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Disability, Disease, and Mortality in Rural China, 1749-1909

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Introduction

The causes and consequences of early and mid-life disease and disability in past populations are important research topics because of their contemporary as well as historical implications. Contemporary epidemiological conditions, of course, have changed as fundamentally as demographic behavior from the past. However the biological consequences of earlier illnesses for later mortality and morbidity persist today, and in spite of their importance for human biology as well as health policy, remain poorly understood.[1] Better understanding of these relationships requires individual-level longitudinal data on health and other conditions in early and mid life linked to later health outcomes including timing of death. Such data are relatively rare, and are especially uncommon for non-Western populations.[2]

Chinese household and population registers from the Qing Dynasty (1644-1911) record information on adolescent and adult disease and disability for several million males that can be linked to their later health and mortality outcomes. This paper uses such sources to make a very preliminary examination of the causes and consequences of early and mid-life disabilities for one distinct subpopulation especially in terms of later mortality. Our study population consists of 84,973 adult men who lived in northeast China between 1749 and 1909, 9,436 of whom were registered as disabled and 3,643 of whom had a specific recorded disability or disease. Because these registers record individuals and families over time, they allow for application of event history methods to examine the determinants of disability, as well as its consequences. Because they organize these largely rural individuals by household and village, they allow for examination of the role of family and community characteristics to determine health and disability status, and to modulate the effects of health and disability status on mortality. Because they record these non-Western populations in their entirety, they allow us to distinguish the effects of different social and institutional conditions as well as different disease environments.

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1 Qualitative sources, including case histories, medical texts, and medical advice books for laypeople, have of course informed a number of important qualitative studies of disease, disability, and medicine in past populations. For examples of such work for China, see Hsiung (1999) and Leung (1987)

2 Until recently the primary source for quantitative studies of health and disability in historical populations have been the records of Friendly Societies in Europe, especially England (Alter and Riley 1989; Riley 1987, 1997) and the medical records of military veterans especially from the United States (Costa 2000; Costa and Steckel 1997). Recently, several historical demographers have developed new sources of longitudinal individual level data (Bengtsson and Lindstrom 2000 and 2003; Bengtsson and Bronstrom 2002). Other studies have been carried out using heights, often of military conscripts, as a proxy for health (Floud, Wachter, and Gregory 1990; Steckel and Floud 1997).

The populations that we examine were part of a Qing military and administrative system known as the Eight Banners (Ding 1992; Ding et al 2003; Elliott 2001). Their records of disease and disability reflect this institutional setting. They were motivated by the desire of the state to register the population potentially liable for military and other state services and were accordingly restricted to adult males. Registration as disabled had distinct advantages and disadvantages. 'Disabled' males were exempt from military and state service, but were also disqualified from ever earning a state salary. Official identification as disabled therefore reflects the interplay of individual social settings and strategies with such institutional incentives and disincentives as well as genuine poor health.

In this paper we assess the reliability of recorded disability as an indicator of health, according to three sets of assumptions or situations. First, since community, household, and individual characteristics should have conditioned disease risks in predictable ways, we examine their influence on the chances of being classified as 'disabled.' Second, since the truly 'disabled' should have had a higher risk of dying, we analyze the association between recorded disability and the risk of dying. Third, in addition to assessing the role of the family, specifically the presence of a spouse and adult children, in conditioning the mortality consequences of disability, we also study the consequences of such disabilities for other household members.[3]

Our paper is organized in four sections. In section one, we describe our Eight Banner population register data, focusing on patterns and trends in the recording of disability. In section two, we very briefly introduce the event-history methods that we use and outline our models, specifying the hypotheses that each variable is intended to test. In section three, we present our results. Finally, we conclude with an assessment of the implications of these results for the future use of such Chinese sources to study human health.

Data

Map 1 here

The data we analyze here are a subset of a larger population of nineteen distinct state farm subpopulations which currently includes 938,413 observations of 171, 715 individuals who lived in more than four hundred largely rural communities in what is

3 In Qing China as in many historical societies, the family rather than the church or state cared for the disabled and ill (Das Gupta 1997, 1998; Lang 1946; Skinner 1997). We have also shown elsewhere that understanding the causes and consequences of disease and disability in historical populations is crucial because pre-industrial households depended on the labor of their members to survive (Bengtsson, Campbell, and Lee et al 2003). The incapacity of an adult could reduce a family to dependence on the generosity of other household members, kin living in other households, or the community or state. Thus systematic variation in the health or disability status of adults was potentially a major source of inequality between families, households, and even communities.

now Liaoning province between 1749 and 1909.[4] Map 1 summarizes the geographic distribution of this larger population over an area of 6000 square miles.

These populations are well recorded in what are called 'Household and Population Registers of the Eight Banner Han Army' (*Hanjun baqi rending hukou ce*) compiled triennially for a number of populations in northeast China and certain other locations.[5] The Qing relied heavily on these registers for civilian and military administration. They accordingly devised a system of internal cross-checks to ensure consistency and accuracy. First, they assigned every person in the banner population to a residential household (*linghu*) and registered them on a household certificate (*menpai*). Then they organized households into clans (*zu*), and compiled annually updated clan genealogies (*zupu*). Finally, every three years they compared these genealogies and household certificates with the previous household register to compile a new register. They deleted and added people who had exited or entered in the last three years and updated the ages, relationships, and official titles of those people who remained as well as any changes in their given names. Each register, in other words, completely superseded its predecessor.

The banner registers provide far more comprehensive and accurate demographic and sociological data than the household registers and lineage genealogies common elsewhere in China (Harrell 1987, Jiang 1993, Lee and Campbell 1997, Skinner 1987, Telford 1990). This is because banner populations were under special state jurisdiction, distinct from provincial administration elsewhere. In Liaoning, population registration began as early as 1625, when the Manchus made Shenyang their capital and incorporated the surrounding communities into the banner system. It was not until the establishment of the General Office of the Three Banner Commandry in 1749-1752, however, that a single 'provincial' authority assumed control of the population registration process (Tong and Guan 1994, 1999); and it was not until 1749 that Liaoning population registers assumed a uniform format as well as a uniform triennial schedule.

From 1749 onwards, the registers record at three year intervals for each person in the target population the following information in order of appearance: relationship to their household head; name(s) and name changes; adult banner status, including official title, if any; age; animal birth year; lunar birth month, birth day, and birth hour; marriage, death, or emigration, if any during the intercensal period; physical disabilities, if any and if the person is an adult male; name of their household group head; banner affiliation; and village of residence. Individuals are listed one to a column in order of their relationship to the head, with children and grandchildren listed first, followed by coresident siblings and their descendants, and uncles, aunts, and cousins. Wives are always listed

4 Fewer than 5 percent of these men lived or worked in cities and if they did this was usually the provincial capital, Shenyang.

5 Such data are available for populations from Beijing and immediate surrounding counties as well as the provinces of Heilongjiang, Jilin, Liaoning, Nei Menggu, and Xinjiang and what is now Mongolia.

immediately after their husbands, unless they are superceded by a coresident widowed mother-in-law.

The data from the banner registers are also distinguished by the ease with which they can be reorganized longitudinally. Individuals and their households can be followed very easily from one register to the next because they appear in almost the same order in successive registers. Accordingly, it is relatively straightforward to reconstruct life histories and generate variables describing individual past characteristics including recorded disabilities or disease as well as eventual outcome measures at particular times or over a specific time interval.

Table 1 here

For this analysis, the most important feature of these registers is that they distinguish disabled adult males, classified as *feiding* or *chenfei*, from healthy adult males classified as *zhuang ding* (healthy adult male) or according to whatever specific Banner position or state office they held. Classification as disabled could occur for any one of a number of reasons and until 1786, the registers generally specified a specific disease or condition for each disabled male. In Table 1 we have regrouped these into fifteen broad categories based on the organ or limb affected. Reflecting the prevalence of tuberculosis in the eighteenth and nineteenth centuries, respiratory diseases, especially consumption (*laozheng*), were by far the most common, affecting more than 5 percent of adult males and 25 percent of all the disabled. Eye diseases were second most common, affecting more than 3 percent of adult males and 15 percent of the disabled, followed by such neurological disorders as retardation, insanity, dementia, and epilepsy which affected and afflicted 2 percent of adult males and 10 percent of the disabled.

Figure 1 here

Figure 1 presents the proportions of adult males annotated as disabled from the middle of the eighteenth century until the beginning of the twentieth.[6] There was a pronounced temporal trend in the recording of disability that most likely reflects changes in the registration system, not changes in morbidity. The highest proportions of 'disabled' were the half century from 1775-1825 when more than a quarter of adult males were so classified. After the first quarter of the nineteenth century, the proportion of males listed as disabled declined steadily, till by the beginning of the twentieth century, the officially disabled had almost disappeared.

