged, and why.[1] Among various discussions about the mechanisms of this relationship, selection theory argues that it is easier for healthier people to enter and stay in marriage.[2] A few scholars have conducted further in-depth research on if and how the mortality differential is associated with variations in the degree of mate selection (Goldman and Hu 1993; Goldman, Takahashi, and Hu 1995).

This study looks at the marriage-mortality association in China from the perspective of variations in the strength of mate selection. The availability of the 1% clustered sample of the 1990 China census with mortality data included offers an opportunity to look at mate selection on health with individual and contextual level differences. At the individual level, this study finds excessively high female mortality differential between the never married and the married that is distinct from existing studies in Western countries where the marital mortality differential is found to be greater for males or is not differentiated by sex.[3] Further, constructing proxies of mate selection power of males under a typology of marriage markets in China, this study points to variations in the degree of mate selection in different contexts, and reveals how such variations are associated with the magnitude of the female marital mortality differential.

Substantial mortality variations exist in China. China in 1990 was in the early stages of a

[1] (Rendall et al. 2011; Hao 1995; Lillard and Panis 1996; Wu and Hart 2002; Manzoli et al. 2007; Scafato et al. 2008, 2008; Liu and Johnson 2009; Rendall et al. 2011; Roelfs et al. 2011; Hu et al. 2012; Shor et al. 2012; Guner, Kulikova, and Llull 2014; Goldman 2015; Kravdal 2017; Franke and Kulu 2018)

[2] (Goldman 2015; Goldman and Hu 1993; Goldman, Korenman, and Weinstein 1995; Hu and Goldman 1990; Joung et al. 1998; Williams and Umberson 2004)

[3] (Brockmann and Klein 2004; Kaplan and Kronick 2006; Liu and Johnson 2009; Scafato et al. 2008; Shor et al. 2012)

major shift from the Stalinist-style focus on heavy industry in urban areas and rural collectivism, to market reforms and decentralization initiated in 1978. In 1990, the hukou system that held population in place was relaxing, setting off a wave of rural to urban migration. Multiple policy factors, as well as distinct natural endowments of different provinces created regional disparities in economic development and social services across multiple administrative hierarchies that extended far beyond a rural-urban dichotomy (Tsui 1993). The 1990 census data echo Tsui's findings: while urban areas show an average death rate of 6.68, much lower than that of rural areas' 9.19, intra-urban and intra-rural mortality disparities are large, represented by a standard deviation of 3.8 and 4.3 respectively. Mortality varies greatly not only by rural and urban categories but also across villages and urban neighborhoods.

Marriage in China serves unique social and economic purposes: it aims for the continuation of the family ancestral line, not merely the unification of two individuals (Li and Lavely 2003; Xia and Zhou 2003). Patrilocal traditions and hypergamy norms prevailed in marriage before the Reform. Lavely (1991) pointed out that for rural women, "the social and economic status of the family she joins will largely determine her own status for the rest of her life" (288). Families of males, on the other hand, seek brides with reproductive capability and commitment to household activities (288). Marriage is a social imperative with a strong, utilitarian mate selection tradition and gendered mate selection strategies. Economic reform allowed for greater individual choice, but also strengthened spatial hypergamy in which women migrate to marry men residing higher up in the rural-urban hierarchy, creating sex imbalances within the marriage markets of urban and rural areas (Davin 2005; Lavely 1991; Yu and Xie 2015).

Power dynamics play a role in mate selection. Guttentag and Secord (1983) argued that in societies of high sex ratio of males to females, women have greater dyadic power knowing there exists a surplus of possible mates. Men on the other hand, use structural power to restrict women to feminine, domestic roles, providing marriage as a narrow path of social mobility to women (Eklund and Attané 2017; Guttentag and Secord 1983). For example, in China marriage migration is an important way for women to escape poverty and gain higher socioeconomic status (Davin 2005). This study further extends the theory by arguing that gendered mate selection criteria add an additional dimension to the power dynamics within the marriage market. Males in high socioeconomic contexts command large selective power that is both dyadic and structural, as can be shown by stronger mate selection on women's health in more developed areas.

2. LITERATURE REVIEW

2.1. Marriage-mortality debates: magnitude and direction of the relationship. Evidence about the mortality differential of groups with different marital statuses mostly reveals that marriage is associated with a lower mortality rate as compared with the not married, though conclusions are not overwhelmingly unanimous. In a meta-analysis of 53 independent studies on mortality differentials between people in and out of marriage for aged populations, Manzoli et al. found only 26 studies showing a significant survival benefit of the married group, with an overall relative risk of death being 0.88 compared to their unmarried counterparts (Manzoli et al. 2007). Their study raises a further question on factors associated with or possibly affecting this relationship: who experiences the largest mortality differential from the married? (Rendall et al. 2011). In different studies, the mortality disadvantage is found to be greatest for the never married (Rogers 1995; Cheung 2000; Kaplan and Kronick 2006), the widowed (Goldman, Korenman, and Weinstein 1995; Liu and Johnson 2009) or the divorced group (Hu and Goldman 1990; Sorlie, Backlund, and Keller 1995). Rendall et al. on the other hand, found no significant mortality difference among these groups (Rendall et al. 2011). Studies also found that the excess mortality is higher for males[4] and declines as people age (Rendall et al. 2011; Roelfs et al. 2011; Shor et al. 2012). Guner et al. (2014) however, found a greater marriage health gap among the old-aged than the young. Different conclusions about factors associated with the marriage-mortality relationship stress the importance of the richness and quality of data, as well as contexts of the relationship studied.

Studies that debate the mechanism of the marriage-mortality relationship mainly develop around marriage selection and protection. Selection theory argues that longevity of the married group is the result of mate selection: people with better health are more attractive on the marriage market and will enter marriage more easily compared with those with poor health[5]. Studies on adverse selection found that population with poorer health get selected into dissolution of marriage more easily (Hewitt, Turrell, and Giskes 2012; Williams and Umberson 2004). The alternative protection hypothesis has found relatively stronger empirical evidence in recent years, made possible by the availability of prospective, individual-level data (Goldman 1993; Rendall et al. 2011). Stemming from Durkheim's groundbreaking theory on suicide (Durkheim 1897), multiple researchers identified marriage's protective effect through channels such as social integration, and socio-emotional and financial support.[6] Some recent studies moved from the selection versus protection debate to if and how might the two types of effect work together in

[4] (Rogers 1995; Lillard and Panis 1996; Brockmann and Klein 2004; Scafato et al. 2008; Liu and Johnson 2009; Hu et al. 2012)
[5] (Hu and Goldman 1990; Joung et al. 1998; Lillard and Panis 1996; Goldman, Korenman, et al. 1995)
[6] (Wu and Hart 2002; Manzoli et al. 2007; Scafato et al. 2008; Rendall et al. 2011; Shor et al. 2012)

different phases of life (Guner, Kulikova, and Llull 2014; Franke and Kulu 2018). Synthetically reviewing past literatures on this debate, Robards et al. (2012) argued for the importance of considering long perspectives of data and jointly assessing the effect of multiple life changes that may have determinant effect on health and mortality.

With a cross-sectional dataset, we cannot empirically test the direction of the marriage-mortality effect in this study. Existing discussions about mate selection and mortality nevertheless provide a theoretical perspective for looking into the marriage-mortality relationship.

The mortality differential between the never married group and the married may vary with the degree of marriage selection in different contexts. Built on the argument of demographers that the relative proportion of the never married population is inversely related to the group's mortality rate (Kisker and Goldman 1987; Livi-Bacci 1985) in societies where health characteristics are a basis of mate selection, Hu and Goldman (1990) compared the marriage-mortality relationship across 16 countries and provided strong evidence that the higher the proportion of population married, the higher the mortality rate of the never married. Among these 16 countries, the Japanese population of the mid 1900s is found to be an extreme case with excessive mortality rate of the single population and high mortality rate of single females that is contrary to cases in Europe, Australia, and Northern America. Further studies by Goldman et al. cited the importance of health in mate selection, the involvement of family members in marital decision making and universality of marriage in Japan as reasons for such abnormality (Goldman and Hu 1993; Goldman, Takahashi, et al. 1995). Such investigations provide a rare glimpse into a different marriage-mortality relationship found in societies with a patriarchal bias, however, no follow-up research was made in other Asian societies. This study builds on findings of Goldman et al. and argues that the magnitude of the marriage-mortality association varies by degree of mate selection associated with men's mate selection power in different contexts. Specifically, characteristics of different marriage markets in China provide an explanation of differences of the mortality differential experienced by the never married population as compared to the married. In the following section we discuss why and how mate selection varies in the Chinese marriage market.

2.2. The Chinese context: power dynamics of mate selection in a patrilineal family system. Despite the ongoing development of the marriage-mortality discussion, studies on this relationship in the context of China have remained scant. Hao (1995) discussed marriage and mortality differentials in China without controlling for any covariates. Hu et al. (2012) measured the effects of marital status and education on a specific type of disease, Acute Myocardial Infarction (AMI). Va et al. (2011) examined the relationship among middle and old-aged people in the context of urban Shanghai. A more recent study by Liu et al. (2019) used six waves of panel data surveyed from a rural population over 60 years old in Chaohu, China and found a bereavement effect on the widowed group. Until the present study, however, no attempt has been made to study the marriage-mortality relationship on China's national population or population partitioned by different domestic marriage markets.

Several features of marriage in China make it distinct from marriage in Western societies. First, China has a patrilineal family system where traditionally, the goal of marriage was the continuation of family ancestral line rather than the union of two individuals (Baker 1979; Xia and Zhou 2003). Under such a system, virilocal multi-generational co-residence of families was the cultural ideal. Traditional norms of filial piety and kinship, economic considerations of shortage of housing, reciprocity between adult children and their parents to support each other in areas such as child rearing and financial support together form a sufficient ground for the married couple to live with their parents (Lee and Xiao 1998; Logan and Bian 1999; Riley 1994). The function of marriage was so utilitarian that heavy parental involvement existed in marital decision making, resulting in strong, gender-specific mate selection criteria and universality of marriage. The Marriage Laws of 1950 and 1980 to an extent freed people's marital choices and put emphasis on individual choices of marriage (Xia and Zhou 2003). However, parental involvement in marital decisions, family co-residence and mate selectivity remained not only as part of tradition but also as strategic choices of families (Logan and Bian 1999; Riley 1994; Xia and Zhou 2003). Marriage remained a social imperative: data from the 1% clustered sample of the China 1990 census show that 31.87% of the population aged 15 above are not in marriage, much lower than the US in 1990 where the not married account for 41.27% of population aged over 15 (US Census Bureau 2020).

