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Kinship Structures and Survival: Maternal Mortality on the Croatian-Bosnian Border 1750-1898

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Abstract

Automated family reconstitution of 23,307 marriages, 112,181 baptisms, and 94,077 burials from 7 contiguous Catholic parishes of south central Slavonia (Croatia) 1714-1898 is used to analyse maternal survival of up to 13,202 mothers in 56,546 parturitions. Analysis employs a proportional hazard model. Physiological factors have usually expectable effects. General economic and social conditions plausibly related to withdrawal of male labour from family farming, consequent on military mobilisations and growing levels of wage labour, increase maternal risk. Membership in large patriarchal kin groups decreases risk, but both the presence of classic rivals (husband's brothers' wives) and being married to a husband junior among his brothers increase risk. Analysis demonstrates the sensitivity of maternal survival to macrolevel changes such as the collapse of feudalism, military involvement, economic stagnation, and monetisation, as well as to microeconomic and micropolitical factors at the household and local kin group level.
Keywords: Maternal mortality, historical demography, patriarchy, kinship, networks, feudalism, Croatia, Slavonia

Introduction[1]

This paper explores the effects of the microeconomics and micropolitics of patriarchal kin groups on maternal survival, in the presence of physiological and macrolevel social, political, and economic factors, using parish record data from historical Slavonia. It confirms earlier results (Hammel and Gullickson 2000) on the physiological and the macrolevel factors, most importantly on those that resulted in episodic or secularly increasing withdrawal of male labour from family farming. Deepening these results through ethnographic insight, it finds that women from larger kin networks and/or married into larger kin networks had improved survival chances. It further finds that women with larger numbers of husband's brothers' wives (HBW) and those whose husbands were relatively young with respect to their brothers had decreased chances of survival.

We attribute the effect of the size of women's natal kin networks to the ability of large kin groups to command respect and offer assistance to their daughters, and that of the size of women's husbands' networks to the economies of scale in large, corporate, and relatively autarkic patriarchal groupings. We attribute the decreased chances of survival in the presence of HBWs to the classic rivalry between such women and that of women with junior husbands to strong age ranking in patriarchal groupings and the ability of more senior men to receive better care for their wives. Both inter-uxorial rivalry and juniority, like the withdrawal of male labour, would impose heavier labour burdens on pregnant and parturient women and would diminish the amount of nurturant labour available to them. The kinship effects are strong.

Historical overview

Slavonia is the triangle of land between the Sava and Drava rivers of Croatia, its apex pointing toward Belgrade in Serbia, its base approximately at the Ilova near Jasenovac (Fig. 1). The Ottomans occupied it from 1526 to 1683, when it was retaken by Habsburg forces, but it was not completely pacified until about 1700. The Sava became the border between the Habsburg and Ottoman lands; the parishes studied here are in the zone facing Bosnia across the Sava. The Habsburgs imposed a "new feudalism" on the region, granting large tracts to favorites of the Court and enserfing the peasantry — those peasants in the immediate vicinity of the border in a military capacity — those farther from the border as civil serfs, although the territorial distinction was sometimes imprecise. In 1745 the institutional distinction between the military Border (*Vojna Krajina, Militärgrenze*) and civil Croatia (*Banska Hrvatska*) was formalised. Civil serfs paid money taxes and/or a portion of their production, plus labour service to their landlord; military serfs were obliged to serve as frontier guards and fight in foreign wars, and also to engage in fortress and road construction and maintenance. Civil serfdom was abolished in 1848, but serfs were obliged to amortise the value of the land granted to them over a period of about 20 years, a process that did not begin in earnest until the 1860s and led to great immiseration. Military serfs were freed in 1871, had no amortisation burden, and unlike civil serfs had unrestricted access to the commons. The two zones were united in 1881. Mobilisation of military serfs was frequent, although it is impossible to discover the local impacts of such mobilisation; there were 14 military crises in the study period that affected some, if not all, regiments of the border forces. Up to a third of able-bodied male military serfs were on frontier duty at any one time, and another third or more could be called up for foreign wars. Migration into the study area was intense in the early years after the reconquest but slackened thereafter. Natural growth continued, but slowed after about 1780 as peasants began to control fertility to avoid excessive parcellisation. Medicinal and mechanical abortion are attested at least from the 1760s, and the region was notorious in the 19th century for its low fertility (Tomasevich 1955, Rothenberg 1960, 1966, Hammel 1985, Andorka and Balazs-Kovacs 1986, Vassary 1989, Hammel 1993, Hammel and Herrchen 1993, Hammel 1995, Hammel and Wachter 1996a, 1996b, Hammel and Galloway 2000a, 2000b. See other citations in Hammel and Gullickson 2000.).

Fig. 1 about here

Although there were great estates in the civil zone, commercial agriculture was little developed, partly because transportation of bulky goods was difficult. Only military serfs were permitted to hold land in the Military Border. Agriculture in both zones was non-intensive and devoted largely to subsistence. Stock raising was a major activity, especially of swine, which were a source of money income along with wage work for civil landlords or for road construction and haulage in the military zone. There was virtually no commercial or industrial development until after 1900. Railroads did not reach the study region until 1871, development having been blocked by competing Austrian and Hungarian interests.

Kinship and household organisation

While household organisation between the Alps and the Mediterranean, and between the Adriatic and the Carpathians varied widely, the study area has a long tradition of complex household formation and the predominance of local agnatic (“patrilineal”) groupings. Usually, sons remained in their natal household at marriage, while daughters moved to their husband’s father’s household. This residence pattern could persist for several generations, so that as the older generations died, the household core of adult males consisted of brothers, then cousins. Eventually, such households fissioned, sometimes on the death of the founding couple, sometimes not until several generations later. Even after fission, agnatically related households tended to reside close to one another, forming sections of a farmstead, hamlets, or wards of villages. Corporate interests were strongest within the agnatic household itself, with all productive property typically held in common, but some corporate interests and the sharing of resources such as plow oxen, labour exchange at peak seasons, access to pasture, etc., persisted in the broader agnatic group. There was substantial labour differentiation in complex households, with males typically specialising in the care of particular stock, smithing, etc., women in particular aspects of household production such as weaving, tailoring, etc. Creche care of children and surrogate nursing were common. Complex households were most frequent in the Military Border, where they were encouraged by the military authorities in the interest of permitting continued subsistence production even when some men were called for military duty. Status in a household was a function of gender and age; usually males dominated females, the elder dominated the younger. In-marrying women were regarded with some suspicion; their status improved as they bore sons. The relationship between an in-marrying woman and her husband's parents, especially his mother, was characterised by clear dominance of the latter. That between the wives of brothers, i.e. mutually husband's brother's wives (HBW) was one of rivalry, often of dislike and suspicion. The folklore (and ethnographic informants' explicit statements) often attribute the fission of complex households to disputes between HBWs, each seeking advantage for her own children. (On household organization see Halpern 1958, Erlich 1964, Hammel 1968, Halpern and Anderson 1970, Hammel 1972, Hammel 1980, 1990, Todorova 1993, Čapo-Žmegač 1996, Hammel and Wachter 1996a, 1996b, Hammel and Kohler 1997, Kohler and Hammel 2001.)