Figure 2 here

For whatever reason, from the late 1820s onward, very few men were newly classified as disabled. Figure 2 presents the proportions of men in each year who were listed as disabled in the subsequent register. Whereas before the 1820s, anywhere between 2 and 12 percent of non-disabled men would be classified as disabled by the

6 For this calculation we only considered men ages 21 to 60 *sui* because at later ages men, including those previously listed as disabled, were typically reclassified as old (*lao*) or retired (*tui*).

next register, after 1800 less than one-half of a percent of men similarly changed status. After the middle of the 1850s, no men changed status. Men in the last half of the nineteenth century who were still listed as disabled, in other words, were mostly men who had been classified as 'disabled' much earlier.

Figure 3 here

Age patterns in the recording of disability were also pronounced, and partly reflected the registration system. Figure 3 presents the proportions of disabled males by age. Because recording of banner statuses for males began in the late teens and early twenties (Lee and Campbell 1997, 160-165), no children and very few young teenagers were identified as disabled. After age 18, however, the proportions of males listed as disabled rose steadily, peaking in the fifties at almost one-fifth, and declining steadily thereafter as men in their late fifties and sixties were reclassified as retired (*tui*) or old (*lao*) and unsuitable for military or other sorts of state service.

Figure 4 here

To better estimate the actual proportion of disabled males, Figure 4 summarizes the proportions of men ever listed as disabled. The proportions rose steadily from the age 18 onward and plateaued in the mid to late sixties at almost 30 percent of elderly males. At each age, the proportions ever disabled are higher than the proportions currently disabled in Figure 3, indicating that some of the males listed as disabled changed to other banner statuses even before reaching old age. Since such shifts may not have reflected genuine improvements in health, but instead may have been prompted by changes in the registration system, our analysis of the mortality consequences of disability considers the effects of ever having been registered as disabled, not the effects of currently being listed as disabled.

Figure 5 here

To better understand the age profile of such disabilities, Figure 5 summarizes the proportions of men at each age who become newly disabled, that is the proportions of men not currently listed as disabled who are classified as disabled in the following register. According to the results, men became disabled at virtually any age. There is a pronounced peak at 15-17 years of age reflecting initial registration as well as early labor force entrance. Then beginning in the late thirties the incidence of disability gradually increases peaking again in the early fifties. After age 55 the chances of being classified as disabled declined significantly as older men were categorized as either old or retired. The state had no vested interest in recording the disabilities and diseases of old and retired men who were ineligible for state service.

Methods

For our basic event-history analysis of the influence of individual, family, and community characteristics on the chances of becoming disabled and eventually dying, we make use of logistic regression (Long 1997). Equation 1 summarizes the basic model. The logistic transform of the probability *p* of an outcome of interest is expressed as a linear function of a set of right-hand side variables **X** that measures individual and family characteristics. Estimated coefficients **B** measure the strength of the association between these variables and the log-odds of the outcome of interest. For presentation, we transform the coefficients into odds ratios that reflect the proportional change in the risk of being listed as disabled or dying associated with a one-unit change in the associated explanatory variable. An odds ratio greater than one indicates that higher values of the right-hand variable of interest are associated with increased chances of the outcome, an odds ratio less than one indicates an inverse association, and an odds ratio close to one suggests a lack of association. Tests of statistical significance help indicate whether differences between estimated coefficients and zero, that is between odds ratios and one, are large enough to reject the null hypothesis that there is no relationship and that the observed relationship might be the result of random variation in the data.

$$\mathrm{Log}(p(y = 1)/[1-p(y=1)]) = a + \mathbf{BX} \quad (1)$$

For each analysis of the determinants and consequences of being listed as disabled, we estimate two sets of models. In the first, which we will refer to as the basic model, we account for differences by register year, state farm subpopulation, and length of time until the next available register by the inclusion of sets of control variables.[7] This helps ensure that observed effects of the variables of substantive interest do not reflect compositional differences according to the values of these variables. Controlling for register year accounts for temporal change in the likelihood of being registered as disabled apparent in Figures 1 through 3. Controls for state farm subpopulation account for differences in the chances that men would be listed as disabled or would die and ensure that measured relationships are not attributable to compositional differences by age, time period, or institutional context.[8] To save space we do not present the estimated coefficients.

To confirm that associations apparent in the results for the basic models do not reflect the influence of omitted variables, we also estimate logistic regressions with fixed effects that account for otherwise unobserved features of local context. In this second approach, which we call the fixed effects model, observations are treated as clustered, and observations in the same cluster are assumed to have some unmeasured features in common that affect outcomes. If not controlled for, such unmeasured features of local

7 In all cases, the controls were in the form of sets of dichotomous indicator variables.

8 For the purposes of these calculations we used data for sixteen state farm populations: Bakeshu, Changzhaizi, Chengnei, Dadianzi, Dami, Daoyitun, Daxintun, Diaopitun, Feicheng Yumiancheng, Gaizhou Manhan, Gaizhou Miandidng, Guosantun, Langjiabao, Nianma Dahaizhai, Niuzhuang, and Wangzhihuitun.

context may bias coefficient estimates.[9] If they are positively or negatively associated with both the outcome variable and an explanatory variable included in the analysis, the estimated coefficient will overstate the strength of their relationship. If they are positively associated with one but negatively associated with the other, the estimated coefficient may underestimate the strength of the relationship. A fixed effect logistic regression controls for the effects of these unobserved features of local context by estimating effects of the measured variables on the chances of the occurrence of the outcome of interest, conditional on at least observation in the cluster experiencing that outcome.[10]

For the fixed effect models, we assume that the members of a household group at a specific point in time form a cluster, and exclude measured variables that were the same for all members of a household group. The household group was the lowest formal administrative unit above the household itself, with an unpaid head chosen from among members of the households. It normally consisted of one to five households, most commonly two or three. The members of the households that made up a group were almost always members of the same descent group. Thus the members of a household group in a particular year were likely to have been relatively homogenous with respect to unmeasured features of local context, socioeconomic characteristics, and genetic endowments that affected disability and mortality.

Explanatory Variables

Determinants of Disability

To examine the determinants of being listed as disabled, we use as an outcome an indicator of whether or not an individual currently not identified as disabled is classified as disabled in the following register. We only include males between the ages of 11 and 50 because as shown earlier, it was uncommon for children and the elderly to become listed as disabled. Since there were no new 'disabled' males after 1855, we exclude the data from later registers. Moreover we estimate separate models for males between ages 11 and 30, and between ages 31 and 50 based on the bimodal age profile of new disabilities in Figure 5, distinguishing between disabilities that may have persisted from childhood or adolescence, and disabilities definitely acquired in adulthood.

Our models account for geographic, institutional, and temporal variation in the likelihood that a male would be classified as disabled. Calculations not shown here reveal that adjacent and even overlapping state farm populations sometimes differed substantially in the percentages of men listed as disabled, suggesting that institutional

9 For example, if some villages had persistently lower death rates because of ecological features of their setting and their households as a result had more members, a simple correlation of household size and death rates might suggest an association between the two.

10 Thus a fixed effect logistic regression is also referred to as a conditional logit.

context was as important a determinant of being listed as actual health status. The basic model accounts for institutional variation, as well as the temporal variation apparent in Figure 2, with controls for state farm system and register year noted earlier. The fixed effect model not only accounts for institutional and temporal variation, but geographic variation within state farm systems, since any higher or lower propensity of men in certain villages to be recorded as disabled is absorbed by the fixed effect of household group.

We examine the effects of population density on the chances of being listed as disabled. In a historical population, increased population density raised the risk of being disabled by increasing the frequency of exposure to disease. Thus in nineteenth century England, residing in a more crowded household lengthened sickness and raised death rates (Riley 1997, 249). In Liaodong, the residents of larger villages had higher death rates (Campbell and Lee 2003). Growing up with more siblings may have had similarly adverse consequences net of household size because we expect contacts with siblings to have been the most frequent and intense. A finding here that density was positively associated with the chances of being listed as disabled would suggest that disability status in the registers was indeed reflective of underlying health, in particular disease, not solely an artifact of institutional incentives. A finding that density had no effect, meanwhile, would cast doubt on the usefulness of the disability status listed in the registers as an indicator of health.