Under the patrilineal system, a second distinct feature of marriage in China is the hypergamy norm, and gender-specific mate selection criteria. Women in general look for men with superior socioeconomic resources, while men value women's physical appearance, health (reproductive potential) and domestic capabilities (Lavely 1991; Song and Li 2017; Xia and Zhou 2003). For women, marrying into the groom's family is akin to "getting born a second time", a life change that strongly impacts the social and economic status of the bride and their future children. Men, on the other hand, pay strong attention to women's physical look and ability to bear male decedents. A derogative expression, *bu hui xia dan de mu ji*, "hen that cannot lay eggs", reflects women's crucial position in carrying on the family's blood line, and the stigmatization of infertility. An empirical study comparing mate selection criteria among the never married young adults in China and the US found that Chinese respondents focused more on family background and status, while US respondents put more emphasis on individual traits of potential mates (Chen et al. 2015). Further, it was found that among Chinese young adults, women had higher expectation of potential spouses' high earning power and social status, while men put stronger emphasis on women's housework capacity, physical attractiveness and willingness to have children (Chen et al. 2015). We argue that this is part of the reason marriage selection is more strongly associated with the mortality (likely health condition) of females than males.

China's marriage market is characterized by a male marriage squeeze, particularly for poor and rural males. Female marriage migration in conjunction with hypergamy norms create involuntary bachelors of poor socioeconomic status. Modernization of institutions and norms has led to delayed age of marriage, more personal freedom in choosing a spouse, and greater educational homogamy especially in urban China (Han 2010; Song 2009). Uneven regional development and increased spatial mobility under the market reforms further gave women opportunities to migrate and marry into more prosperous places, creating male marriage squeeze in less developed regions (Davin 2005; Song and Li 2017). Men in developed regions, on the other hand, stand at the "buyer" side of marriage market with a larger pool of selection for potential wives (Song and Li 2017). The 1% clustered sample of China 1990 census quantifies the marriage squeeze phenomenon: there are 852,803 never married females and 1,238,173 males, 45% more. Most recent research on contemporary Chinese society further confirmed the continuous development and intensification of marriage squeeze for rural bachelors of poor educational status, economic prospects or hukou in less developed regions (Attané et al. 2019; Jiang et al. 2016; Yang, Wang, and Eklund 2020; Yu and Xie 2015).

The sex ratio theory proposed by Guttentag and Secord (1983) provides a theoretical explanation of hypergamy norms and female migration we see in China. The authors argued that in societies with a high male/female sex ratio, women have greater dyadic power at the micro level in light of a surplus of possible mates. Men on the other hand, use structural power to influence social norms, prevent divorce and encourage feminine, domestic roles for women. Interaction of women's dyadic power and men's structural power brings intensification of hypergamy where women mostly gain social mobility through marriage (Eklund and Attané 2017; Guttentag and Secord 1983), just as we observe in the Chinese context. Further, we argue that mate selection criteria add another dimension to sex-based power dynamics in the marriage market where males of high socioeconomic status command both dyadic and structural power in mate selection. Under China's status and spatial hypergamy norms, we see a surplus of high socioeconomic status women of marriage age and excessive unmarried males of lower status, inverting the sex ratio of marriageable candidates for different groups of the never married.

It is difficult to measure the selection power of males in different marriage market segments. With the available data, we provide indirect measurements of proportion married, regional development and level of education as proxies of men's selection power over women. It is hypothesized that men in more developed, better educated areas have greater chances of getting married, and such attractiveness signals men's greater mate selection power on women. As a result, the degree of selection on women's health should be higher in places of high socioeconomic background and lower in low socioeconomic contexts. It is also worth noting that the intensity of marriage selection might also play a role in the differences of marital mortality differential we observe, since the smaller the proportion of unmarried in a population, the more concentrated the unhealthy might be in the never married group (Hu and Goldman 1990). The effects of the intensity and power of marriage selection are not entirely separable, however. We will focus on the selection power explanation in this study.

Building on the observations described above, we expect to see two groups standing at a disadvantaged position among the never married: women with physical or mental defects that are subject to low reproductivity (especially in urban places where men have larger mate selection power), and men of poor socioeconomic status. *Shengnv*, or translated as the "leftover" women, comprise a third group of the never married that experience difficulty and stigma in finding the right spouse. "Leftover" women refer to a group of relatively well-educated professional women unmarried into their late 20s and beyond. The derogative term "leftover" women did not appear until the 2000s but similar descriptions such as *lao guniang* (old maid) existed long before (Gaetano 2017).

> Overtime, it has evolved into a label for any woman who does not conform to the normative life course pattern and social roles ascribed by gender and class, and reinforced by legislation or policy: universal and early marriage, heterosexuality and monogamy, procreation within marriage, and prioritizing the feminine character and domestic role of the 'virtuous wife and good mother'. (Gaetano, 2017, p.126)

Compared to their urban male counterparts who enjoy a buyers' market position with greater selective power, shengnv are hard pressed to find a spouse of same or higher socioeconomic status. They suffer discrimination and stigmatization from suitors, parents and society, who are disdainful of their reduced chance of getting married or having children as they age (To 2013).

The above mentioned three groups of the never married – women with defective health, men with poor socioeconomic resources, and "leftover" women – are extreme examples of how patrilineal tradition and hypergamy norms reinforce marriage market power imbalances between men and women. By partitioning the population by levels of income, education and proportion of females and males married, this study takes a deeper look at the disadvantaged never married females and demonstrates how men's mate selection power is associated with the mortality differential experienced by women in different contexts.

3. METHODS

3.1. Data. This study uses the 1% clustered sample of the 1990 census of China. The sample is one of two available micro samples of the 1990 China census. No official documentation is provided (Lavely and Mason 2006). Adding to the public clustered sample is the corresponding mortality data that Lavely obtained through unofficial sources and is not publicly available. Lavely and Mason (2006) compare the clustered sample with the 100% enumeration of the full census both at national and county levels, concluding that the sample data is of high quality. It is also the only available micro sample of any China census that contains mortality data. Out of each of the 30 provinces in China 1990, every hundredth of administrative village/urban neighborhoods are selected, of which all households are then sampled (Lavely and Mason 2006). Within each household, all living persons and deaths that occurred during January 1, 1989 to July 1, 1990, the census time, are enumerated. The sample contains 8,514 administrative villages or urban neighborhoods and 11,574,290 enumerated persons, out of which 99,196 are recorded dead. For each individual record, data contain information such as geolocation, marital status, education, occupation, nationality, and residency status.

We take several steps in data pre-processing. In the raw dataset, there are four villages with a 100% death rate that are erroneously counted (Lavely and Mason 2006). We remove these villages. During the variable generation process, we remove extreme cases of villages with no females. To fit the research purpose, this study looks at information of sample population aged

22 and above, where age of 22 is the legal age of marriage for male as established by the 1980 Marriage Law. Further, this study removes collective household type, of which the measurement of household size does not apply, leaving 6,401,396 records. [7] Finally, to include the measurement of county per capita income, in a separate model, China-A dataset compiled and generated by Skinner (Skinner and Henderson 2012) is joined with the 1% census sample, generating a subsample of 3,756,490 records. Table 1 below reports the number of records with each step of data preparation used by the main model and context models without the county income variable. Creation of the sub-sample containing county income data happens between step 1 and 2.

Table 1. Accounting of Number of Records with Steps of Data Preparation

Data preparation steps	Number of total cases	Percentage removed of total	Category of data elimination
Step 0. Raw dataset	11,574,290	N.A.	N.A.
Step 1. Remove villages with death rate of 100%	11,574,167	0.001	Enumeration error
Step 2. Remove extreme values of village-level variables	11,564,627	0.082	Villages with no females
Step 3. Keep population aged 22 and above	6,623,209	42.693	Population aged below 22
Step 4. Keep family household only	6,401,396	1.916	Collective household

[7] Household type of "family" or "collective" refers to the household registration status (hukou) of the person.

Table 2. Mean, Standard Deviation and Range of Variables of Interest and Covariates

Variable	Mean	SD	Low	High
Individual level				
Deceased	0.012	0.108	0	1
Marital status				
Never married	0.070	0.256	0	1
Married	0.840	0.367	0	1
Divorced	0.007	0.085	0	1
Widowed	0.083	0.276	0	1
Age	42.400	15.475	22	120.21
Age over 60	0.160	0.367	0	1
Female	0.499	0.500	0	1
Years of schooling completed	4.940	3.866	0	15
Han ethnicity	0.928	0.259	0	1
Urban residence	0.283	0.450	0	1
Household level				
Household size	3.974	1.692	1	20
Spousal years of schooling gap (Male - Female)	1.652	2.635	-15	15
Village level				
Proportion females married	0.509	0.058	0.044	0.716
Proportion males married	0.475	0.069	0.032	0.924
Male mean years of schooling	4.753	1.344	0.073	13.785
Female mean years of schooling	3.559	1.541	0	13.703
Adult sex ratio (Male/Female)	1.094	0.627	0.367	48.413
County level (sub-sample)				
Per capita national income (10,000 yuan)	0.109	0.075	0	1.307
Number of cases = 6,401,396				
Number of cases (sub-sample with county income) = 3,756,490				

3.2. Measures. In this section, we introduce both focal and control variables of the main model, as well as variables that represent proxies of men's mate selection power in different contexts. Table 2 above reports summary statistics of all variables used.

It is worth noting that the construction of all contextual level variables happens between steps 1 and 2 as reported in Table 1, capturing the total population of the contexts that include villages without females, population aged below 22 and of collective household registrations. The statistics we report in Table 2 above represent variables that are included in the model, i.e., after step 4 as shown in Table 1. Village and county level variables are all constructed using sample mean, thus the respective value is assigned to each individual in the village/county.

3.2.1. Focal variables and covariates. Deceased is the focal dependent variable. It assumes a value of 1 when the record died between January 1, 1989 and July 1, 1990, the data collection period of the census, and 0 when the record is alive.