Data

The data for this analysis consist of ecclesiastical records of 23,307 marriages 1717-1864, 112,181 baptisms 1714-1898, and 94,077 burials 1717-1898 from 7 contiguous Catholic parishes of south central Slavonia (Bogičevci, Cernik, Nova Gradiška, Orioviac, Staro Petrovo Selo, Štivica, Vrbje. See Fig. 1). The 7 parishes came into existence at different times, partly by division; all were recording marriages by 1790 at the latest (Hammel and Gullickson 2000, Table 1). The detail of priestly recording improved after about 1750, and we restrict analysis to data after that point. Hammel had collected marriage data only up to 1857-64, so that the parity of recorded births appears to increase soon thereafter, since no new marriages contributed low parity births. Since parity and parish are both controlled in the analysis we do not regard these compositional shifts as producing bias. Baptismal data were recorded until almost the end of the century for several of the parishes.

The quality of the data is quite good by comparison with many parish registers. The priests were generally diligent. The data are rich, especially after about 1750, including first and last names of (usually) all persons involved in an event, maiden names of brides, full names of baptismal and marriage sponsors, places of birth, burial, marriage, and often of residence of the principal actors (including the ritual sponsors), parish of record, etc. Marriage records include the name of the father of groom and bride or of the previous husband of a remarrying woman. This richness and redundancy make reconstitution more reliable. We rejected links in which the data did not provide at least 3 of the first and last names of both principal actors, e.g. of parents on a baptismal record or spouses on a marriage record, or both names on a burial record. For this analysis we have used completely automated linkage routines (written in the Perl language), because the computer scripts provide an exact record of the resolution of ambiguities. Fragmentary evidence from *libri status animarum* and the *Chronicle* of the Monastery of Cernik indicates that baptisms were typically performed at birth by the midwife, thus diminishing the number of births followed by neonatal death that might otherwise go unreported. Information for baptismal recording was probably reported to the priest by the midwife, raising the possibility that data for people poorly known in the local community, such as transients, might be erroneously reported. However, as discussed elsewhere in the text, such persons are not likely to form part of this analysis.

Methods

The rate of maternal mortality is often used as an indicator of the quality of life and of the relative position of women in society. It has sometimes been estimated for historical populations (Högberg 1985, Imhof 1986, Knodel 1986, Schofield 1986, Henry 1987, Cortes-Majo et al. 1990, Humphries 1991, Wrigley et al. 1997, Andersson and Högberg 2000). In historical estimation, one is usually obliged to rely on a temporal definition, since death or burial records for past populations seldom contain reliable clinical diagnoses. Since almost all deaths clinically diagnosed as maternal deaths occur quite soon after parturition, deaths in historical records that so occur are typically evaluated as instances of maternal death. However, since deaths from other causes may also occur soon after parturition, it is necessary to estimate this "background" mortality; the difference is the incidence of net maternal mortality.

We count as gross maternal mortality all deaths to mothers occurring within 60 days of parturition. We estimate background mortality by counting deaths to mothers from 61 days to two years from their date of giving birth. We use annual background mortality rates as a covariate in analysis of gross maternal mortality; thus the effects of other covariates can be construed as those on net maternal mortality.

We estimate the model of maternal mortality using a Cox proportional hazards model. Each woman contributes a variable number of 60-day observation periods to the data, depending on the number of children produced. At each such interval, new values for the covariates are computed. This method does not deflate standard errors despite including multiple exposure periods for each woman (Petersen 1995).

Mothers are known to us because they appear on the baptismal records of their children. We examine a mother's experience only in her first marriage. There are three kinds of mothers in our data set.

(1) Some mothers are linked to their marriage record and from that to their own baptismal record.
(2) Some mothers are linked to their marriage record, but not to their own baptismal record.
(3) Some mothers cannot be linked either to a marriage or their own baptismal record but are known only from the baptismal records of their children.

Overall, there were 94,258 baptismal events (childbirth) occurring to 29,677 mothers. Table 1 breaks this down by the type of mother (above). Forty-four percent of the mothers were linked to their marriage, and they accounted for 60 percent of the baptisms. The number of births per woman where there is no linkage between a child's baptism and the marriage and/or baptism of its mother is about half that in the other types of linkage. Mothers without such linkages are likely to have migrated into the catchment area after their marriage so that we can capture only part of their childbirth histories.

Notice that these mothers cannot be included in an analysis that examines age, parity, lifetime average birth interval, or any other factor that requires information on the entire reproductive history.

Table 1 about here

Because one model we wish to examine includes variables on both consanguineal and affinal kin, we must take a subset of this population. In order to find consanguineal kin for a mother, we must have her own baptismal record, which allows us to collect her parents and siblings. This necessity restricts our sample to the women in the first category (row 1) of Table 1. In order to find her husband's consanguineal kin, we must also have the baptismal record of the father. We are thus obliged to look only at the subset of the population where both the father's and mother's baptismal record is known for a particular birth event (row 2). As Table 1 shows, the data for a model including consanguineal and affinal kinship are reduced to 27,846 birth events occurring to 6,261 women, about a third of the original corpus of births and about 20 percent of the original corpus of mothers.