We consider density at the levels of the village, the household, and the family. Thus we include the village population, number of male household members between ages 16 and 55 *sui,* and the number of siblings born in the index individual's natal family. For the village population, the variable consists of the log of the population base 1.1, so that odds ratios reflect the effects on the chances of being disabled of a 10% increase in village population. Since members of the same household group lived in the same village, the fixed effect models do not include village population. For the count of male household members between ages 16 and 55, the odds ratio reflects the changes in the chances of being disabled associated with increasing the number of adult males in the household by one by 1.[11] For the count of siblings, the odds ratio reflects the effects of having an additional sibling.

We also consider the effects of the number of males in the household already listed as disabled. We expect increases in the number of disabled males in the household to have raised the chances that an individual would be listed as disabled. To the extent that the other household members had been listed as disabled because they had a contagious chronic disease such as tuberculosis, initially healthy individuals living in the household should have been at higher risk of being exposed to the disease and contracting it. Many of the other infirmities identified in the registers such as vision and neurological

11 We restrict our measure of household size to adult males because the numbers of children and elderly may be influenced by unmeasured characteristics that condition survival, while the numbers of females may reflect household success at acquiring brides for their sons, which in turn is reflective of household socioeconomic status.

disorders, paralysis and certain deformities are also likely to have originally stemmed from a chronic infectious disease, perhaps in infancy and childhood. Failure to find an association between the number of disabled males in the household and individual chances of becoming disabled would cast doubt on the usefulness of Chinese historical disability data for the study of human health.

We measure the association between marital status and the chances of becoming disabled. In most societies, the currently married are healthier and have lower risks of dying than the never married, the divorced, and the widowed (Hu and Goldman 1990). Widows and widowers in Liaoning were at much higher risk of dying (Campbell and Lee 1996, 2000, 2002). A finding that unmarried men in Liaoning were more likely to become disabled than married men would provide additional confirmation that disability status in the registers reflected underlying health. The age pattern of influence of marital status on disability, meanwhile, may suggest whether the association between marital status and disability reflected marriage selection, in which the disabled were less likely to marry, or marriage protection, in which married men were less likely to become disabled. If an effect of marital status is only apparent for men aged 11-30 *sui,* who we earlier suggested were likely to already be disabled when they were registered as such, a selection effect is likely to have played a role. If an effect of marital status is apparent at later ages as well, there may have been a protection effect as well.

We examine the effects of the survival status of parents. The loss of a parent raised death rates in childhood and adolescence in Liaoning (Campbell and Lee 1996, 2000, 2002), thus we expect the loss of a parent to also have raised the risk of becoming disabled. If an effect of parents' survival status is apparent in the basic model but not the fixed effect model, it would indicate that the death of one or both parents was indicative of an unhealthy village environment or a genetic predisposition to disease and early death, and that whatever caused their deaths may have raised the chances that their son would be disabled. If the effect of a loss of a parent persisted after the introduction of the fixed effect of household group, it would rule out village environment and genetic endowment as a source of the effect, and suggest that the loss of a parent directly affected well-being.

To explore how conditions in childhood affected the chances of being listed as disabled, we also measure the loss of a parent in childhood. Specifically, we include a variable indicating whether father or mother had died by the time the individual was age 10. As mentioned earlier, previous results suggest that the loss of a parent during childhood had immediate adverse effects on mortality (Campbell and Lee 1996, 2000, 2002). Conditions in early life are widely hypothesized to affect health in later life, and a number of specific pathways have been suggested (Elo and Preston 1992). Empirical results from historical populations confirm that conditions in childhood affected mortality at later ages (Bengtsson and Lindström 2000). Through inclusion of the variables for early loss of parent, we examine whether or not there were long-term adverse health effects among those who survived childhood and adolescence.

For the elderly, we also consider the effects of presence of sons, daughters-in-law, and grandchildren. Daughters-in-law especially were an important source of support for elderly males in Chinese society. For example, in Taiwan even in recent decades daughters-in-law have provided more assistance to the elderly than sons or other kin, and have provided more assistance to elderly males than females (Hermalin, Ofstedal and Chang 1992; Hermalin, Ofstedal, Lee 1992). To the extent that care provided by daughters-in-law affected health, we expect their presence to have reduced the chances of becoming disabled. By including a count of grandsons, we examine whether or not competition with young dependent household members adversely affected the health of elderly males In Liaodong, children who had a living grandfather had substantially higher mortality than children who had no living grandparents or only had a grandmother (Campbell and Lee 2000, 2003), suggesting that children and grandfathers competed as dependents for the same share of household resources.

We also examine the effects of economic circumstances. We examine whether or not the possession of a Banner title by an individual's father and brothers affected the chances of becoming disabled. In these populations, possession of a Banner title was indicative of substantial wealth and power. An individual growing up as the son or brother of the holder of a title led a life of relative privilege, may have been healthier as a result of increased consumption. We do not have strong priors about the effects of these variables, however, since our previous analyses of the effects of possession of title on mortality have yielded inconsistent results (Campbell and Lee 1996, 2000; Lee and Campbell 1997).

Finally, we explore the effects on the chances of becoming disabled of increases in sorghum prices. Increases in sorghum prices appear to have been associated with hard times for farmers: our previous analysis revealed that in northern and central Liaoning, higher prices led to increased death rates (Campbell and Lee 2000). We speculate that high sorghum prices, by worsening the health of the population in the short-term, may have increased the chances that individuals would become disabled. Again, however, we do not have strong priors about the influence of sorghum prices since there may have been a time lag between the development of a disability and its registration.

Consequences of Disability

The clearest test of the reliability of disability status recorded in the registers as an indicator of health is whether or not it predicted higher subsequent mortality. To the extent that disability status reflected a genuine underlying disease or condition, individuals listed as disabled should have had higher death rates.

We divide our analysis of the consequences of disability into three parts. First, we carry out an arithmetic comparison of death rates according to whether or not an individual has ever been listed as disabled. Second, we carry out an event-history analysis of the records of individuals identified before 1786 with a specific disability to assess whether particular conditions were especially likely to result in death. The outcome measure is an indicator of whether or not a male died by the next register. We expect that individuals with a respiratory condition should have been at much higher risk of dying since many of these individuals probably had respiratory tuberculosis.

Finally, through a more detailed event-history analysis of mortality, we explore how household and community context modulated the mortality effects of disability status. We use as our measure of disability an indicator of whether or not a male had ever been recorded as disabled. Accordingly, we can examine the experience of elderly men even though most of them were recorded in the registers as old or retired (Lee and Campbell 1997) even if they had been listed as disabled earlier in their lives. Because no males are newly listed as disabled after 1855, we restrict analysis to observations of males who were recorded at least once between ages 21 and 60 *sui* by 1855.[12]

We focus on interactions between the measure of disability status and variables describing local and household context. These explanatory variables are the same as the ones included in the analysis of the determinants of disability. Odds ratios for interaction terms reveal the proportional changes in the effects of disability on mortality associated with one-unit changes in the interacted variable. Thus, for example, an odds ratio for an interaction between number of adult males in the household and the disability status measure suggests the proportional change in the effect of disability on mortality associated with adding a household member. Odds ratios greater than one indicate that increases in the interacted variable strengthen the effect of disability on mortality, while odds ratios less than one indicate that such increases reduce the mortality effects of disability.

We expect that the same contextual features that may have increased the chances of becoming disabled in the first place may also have led to more rapid deterioration and eventual death. Population density, for example, not only may have increased the chances of becoming disabled, but by continuing to expose already vulnerable disabled individuals to new infections, may have hastened their decline.[13] Similarly, the same feature of household environment or genetic makeup that contributed to the loss of a parent and the development of a disability may have accelerated deterioration in health and eventual death.

We examine how the presence or absence of particular kin affected the progression from disability to death. In a pre-industrial society, and especially in China, the family was supposed to be the primary provider of support to the vulnerable. We investigate whether the presence of particular relatives who could provide care or assistance ameliorated the mortality effects of having a disability. Thus for older males, we examine whether additional sons and daughters-in-law reduced the mortality impact of disability. As noted earlier, even today daughters-in-law are important sources of care

12 In other words, all of the observations from after 1855 included in the analysis were of men who had been in the registers by 1855, and who had the opportunity to be newly recorded as disabled.

13 The adverse mortality effects of population density have been known for some time. William Farr first observed the association between town size and the risk of dying in England during the nineteenth century. Most recently, Riley (1997) showed that in nineteenth century England, residents of larger towns experienced higher mortality.

for dependent elderly males in Chinese society (Hermalin, Ofstedal, and Chang 1992; Hermalin, Ofstedal, and Lee 1992). To the extent that sons or daughters-in-law acted as caregivers, increases in their numbers should have benefited older disabled males. We also examine the effects of grandchildren for evidence whether or not they competed with elderly males for household resources.

