THE RISK OF CHILD AND ADOLESCENT MORTALITY AMONG VULNERABLE POPULATIONS IN RIO DE JANEIRO, BRAZIL

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Summary. The importance of socio-economic factors such as education, income, religion, family structure and residence in explaining the increased risk of mortality among vulnerable populations aged less than 20 years in Rio de Janeiro, Brazil were investigated, based on data from the 1991 Brazilian Demographic Census for a sample of 121,060 women aged 15 to 49 who reside in Rio de Janeiro, Brazil. Two alternative statistical methods are used to calculate the risk of death. The first method adopted is the widely-used Brass method. The second method is a case-control study. Together, the indirect estimates (which assess population risks) and the case control study (which assess individual risks) are used to investigate the probability of death among vulnerable populations. The study also focuses on the importance of indicators of human and social capital, the lack of which may explain the higher risk of death among children and adolescents. The lack of education plays a major role as a determinant of mortality at young ages. Residence in a *favela* (shantytown), families in which mothers are the head of the family, and a lower median level of income are also significant determinants of mortality among vulnerable populations in Brazil. Religion is not found to be as important a predictor.

Introduction

A feature of contemporary urban demographic experience in the developing world is surplus mortality among children and adolescents who live in disadvantaged areas of large cities. The increased risk of mortality among populations aged less than 20 years is particularly prominent in Rio de Janeiro, Brazil (Wood and Carvalho, 1994; Arieira and Haynes 2001; Formiga et al. 2001; Monteiro, 2001). Populations are typically categorised as 'vulnerable' in areas where they are made vulnerable by social conditions. For children and adolescents in the age group 5 to 19 years in Brazil, 75% of deaths are violent and can be attributed to unnatural causes such as accidents, homicides and suicides (Monteiro 2001). It is important to ascertain to what extent this increased risk of mortality can be explained by socio-economic factors such as education, income, religion, family structure and region of residence. This study investigates this question using demographic data from the Brazilian Census of 1991 for a sample of 121,060 women who reside in Rio de Janeiro. Two alternative methods are used to calculate the risk of death. The first method used is indirect techniques of mortality estimation based on the Brass method. This method of estimating the risk of death is contrasted with the epidemiological technique of a case-control study in which deaths in particular categories are compared with control samples to

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establish differences in the associated socio-economic conditions; analysis by relative risk methods then gives estimates of these differentials (Brass, 1979). The literature that has analysed this issue in recent decades has focused primarily on income, education and the associated risk of child mortality (Caldwell, 1979; Caldwell and McDonald, 1981; Carvalho and Wood, 1978; UNICEF, 1996), and the mortality of vulnerable populations in Brazil (Fernandes, 1984; Monteiro, 1990; Wood and Carvalho, 1994; Paim et al. 1997; Arieira and Haynes 2001; Formiga et al. 2001; Monteiro, 2001) In the present analysis in addition to these factors, other influences such as the lack of social capital are also included, which are measured by family structure, *favela* (shantytown) or non-*favela* residence, and the role of religion (Dasgupta and Serageldin 2001). The analysis undertaken estimates first through indirect methods, the risk of child and adolescent mortality for those aged less than 20 years, according to family income per capita, maternal education, structure of family, place of residence and religion in the municipality of Rio de Janeiro. Secondly, a child mortality indicator is constructued that uses the proportion of young mothers (15 to 29 years) that have lost at least one child born alive, and evaluates the relative importance of each factor - family income per capita, maternal education, structure of family, place of residence and religion - on the risk of child and adolescent mortality by conducting a case-control study and then by undertaking multivariate statistical analysis using logistic regression (LOGIT) techniques. On the basis of these analyses considered collectively, it is possible to make cautious suggestions for economic and social policies to decrease the risk of child and adolesent mortality among vulnerable populations in Brazil.

'Vulnerable' populations are defined as populations who are less able than others to safeguard their own needs and interests due to their financial circumstances, place of residence, health, age, physical, functional or cognitive status or other personal characteristics such as race, ethnicity or sex. This includes, but is not limited to the street-dwelling poor and their counterparts in shelters, migrant workers, substance abusers, orphans and other street children, refugees, youths trapped in forms of exploitation, and other victims of abuse (Cohen 2001). In some cultures the most vulnerable may simply be widows or high parity daughters. (Preston and Mari Bhat 1984; Das Gupta 1997). Mortality influences parental investments in education and child health (Montgomery 1996). Child mortality also engenders other effects including the insurance effect, the lactation-interruption effect, the child-survival and child-replacement hypotheses, also termed a 'behavioural replacement effect' (Scrimshaw 1978; Preston 1978, Montgomery 1996). This implies that if the perception that the likelihood of survival is improved, then the actual risk might also be affected. There is also evident a changing age pattern of risk, which goes from the relatively high-risk period of infancy to the post-infancy period; Preston (1980) argued that risks faced by children and adolescents even in high-mortality environments, are low. In Brazil however, the pattern of this risk of death is quite different to many other developing societies, and is in fact high even much after infancy (Arieira and Haynes 2001; Formiga et al. 2001). High mortality environments like Brazil also exhibit considerable local variation in mortality (Monteiro 2001).