The kinship variables in our model are based on counts of particular types of kin. Such counts may conflate the effects of kin with local health environments, because networks with large numbers of kin are networks with large numbers of *surviving* kin. We attempt to control for this difference, which may reflect the local health environment, by including a random effect term in the model that captures the clustered maternal mortality within affinal agnatic networks. For the jth birth in the ith cluster, the hazard model is:

$$h(t_{i,j} \mid w_i) = w_i \lambda_0\left(t_{i,j}\right) e^{\beta' \mathbf{x}_{i,j}\left(t_{i,j}\right)}$$

where $\lambda_0(t_{i,j})$ is some unspecified baseline hazard, $\mathbf{x}_{i,j}$ is a vector of covariates for the jth birth in the ith cluster, and w_i is a random frailty effect specific to each affinal agnatic cluster. This frailty effect is assumed to be drawn from a gamma distribution with an expected value of 1 and a variance of ϕ. This distributional assumption, although more restrictive than a non-parametric approach, is well established in the literature on frailty effects (Guo and Rodriguez 1992, Sastry 1997a, Powers and Xie 2000, pp.196-199) and allows for an intuitive interpretation of the ϕ term. Under the gamma distribution, $1+\phi$ can be interpreted as the proportional increase in the odds of death in an observation period for every other death occurring in the cluster. The use of a clustered frailty term allows us to both explore the degree to which maternal mortality clusters in particular agnatic networks and to control for the potential bias of shared health environments on the contribution of kin to the risk of maternal mortality.

Covariates

Our covariates are divided into three broad groups: physiological, socio-economic, and kinship network variables. Table 2 shows means and standard deviations for these and other variables.

Table 2 about here

Most studies of maternal mortality focus on physiological variables such as age and parity (Yerushalmy 1940a, 1940b, 1945, Högberg 1985, Schofield 1986, Loudon 1992, Wrigley et al. 1997, Andersson and Högberg 2000, *inter alios*). From the literature we expect that first births will have the highest risk, but that risk will again increase from the second to higher order births. At each parity, we expect risk to increase with age. Multiple births are more dangerous. Background mortality should be positively correlated with (gross) maternal mortality. In the models, we include age as a continuous variable. We include parity as a set of categorical variables: parity one, parity two through four (the omitted category), parity five through seven, and higher parity. We include a dummy for multiple birthings. We include a measure of the birth interval since the last birth (or marriage in the case of first births) and one for the mean of all intervals up to the index birth. Background mortality is the crude mortality rate for the entire sample of mothers in the 61 day to two-year window after a birth for the year in which the reference birth took place.

Birth intervals present a special problem. In historical data of this kind, long birth intervals may indicate unobserved stillbirths and abortions as well as a lack of maternal depletion. These effects are expected to influence mortality in opposite ways and may be conflated by a single birth interval measure. In prior research (Hammel and Gullickson 2000), we have included both a previous birth interval term and a lifetime mean birth interval term. However, this approach is problematic because it incorporates information on future events at all non-final births. We redefine our measure of the previous birth interval to be a deviation from a woman's lifetime average, which captures unobserved difficulties in the interval preceding the index birth. We also include a measure of mean birth interval up to the index birth, which captures maternal depletion. These measures are somewhat problematic for the small number of women who have only one birth, but we find that the results are consistent when these women are excluded and that the inclusion or exclusion of these birth interval covariates has no substantial effect on other findings in this paper.

The economic and social variables involve military vs. civil status, using parish dummies, with the civil parish omitted. The military parishes were at a slightly lower elevation than the civil parish and closer to the Sava river. Rates of malaria may have been higher in those locations; there is one mention in the chronicle of the monastery of Cernik of a complaint by villagers who had been moved to a lower elevation. We have no other specific information on malaria, but it was endemic throughout the lowlands of the Sava and Danube. Similarly, contamination of well water may have been more frequent at lower elevations where the water table was high, but again we have no specific information. Nevertheless, the parish dummies give us some control for these factors in the analysis. This set of factors also includes whether a birth occurred within a year following a military mobilisation ("crisis"), and the calendar year of the birth (as a difference from 1815). Several of these involve the withdrawal of male labour from subsistence farming, so that women endured a heavier burden of agricultural work and had less time to nurture parturients. The regular withdrawal of as much as a third of the male labour force among military serfs for frontier duty would have imposed a burden on women, as would the heavy labour obligations for fortress and road construction. Major mobilisations in excess of those requirements would have intensified such withdrawal. In the civil zone, and in the military zone in the last part of the 19th century, land shortage, immiseration, and increasing dependence on wage labour would have pulled men away from family farming, leaving more tasks for women.

We caution that the kinship clusters we can deduce from the reconstitution are not necessarily congruent with household boundaries. For example, we estimate the influence of the number of husband's brothers' wives on a parturient's survival. Some but not necessarily all of these individuals were most likely coresident with her. If not, they were almost surely on the same farmyard or in the same street, ward, or hamlet. On the other hand, where we estimate the influence of a woman's own consanguineal kin, we can usually be sure that none of them were in the same household, and fewer of them would be close by, although they must have been in the same set of seven parishes, most likely in the same parish, else we would have no knowledge of them. In the rare instances in which a household contained no sons, the eldest daughter might remain on marriage, with an in-marrying husband. Such women would not have other wives coresident, since the other daughters would marry out. Their own parents and their unmarried sisters would be coresident. We count a mother's sisters only until they are married out of their natal group and a mother's husband's brother's wives only once they are married into the parturient's network of residence. We count only persons living and over age 15 at the time of the reference birth. We count parents and siblings but not more distant kin. Thus we may undercount surviving grandparents, uncles and their wives, consanguineal aunts, and cousins. While some households in the surviving *libri status animarum* contain father's brothers and their sons and those sons' wives, they are relatively rare. Thus our kin counts are only of the core of the agnatic network, the part most likely to be congruent with the household or a superset of it.

Given the household arrangements in this area discussed earlier, we expect the affinal kin count to have a stronger relationship than the consanguineal kin count to maternal mortality, as it more directly reflects the economies of scale operating in the household or network of the parturient's residence. We nevertheless expect that women with large consanguineal networks may have had some assistance and protection from them. However, since we also know that HBW's were not always a resource but also in a competitive position, we include a count of HBW separately in the models. This allows HBW's to contribute both to the overall affinal network and separately as a distinct entity. We predict that these contributions will influence mortality in opposite ways.