Marital status is the focal independent variable of the study. The variable contains five categories: not asked (for population aged 15 and below), never married, married, widowed, and divorced. Since data is truncated for population aged 22 and above, only the latter four categories are used in analysis.

At the individual level, the following covariates are controlled for: age, years of schooling completed, a binary variable of Han ethnicity, and type of place of residence of urban/rural. For all models, we look at results for males and females separately. The distribution of age as displayed by Figure 1 shows that as expected, population of the never married is the youngest, followed by the married, the divorced and the widowed. Years of schooling completed (edyrs) is constructed by Lavely and Mason using raw variables of education level and education status from the census. [8] To standardize extreme values introduced by variable creation, variable years of schooling completed is rounded. Summary statistics show that 27.9% of the sample population received zero years of schooling with an average level of education of less than 5 years, below middle school. Poor education achievement of the population could partly be explained by the socialist redistributive economy before the Reform (Fang et al. 2012), and Cultural Revolution that caused interruption to education (Meng and Gregory 2002). It was not until the China Compulsory Education Law of 1986 that the People's Republic of China established a systematic compulsory education system (Fang et al. 2012). Variable Han describes whether the person belongs to Han nationality. Variable urban is constructed by Lavely and Mason that reports a value of 1 when the type of place of residence of the record is urban, and 0 if rural. [9] Individual level statistics as reported by Table 2 and Figure 1 show that the sample population studied are young, largely rural with few or no years of education. The majority (84.0%) of the sample population are married. Finally, interactions between a binary representation of age over 60 and marital status are controlled for, following existing research that survival differential of marriage wanes as people age (Rendall et al. 2011; Roelfs et al. 2011; Shor et al. 2012).

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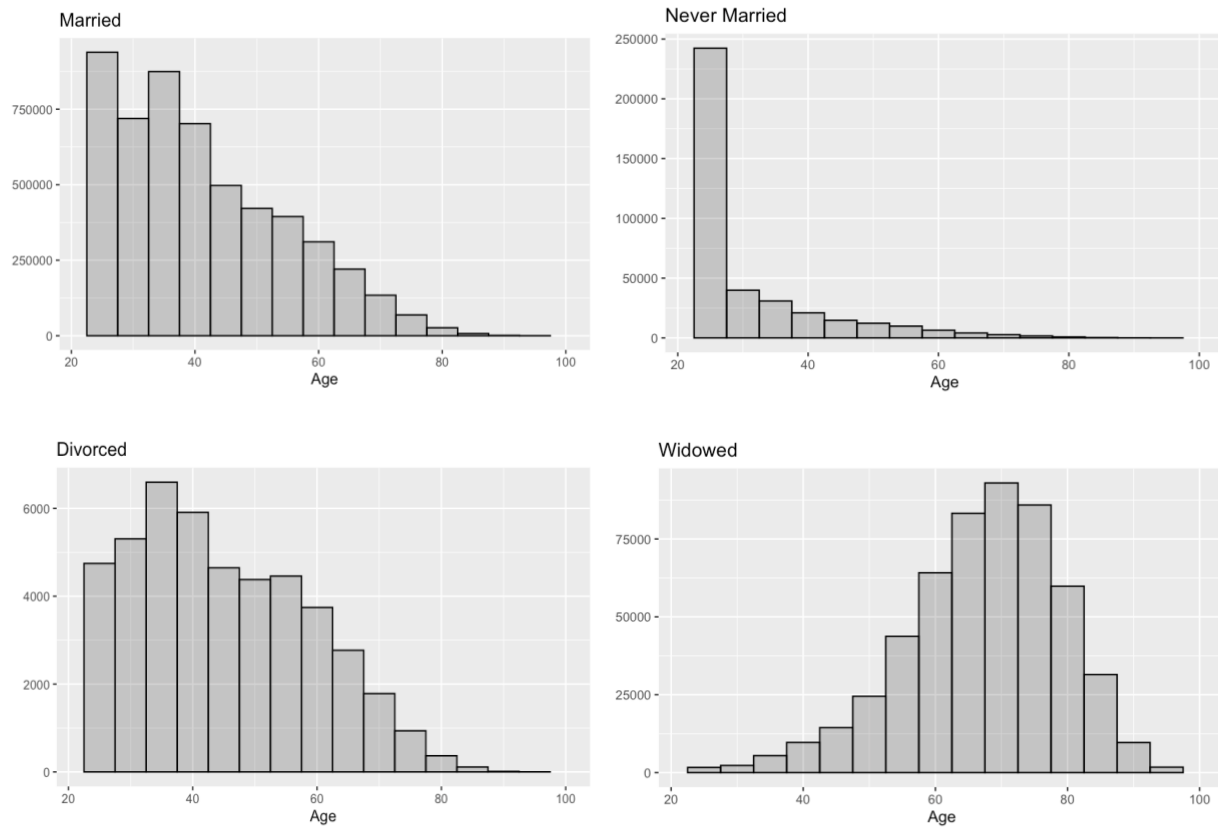
[8] According to an unpublished memo from Lavely and Mason on 1/29/2001, the method "relies on empirical data collected by Donald Treiman and colleagues in their 1996 survey of China, which permits comparison of total years completed with the educational status and by graduate or matriculate." Lavely and Mason further construct this variable using different approaches for the following four groups: living persons older than age 23, living persons less than age 23, dead persons older than age 23 and dead persons less than age 23. The method adopted fully considers the in-school category and impute values for the dead for which raw information on education status are unavailable. For the purpose of this study however, we do not look at population aged less than 22.

[9] According to an unpublished memo from Lavely on 1/29/1997: "The standard rural-urban classification is tripartite … Skinner makes an additional distinction, yielding a four-level classification. 1) residents of the central cities of municipalities; 2) residents of towns that are the seat of 'urban townships'; 3) residents of villages within urban townships, and 4) residents of rural townships. This makes a distinction between rural residents who live in a rural township and those who live in an urban township: both are rural, but some are more rural than others."

Figure 1. Distribution of Age by Marital Status



This study further controls for variables at the household level, including spouse effects and size of household. At spouse level, we look at years of education gap between husband and wife. Multiple studies have investigated the effect of own education, spousal education, and the gap between them on individual mortality.[10] Jaffe et al. (2006) for example, pointed out that the risk of highly educated wives suffering cardiovascular disease when married to lower educated husbands is two times greater than that of lower educated females. In the present study, we control for spousal years of schooling gap, calculated as years of schooling received by the husband minus that of the wife for married couples and the widowed whose spouse could be identified within the household. For the never married, we substitute the value zero. For the

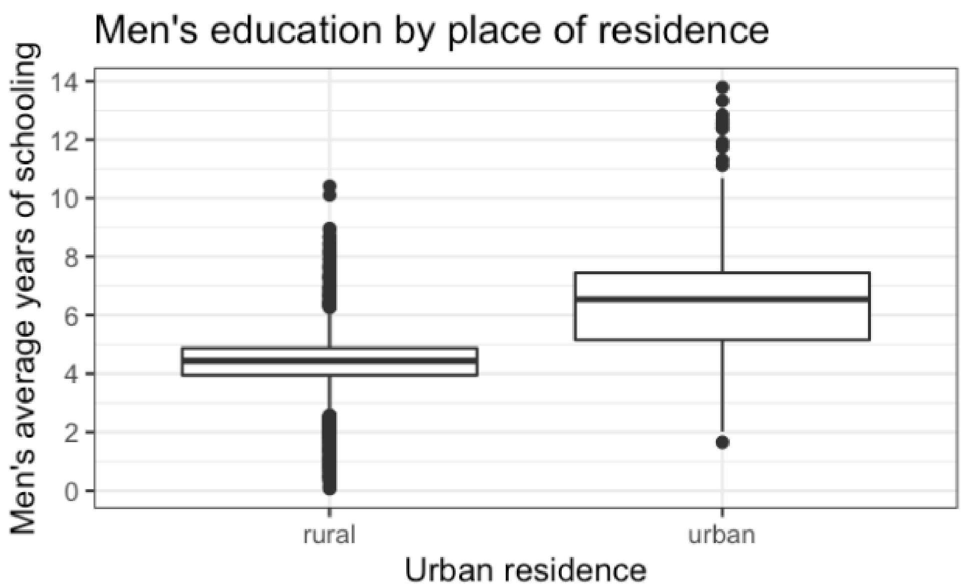
[10] (Monden et al. 2003; Jaffe et al. 2005, 2006; Skalická and Kunst 2008; Brown, Hummer, and Hayward 2014)

divorced as well as widowed with unidentifiable spouse, the value of the spousal years of schooling gap is imputed as the village/neighborhood mean. Table 2 above shows that in general, the spousal years of schooling gap is low, with a mean of less than 2 years and standard deviation of 2.6 years. Cases in which one completes three educational transitions (from primary to junior, junior to high school and high school to college) with 15 years of schooling whose spouse is illiterate are quite rare, demonstrated by Han (2010). On the household level we control for the size of household, which may affect mortality through resource allocation and competition (see for example, Campbell and Lee 1996).

3.2.2. Proxies of male mate selection power. There are six contextual-level variables employed in this study: village level proportion of married females and males; village level average years of schooling received by males and females; village level adult sex ratio; and county income. Among these, village level proportion of married females and males, average years of schooling of men and county income are used as grouping variables to measure local socioeconomic context, serving as proxies of men's mate selection power in different areas.

Both village level proportion of population married, and average years of schooling are calculated separately for females and males. Building on arguments from existing demographic research (Hu and Goldman 1990; Kisker and Goldman 1987; Livi-Bacci 1985) that mortality of the single population is inversely related to the relative size of the single group in the total population, we further split the population by sex to delve deeper into the operation of certain marriage markets, i.e., if selection of one sex over the other will be especially strong in some places compared to others. Years of schooling variable measures the accessibility of social services by males and females separately and thus is a representation of the degree of modernization of the area with fine granularity. For example, as was found in a 1994 survey conducted by Li and Lavely in a county in Yunnan province, for women aged 18-24 in mountainous villages, 86.7% report being illiterate, compared to 54.5% of their counterparts living in plains (2003). Here we use village level men's education as a grouping variable for measuring contextual effect, following initial results of the main model that men’s education possibly affects the relationship between women’s education and mortality. Figure 2 displays the disparity of men’s education between urban and rural areas. Village level sex ratio of adults is calculated as the ratio of the number of males to females aged between 18 to 60 in the village and is used as a measure of the relative sizes of the population of marital age of the two sexes.