Results

Determinants of Disability

Generally, patterns of disability status in the registers seem consistent with the notion that recorded disability reflected genuinely poor health. The clearest evidence are in the results for population density, loss of a mother or especially father, and numbers of other disabled males in the households. The effects are strong, and almost all in the expected direction. Characteristics of the community and household that would be expected to increase exposure to disease all seem to have affected the chances of being listed with a disability.

Table 2 here

Population density at several different levels, for example, had the expected positive association with the chances of becoming disabled. Table 2 presents results from the event-history analysis of being newly listed as disabled. According to the results for the basic model, in a village that was 10 percent larger than another, the chances of being listed as disabled were 1.2 percent higher for young adult males and 0.9 percent higher for older adult males. Since villages ranged in size from a handful of residents to hundreds of residents, this effect is substantial. Comparing villages with 10 and 320 residents, the risk of being newly listed as disabled in the larger village would have been 81.6 percent higher for young adults, and 56.5 percent higher for older adults. By itself, of course, this result does not validate the disability statuses recorded in the registers, since it is entirely possible that the recording of disabilities was simply more complete in larger villages, and incomplete in small, remote villages.

Household crowding also raised the chances of becoming disabled, just as it did in nineteenth century England (Riley 1997). In the basic model, every additional adult male in the household raised the chances of being listed as disabled by 8.9 percent for older males. The influence of household size is even clearer in the fixed-effect model that compares men in the same household group. Comparing two households in the same group that differed only in that one had one more adult male than the other, young and older adult males in the household with the extra male were 3.7 percent and 13.8 percent more likely to be listed as disabled, respectively. Since the fixed-effect ensures that this reflects differences within household groups made up of kin living in the same village, not differences between household groups in the same or different villages, this is highly unlikely to have reflected variations in institutional context in the way the village size effects might have.[14]

Family size, measured as the total number of siblings ever born, had substantial additional effects on the chances that young adults would be listed as disabled. Each additional sibling raised the chances of being listed as disabled by 7.2 percent in the basic model and 6.4 percent in the fixed-effect model. This may not only reflect the epidemiological environment, but also the adverse effects of the dilution of parental resources among more children. Even in contemporary societies, children with more siblings experience less favorable outcomes on a variety of measures such as educational attainment (Blake 1981).

The presence of household members who were already disabled raised the chances that additional members would be newly listed as such. According to Table 2, the presence of other disabled males also raised the chances of becoming disabled. For young males, every additional disabled male in the household raised the chances of becoming disabled by about 17.4 percent in the basic model and 10.8 in the fixed effect model. The persistence of this effect after the introduction of a fixed effect of the household group rules out the possibility that it reflects institutional or other reasons which would make registration of disability easier in some regions or villages than in others. Given the importance of respiratory diseases apparent in Table 1, such patterns may reflect the spread of tuberculosis from member to member within households. It may have reflected the spread of other diseases as well, since tuberculosis was by no means the only infectious disease that could produce chronic debility.

The loss of a parent also had effects in the expected direction on the chances of being listed as disabled. In the basic model, fathers appear more important. Their absence raised the chances that younger and older males would be listed as disabled by 13.1 and 23.5 percent, respectively. The effect for younger males is statistically significant only by very liberal criteria. Results from the fixed-effect model differ slightly. Weakly significant effects for the absence of a father persist, while effects of the absence of a mother become apparent for older males. That effects remain after the characteristics of the household group are controlled for indicates that these associations do not simply reflect features of local context that simultaneously affect the survival status of parents and the disability status of males.

Family economic status, as reflected in the possession of a Banner title by kin, affected the chances of becoming disabled. Growing up as the son of the holder of a Banner position does not seem to have reduced the chances of being disabled, suggesting that privilege in early life did not improve health later. Among older males, however, having brothers who held positions, however, substantially lowered the chances of

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14 Indeed, the strengthening of the effect of household size after the introduction of the fixed effect for household group suggests that some feature of village or household group context affected household size and chances of being listed as disabled in opposite directions, so that areas where households were larger had lower proportions of men being listed as disabled. As a result, the basic model underestimated the strength of the association between the two.

becoming listed as disabled. While this may reflect a genuine association between household socioeconomic status and disability, it may also have reflected manipulation of the registration system. State obligations were assessed on a household basis, thus such sibling achievements both protected their brothers from unwanted state service and encouraged them to hold on to their eligibility for coveted banner positions of their own.

Other variables of substantive interest had little in the way of an effect. The loss of a parent while still a child does not seem to have had any additional long-term consequences. Marital status does not seem to have affected the chances of becoming disabled. Economic conditions, as reflected in sorghum prices, appear to have an effect. High grain prices seem to have reduced the chances of being listed as disabled, but we are hesitant to make much of this result given the possible lag between the onset of disability and recognition of it in the registration system.

This is not to say that disability status in the registers was entirely accurate. As we noted earlier, institutional incentives and social context are also likely to have affected the chances that an individual would achieve official recognition of their disability. Some genuinely disabled males may have failed in their efforts to have their condition acknowledged, while some perfectly health males may have been able to manipulate the system to their advantage. The analysis here was not designed to detect the influence of such processes, so we cannot yet assess their importance. In future work we will design analyses specifically to examine the role played by institutional incentives and social context.

Consequences of Disability

Figure 6 here

Arithmetic comparison of death provides further evidence that the disability status recorded in the registers reflected underlying health. Figure 6 plots the chances of dying in the next three years for males according to whether or not they were ever identified in the registers as disabled. At least from middle age onward, males listed as disabled had higher death rates. As a result, calculations not shown here reveal that life expectancy at age 21 *sui* was nearly four years lower for disabled men than for men not identified as disabled: 37.3 years versus 41.2 years. The gap persisted at later ages, so that life expectancy at age 61 *sui* differed by three years according to disability status: 12.6 years for the disabled versus 15.9 years for those not disabled.

Table 3 here

Respiratory conditions had the clearest effects on mortality. Table 3 presents the results of an event-history analysis of the data through 1786 that includes as explanatory variables indicators of whether or not a male has ever been listed with a disability of a particular category. For younger adult males, a respiratory condition raised the chances of dying by nearly two-thirds. For older adult males, a respiratory condition raised the chances of dying by one-third. These effects persist, indeed become slightly stronger, in the fixed effect model. This result is as expected. The respiratory category consisted largely of *lao zheng*, which is likely to have corresponded to tuberculosis, and was widespread during the eighteenth and nineteenth centuries.

Disabilities in other categories are also associated with elevated mortality risks, but the evidence is more tentative. In the fixed effect model, young adult males with a brain disorder were half again as likely to die as other men. In the same model, a deformity raised the chances that a young adult male would die by three-quarters. Both effects, however, were statistically significant only by very liberal criteria. In the basic model, eye and vision problems raised the chances of dying, though again the effect was weakly significant. In the fixed effect model, the magnitudes of the coefficients changed little, but the effects were no longer statistically significant. The tenuous nature of these results may reflect the small numbers of observations with disabilities in the associated categories, thus a definitive conclusion may await the addition of new data.

Disability status in general was associated with a higher risk of dying. Table 4 presents results from an event-history analysis of the risks of dying between the current register and the next. Whereas the analysis of the risks associated with specific categories was restricted to men who had been observed as adults before 1789 and had the opportunity to be recorded with a specific disability, this analysis included all of the men who were observed as adults by 1855 and had the opportunity to be recorded as disabled, with no specific details. In the basic model in Table 4, young males ever listed as disabled were 13.1 percent more likely to die, and older males were 14.6 percent more likely to die. Results from the fixed effect model rule out the possibility that this reflected more frequent registration of disability in settings where the death rate was higher. Compared to other men in the same household group, young males registered as disabled were 13.2 percent more likely to die, and older males were 23.8 percent more likely.

Table 4 here

Family context affected mortality risks. The absence of a mother appears to have been especially harmful for young adult males, raising their mortality risks by 16 percent in both the basic and fixed-effect models. The harmful effect of the absence of the father was only weakly significant in the basic model, and not significant at all in the fixed effect model, suggesting that effect of loss of father in the basic model simply reflected some aspect of local context or genetic endowment that raised mortality risks for both father and son. That only the absence of mother was consistently harmful, meanwhile, is consistent with results on the effects of a parent on male child and adolescent mortality in Lee and Campbell (2002). In keeping with previous findings for Liaodong (Campbell and Lee 1996, 2000, 2003) and for human populations in general (Hu and Goldman 1990), the presence of a wife reduced mortality risks. According to the fixed effect model, young males who were married were one-fifth less likely to die than other men in their household group. Older males were 6.5 percent less likely to die.