Additionally, because a woman's position in her husband's agnatic network would be a function of his age rank among his brothers, we expect that the more junior a woman was, the higher was her risk. Wives married to senior brothers were often in an advantageous situation. To capture this potential dynamic, we include a relative rank measure. Senior wives are coded as one and the most junior wife is coded as zero. Intermediate wives were scored at equidistant values between the most senior and most junior wife. If A is the absolute rank where 1 is the most senior rank and there are W women in the network, then the relative rank (R) is

$$R = \frac{(W - A)}{(W - 1)}$$

This measure preserves the relationship between the most senior and most junior wives regardless of network size. Furthermore, it assumes that intermediate wives of the same absolute rank will have a more senior relative rank in larger households. We find this to be intuitively appealing. This measure is problematic for women who have no HBW's. For these women, we impute a value, treating them like senior wives but also assign them a dummy variable. Because of the dummy variable, the imputation has no effect on the estimate of the relative rank coefficient. The coefficient on the dummy variable also indicates how incorrect our imputation might be. Statistically, the particular value imputed is not important, but we chose the value of one because it allows a direct comparison of the risk of women without HBW's relative to senior wives in networks with other HBW's. If the coefficient is negative, women without HBW's do better than senior wives. If it is positive, they do worse.

Results

Table 3 summarises the results of the Cox regressions. We provide p-values for all parameter estimates, even though our data are not drawn from a random sample. There is inherent noise generated in any life history reconstitution, in addition to the natural variability involved in life course processes. By including p-values we hope to provide some indication that our parameters are not simply capturing this noise. Nevertheless we note that all of our expectations are directional, so that if p-values are to be interpreted, it is the one-tailed values that should be employed. While we have confidence in the integrity of the data, we realise that a particular reconstitution, no matter how consistent it appears nor how carefully constructed, is in some sense a sample from a universe of possible reconstitutions from the same underlying data. We do know from examination of the reconstituted data that marriages recorded tended to be parish endogamous, ritual sponsors tended to be selected from nearby, and most children of a family were baptised in the same parish. These factors make good linkage more likely, but at the same time these attributes could be the result of reconstitution and not the factors that make reconstitution reliable. There was significant migration into the study area, but mostly before 1750, and some migration out of it, although the historical sources are not very informative on this. There is some suggestion that families with high fertility, facing land shortages for their heirs, relocated. The fact that mean parity increases in the last part of the data, because marriage records were not recovered up to 1900, may impart some bias to estimation of change over time, but the effect of that would be the opposite of the observed increase in maternal mortality over time, since primiparous births are the most dangerous. These and similar considerations lead us to be cautious in our conclusions. Nevertheless, the results seem strong.

Table 3 about here

For comparative purposes, we begin with a model that includes only physiological and macrolevel socioeconomic factors. This model uses a larger subset of the data (rows

1 and 4 of Table 1) and thus provides better estimates of these variables. (See Table 3, column 2, “without kinship”.)

Results are strong for parity one, multiple birthing, previous birth interval deviation (unrecorded stillbirths and abortions), and mean birth interval (maternal depletion). Higher levels of background mortality are associated with higher levels of maternal mortality. These confirm our expectations. Results are weak and ambiguous for age and in the expected direction but weak for parities over four. The weakness of an expected positive age effect may reflect only the close association between age and parity in a population in which age at marriage was relatively invariant.

The effect of parish identity is fairly consistent, the military parishes generally having higher mortality than the civil parish. We attribute this difference to the greater withdrawal of male labour from family farming in the military zone, both for regular frontier duty and for military construction and maintenance. The effect of military crises in the Border is positive as well, strengthening our view of the importance of male labour to female survival. We take note, however, that if the 14 crises are used individually in analysis, not all have a significant effect (not shown). However, all have a positive sign. One could surmise that the effect of such crises was to increase maternal mortality by the transmission of disease from returning soldiers to their wives, not because their labour had been withdrawn. However, in major campaigns, which took place in Italy, Prussia, and other distant locations, the return of soldiers was delayed (they had to walk back). The effect we see in the regressions is that of mortality risk within a year of a crisis. Further, disease transmission would affect background mortality beyond the 60-day window, and the regressions control for that factor. The crisis variable has no significant effect on background mortality, reinforcing this view (not shown; see Hammel and Gullickson 2000). It was the absence of men that increased maternal mortality, not their presence. In the same vein we note the increase in maternal mortality over historical time. We attribute this to the known increase in wage labour among military (and former military) serfs as foreign interests began to exploit forest resources and to the increasing dependence of civil serfs on wage labour. Indeed, land shortage for both classes of serfs, and the obligation to amortise emancipation grants for civil serfs, led both to enter wage labour increasingly at the expense of subsistence farming. It is noteworthy that the effect of interaction of baptismal year and first births is positive; the increase in maternal mortality over time was stronger at first parity than for other parities.

We conjecture that the effect of the withdrawal of male labour was to increase the labour burden of women. Women in late pregnancy with increased workloads might suffer miscarriage or stillbirth, events that carry high risk of death or damage that might lead to later high risk. We think it likely that some stillborns may have been baptized provisionally during the birth process or *in extremis* and entered on the baptismal rolls. If the mother died in consequence of such a stillbirth or very early neonatal death, our reconstitution would capture it. Other women might have less time attend to women in late pregnancy, or to parturient women, or to assist with surrogate nursing and child care. A shortage of available female labour (also a characteristic of networks with small numbers of adults under any circumstances) could lead to critical failures - not being able to fetch the midwife in time, not being able to keep the childbed clean or follow the midwife's instructions for postpartum care, not being able to give a parturient woman enough time to recover from a difficult birth, and so on.

The second model in Table 3 (column 3) includes the kinship factors, and thus the sample size is reduced significantly. The effects of the physiological and socioeconomic variables are consistent with those of the previous model, although they are not as strong statistically, owing to the reduction in sample size.

Of the network variables, the larger is a woman's affinal network, the lower is her risk of death. We attribute this to the substantial economies of scale achieved in joint households and in their embedding networks. We know from the scattered *libri status animarum* for Cernik that many households were quite large, with membership in the 30s (including children), while small nuclear households were rare. Within large households, labour was finely divided, as earlier indicated. Even if a household were not large, it would have some economies if its embedding network were large. We know that oxen were probably shared within agnatic groups but not beyond them (Hammel and Kohler 1997, Kohler and Hammel 2001). Labour exchange was a common tactic in peak seasons or for tasks in which extra labour might be required, such as raising a roof, or the plowing of boggy fields with a heavy wheeled plow. Agnatic kin were the most important participants in labour exchange. Of course we cannot overlook the fact that large networks might have been more prosperous, even if only because their numerical strength gave them political advantage in the community. But such prosperity need not result in lower maternal mortality.