Figure 2. Men’s Education by Type of Place of Residence



Finally, at county level, this study uses per capita national income (10,000 yuan) of year 1991 as compiled by Skinner from the 1992 Provincial Statistical Yearbooks as a measure of regional development. It is hypothesized that males from high income regions are more attractive on marriage market, and subsequently have a greater selective power over females compared to their counterparts in less developed regions.

3.3. Statistical Methods

3.3.1. Hypotheses. The main goal of this study is to measure the relationship between men's mate selection power and women's marital mortality differential. Without a panel dataset or an appropriate instrumental variable, it is empirically difficult to specify the direction of relationship between marriage and mortality net of the reverse causality issue (Rendall et al. 2011). Discussions of the mechanisms, as well as literatures on mate selection power in patrilineal China, nevertheless provide a meaningful ground for hypotheses building. Here, since the dependent variable mortality is a direct indication of health, a major criterion of mate selection on women, we put the focus more on marriage selection of women. In other words, we argue that a frail man with high socioeconomic status has more marriage potential than does a frail and possibly infertile woman. Frailty for example measured by a low Body Mass Index, irregular menstrual cycle, previous stillbirth or miscarriage, and histories of operations are all found to be significantly associated with infertility (Cong et al. 2016; Zhou et al. 2018).

Based on the Chinese context as described above, women should experience a larger mortality differential between the never married versus the married than their male counterparts, since women with physical defects are more often regarded as un-marriageable. It is also anticipated that men in more developed areas have greater selective power on women, resulting in a small and relatively less healthy group of never married women as compared to cases in less developed regions. The mortality differential of the never married women versus their married women counterparts thus should vary by the socioeconomic characteristics of their milieu: economic development, education and proportion of females and males married. A recent heated online discussion on China's twitter-like weibo forum about the marriage market condition in impoverished rural Suzhou, Anhui province notes:

> …bachelor villages are everywhere (in Suzhou). Men line up to be arranged to date a woman, and to fight for a position in line they have to send cigarettes and alcohol (to the marriage matcher). Any divorced woman will have several suitors that are never married, and a disabled woman will have several healthy suitors, as long as she is not too seriously disabled.[11]

We expect such imbalance would appear much less in more developed regions, and a disabled woman will find it less easy to marry compared to cases in Suzhou, for example.

Tables 3 below presents a typology of marriage market conditions in China 1990, in which we provide descriptive statistics of the three proxies of men's mate selection power: proportion married of two sexes, regional development (measured by groups of provinces and proportion of urban population here, and by county income in the model with a sub-sample of data) and village level average years of schooling. The proportion of married males and females have been used to divide the population into four marriage market conditions: A balanced high market where both sexes have high proportions of population married. A balanced low market where both sexes have low proportions of population married. A male market where proportion of married males is high, and females low, signaling greater mate selection power of men. Vice versa, a female market has a high proportion of married females and a low proportion of married males. All values refer to means of the binary variables; the mean for the total sample population is also provided. Here, provinces are grouped into three partitions that correspond to the regional development plan of the 1990s.[12] Coastal areas are the most economically developed and urbanized, followed by Interior and then Western areas. Table 3 shows that the balanced high

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[11] Sina Weibo, Beijing Da Tudou's page, accessed April 7, 2021, https://m.weibo.cn/3764674343/4606465493441819.

[12] According to the Seventh Five-Year Plan (1986), provinces are grouped into Coastal, Interior and Western regions (see Tsui 1993). Coastal provinces are Liaoning, Hebei, Beijing, Shandong, Tianjin, Shanghai, Jiangsu, Zhejiang, Fujian, Guangdong, Guangxi, and Hainan. Interior provinces include Heilongjiang, Jilin, Neimenggu, Shanxi, Henan, Anhui, Hubei, Hunan, and Jiangxi. The rest are grouped as Western provinces.

and male markets are more coastal, urban, and better educated. On the contrary, female market and balanced low market are more western, largely rural and with below-average years of schooling for both females and males. Data here confirm the existence of spatial hypergamy and male marriage squeeze under female marriage migration in the Reform era. We hypothesize that mate selection on women's health is stronger in balanced high and male markets where men have larger selection power. Another observation that speaks to the sex ratio theory of mate selection (Guttentag and Secord 1983) is that the market segment with the highest adult sex ratio of 1.161 is found to be the female market, with a high proportion of married females and low proportion of males. Table 4 below further shows that in balanced high and male markets, the never married population are younger. In the remaining two markets, especially the female market, we see a larger percentage of the never married aged 30 to 50, indicating difficulties to enter marriage especially for males in these areas.

We present the following set of hypotheses based on the above-mentioned arguments:

3.3.1.1 Mortality differential of marriage

H1: Not married groups, namely the never married, the widowed and the divorced experience higher odds of death as compared to the married.

3.3.1.2 Sex differences in marital mortality differential

H2. Never married females compared to married females experience a larger mortality differential than never married males compared to married males.

3.3.1.3 The effect of male mate selection power on female marital mortality differential

H3: The mortality differential between the never married and married females is higher in places with greater selective power of males.

Table 3. A Typology of Marriage Market Conditions in China 1990

Variables	Total	Balanced high market	Male market	Female market	Balanced low market
Means of demographic variables					
Han	0.928	0.964	0.933	0.957	0.875
Female	0.499	0.502	0.507	0.484	0.494
Means of regional development variables					
Coastal	0.338	0.500	0.321	0.222	0.160
Interior	0.325	0.268	0.380	0.318	0.385
Western	0.336	0.232	0.299	0.460	0.455
Urban	0.283	0.469	0.300	0.107	0.076
Means of village-level proportion married					
Females	0.509	0.559	0.486	0.530	0.459
Males	0.475	0.535	0.495	0.439	0.418
Means of village-level years of schooling					
Females	3.559	4.461	3.603	3.173	2.739
Males	4.753	5.503	4.851	4.340	4.077
Means of village-level adult sex ratio					
Adult sex ratio (M/F)	1.094	1.090	1.090	1.161	1.085

Table 4. Age Distribution (%) of the Never Married under Different Marriage Market Conditions

Age group	Total	Balanced high market	Male market	Female market	Balanced low market
22-30	73.217	77.056	76.161	63.820	70.692
30-40	12.924	12.072	10.785	18.155	13.184
40-50	6.824	5.375	6.101	9.642	7.839
50-60	4.210	3.244	3.839	5.222	5.025
60-80	2.658	2.104	2.856	3.007	3.260
80+	0.167	0.148	0.257	0.154	0.001
Total	100	100	100	100	100

3.3.2. Model. We use logistic regression to explore the relationship between marital status and mortality. Logistic regression models the log odds of an event occurring as a linear combination of covariates, assuming the absence of multi-collinearity and strong outliers in the data:

$$\log \frac{p_i}{1-p_i} = \beta_0 + \boldsymbol{\beta_1 X_i} + \boldsymbol{\beta_2 H_i} + \boldsymbol{\beta_3 V_i} + \varepsilon_i$$

where p in this case is the probability of death; i represents an individual; X_i represents a vector of individual-level focal independent variable of marital status, and covariates of years of education, age, urban residence, Han ethnicity and interaction between age over 60 and marital status; H_i identifies a vector of household-level covariates of years of education gap between the husband and the wife and household size; V_i represents a vector of village-level covariates of percentage of females and males married, average education levels of females and males, and sex ratio of adults; β_s represent vectors of respective coefficients; and ε represents residual. Finally, county-level variable of income per capita is controlled for in a separate model using a sub-sample of the dataset.

In the baseline model, the sample population is partitioned into the female group and the male group, addressing findings from the existing literature that the effect of marriage on mortality differs by sex.[13] We then look at four sub models where the sample population is further grouped by village-level years of education received by men, village-level percentage of married females and males, and county per capita income. Doing so allows us to observe how contextual differences in men's mate selection power interact with the marriage-mortality relationship, and to assess the magnitude of the marriage-mortality differential under different marriage market conditions. Further, we develop a model that specifically looks at the "leftover" women, comparing mortality differential of this group with their rural counterparts and with men of the same social status. Finally, as a robustness check, we include results of a mixed effect logistic regression of the main model that accounts for village level variations.

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[13] (Rogers 1995; Lillard and Panis 1996; Brockmann and Klein 2004; Scafato et al. 2008; Liu and Johnson 2009; Hu et al. 2012)

Methodologically, it has been argued that group comparison of the estimated coefficients of logistic regression models is invalid. This problem has been discussed by Allison (1999), Williams (2009) and Mood (2010). Specifically, Mood (2010) pointed out that because of the unobserved heterogeneity associated with the latent response variable of logistic regression, it is neither appropriate to interpret log-odds or odds ratios as true effects, nor to compare them across groups or points in time. A more recent study of Kuha and Mills (2020) refuted such concern. According to the authors, regression coefficients of the two groups $\hat{\beta}_A$ and $\hat{\beta}_B$ are comparable if "a binary Y, its scale – that is, the meaning of the values 0 and 1– can be defined identically in the two groups" (508). In this study, since we have a true dichotomous response variable (deceased, not deceased), we argue that comparison of odds ratios across groups is appropriate.

4. RESULTS

In this section we present models that assess individual and contextual differences of the marriage-mortality relationship, as well as the unique phenomenon of the "leftover women". Table 5 presents the main model, and other model results are provided in the Appendix.

Controlling for a set of individual and contextual-level variables, results in Table 5 confirm the existence of mortality differential between groups of the not married and married. For both females and males aged 22 to 60, the never married and widowed experience higher odds of death compared to the married, while the divorced only see a small mortality differential for males that is statistically significant. Young never married females experience an exceptionally high odds ratio of death as compared with their married female counterparts. Specifically, controlling for other variables, this group see a 246% higher odds of death than their married counterpart. The never married males of the same age group, by contrast, experience a much lower mortality differential of 70% higher odds than married males. The widowed group see a 9% and 35% higher odds of death than their married counterpart of females and males, respectively. The divorced males see a 16% higher odds of death than married males. Large odds ratios of the never married versus married of the younger population imply the possible existence of strong negative selection on population that are relatively unhealthy, especially females. Odds ratios of the young widowed group on the other hand suggest a possible bereavement effect in which the higher odds of death is related to the loss of spouse and the protection of marriage. However, in this study we are not able to control for factors such as family environment, access to social services or life habits that may systematically impact the health of the dead spouse, as well as the widowed.