For older males, there is little evidence in Table 4 of a protective effect of sons or daughters-in-law, or an adverse effect of grandsons. Additional sons and daughters-in-law, in other words, did not lower mortality. If anything, they increased it, though the result is not statistically significant. As for the adverse effects of grandsons, they were only apparent in the basic model, not the fixed effect model. This suggests that in settings where mortality was higher, fertility was higher as well, so that whereas older males with additional grandsons were more likely to die overall, they were not more likely than other men in their household group to die.

Family context could nevertheless condition the impact of disability. Table 5 presents an estimate of the basic model that includes interactions between disability status and the explanatory variables, and Table 6 presents results from a fixed-effect model with interactions. Each additional daughter-in-law actually increased mortality risks for men who were not listed as disabled, by 8.2 percent in the basic model and 10.7 percent in the fixed effect model. For males listed as disabled, however, each additional daughter-in-law actually seemed to lower mortality. According to Table 5, an additional daughter-in-law lowered the mortality risks of a disabled male in the basic model by 3.5 percent (1.082*0.892=0.965). Once unmeasured characteristics of local context were controlled for in the fixed effects model in Table 6, each additional daughter-in-law lowered the risk of dying by 7.0 percent (1.107*0.840=0.930). The implication is that whereas daughters-in-law competed with elderly males for household resources, so that healthy adult males actually were worse off if they had additional daughters-in-law, daughters-in-law did provide care when elderly males were in need that actually lowered their risk of dying.

Tables 5 and 6 here

The presence of privileged kin also blunted the mortality effects of disability. In Tables 5 and 6, the presence of brothers who held official titles substantially lowered the mortality risks of men listed as disabled. Results from the fixed effect model in Table 6 were especially consistent, and indicated that a disabled male whose brother held an official title was one-fifth less likely to die than another disabled man in the same household group. Since the fixed effect model accounts for unmeasured of features of local context that may have affected mortality and the propensity to register as disabled, this either reflects a genuine effect of having privileged kin on the mortality effects of disability, or a strategy for seeking successful recognition of less serious disabilities that was specific to families with members who held titles.

Older disabled males were especially vulnerable to economic fluctuations. According to Table 5, a 10 percent increase in sorghum prices raised the mortality of disabled males by 4.2 percent (1.020*1.022) but raised the mortality of non-disabled males by only 2.0 percent, an effect which was not even statistically significant. Since previous work has shown that the mortality effects of food prices were most pronounced in the central and northern Liaoning populations (Campbell and Lee 2000, 2003), in future analyses we will investigate whether price effects on the mortality of the disabled also varied by region.

There is some hint that some households may have been more likely to achieve recognition of less serious disabilities. According to both Tables 5 and 6, additional disabled males in the household actually lowered the chances that a man registered as disabled would die. According to Table 6, a disabled man in a household with one other disabled adult male was 12 percent less likely to die than a disabled man in a household in the same group in which no one else was disabled. Holding the number of adult males in the household equal, additional disabled males should have increased mortality rates, if only because the household had reduced labor capacity. The implication is that the households in which disabilities were more common were more likely to have less serious disabilities recognized and recorded.

Conclusion

These results suggest that disability statuses in the Eight Banner household registers are at least partially reflective of the health status of individuals. They were not, in other words, artifacts of institutional incentives that may have encouraged people to manipulate their statuses. A variety of factors expected to have increased the risks of disease also seem to have increased the chances of being registered as disabled. Population density, especially as reflected in village population size and number of adult males in the household, was positively associated with the chances of being disabled. Individuals who had lost a parent, especially a father, were also at higher risk of becoming disabled.

Registration as disabled had an unambiguous association with the chances of dying. At almost every age, men who had ever been listed as disabled were more likely to die. Certain conditions, especially respiratory problems, were especially likely to result in death. Event-history analysis confirmed that the elevated mortality of the disabled was not because the factors that affected the chances of being disabled had independent effects on the chances of dying. Even when these were controlled for, the mortality effects of being disabled persisted.

The results of this analysis also demonstrate the potential of these data and methods to clarify the implications of disability in an agrarian society. We showed that household context, in particular the number of daughters-in-law, could condition the mortality effects of disability. For vulnerable disabled men who may have needed assistance with daily living, the care that a daughter-in-law could provide more than offset the adverse effects of having to compete with her for scarce household resources. Obviously this analysis is preliminary, and in future analyses we will examine in much more detail the role of households and kin networks in caring for the disabled.

We still need to investigate the role of institutional incentives and other features of social context in determining whether or not individuals would be listed as disabled. In other words, we need to account for fact that disability in Liaoning, as it was anywhere, was a social construction as well as a biomedical reality. The analysis here focused on establishing whether or not disability status in the registers reflected underlying health, and the conclusion seems to be that it does. In future analyses we will have to account for the likelihood that some individuals actively sought to have themselves listed as disabled when they were not, and conversely that administrators may have sought to list disabled individuals as healthy in order to facilitate state extraction.

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Table 1. Percentages of males age 21-60 *sui* with disabilities reported, 1749-1786

Category	Examples	Percent
Respiratory	Lao2 zheng4, hou2 lao2, hou3 zheng1, tu3 xie3	5.1
Eye/vision	Xia1 zi5, yan3 huai4	3.1
Brain	Sha3 zi5, feng1 ji2, chi1 sha3, Yang2 gao1 feng1, mi2 ji2	2.2
Leg	Tui3 huai4, tui3 que2	1.9
Arm	Ge1 bo1 huai4	1.4
Lame	Que2 zi5	1.4
Deformity	Can2 ji2	1.3
Back	Yao1 huai4	0.7
Paralysis	Tan1 zheng4, feng1 tan1	0.6
Sores	Lou4 chuang1	0.5
Internal	Chang2 shan4 qi4, tong1 chang2	0.4
Deaf	Er3 long2	0.3
Mute	Ya3 ba1	0.2
Dwarf	Cuo2 ai3	0.1
Injury	Lao2 shang1, hu3 yao3 shang1, shang1 lao2	0.1
Total (includes unspecified, others not above)		20.7
N		19722

Table 2. Logistic Regression of Being Newly Reported With a Disability, 1789-1855, Men 11-50 *sui*[a]

	11-30 *sui*		31-50 *sui*	
Variable	Coefficient	p-value	Coefficient	p-value
Basic model, with controls for state farm system, register year, and age group[b]				
10% increase in village population	1.012	0.00	1.009	0.00
Number of males in household age 16-55	1.014	0.34	1.089	0.00
Total number of siblings ever born	1.072	0.00	0.964	0.12
Number of disabled in household	1.174	0.00	1.043	0.19
Currently married	0.907	0.13	1.041	0.63
Father ever held a Banner title	1.112	0.22	1.222	0.10
Number of brothers who hold Banner titles	0.945	0.39	0.727	0.00
10% increase in sorghum prices	0.944	0.07	0.859	0.00
Mother is dead	1.061	0.39	1.106	0.16
Father is dead	1.131	0.06	1.235	0.01
Mother died before individual reached age 11 *sui*	1.069	0.59	1.085	0.67
Father died before individual reached age 11 *sui*	1.111	0.37	0.978	0.91
Individual not observed before age 11 *sui*	0.979	0.74	1.018	0.83
N		67773		44071
With fixed effect of household group and controls for age group				
Number of males in household age 16-55	1.037	0.02	1.138	0.00
Total number of siblings ever born	1.064	0.00	1.007	0.78
Number of disabled in household	1.108	0.00	0.949	0.14
Currently married	0.891	0.08	0.992	0.93
Father ever held a Banner title	1.126	0.17	1.167	0.21
Number of brothers who hold Banner titles	0.947	0.42	0.719	0.00
Mother is dead	1.055	0.44	1.151	0.05
Father is dead	1.123	0.08	1.164	0.07
Mother died before individual reached age 11 *sui*	1.065	0.62	1.177	0.41
Father died before individual reached age 11 *sui*	1.117	0.35	1.009	0.96
Individual not observed before age 11 *sui*	1.052	0.43	1.069	0.43
N		43343		26493

[a] The dependent variable was a dichotomous indicator of whether or not a male was reported as disabled in the following register. Observations were restricted to males who were not currently reported as disabled, and for whom the immediately succeeding register or the one after that were available.
[b] To save space, we do not present the coefficients estimated for these additional controls.