Similarly, the size of a woman's own consanguineal network has a negative, although small and statistically insignificant, effect. We expected that women with a strong network would enjoy political support and pressure for nurturance. But households and networks were autarkic. Agnatic networks were exogamous, and women often came from a different village even if from the same parish. The lineage system was strong, and women tended over their lifetime to be socially incorporated into their husband's lineage (even if not as consanguineal members). These factors may weaken the anticipated effect of support from consanguines.

The number of HBW's in a woman's network is positively related to her risk of death, controlling for the size of the adult affinal network. This means that as the proportion of those adults that are HBWs increases, the higher is the woman's risk. To what should we attribute this nefarious influence of HBW's? The relationship between women who are the wives of brothers is, in folklore and ethnographic observation, strained. But it would be a harsh judgment to suggest that HBW's did their sisters-in-law in. We must recognise that in the developmental cycle of fraternal joint families, all actors realise that some day the unit (whether it be a household or a lineage) will fission. Over the cycle, and over the life cycle of actors, that anticipation leads to a pursuit of self-interest. The wives, who are viewed as the nuclei of dissent and division, will begin to reserve some resources for themselves. In particular, they will direct their own labour increasingly to the interests of their own maturing conjugal families, leaving less to contribute to the nurturance of those outside it. For example, women assisted daughters in the preparation of their dowry and hoarded gold jewelry, which might be part of the dowry and which was handed down from mother to daughter, despite the prevailing patrilineality of the descent system and the fact that females did not ordinarily inherit land, stock, or other communal property.

The relative rank of a woman's husband among his brothers is an important influence. The strong negative value indicates that more senior wives had lower hazards of maternal mortality. We interpret it as an element in the gender/age politics of households and networks. Age dominance was an important feature of kinship relations (see especially Erlich 1964). By itself, the effect of age rank would be ambiguous. The age gap between spouses was not large or greatly variant, and the age of the parturient is taken into account in the regressions already. What is at issue is the relative rank, thus the dominance position of the husband. Our interpretation is that the less dominant a man was in his fraternal set, the less care he could expect by deference or demand for his wife. Similarly, the more junior he was, the more likely it would be that he would be called up for military duty, since younger men were called first, thus leaving his wife at least some of his chores and on her own to negotiate her nurturance.

Women who had no HBW's in their affinal network possibly had lower risk than women who were senior to other HBW's and certainly did not do worse, as evidenced by the small negative (although statistically insignificant) value of the "No husband's brothers' wives" variable (Table 3, row 5, under "Network Variables"). Based on the values of the kinship variables employed here, we might hazard a guess as to the network a woman would prefer to live in or how her survivability would unfold over the life course. Affinal kin were a benefit so long as they were not HBW's. Therefore, a woman would have her best chances in a large affinal network that was made up of unmarried husband's brothers and unmarried husband's sisters. As these husband's sisters started marrying out and husband's brothers wives began marrying in, a woman's hazard would increase, independent of her own age and parity. However, if such a situation were destined to be, a woman was in a far better position if she were the senior member of these in-marrying wives. Fig. 2 shows these effects graphically, using the risk factors from the proportional hazard model. It contrasts a hypothetical lone woman who marries into a household where her husband has two celibate brothers (HB) and two sisters (HZ) who marry out, the first after the woman's first birthing, the second after her second. She has of course no HBW. Her risk increases with each loss of labour in the household. Her curve of risk is paralleled by that of another lone woman, whose husband has no brothers but two sisters. Her risk is higher because of the absence of the labour of two brothers, increases with the loss of each HZ but is not exacerbated by the presence of any HBW. A third woman, the first to marry into a household with two HB and two HZ, and thus the senior wife, shows a more complex development of risk. She loses a HZ after her first birthing in this hypothetical scenario and again after her second, but she gains a HBW at the same points. Her risk goes up more steeply than that of the other women, above, because the replacement of the labour of a HZ by the labour of a competing HBW increases her relative risk. Even more extreme is the risk profile of a junior wife, the last to marry into a household in which the HZ have married out and two other competing HBW are already present. Her risk is high and stays high. Similar expected values can also be computed for other contrasting covariates.

Fig. 2 about here

Some control over background conditions of morbidity and mortality is achieved by using background mortality for deaths to parturients in a two-year window. Parish identity also serves as a control over local health conditions. There was also strong clustering of maternal mortality within affinal networks as evidenced by the size of the random effect variance (the "clustered frailty" variable). This clustering reflects unobserved shared environmental conditions. While many of these conditions may have been particular to households or networks, it is also likely that they were common to villages and other, larger geographical groupings. Therefore, the affinal clustering measure we use probably overestimates the extent of clustering that is due just to household or network level factors (Sastry 1997b). Be that as it may, the value of this variable indicates that a woman's baseline risk is increased by about 38 percent for every maternal death in her affinal network.

Conclusions

In this paper we have extended and refined earlier work on factors influencing maternal mortality among serfs and then emancipated serfs in civil and military regions of Slavonia 1750-1898. Our results regarding physiological factors give us confidence in the quality of the data, since they are generally in accord with results in the literature. Macrolevel socioeconomic influences are plausibly attributable to secularly increasing and episodic withdrawals of male labour from family farming. Military parishes, more subject to such withdrawals even on a regular basis, had higher levels of maternal mortality.

Our particular intent in this paper was to examine the effect of kinship structure and kinship relations on maternal survival. In the context of a strong patrilineal system and a tradition of agnatic corporacy and joint household organisation, we find strong and consistent effects. Women married into a large agnatic network enjoyed economies of scale and had lower risk. However, the number of other wives in the network in their generation was a counter-influence and raised their risk, in consequence of the diverging self-interest and rivalry of the wives of brothers. Women coming from a large agnatic network had lower risk as well, probably enjoying political support and even intervention in their behalf, but the effect is weak. We attribute that weakness to the autarky of networks, distance between the network of origin and of marriage, and the gradual incorporation of wives into their affinal networks over the life cycle. The more junior was a woman's husband in his own fraternal set, the higher was his wife's risk. Wives in an agnatic network in which maternal death risk was high for the other wives, also had higher risk. This clustered frailty factor, with background mortality and parish identification, gives us some control over the local health environment. We conjecture as before that restrictions on the ready availability of female labour to assist women in late pregnancy and after birthing are the critical factors, here determined by the constitution of agnatic networks within the framework set by macrolevel conditions. Women with husband's unmarried sisters were advantaged; their labour was a public good. Women with husband's brothers' wives were, all else equal, disadvantaged. The labour of those women was increasingly privatized. Junior women were disadvantaged because their own husbands were more likely to be absent and because the labour of other women could less easily be commanded in their behalf. The causality suggested at the microlevel is the same as that put forth for the macrolevel – an institutionally conditioned supply of labour at critical times.