Mortality disadvantages of the not married groups are lower for the population aged over 60. For males, the old age effect seems to be stronger. Only the aged widowers show a 7.9% higher odds of death compared to their married counterpart. For the divorced and the never married, the odds of death for old-aged males as compared with their old-aged married counterparts are lower by 36.6% and 29.1% respectively. Female groups on the other hand, see a statistically significant age interaction with the never married, whose odds of death is still higher than the married, but the magnitude reduces to 53.3%. Old-aged widows experience a 18.2% higher odds of death than their married old-aged counterpart. Results here are consistent with findings from existing literatures that the marriage's survival premium wanes as people age [14], especially for males (Kaplan and Kronick 2006).

[14] (Rogers 1995; Johnson et al. 2000; Rendall et al. 2011; Roelfs et al. 2011; Shor et al. 2012)

Table 5. Logistic Regression of Death on Marital Status, Females and Males, Age over 22

	Females			Males		
Predictors	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*
(Intercept)	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**
Individual level						
Married (omitted)						
Never Married	3.46	3.05 – 3.93	**<0.001**	1.70	1.61 – 1.79	**<0.001**
Divorced	1.14	0.83 – 1.57	0.409	1.16	1.02 – 1.32	**0.020**
Widowed	1.09	1.01 – 1.17	**0.023**	1.35	1.26 – 1.45	**<0.001**
Age Over 60	1.02	0.97 – 1.06	0.427	1.22	1.18 – 1.27	**<0.001**
Years of Schooling	0.93	0.92 – 0.93	**<0.001**	0.93	0.92 – 0.93	**<0.001**
Age	1.08	1.08 – 1.08	**<0.001**	1.08	1.08 – 1.08	**<0.001**
Urban	0.95	0.91 – 0.98	**0.002**	1.00	0.96 – 1.03	0.783
Han	0.84	0.80 – 0.87	**<0.001**	0.90	0.87 – 0.94	**<0.001**
Household level						
Household Size	0.90	0.90 – 0.91	**<0.001**	0.90	0.89 – 0.90	**<0.001**
Years of Schooling Gap	0.98	0.97 – 0.98	**<0.001**	1.03	1.02 – 1.04	**<0.001**
Village level						
Male Mean Years of Schooling	0.96	0.93 – 0.98	**0.002**	0.98	0.96 – 1.00	0.078
Female Mean Years of Schooling	1.00	0.97 – 1.02	0.756	1.01	0.99 – 1.03	0.331
Proportion of Females Married	3.74	2.56 – 5.47	**<0.001**	0.21	0.15 – 0.30	**<0.001**
Proportion of Males Married	0.18	0.13 – 0.25	**<0.001**	1.53	1.12 – 2.10	**0.008**
Adult Sex Ratio	1.01	0.98 – 1.04	0.498	0.92	0.87 – 0.98	**0.006**
Interaction						
Divorced * Age Over 60	0.93	0.62 – 1.39	0.722	0.55	0.45 – 0.66	**<0.001**
Never Married * Age Over 60	0.44	0.35 – 0.57	**<0.001**	0.42	0.38 – 0.46	**<0.001**
Widowed * Age Over 60	1.09	1.01 – 1.17	**0.034**	0.80	0.74 – 0.86	**<0.001**
Observations	3190795			3210601		
Pseudo R^2	0.045			0.048		

Directions of the sociodemographic control variables on both individual and contextual levels are consistent with previous studies (Brown, Hummer, and Hayward 2014; Galama, Lleras-Muney, and Kippersluis 2018). With an additional year of schooling, odds of death decreases by 7.5% and 7.1% for females and males respectively. Effect of age appears to be nonlinear for males such that odds of death with an additional year of age increases at an accelerating rate after age 60. Urban residence has a possible mortality-decreasing effect for females, and Han ethnicity has a possible mortality-decreasing effect for both females and males.

Looking at covariates at the contextual level, an additional year gap of schooling received by married couples is associated with a 2.2% lower odds of death for females and a 3.0% higher odds of death for males, suggesting that females benefit from education hypergamy but males do not. A larger household is associated with decreased mortality for both females and males, a possible result of stronger family support and more resources. The proportion of married females in a village has a strong positive association with mortality of females, with proportion of married males working in an opposite direction. For males, the proportion married variable works in the opposite direction from that of females. Village-level men's education appears to affect the association between village-level women's education and odds of death. Stepwise model selection shows that while village-level women's education is significantly associated with the death of females, the effect becomes insignificant after village-level men's education is controlled for. An additional year of village level average year of education received by males reduces the odds of death by 4.1% for females. One possible factor that explains such association is domestic violence. A recent study showed that while over a quarter of women in China report having experienced at least one incidence of domestic violence in their lives, lower education of husbands is associated with more violence against wives (Song, Zhang, and Zhang 2020).

Finally, the model also shows that village-level ratio of adult males to females is negatively related to mortality of males, an indication of a possible protective effect in more male-dominated places.

(Table A1 to A6 are included in the Appendix.)

As a robustness check, a mixed effect logistic regression of the main model is performed to account for village level variations. We show in Table A6 that the results are similar enough with standard logistic regression as reported in Table 5. Since it is extremely computationally intensive to fit mixed effect models over the scale of the current dataset, we opt to use standard logistic regression.

Tables A1 to A4 reveal interesting findings about mortality differentials between the never married and the married group under markets with different mate selection power of males. As shown by Table A1 and A2, for population aged under 60, the never married males in female market and females in male market experience the largest mortality differential from their married counterparts. Large mate selection power, as reflected by a high proportion married, is associated with an increased marital mortality differential of the opposite sex. Specifically, for the younger group, the never married mortality differential is 356% for females in a male market and 97% for males in female market; in the balanced high market, the never married mortality differential is high for both sexes, while in the balanced low market, the never married mortality differential is the lowest – 168% for females and 58% for males. Results here speak to the argument made that the degree of mate selection on health is stronger in markets with greater mate selection power. Considering the focus of mate selection on women's health, it is as we hypothesized, that women experience a larger mortality differential between the never married and the married.

For population aged below 60, the directions of two other proxies of mate selection power work as expected in different contexts, with females experiencing a larger never married mortality differential in more developed areas, a reflection of stronger male marriage selection on health. In villages with high levels of men's education, the never married mortality differential is 292% and 79% for females and males respectively. In villages with poorer education achievement, the differentials are 208% and 62% for females and males. Similar patterns are found in the separate county income model. In high-income counties, the never married mortality differentials are higher than in low-income counties for both sexes and is much larger for females than males. We take a deeper look at the implications of such sex and contextual differences in the Discussion section.

It is worth noting that the never married mortality differential is reduced for old-aged females in high income, high education areas and in places with a high proportion of married males. In high income counties, the odds of death of aged never married females is lower by 31.1% compared to their married counterparts. In high education villages, the mortality differential between the old-aged never married females and their married counterparts is reduced from 292.0% in the younger population to 24.1%. In areas of low income, low levels of education or low proportion of married males, the old age effect on the never married groups is much smaller.

Table A5 reports further breakdowns of the never married population with a focus on the "leftover" women. Here, the "leftover" group only includes population with more than 5 years of education (completed primary school), aged beyond 30, reside in urban areas and are never married. The "not picked" group, on the other hand, represent the remaining never married population aged over 30 that are largely rural and poorly educated. The married group is set as a baseline, with widowed and divorced combined into one category. Table A5 reports two main findings for groups of the "leftover" and "not picked" aged between 30 to 60. First, compared to males, both the "leftover" women and the "not picked" women experience much larger mortality differentials from married women. Specifically, controlling for other variables, the "leftover" women experience 223% higher odds of death than their married counter parts, while for the "leftover" men, the mortality differential is only 17% and not statistically significant. This demonstrates that there is no comparable category of urban educated "leftover" men. Rather, the "leftover" men refer to a group of voluntary bachelors who are not subject to marriage selection on health from women. The "not picked" females see 300% higher odds of death than the married, while males see only 31% higher odds of death. Comparison of odds ratios of the "not picked" males with the voluntary bachelors reveals that negative selection is stronger on males with lower socioeconomic status. Second, the "not picked" women experience a larger mortality differential than their "leftover" counterparts, with an odds ratio of death of 4.0 compared to the "leftover" women's 3.23, 23.8% higher. For the old aged, the "leftover" groups of women and men see larger reduction of odds of death than do the "not picked". Results further confirm the existence of the "leftover" women group whose un-marriageability is less attributable to poor health than it is for the "not picked". It also highlights stronger negative selection on rural, poorly educated never married women who have passed their prime age for marriage under China's marital norms. We discuss further implications of these findings in the Discussion section.

5. DISCUSSION

Two distinct findings emerge from this study. First, large and significant sex differences exist in the mortality differential between the never married and the married. Second, the mortality disadvantage of the never married females versus married females varies by context, a phenomenon that can be explained by unequal selective power of males under different marriage market conditions.

While numerous previous studies set in the US, UK and European countries find mortality differential to be larger between married and unmarried males than females [15], and many find no significant marriage-related mortality differentials between sexes (Manzoli et al. 2007; Rendall et al. 2011; Roelfs et al. 2011), the China 1990 census data show that never married females experience a significantly larger mortality differential from the married than never married males versus married males. The greater mortality differential of this group signals stronger negative selection on health. Marital mortality differentials are greater with population younger than 60 and decrease with both sexes for the old-aged.

In Table 6 below we provide a brief comparison of model results for groups of the unmarried females and males aged between 22 to 60. Results from Table 5 the main model, and Table A5, the model on the "leftover" group are transformed into log forms here. We use Wald chi-square statistics to test the difference between group coefficients. The comparison reveals that the ratio of coefficients of never married females to males is 2.35 and is even substantially larger for the "leftover" (7.62) and the "not picked" (5.17) group, pointing to an extreme sex difference of mortality differential between the never married and the married for population

[15] (Brockmann and Klein 2004; Kaplan and Kronick 2006; Liu and Johnson 2009; Scafato et al. 2008; Shor et al. 2012)

aged beyond 30. Our findings echo the study of Hu (2012) on China that unmarried women with low levels of education experience the highest risk of Acute Myocardial Infarction.