Table 3. Logistic Regression of Dying on Types of Disability Ever Reported, Men 21-80 *sui*[a]

	21-50 *sui*		51-80 *sui*	
Nature of disability	Odds Ratio	p-value	Odds Ratio	p-value
Basic model, with controls for state farm system, register year, and age group[b]				
Brain	1.267	0.24	1.098	0.45
Respiratory	1.622	0.00	1.329	0.00
Eye/Vision	1.338	0.12	1.221	0.05
Deformity	1.446	0.09	0.983	0.89
Arm	0.723	0.29	0.888	0.45
Leg	0.493	0.04	0.843	0.25
Lame	1.621	0.09	1.295	0.10
Other Disability	1.234	0.26	1.077	0.46
N		15906		13905
With fixed effect of household group and controls for age group				
Brain	1.527	0.08	0.942	0.74
Respiratory	1.718	0.00	1.408	0.01
Eye/Vision	1.333	0.24	1.167	0.31
Deformity	1.768	0.06	1.085	0.66
Arm	0.945	0.87	0.715	0.17
Leg	0.524	0.13	0.897	0.62
Lame	1.473	0.28	1.047	0.85
Other Disability	1.194	0.42	1.179	0.27
N		3801		5609

[a] The dependent variable was a dichotomous indicator of whether or not a male was reported as dead in the following register. Observations were restricted to males who were currently alive, and were at risk of having been recorded with a specific disability, having been observed at least once from 1749 to 1786 between the ages of 21 and 60.

[b] To save space, we do not present the coefficients estimated for these additional controls.

Table 4. Logistic Regression of Dying on Disability Status and Other Characteristics, 1789-1909, 21-80 *sui*[a]

	21-50 *sui*		51-80 *sui*	
Variable	Coefficient	p-value	Coefficient	p-value
Basic model, with controls for state farm system, register year, and age group[b]				
Ever disabled	1.131	0.00	1.146	0.00
10% increase in village population	1.002	0.27	1.007	0.00
Number of males in household age 16-55	0.998	0.81	1.014	0.02
Total number of siblings ever born	0.978	0.03	1.002	0.84
Number of disabled in household	0.957	0.02	0.969	0.03
Currently married	0.850	0.00	0.928	0.01
Father holds a Banner title	1.023	0.83		
Number of brothers who hold Banner titles	0.975	0.44	0.945	0.07
10% increase in sorghum prices	0.990	0.71	1.021	0.56
Mother is dead	1.163	0.00		
Father is dead	1.081	0.06		
Mother died before individual reached age 11 *sui*	0.972	0.70		
Father died before individual reached age 11 *sui*	1.054	0.47		
Individual not observed before age 11 *sui*	1.054	0.19		
Number of living sons			1.011	0.53
Number of living daughters-in-law			1.040	0.10
Number of living grandsons			1.053	0.00
N	111467		52421	
With fixed effect of household group and controls for age group				
Ever disabled	1.132	0.02	1.238	0.00
Number of males in household age 16-55	0.981	0.09	0.990	0.43
Total number of siblings ever born	0.970	0.02	0.989	0.43
Number of disabled in household	0.965	0.21	1.003	0.92
Currently married	0.805	0.00	0.935	0.08
Father holds a Banner title	0.995	0.97	0.934	0.13
Number of brothers who hold Banner titles	1.006	0.89		
Mother is dead	1.161	0.00		
Father is dead	1.005	0.92		
Mother died before individual reached age 11 *sui*	0.992	0.93		
Father died before individual reached age 11 *sui*	1.082	0.37		
Individual not observed before age 11 *sui*	1.058	0.25		
Number of living sons			0.989	0.65
Number of living daughters-in-law			1.043	0.20
Number of living grandsons			1.021	0.28
N	27859		18837	

[a] The dependent variable was a dichotomous indicator of whether or not a male was reported as dead in the following register. Observations were restricted to males who were currently alive, and were at risk of having been recorded with a disability, having been observed at least once between 1749 and 1855 between the ages of 21 and 60 *sui*.
[b] To save space, we do not present the coefficients estimated for these additional controls.

Table 5. Logistic Regression of Dying on Disability Status, Other Characteristics, and Interactions, with Controls for Register Year, State Farm System, and Age Group, 1789-1909, 21-80 *sui*[a]

	21-50 *sui*		51-80 *sui*	
Variable	Coefficient	p-value	Coefficient	p-value
Ever disabled	1.121	0.62	1.671	0.00
10% increase in village population	1.001	0.37	1.008	0.00
Number of males in household age 16-55	0.996	0.61	1.012	0.06
Total number of siblings ever born	0.970	0.01	1.004	0.67
Number of disabled in household	0.981	0.40	0.968	0.13
Currently married	0.856	0.00	0.945	0.09
Father holds a Banner title	0.964	0.77		
Number of brothers who hold Banner titles	1.022	0.53	0.964	0.31
10% increase in sorghum prices	0.992	0.77	1.020	0.58
Mother is dead	1.152	0.00		
Father is dead	1.115	0.02		
Mother died before individual reached age 11 *sui*	0.981	0.82		
Father died before individual reached age 11 *sui*	1.078	0.36		
Individual not observed before age 11 *sui*	1.044	0.35		
Number of living sons			1.025	0.24
Number of living daughters-in-law			1.082	0.01
Number of living grandsons			1.037	0.03
Ever disabled *				
10% increase in village population	1.000	0.87	0.998	0.37
Number of males in household age 16-55	1.023	0.27	1.001	0.95
Total number of siblings ever born	1.033	0.15	0.990	0.55
Number of disabled in household	0.918	0.03	1.019	0.51
Currently married	0.957	0.61	0.948	0.34
Father holds an official title	1.318	0.28		
Number of brothers who hold Banner titles	0.769	0.01	0.903	0.15
10% increase in sorghum prices	0.993	0.53	1.022	0.01
Mother is dead	1.051	0.57		
Father is dead	0.856	0.12		
Mother died before individual reached age 11 *sui*	0.956	0.82		
Father died before individual reached age 11 *sui*	0.887	0.53		
Individual not observed before age 11 *sui*	1.058	0.53		
Number of living sons			0.953	0.20
Number of living daughters-in-law			0.892	0.02
Number of living grandsons			1.041	0.16
N	111467		52421	

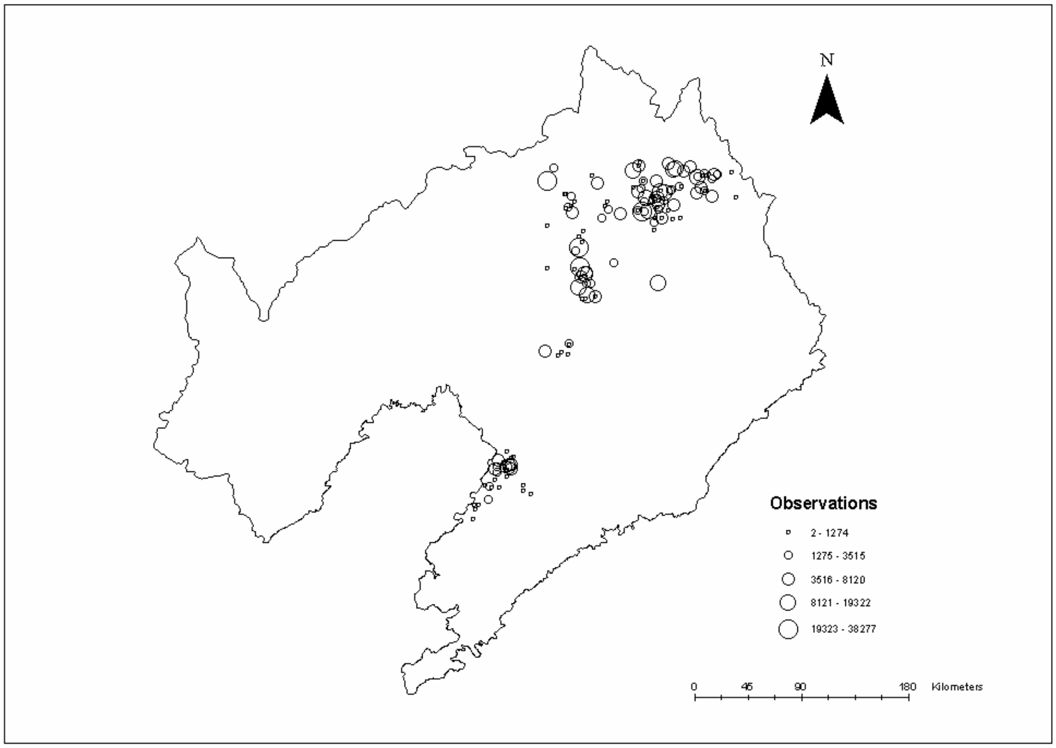
[a] The dependent variable was a dichotomous indicator of whether or not a male was reported as dead in the following register. Observations were restricted to males who were currently alive, and were at risk of having been recorded with a specific disability, having been observed at least once from 1749 to 1786 between the ages of 21 and 60. To save space, we do not present the coefficients estimated for the controls for age group, state farm system, and register year.