We conclude from estimation of these kinship factors that the cyclical dynamic of the household and lineage, with its changing producer:consumer ratio, the diverging self-interest of the fissionable parts of social units, with age dominance an important factor in personal relations, had strong effects on the life chances of women. The study of maternal survival is sharpened and enhanced by taking account of micropolitical factors even within a rapidly changing macrolevel environment. Knowledge of such factors can be gleaned from historical and sometimes from ethnographic sources. Indeed, demographic evaluation of maternal survival in modern LDCs, in which strong agnatic structures and complex households (including polygynous ones) often exist, would be furthered by the incorporation of ethnographic and historical knowledge.

Tables and Figures

Note to Fig. 2

HB: “Husband’s brother”

HBW: “Husband’s brother’s wife”

HZ: “Husband’s sister”

Relative risk is relative to that of a woman with no husband’s siblings.

References Cited

Andersson, T., U. Högberg, et al. 2000. Swedish maternal mortality in the 19th century by different definitions: previous stillbirth but not multiparity risk factor for maternal death. Umeå: *Acta Obstetrica Gynecologica Scandinavia* 79:679-86.
Andorka, Rudolph. and Sandor Balazs-Kovacs. 1986. The social demography of Hungarian villages in the eighteenth and nineteenth centuries (with special attention to Sárpilis, 1792-1804). *Journal of Family History* 11 (2): 169-192.
Čapo-Žmegač, Jasna. 1996. New evidence and old theories: multiple family households in northern Croatia. *Continuity and Change* 11(3): 375-398.
Cortes-Majo, Margarita, Carmen Garcia-Gil, et al. 1990. The role of the social condition of women in the decline of maternal and female mortality. *International Journal of Health Services* 20(2): 315-28.
Erlich, Vera S. 1964. *Porodica u transformaciji: studija u tri stotine jugoslavenskih sela*. Zagreb, Naprijed.
Guo, Guang and German Rodriguez. 1992. Estimating a multivariate proportional hazards model for clustered data using the EM algorithm, with an application to child survival in Guatemala. *Journal of the American Statistical Association* 87(420): 969-976.
Halpern, Joel M. 1958. *A Serbian Village*. New York: Columbia University Press.
Halpern, Joel M. and David Anderson 1970. The zadruga, a century of change. *Anthropologica* 12 (1): 83-97.
Hammel, E. A. 1968. *Alternative Social structures and Ritual Relations in the Balkans*. Englewood Cliffs, N.J.: Prentice-Hall.
Hammel, E. A. 1972. The zadruga as process. *Household and Family in Past Time*. P. Laslett (ed.). Cambridge: Cambridge University Press, pp. 335-73.
Hammel, E. A. 1980. Household structure in 14th century Macedonia. *Journal of Family History* 5(3): 242-73.
Hammel, E. A. 1985. Short term demographic fluctuations in the Croatian military border of Austria, 1830-47. *European Journal of Population* 1(2-3): 265-90.
Hammel, E. A. 1990. Demographic constraints on the formation of traditional Balkan households. Dumbarton Oaks Papers: Marriage and the Family in Byzantium. A. Laiou (ed.). Washington, D.C.: Dumbarton Oaks, No. 44, pp. 173-180.
Hammel, E. A. 1993. Censored intervals in family reconstitution: a sensitivity test of alternative strategies with historical Croatian data. *Old and New Methods in Historical Demography*. D. Reher and R. Schofield, (eds.). Oxford: Clarendon University Press, pp. 125-44.-
Hammel, E. A. 1995. Economics 1: Culture 0. Fertility change and differences in the northwest Balkans 1700-1900. *Situating Fertility: Anthropology and Demographic Inquiry*. S. Greenhalgh (ed.). Cambridge: Cambridge University Press, pp. 225-258.
Hammel, E. A. and P. R. Galloway. 2000a. Structural and behavioural changes in the short-term preventive check in the northwest Balkans in the 18th and 19th centuries. *European Journal of Population* 16(1): 67-108.
Hammel, E. A. and Patrick R. Galloway. 2000b. Structural factors affecting the short-term positive check in Croatia, Slavonia, and Srem in the 18th-19th century. *Population and Economy: from Hunger to Economic Growth*. T. Bengtsson and O. Saito (eds.). Oxford: Oxford University Press, pp. 227-48.

Hammel, E. A. and Aaron Gullickson. 2000. Maternal mortality as an indicator of the standard of living in eighteenth and nineteenth century Slavonia. Conference paper: New Evidence of the Standard of Living in Europe and Asia, Arild, June. T. Bengtsson and M. Dribe, organisers. (Oxford University Press, in press.) See www.demog.berkeley.edu/croatia

Hammel, E. A. and Beate Herrchen. 1993. Statistical imputation in family reconstitution. *Proceedings of the IUSSP XXIInd International Population Conference*, Montreal, v. 3, pp. 245-58. Brussels: International Union for the Scientific Study of Population.

Hammel, E. A. and Hans-Peter Kohler. 1997. Kinship-based resource sharing in the agrarian economy of frontier Slavonia, 1698: evidence from an early census. *Journal of the History of the Family* 1(4): 407-23.

Hammel, E. A. and Kenneth W. Wachter. 1996a. Evaluating the Slavonian census of 1698. Part I: structure and meaning. *European Journal of Population* 12(2): 145-166.

Hammel, E. A. and Kenneth W. Wachter. 1996b. Evaluating the Slavonian census of 1698. Part II: A microsimulation test and extension of the evidence. *European Journal of Population* 12(4): 295-326.

Henry, Louis. 1987. Mortalite des hommes et des femmes dans le passe. *Annales de Demographie Historique*, pp. 87-118.

Högberg, Ulf . 1985. *Maternal mortality in Sweden*. Medical Dissertations, New Series, No. 156. Umeå: Umeå University.

Humphries, Jane. 1991. Bread and a pennyworth of treacle: excess female mortality in England in the 1840s. *Cambridge Journal of Economics* 15(4): 451-73.