Table 6. Comparison of Model Coefficients for Predicting Death of Females and Males, Age 22 to 60

Variable	Females Coefficient	SE	Males Coefficient	SE	Ratio of Coefficients	χ^2 test for Difference
Main model						
Never married	1.242	0.064	0.529	0.028	2.348	104.174***
Divorced	0.134	0.161	0.151	0.065	0.887	0.010
Widowed	0.084	0.037	0.301	0.037	0.279	17.198***
The "leftover" model						
The "leftover"	1.173	0.304	0.154	0.168	7.617	8.607**
The "not picked"	1.386	0.140	0.268	0.037	5.172	59.608***
Widow or divorced	0.101	0.036	0.227	0.033	0.445	6.657**

Significance: *** = p < 0.001; ** = p < 0.01; * = p < 0.05

Why do such sex differences exist? Our explanation rests on how marriage selectivity varies with the three proxies of mate selection power. As shown by the results of context models displayed in Figures 3 to 5, for population aged between 22 and 60, the marital mortality differential of females is highest in villages/neighborhoods of high proportions of married males, in high-income counties and in villages with better men's education. In our marriage market typology as shown in Table 3 above, it is the balanced high and the male markets that are more coastal and better educated. The balanced low market is largely located in west China, with the least average years of education for both sexes, and the lowest mortality differential between the never married and married population. In other words, from a marriage selection perspective, in a marriage market where men have greater selective power, namely the more economically developed urban areas, women who are unable to marry are in poorer health. In the least developed areas, namely the balanced low region, we see the smallest mortality differential between the never married and married females, signaling higher marriageability of less desirable women with real or perceived frailty in this market.

Figure 3. Odds Ratio of Death, Never Married versus Married, Age 22 to 60, Females and Males by Proxy of Mate Selection Power of Men: County Income

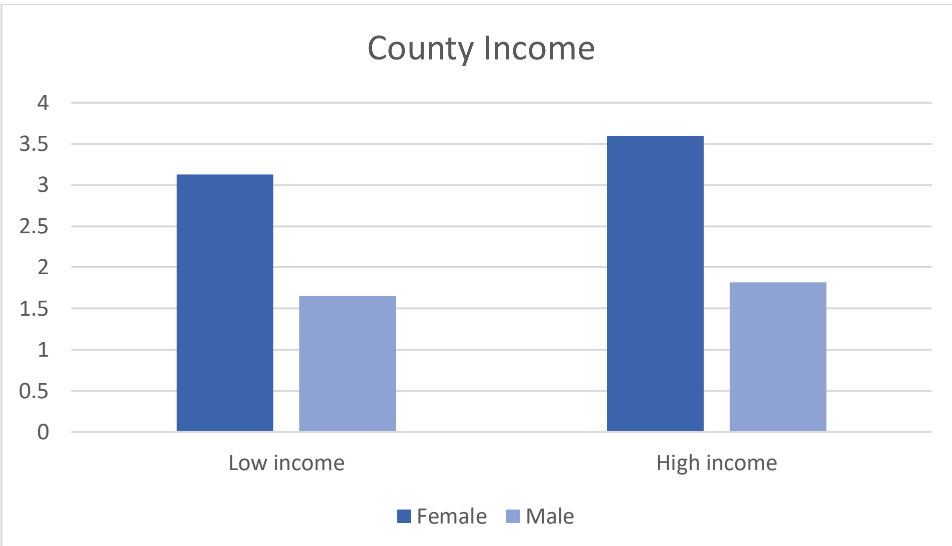


Figure 4. Odds Ratio of Death, Never Married versus Married, Age 22 to 60, Females and Males by Proxy of Mate Selection Power of Men: Village Level Men's Education

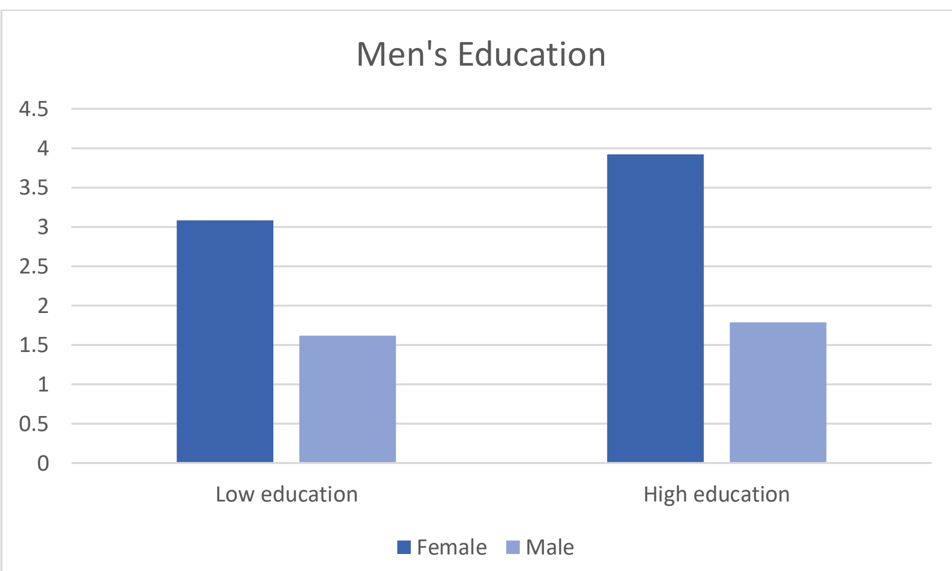
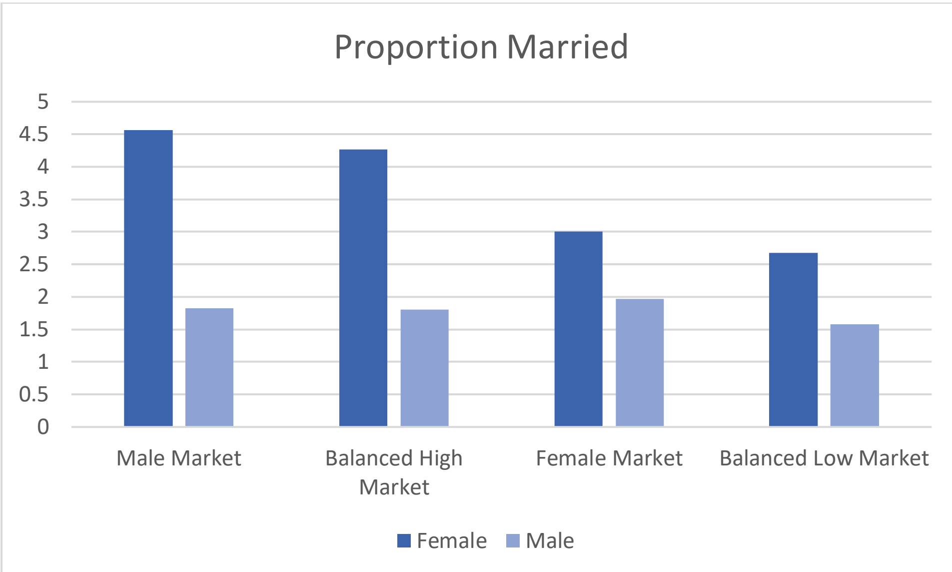


Figure 5. Odds Ratio of Death, Never Married versus Married, Age 22 to 60, Females and Males by Proxy of Mate Selection Power of Men: Village Level Proportion Married



The foregoing analyses show how the never married unhealthy women are marginalized in marriage market segments according to the mate selection power of males. Nevertheless, it is acknowledged that the reasoning is by no means conclusive, as there are multiple factors that could contribute to the mortality differential experienced by never married women. One element might be the stress that came along with staying single, as it defies pro-marriage social norms, resulting in stigma and discrimination (Byrne and Deborah Carr 2005; Morris, Sinclair, and DePaulo 2007; Ta et al. 2017). Another perspective is from the marriage protection theory where one can argue that without marriage, such a group of single women stand in a most disadvantaged position with possible lack of financial support, and resources such as rationed food and life necessities due to an absence of a family relationship network (Riley 1994). The male mate selection power perspective provides a more nuanced explanation of how the degree of negative selection on unhealthy women changes in different marriage market conditions.

While rural male marriage squeeze has received considerable scholarly attention, little research has been directed to the status of the urban single women who face a more competitive marriage market.

6. CONCLUSION

This study presents findings about the mortality differential between never married and married groups in China that are distinct from the Western experiences. Females are selected into marriage based in part on health criteria, and such selectivity is stronger in high socioeconomic contexts where men's resources equate to greater mate selection power.

Economic reform, establishment of marriage laws and population mobility are all conducive to broader freedom to make individual choices about marriage and possible evolution of marital norms. However, Chinese societal values and marital practices have not progressed in a linear manner. The disadvantaged never married groups – unhealthy women, poor men and the "leftover" women – face the same predicament today as they were in marriage markets three decades ago. A relatively recent study comparing mate preferences of modern Chinese and a cohort of 25 years earlier showed that while norms such as emphasis on virginity decreased with modernization, women continue to value men for resources and men value women for fertility (Chang et al. 2011). Yu and Xie (2015) outlined several features that mark marriage entry in China's post-reform era: a large presence of poorly educated bachelors (a quarter of a recent cohort), increased emphasis of women on men's earning capacity, and a negative association between women's education and the timing of marriage. The association between mate selection power and mortality differentials as shown in this study calls for a renewed policy focus on excessive mortality of the never married females and unequal access to marital opportunities of males in China.

The limitations of this study point to meaningful possibilities of future research. It would be valuable to compare the marital mortality differential as found in the 1990 census with data from prior or later censuses, if such micro-samples with death records were ever to become available. Doing so would allow for more detailed analyses on if and how the degree of mate selection changes over time, and the associated mortality implications for the never married population.

Appendix. Results of logistic regression.