Table 6. Logistic Regression of Dying on Disability Status and Other Characteristics and Interactions, With Fixed Effect of Household Group, 21-80 *sui*[a]

	21-50 *sui*		51-80 *sui*	
Variable	Coefficient	p-value	Coefficient	p-value
Ever disabled	1.177	0.32	1.375	0.00
Number of males in household age 16-55	0.976	0.04	0.989	0.27
Total number of siblings ever born	0.966	0.02	0.989	0.47
Number of disabled in household	0.999	0.97	1.009	0.79
Currently married	0.807	0.00	0.918	0.07
Father holds a Banner title	0.959	0.77		
Number of brothers who hold Banner titles	1.047	0.29	0.978	0.66
Mother is dead	1.142	0.01		
Father is dead	1.041	0.46		
Mother died before individual reached age 11 *sui*	1.020	0.84		
Father died before individual reached age 11 *sui*	1.098	0.34		
Individual not observed before age 11 *sui*	1.048	0.39		
Number of living sons			0.991	0.74
Number of living daughters-in-law			1.107	0.02
Number of living grandsons			1.004	0.85
Ever disabled *				
Number of males in household age 16-55	1.043	0.08	0.997	0.87
Total number of siblings ever born	1.015	0.58	0.999	0.97
Number of disabled in household	0.880	0.01	1.008	0.84
Currently married	0.983	0.86	1.051	0.53
Father holds an official title	1.208	0.51		
Number of brothers who hold Banner titles	0.785	0.02	0.826	0.03
Mother is dead	1.075	0.47		
Father is dead	0.842	0.13		
Mother died before individual reached age 11 *sui*	0.858	0.51		
Father died before individual reached age 11 *sui*	0.941	0.79		
Individual not observed before age 11 *sui*	1.058	0.59		
Number of living sons			0.993	0.90
Number of living daughters-in-law			0.840	0.01
Number of living grandsons			1.052	0.22
N	27859		18837	

[a] The dependent variable was a dichotomous indicator of whether or not a male was reported as dead in the following register. Observations were restricted to males who were currently alive, and were at risk of having been recorded with a specific disability, having been observed at least once from 1749 to 1786 between the ages of 21 and 60.