Imhof, Arthur E. 1986. Regulation, manipulation und explosion der bevölkerungsdichte — aus der sicht eines sozialhistorikers. *Regulation, Manipulation und Explosion der Bevölkerungsdichte*: Vortrage gehalten auf der Tagung der Joachim Jungius-Gesellschaft der Wissenschaften Hamburg am 15. und 16. November 1985. Göttingen: O. Kraus — Vandenhoeck und Ruprecht.

Knodel, John. 1986. Two centuries of infant, child, and maternal mortality in German village populations. *Society, health and population during the demographic transition*. A. Brandstrõm and L.-G. Tedebrand (eds.). Stockholm: Almqvist and Wiksell International: 23-48.

Kohler, Hans-Peter and E. A. Hammel. 2001. On the role of families and kinship networks in pre-industrial agricultural societies: an analysis of the 1698 Slavonian census. *Journal of Population Economics* 14 (1): 21-49.

Loudon, Irvine. 1992. *Death in Childbirth: an International Study of Maternal Care and Maternal Mortality, 1800-1950*. Oxford: Clarendon Press.

Petersen, Trond. 1995. Analysis of event histories. *Handbook of Statistical Modeling for the Social and Behavioral Sciences*. Gerhard Arminger, Clifford C. Clogg and Michael E. Sobel (eds.). New York: Plenum Press, Chapter 9.

Powers, Daniel A. and Yu Xie. 2000. *Statistical Methods for Categorical Data Analysis. New York*: Academic Press.

Rothenberg, Gunther E. 1960. *The Austrian Military Border in Croatia, 1522-1747*. Urbana: University of Illinois Press.

Rothenberg, Gunther E. 1966. *The Austrian Military Border in Croatia, 1740-1881*. Chicago: University of Chicago Press.

Sastry, Narayan. 1997a. A nested frailty model for survival data, with an application to the study of child survival in Northeast Brazil. *Journal of the American Statistical Association* 92(438): 426-435.
Sastry, Narayan. 1997b. Family-level clustering of childhood mortality risk in northeast Brazil. *Population Studies* 51(3): 245-61.
Schofield, Roger. 1986. Did the mothers really die? Three centuries of maternal mortality in 'The World We Have Lost'. *The World We Have Gained: Histories of Population and Social Structure*. L. Bonfield, R. M. Smith and K. Wrightson (eds.). Oxford: Basil Blackwell, pp. 231-60.
Todorova, Maria N. 1993. *Balkan Family Structure and the European Pattern: Demographic Developments in Ottoman Bulgaria.* Washington, D.C. American University Press.
Tomasevich, Jozo. 1955. *Peasants, Politics and Economic Change in Yugoslavia*. Stanford: Stanford University Press.
Vassary, Ildiko. 1989. The sin of Transdanubia. *Continuity and Change* 4(3): 429-68.
Wrigley, E. A., R. S. Davies, et al. 1997. *English Population History from Family Reconstitution.* Cambridge: Cambridge University Press.
Yerushalmy, Jacob. 1940a. Studies in childbirth mortality: puerperal fatality and loss of offspring. *Public Health Reports* 55:1010-27
Yerushalmy, Jacob. 1940b. Studies in childbirth mortality: age and parity as factors in puerperal fatality. *Public Health Reports* 55: 1195-1220.
Yerushalmy, Jacob. 1945, Infant mortality and maternal mortality in the modern world, *Annals of the American Academy of Political and Social Sciences* 237: 143-142.

Notes

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Table 1

Linkage	Mothers		Baptisms	
Mothers linked to their own baptism and marriage	8,737 (29%)		37,757 (40%)	
Fathers linked to their own baptism*		6,261 (21%)		27,846 (30%)
Fathers not linked to their own baptism*		2,476 (8%)		9,911 (11%)
Mothers linked to their marriage only	4465 (15%)		18,789 (20%)	
Mothers known only from baptismal records of their children	16,475 (56%)		37,712 (40%)	
All	29,677		94,258	

*This is a subset of the first category

Table 2

Means and Standard Deviations of Variables at each Birth	Mothers linked to a birth and/or marriage		Mothers linked only to a real affinal network	
Variable	**Mean**	**SD**	**Mean**	**SD**
Woman died in 60-day period	0.007	0.086	0.008	0.089
Physiological variables				
Age	30.685	7.306	29.779	6.885
Parity				
Parity 1	0.229	0.420	0.225	0.417
Parity 2-4	0.478	0.500	0.480	0.500
Parity 5-7	0.223	0.417	0.226	0.419
Parity 8+	0.070	0.255	0.069	0.253
Previous birth interval	2.593	1.773	2.554	1.681
Multiple birth	0.026	0.159	0.026	0.160
Background mortality rate	.0124	.0065	.0129	.0061
Macrolevel variables				
Parish				
Parish B	0.040	0.195	0.044	0.205
Parish C (civil parish)	0.288	0.453	0.284	0.451
Parish G	0.231	0.421	0.171	0.376
Parish O	0.112	0.315	0.106	0.307
Parish P	0.175	0.380	0.185	0.388
Parish S	0.058	0.234	0.078	0.267
Parish V	0.096	0.295	0.133	0.340
Year	1816.67	29.854	1827.14	24.11
Crisis period	0.316	0.465	0.334	0.472
Network variables				
Husband's brothers' wives			0.400	0.668
All same generation affinal kin			1.384	1.557
All same generation consanguineal kin	1.963	1.901	2.014	1.899
Husband's absolute rank among brothers			1.760	0.389
No husband's brothers' wives			0.688	0.463
Number of mothers	13,202		6,261	
Number of births	56,546		27,846	