Table A1. Logistic Regression of Death on Marital Status by Percentage of Population Married (Balanced Low and Balanced High Markets), Age over 22

	Females in Balanced Low Market			**Females in Balanced High Market**			**Males in Balanced Low Market**			**Males in Balanced High Market**		
Predictors	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*
(Intercept)	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**
Married (omitted)												
Divorced	1.38	0.87 – 2.21	0.175	0.99	0.61 – 1.59	0.962	1.19	0.99 – 1.43	0.070	1.17	0.95 – 1.44	0.141
Never Married	2.68	2.20 – 3.25	**<0.001**	4.27	3.51 – 5.20	**<0.001**	1.58	1.45 – 1.71	**<0.001**	1.80	1.64 – 1.97	**<0.001**
Widowed	1.16	1.04 – 1.29	**0.006**	1.03	0.92 – 1.16	0.583	1.30	1.16 – 1.44	**<0.001**	1.34	1.19 – 1.52	**<0.001**
Years of Schooling	0.93	0.92 – 0.94	**<0.001**	0.93	0.92 – 0.94	**<0.001**	0.93	0.93 – 0.94	**<0.001**	0.92	0.92 – 0.93	**<0.001**
Age	1.07	1.07 – 1.08	**<0.001**	1.09	1.09 – 1.09	**<0.001**	1.07	1.07 – 1.08	**<0.001**	1.08	1.08 – 1.09	**<0.001**
Age Over 60	1.08	1.01 – 1.16	**0.029**	0.94	0.88 – 1.01	0.094	1.34	1.26 – 1.42	**<0.001**	1.11	1.04 – 1.17	**0.001**
Urban	0.94	0.87 – 1.01	0.088	0.91	0.87 – 0.96	**<0.001**	1.00	0.94 – 1.07	0.996	1.00	0.96 – 1.05	0.860
Han	0.85	0.81 – 0.90	**<0.001**	0.84	0.76 – 0.93	**<0.001**	0.88	0.84 – 0.93	**<0.001**	0.86	0.79 – 0.93	**<0.001**

Household Size	0.91	0.91 – 0.92	**<0.001**	0.88	0.88 – 0.89	**<0.001**	0.92	0.92 – 0.93	**<0.001**	0.86	0.86 – 0.87	**<0.001**
Years of Schooling Gap	0.98	0.97 – 0.99	**<0.001**	0.98	0.97 – 0.98	**<0.001**	1.03	1.02 – 1.04	**<0.001**	1.03	1.02 – 1.03	**<0.001**
Adult Sex Ratio	1.47	1.30 – 1.66	**<0.001**	0.98	0.93 – 1.03	0.478	0.99	0.89 – 1.09	0.840	0.82	0.73 – 0.92	**<0.001**
Female Mean Years of Schooling	1.01	0.97 – 1.04	0.754	1.00	0.96 – 1.04	0.919	1.00	0.97 – 1.03	0.965	0.99	0.96 – 1.03	0.697
Male Mean Years of Schooling	0.92	0.89 – 0.96	**<0.001**	0.95	0.91 – 0.99	**0.021**	0.98	0.95 – 1.02	0.391	0.98	0.94 – 1.02	0.273
Divorced * Age Over 60	0.78	0.43 – 1.42	0.415	1.07	0.59 – 1.94	0.829	0.56	0.43 – 0.73	**<0.001**	0.55	0.41 – 0.75	**<0.001**
Never Married * Age Over 60	0.61	0.43 – 0.87	**0.007**	0.31	0.20 – 0.48	**<0.001**	0.46	0.40 – 0.54	**<0.001**	0.36	0.30 – 0.43	**<0.001**
Widowed * Age Over 60	1.08	0.96 – 1.21	0.179	1.05	0.93 – 1.18	0.458	0.82	0.73 – 0.92	**0.001**	0.80	0.70 – 0.91	**0.001**
Observations	1173160			1505805			1201195			1492144		
Pseudo R^2	0.041			0.049			0.045			0.051		

Table A2. Logistic Regression of Death on Marital Status by Percentage of Population Married (Male and Female Markets), Age over 22

	Females in Male Market			**Females in Female Market**			**Males in Male Market**			**Males in Female Market**		
Predictors	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*
(Intercept)	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**
Married (omitted)												
Divorced	1.18	0.38 – 3.71	0.771	0.67	0.09 – 4.82	0.694	0.65	0.35 – 1.21	0.174	1.62	1.09 – 2.39	**0.016**
Never Married	4.56	3.13 – 6.64	**<0.001**	3.01	1.75 – 5.18	**<0.001**	1.83	1.51 – 2.21	**<0.001**	1.97	1.65 – 2.36	**<0.001**
Widowed	1.16	0.91 – 1.47	0.233	0.96	0.73 – 1.25	0.748	1.57	1.25 – 1.97	**<0.001**	1.64	1.30 – 2.07	**<0.001**
Years of Schooling	0.93	0.91 – 0.95	**<0.001**	0.92	0.90 – 0.94	**<0.001**	0.93	0.92 – 0.95	**<0.001**	0.93	0.91 – 0.95	**<0.001**
Age	1.08	1.08 – 1.09	**<0.001**	1.07	1.07 – 1.08	**<0.001**	1.08	1.08 – 1.09	**<0.001**	1.08	1.07 – 1.08	**<0.001**
Age Over 60	1.08	0.93 – 1.26	0.331	1.07	0.91 – 1.25	0.408	1.18	1.04 – 1.34	**0.008**	1.39	1.21 – 1.60	**<0.001**
Urban	0.85	0.77 – 0.94	**0.002**	0.94	0.80 – 1.11	0.477	0.97	0.88 – 1.06	0.469	1.18	1.02 – 1.36	**0.027**
Han	0.87	0.75 – 1.01	0.060	0.89	0.72 – 1.09	0.244	0.83	0.73 – 0.95	**0.006**	1.00	0.83 – 1.20	0.965
Household Size	0.90	0.88 – 0.91	**<0.001**	0.89	0.88 – 0.91	**<0.001**	0.91	0.89 – 0.92	**<0.001**	0.91	0.89 – 0.93	**<0.001**

Years of Schooling Gap	0.99	0.97 – 1.01	0.198	0.98	0.96 – 1.00	**0.035**	1.02	1.00 – 1.04	**0.024**	1.04	1.02 – 1.07	**<0.001**
Female Mean Years of Schooling	1.10	1.02 – 1.18	**0.019**	1.04	0.95 – 1.13	0.382	1.02	0.95 – 1.09	0.590	1.02	0.94 – 1.10	0.633
Male Mean Years of Schooling	0.85	0.78 – 0.93	**<0.001**	0.87	0.79 – 0.96	**0.008**	0.97	0.89 – 1.05	0.445	0.97	0.89 – 1.07	0.542
Adult Sex Ratio	1.19	0.94 – 1.50	0.149	1.09	0.98 – 1.22	0.107	0.97	0.78 – 1.20	0.782	0.94	0.83 – 1.06	0.330
Divorced * Age Over 60	1.01	0.25 – 4.14	0.986	0.60	0.04 – 9.87	0.723	0.49	0.19 – 1.21	0.121	0.47	0.27 – 0.84	**0.010**
Never Married * Age Over 60	0.28	0.14 – 0.55	**<0.001**	0.94	0.34 – 2.61	0.904	0.43	0.30 – 0.61	**<0.001**	0.41	0.29 – 0.57	**<0.001**
Widowed * Age Over 60	1.10	0.85 – 1.42	0.458	1.28	0.96 – 1.69	0.092	0.68	0.53 – 0.87	**0.002**	0.71	0.56 – 0.91	**0.007**
Observations	299139			212691			290837			226425		
Pseudo R^2	0.048			0.045			0.052			0.047		

Table A3. Logistic Regression of Death on Marital Status by Village Men's Education, Age over 22

	Females in Low-educ Village			**Females in High-educ Village**			**Males in Low-educ Village**			**Males in High-educ Village**		
Predictors	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*
(Intercept)	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**
Married (omitted)												
Divorced	1.59	1.02 – 2.48	**0.040**	0.91	0.58 – 1.42	0.666	1.22	1.03 – 1.45	**0.023**	1.11	0.92 – 1.35	0.273
Never Married	3.08	2.57 – 3.70	**<0.001**	3.92	3.29 – 4.67	**<0.001**	1.62	1.50 – 1.75	**<0.001**	1.79	1.65 – 1.94	**<0.001**
Widowed	1.17	1.06 – 1.30	**0.001**	1.01	0.91 – 1.12	0.878	1.33	1.21 – 1.46	**<0.001**	1.40	1.25 – 1.56	**<0.001**
Years of Schooling	0.94	0.93 – 0.95	**<0.001**	0.92	0.91 – 0.93	**<0.001**	0.94	0.93 – 0.95	**<0.001**	0.92	0.91 – 0.92	**<0.001**
Age	1.07	1.07 – 1.08	**<0.001**	1.09	1.08 – 1.09	**<0.001**	1.08	1.07 – 1.08	**<0.001**	1.08	1.08 – 1.08	**<0.001**
Age Over 60	1.10	1.03 – 1.17	**0.003**	0.94	0.88 – 1.00	0.055	1.27	1.21 – 1.34	**<0.001**	1.17	1.12 – 1.24	**<0.001**
Urban	1.02	0.96 – 1.10	0.478	0.87	0.84 – 0.91	**<0.001**	1.05	0.99 – 1.12	0.085	0.99	0.95 – 1.02	0.401
Han	0.84	0.80 – 0.89	**<0.001**	0.79	0.74 – 0.85	**<0.001**	0.91	0.87 – 0.96	**<0.001**	0.84	0.79 – 0.90	**<0.001**
Household Size	0.91	0.90 – 0.91	**<0.001**	0.89	0.89 – 0.90	**<0.001**	0.92	0.91 – 0.93	**<0.001**	0.87	0.87 – 0.88	**<0.001**