Map 1. Eight Banner Household Register Data, Liaoning, 1749-1909



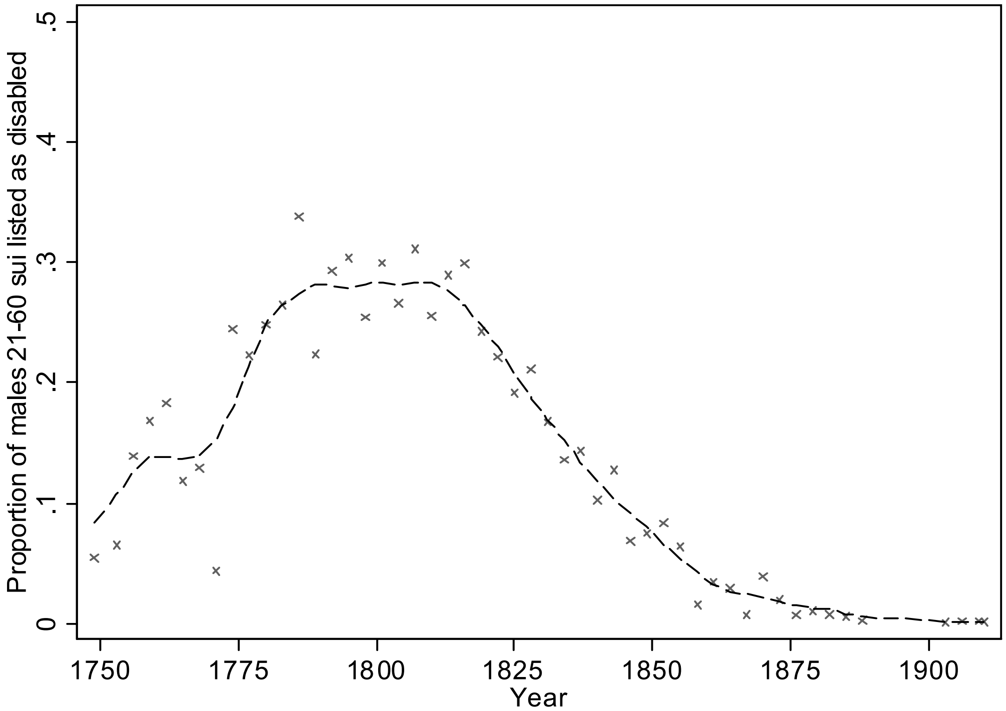


Figure 1 Proportion of men 21-60 sui disabled, by year

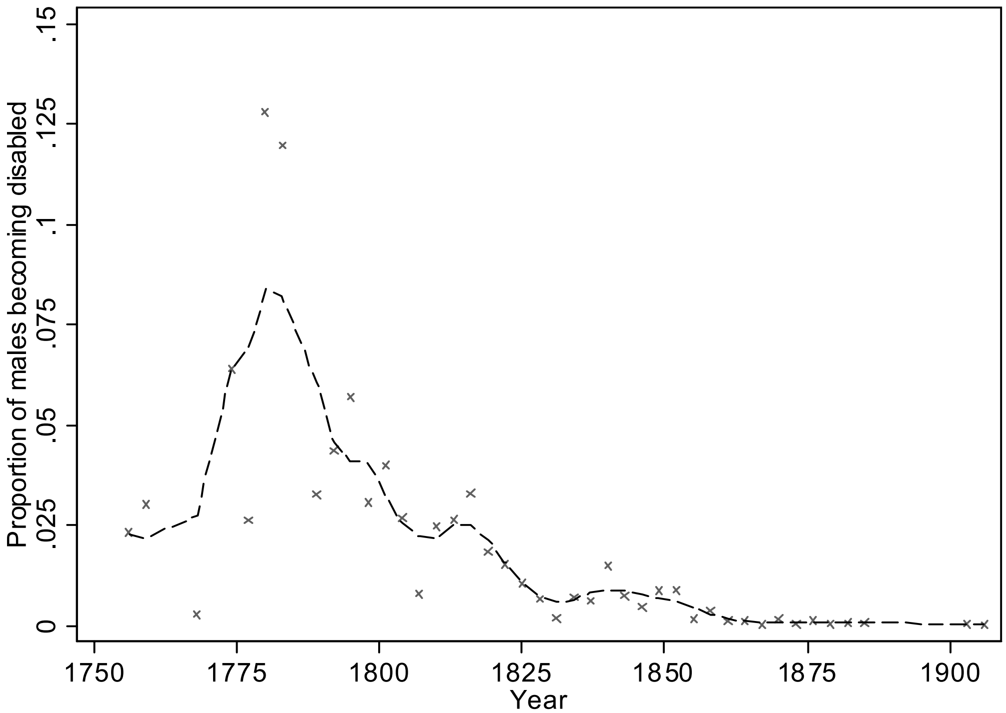


Figure 2 Proportion of men becoming disabled by next register, by year

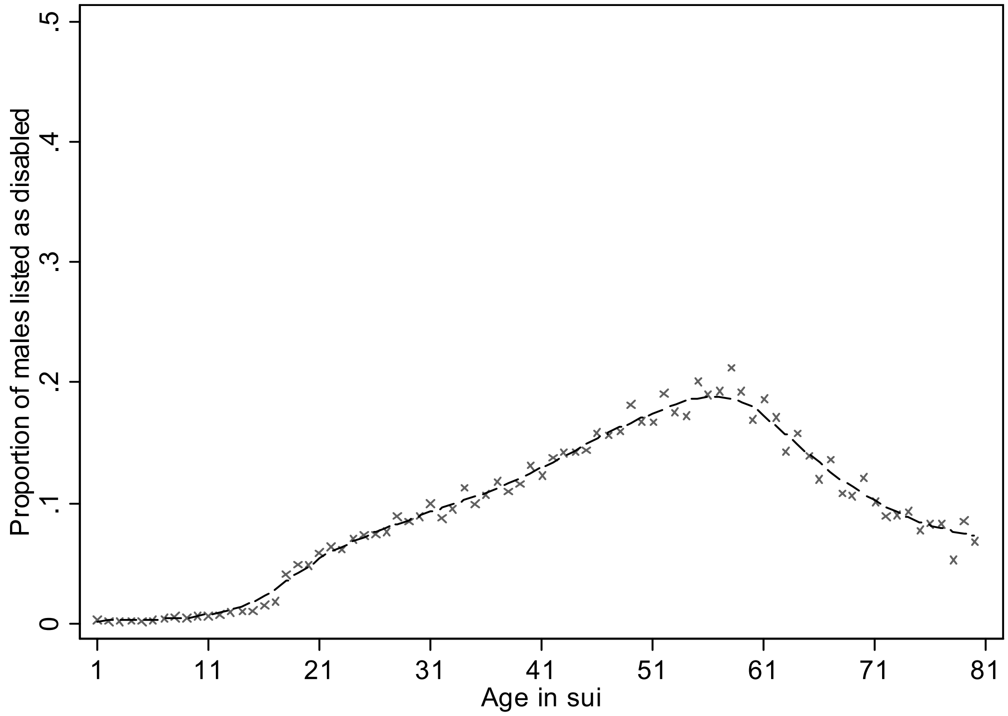


Figure 3 Proportion of males disabled, by age

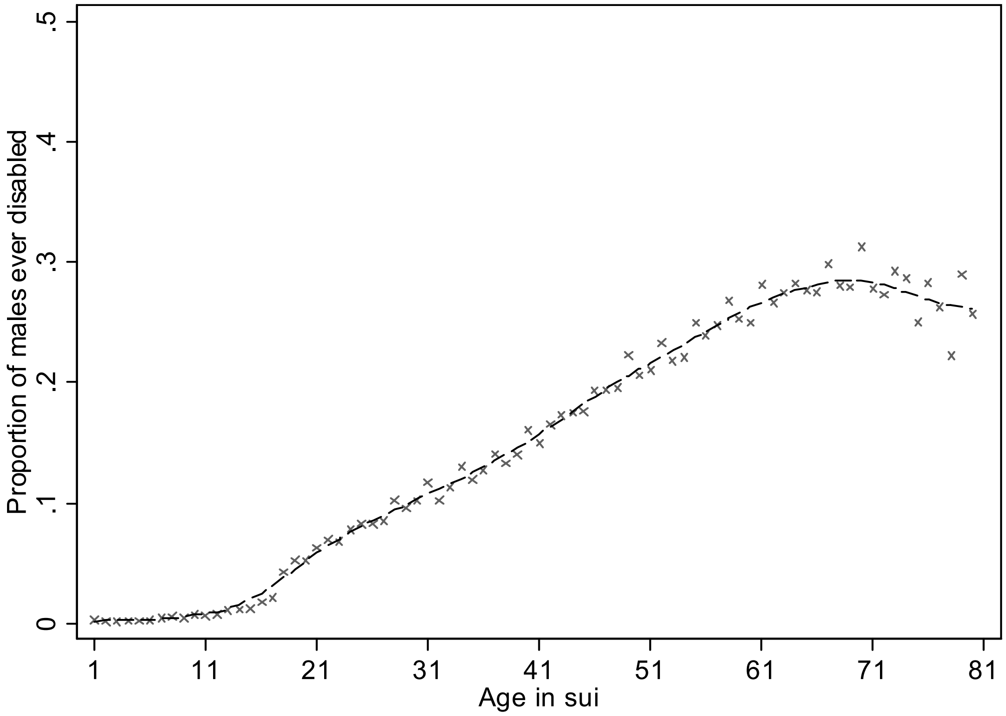


Figure 4 Proportion of males ever disabled, by age

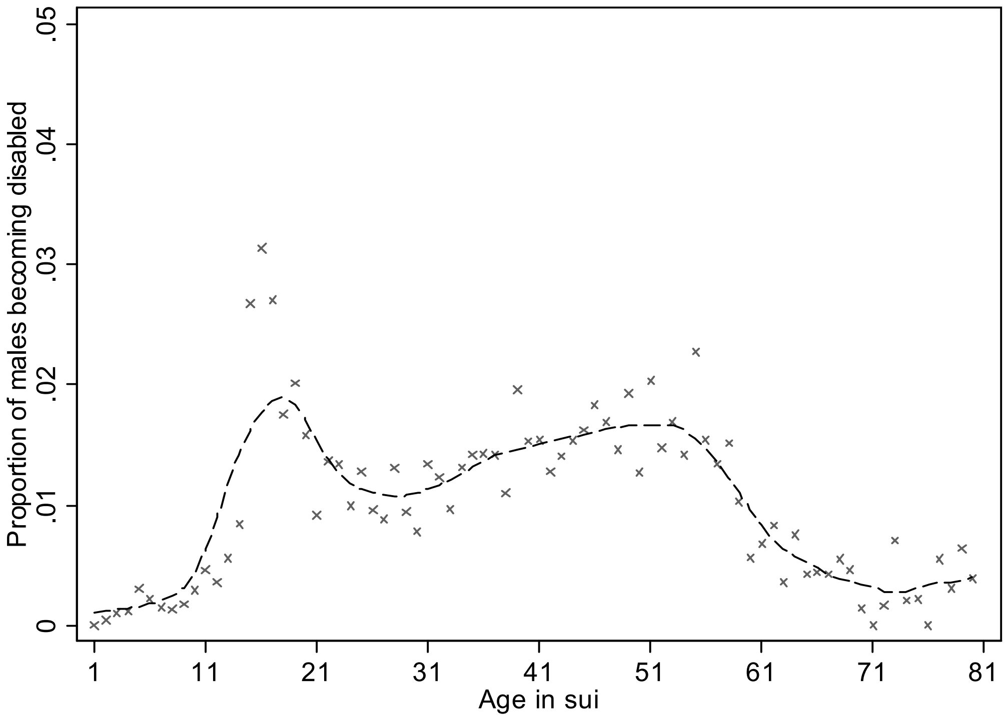


Figure 5 Proportion of men becoming disabled by next register, by age

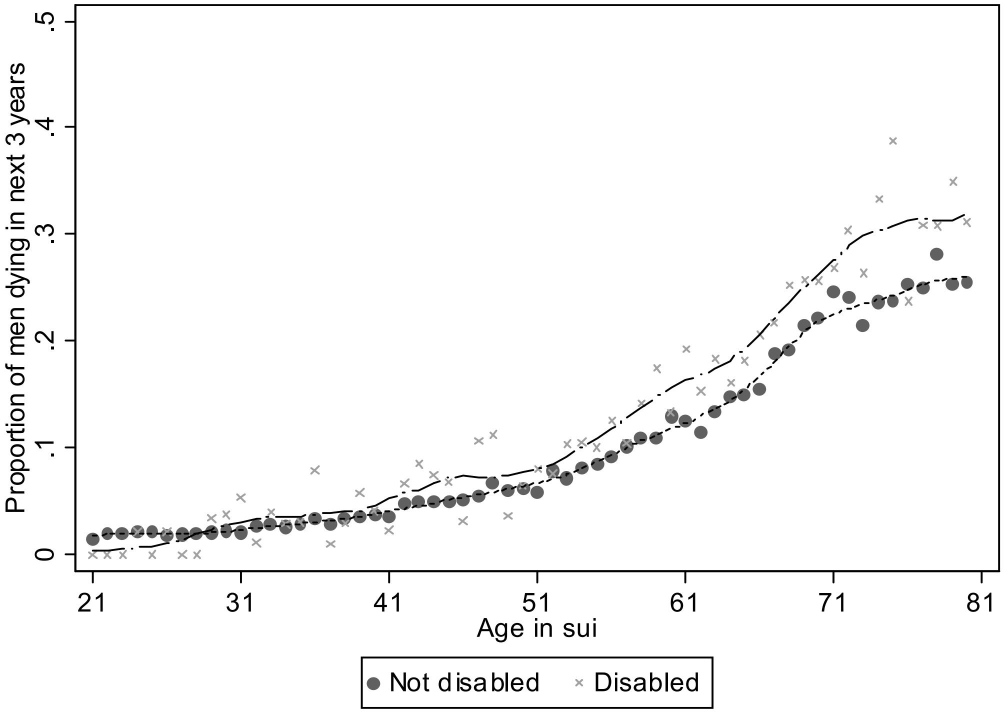


Figure 6 Male chances of dying in next three years, by disability status