Table3

Covariates	Without kinship	With kinship
Physiological Variables		
Age	-0.001 (.010)	0.004 (.014)
Parity		
Parity 1	0.569 (.132)***	0.649 (.193)***
Parity 2-4 (reference)	-	-
Parity 5-7	0.048 (.146)	0.028 (.203)
Parity>7	0.221 (.225)	0.214 (.310)
Previous birth interval deviation	0.214 (.036)***	0.231 (.050)***
Mean birth interval	-0.065 (.040)†	-0.115 (.063)*
Multiplicity of birthing		
Single birth (reference)	-	-
Multiple birth	0.876 (.201)***	0.773 (.290)**
Background mortality	0.019 (.007)**	0.020 (.011)*
Macrolevel Variables		
Parish		
Parish B	0.702 (.210)***	0.546 (.313)*
Parish C (civil parish, reference)	-	-
Parish G	0.009 (.152)	0.109 (.226)
Parish O	0.348 (.173)*	0.339 (.250)†
Parish P	0.325 (.149)*	0.353 (.207)*
Parish S	0.262 (.212)	0.346 (.267)
Parish V	0.131 (.185)	-0.054 (.255)
Year of baptism (origin=1815)	0.004 (.002)*	0.002 (.004)
Year of baptism*Parity 1	0.009 (.004)*	0.006 (.007)
Crisis period		
No crisis (reference)	-	-
Military crisis	0.313 (.105)**	0.287 (.149)*
Network Variables		
Number of adult affines		-0.238 (.083)**
Number of adult consanguines		-0.032 (.038)
Number of husband's brothers' wives		0.477 (.236)*
Husband's relative age rank		-0.396 (.249)†
No husband's brothers' wives		-0.047 (.338)
Clustered Frailty (ϕ)		0.489 (.677)
Number of births	56,546	27,846
Number of mothers	13,202	6261
Number of maternal deaths	417	222

Cols. 2 and 3 show the coefficient, standard error, and p value.
*** $p < .001$, ** $p < .01$, * $p < .05$, † $p < .10$


Slovenia
Zagreb
Hungary
Danube
Tisa
Military
VII, VIII Bjelovar
Drava
Border
Civil
River
Voyvodina
River
Kupa R.
IV. Karlovac
VI. Petrinja
V. Glina
III. Ogulin
Military
Slavonia
River
Sava
Bogicevci
Jasenovac
Cernik
Petrovo Selo
Vrbje
Stivica
IX N. Gradiska
X. Vinkovci
Military Slavonia
Sl. Brod
Oriovac
River
XI. Sr. Mitrovica
II. Otocac
Una
Regiments
I Licka
II Otocka
III Ogulinska
IV Slunjska
V I. Banska
VI II. Banska
VII Krizevacka
VIII Djurdjevacka
IX Gradiska
X Brodksa
XI Petrovaradinska
Border
I. Gospic
Vrbas
Bosnia
Bosna
Drina
Serbia
Belgrade
miles
0 10 20 30 40 50

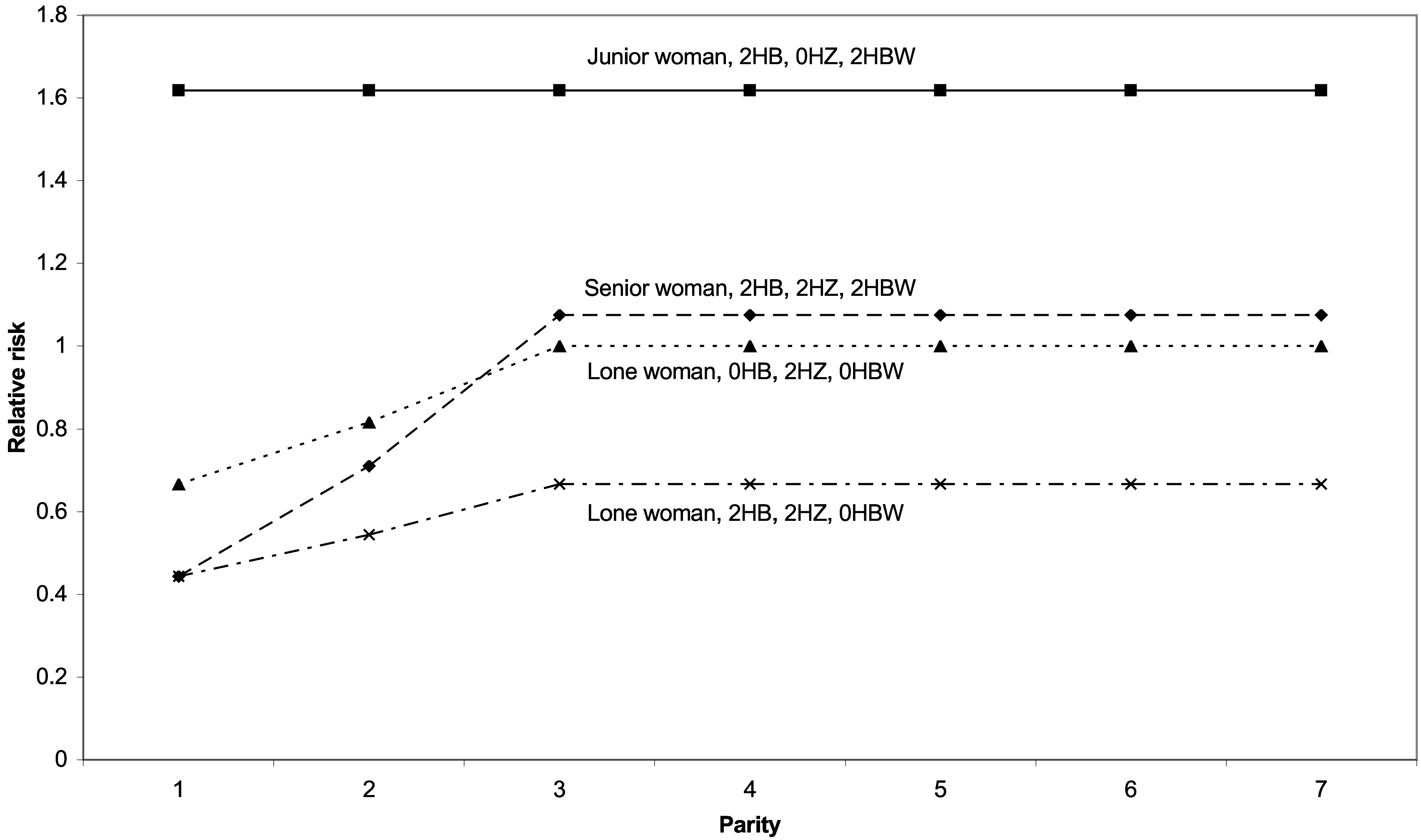
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Relative risk
Junior woman, 2HB, 0HZ, 2HBW
Senior woman, 2HB, 2HZ, 2HBW
Lone woman, 0HB, 2HZ, 0HBW
Lone woman, 2HB, 2HZ, 0HBW
1
2
3
4
5
6
7
Parity

Fig 2