Years of Schooling Gap	0.98	0.97 – 0.98	**<0.001**	0.98	0.97 – 0.98	**<0.001**	1.03	1.02 – 1.04	**<0.001**	1.03	1.02 – 1.03	**<0.001**
Adult Sex Ratio	2.00	1.70 – 2.35	**<0.001**	0.95	0.89 – 1.02	0.137	1.36	1.17 – 1.58	**<0.001**	0.85	0.79 – 0.91	**<0.001**
Proportion of Females Married	1.39	0.77 – 2.51	0.280	3.62	2.18 – 6.00	**<0.001**	0.10	0.06 – 0.18	**<0.001**	0.24	0.15 – 0.37	**<0.001**
Proportion of Males Married	0.40	0.22 – 0.73	**0.003**	0.16	0.10 – 0.25	**<0.001**	4.52	2.60 – 7.86	**<0.001**	0.87	0.59 – 1.30	0.510
Divorced * Age Over 60	0.66	0.37 – 1.18	0.157	1.19	0.68 – 2.08	0.533	0.52	0.41 – 0.68	**<0.001**	0.57	0.43 – 0.75	**<0.001**
Never Married * Age Over 60	0.65	0.47 – 0.90	**0.010**	0.29	0.20 – 0.43	**<0.001**	0.46	0.40 – 0.54	**<0.001**	0.37	0.32 – 0.44	**<0.001**
Widowed * Age Over 60	1.09	0.98 – 1.22	0.095	1.07	0.96 – 1.20	0.215	0.82	0.74 – 0.91	**<0.001**	0.76	0.68 – 0.85	**<0.001**
Observations	1360629			1830166			1410313			1800288		
Pseudo R^2	0.043			0.048			0.046			0.051		

Table A4. Logistic Regression of Death on Marital Status by County Income, Age over 22

	Females in Low-income County			**Females in High-income County**			**Males in Low-income County**			**Males in High-income County**		
Predictors	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*
(Intercept)	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**
Married (omitted)												
Divorced	1.09	0.54 – 2.18	0.819	1.38	0.71 – 2.67	0.338	1.12	0.89 – 1.42	0.325	1.24	0.98 – 1.57	0.071
Never Married	3.13	2.48 – 3.96	**<0.001**	3.60	2.85 – 4.55	**<0.001**	1.66	1.51 – 1.83	**<0.001**	1.92	1.74 – 2.11	**<0.001**
Widowed	1.18	1.04 – 1.34	**0.011**	1.09	0.96 – 1.24	0.168	1.32	1.17 – 1.50	**<0.001**	1.33	1.16 – 1.52	**<0.001**
Years of Schooling	0.93	0.92 – 0.94	**<0.001**	0.93	0.92 – 0.94	**<0.001**	0.93	0.93 – 0.94	**<0.001**	0.93	0.92 – 0.93	**<0.001**
Age	1.07	1.07 – 1.08	**<0.001**	1.08	1.08 – 1.09	**<0.001**	1.07	1.07 – 1.08	**<0.001**	1.08	1.08 – 1.08	**<0.001**
Age Over 60	1.12	1.03 – 1.22	**0.007**	0.99	0.92 – 1.07	0.873	1.30	1.21 – 1.39	**<0.001**	1.23	1.15 – 1.31	**<0.001**
Urban	0.90	0.82 – 0.99	**0.039**	0.92	0.86 – 0.98	**0.009**	1.03	0.95 – 1.12	0.505	0.96	0.91 – 1.02	0.152
Han	0.83	0.79 – 0.88	**<0.001**	0.86	0.78 – 0.95	**0.003**	0.91	0.86 – 0.96	**<0.001**	0.80	0.74 – 0.87	**<0.001**
Household Size	0.91	0.90 – 0.92	**<0.001**	0.90	0.89 – 0.91	**<0.001**	0.91	0.90 – 0.92	**<0.001**	0.91	0.90 – 0.92	**<0.001**
Years of Schooling Gap	0.98	0.97 – 0.99	**<0.001**	0.98	0.97 – 0.99	**<0.001**	1.03	1.02 – 1.04	**<0.001**	1.03	1.02 – 1.03	**<0.001**

Proportion of Females Married	6.71	3.20 – 14.08	**<0.001**	2.24	1.13 – 4.44	**0.021**	0.25	0.13 – 0.48	**<0.001**	0.12	0.07 – 0.22	**<0.001**
Proportion of Males Married	0.16	0.08 – 0.32	**<0.001**	0.47	0.25 – 0.89	**0.020**	1.09	0.57 – 2.08	0.795	3.07	1.74 – 5.44	**<0.001**
Female Mean Years of Schooling	1.01	0.97 – 1.06	0.493	0.97	0.92 – 1.01	0.122	1.07	1.03 – 1.11	**<0.001**	0.95	0.92 – 0.99	**0.020**
Male Mean Years of Schooling	0.90	0.86 – 0.95	**<0.001**	0.98	0.93 – 1.03	0.374	0.91	0.87 – 0.95	**<0.001**	1.04	0.99 – 1.09	0.104
Adult Sex Ratio	1.15	1.05 – 1.26	**0.002**	0.98	0.85 – 1.13	0.785	0.96	0.85 – 1.07	0.436	0.83	0.72 – 0.94	**0.004**
Divorced * Age Over 60	0.80	0.33 – 1.96	0.631	0.96	0.42 – 2.16	0.917	0.59	0.42 – 0.83	**0.002**	0.57	0.41 – 0.80	**0.001**
Never Married * Age Over 60	0.78	0.51 – 1.19	0.244	0.19	0.10 – 0.37	**<0.001**	0.41	0.34 – 0.50	**<0.001**	0.44	0.37 – 0.52	**<0.001**
Widowed * Age Over 60	1.10	0.96 – 1.26	0.162	1.03	0.90 – 1.19	0.628	0.84	0.74 – 0.96	**0.009**	0.81	0.70 – 0.93	**0.003**
Observations	879525			987840			898979			990146		
Pseudo R^2	0.043			0.048			0.045			0.053		

Table A5. Logistic Regression of Death on Marital Status – Study of the "Leftover" group, Age over 22

	Females			**Males**		
Predictors	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*
(Intercept)	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**
Married (omitted)						
"Leftover" group	3.23	1.78 – 5.86	**<0.001**	1.17	0.84 – 1.62	0.361
"Not picked" group	4.00	3.04 – 5.26	**<0.001**	1.31	1.22 – 1.40	**<0.001**
Widowed or Divorced	1.11	1.03 – 1.19	**0.006**	1.26	1.18 – 1.34	**<0.001**
Age	1.09	1.09 – 1.09	**<0.001**	1.08	1.08 – 1.09	**<0.001**
Age Over 60	0.96	0.92 – 1.01	0.111	1.11	1.07 – 1.16	**<0.001**
Years of Schooling	0.93	0.92 – 0.93	**<0.001**	0.93	0.92 – 0.93	**<0.001**
Urban	0.95	0.91 – 0.98	**0.003**	0.99	0.96 – 1.02	0.511
Han	0.84	0.81 – 0.88	**<0.001**	0.90	0.87 – 0.94	**<0.001**
Household Size	0.91	0.90 – 0.91	**<0.001**	0.90	0.89 – 0.90	**<0.001**
Years of Schooling Gap	0.98	0.97 – 0.98	**<0.001**	1.03	1.02 – 1.03	**<0.001**
Proportion of Females Married	3.78	2.57 – 5.57	**<0.001**	0.21	0.15 – 0.30	**<0.001**
Proportion of Males Married	0.19	0.13 – 0.27	**<0.001**	1.52	1.10 – 2.11	**0.011**
Female Mean Years of Schooling	1.00	0.97 – 1.02	0.736	1.01	0.99 – 1.03	0.374

Male Mean Years of Schooling	0.96	0.94 – 0.99	**0.005**	0.98	0.96 – 1.00	0.114
Adult Sex Ratio	1.01	0.98 – 1.04	0.423	0.92	0.87 – 0.98	**0.008**
"Leftover" * Age Over 60	0.33	0.10 – 1.06	0.063	0.38	0.17 – 0.86	**0.020**
"Not picked" * Age Over 60	0.38	0.27 – 0.54	**<0.001**	0.55	0.49 – 0.61	**<0.001**
Widowed or Divorced * Age Over 60	1.02	0.94 – 1.10	0.670	0.83	0.77 – 0.89	**<0.001**
Observations	2334884			2363093		
Pseudo R^2	0.045			0.048		

Table A6. Mixed Effect Logistic Regression of Death on Marital Status, Female and Male, Age over 22

	Females			Males		
Predictors	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*
(Intercept)	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**
Married (omitted)						
Never Married	3.58	3.16 – 4.06	**<0.001**	1.69	1.60 – 1.79	**<0.001**
Divorced	1.14	0.83 – 1.55	0.415	1.14	1.01 – 1.30	**0.036**
Widowed	1.06	0.98 – 1.13	0.130	1.32	1.23 – 1.42	**<0.001**
Age Over 60	1.00	0.96 – 1.05	0.936	1.21	1.16 – 1.25	**<0.001**
Years of Schooling	0.93	0.92 – 0.93	**<0.001**	0.93	0.92 – 0.93	**<0.001**
Age	1.08	1.08 – 1.08	**<0.001**	1.08	1.08 – 1.08	**<0.001**
Urban	0.95	0.91 – 1.00	**0.036**	1.00	0.96 – 1.04	0.924
Han	0.87	0.83 – 0.92	**<0.001**	0.92	0.88 – 0.96	**<0.001**
Household Size	0.89	0.89 – 0.90	**<0.001**	0.89	0.89 – 0.90	**<0.001**
Years of Schooling Gap	0.98	0.97 – 0.98	**<0.001**	1.03	1.02 – 1.04	**<0.001**
Male Mean Years of Schooling	0.95	0.92 – 0.99	**0.006**	0.97	0.94 – 1.00	0.077
Female Mean Years of Schooling	1.00	0.97 – 1.03	0.801	1.02	0.99 – 1.04	0.255
Proportion of Females Married	3.44	2.19 – 5.41	**<0.001**	0.20	0.14 – 0.28	**<0.001**

Proportion of Males Married	0.15	0.10 – 0.23	**<0.001**	1.56	1.11 – 2.19	**0.011**
Adult Sex Ratio	1.00	0.95 – 1.04	0.885	0.91	0.85 – 0.98	**0.011**
Divorced * Age Over 60	0.94	0.63 – 1.39	0.745	0.55	0.46 – 0.66	**<0.001**
Never Married * Age Over 60	0.43	0.34 – 0.55	**<0.001**	0.42	0.38 – 0.46	**<0.001**
Widowed * Age Over 60	1.11	1.03 – 1.20	**0.007**	0.81	0.75 – 0.87	**<0.001**
Random Effects						
σ^2	3.29			3.29		
τ_{00}	0.16 vilID			0.14 vilID		
ICC	0.05			0.04		
N	8481 vilID			8481 vilID		
Observations	3190795			3210601		
Marginal R^2 / Conditional R^2	0.379 / 0.408			0.350 / 0.375		

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