The risk of death in vulnerable populations may be related to (the lack of) social and human capital among them. This is particularly important in Latin America where high mortality is influenced by significant perceptions about the risk of death communicated by families that live in close proximity. The impact of socio-economic variables on children's well-being in the context of schooling, earnings and family structure was investigated by Coleman (1966, 1988, 1991) and by Astone (1991). In these 'rational choice' models, investments in human capital and

trust networks influences child survival (Arieira and Haynes 2001; Fukuyama, 1995). Various measures of human and financial capital are used in these models: parents' education and occupations, parent's income, number of children and their years of schooling. Of all of these variables in Brazil, children's education is found to be the most important, as is parent's education (Arieira and Haynes, 2001). Education is important because if social networks are heterogeneous, then through schooling women absorb facts about changes in the likelihood of survival: they would both be more attentive to health-care messages and believe that mortality is controllable. Caldwell and McDonald (1981) suggest three factors which account for why a better educated mother can improve the survival conditions of her children: first, educated mothers are more likely to break with tradition or become less "fatalistic" about illness, adopting many of the available alternatives in child care and therapeutics without imposing extra costs on the household. Secondly, an educated mother is more capable of demanding the attention of doctors and nurses. Thirdly, the traditional balance of familial relationships that can be potentially harmful to a child's health can be greatly altered if the mother is educated. In the specific context of the *favela*s (shantytowns) of Rio de Janeiro, Brazil this knowledge can permeate from the more educated to the less educated, due to the residential structure in which communities are not ghettoised by income.

Preliminary data released from the 2000 Brazilian Census, show that between 1991 and 2000, the population of Brazil has grown by about 22.7 million, or by 15% to 169, 590, 693 (Neves, 2001). It is estimated that in 1996, 78% of the Brazilian population lived in urban areas. South-east Brazil is the most developed part of the country and Rio de Janeiro has seen repeated and continuous social conflict, with particularly high mortality rates among adolescent groups. Between 1981 and 1999, life expectancy in Rio increased by 11%. But the increase would have proceeded faster if it were not for the city's many incidents of violence. Qualitative evidence shows that on average, about 4000 murders take place in Rio each year, of which most occur in the *favelas* (Vincent, 1993). The victims are almost invariably those involved in the drug trade, which also has significant implications for mortality among populations in the age group 15-19 because local youth often work in the *favelas* as drug couriers (Vincent, 1993). Inequality is rampant within Brazil's major cities: it is estimated that residents from the rural area of Santa Cruz in Rio de Janeiro (which scored 0.51 on a United Nations calculated Human Development Index) will take 101 years at the present rate to reach a comparable living standard to those living in the more affluent Lagoa Rodrigo de Freitas neighbourhood (which scored an HDI rank of 0.90) (PNUD 1998, Neves 2001).

The *favela*[2] is ubiquitous in Rio. The first large one was started in 1897 by the wives of army recruits from the state of Bahia, and was called Morro da Favela. The onset of rapid '*favel*ization' occurred in Rio de Janeiro following the 1888 law liberating the slaves and the rapid migration of 'Nordestinos' from north-east Brazil in search of work from the 1940s and increasing in the 1970s and 1980s.[3] The 1991 Census reveals that in all of Rio, the population of the *favelas* collectively have increased to 962,793 residents spread over 573 shantytowns.

[2] The word '*favela*' refers to a species of plant common to northeast Brazil, from where many of the original residents of the *favela*s who migrated in the 1940s trace their origins.

[3] An indication of the rapidity with which the *favelas* grew is seen in the example of the *favela* Morro da Providência. This *favela* had about 100 shacks at the beginning of the 20th century; by 1991 this had increased to 727 shacks. This *favela* has also gained particular notoriety since the late 1960s, as it has seen many instances of drug-related violence.

Moreover from 1980 to 1991, compared to 8% increase in the rate of growth of population in the city of Rio de Janeiro as a whole, the rate of increase among the *favelados* was of the order of 35% (Espinoza 1997). The *favelas* illustrate curious paradoxes: for example, *favela* Rocinha has both one of the worst records for drug trafficking and violent crimes related to drugs, and also the reputation of being a secure place to live for low-income populations, and a model of public administration (Vincent, 1993). Residents of the *favelas* also have less effective access to state legal services, including legal means of dispute resolution; drug gangs are frequently called upon to settle disputes (Neves, 2001). The structure of the *favelas* and the way in which they influence household activity therefore may have very significant implications for child and adolescent mortality in Rio de Janeiro.

In summary therefore, it is necessary to examine both indicators of human capital (such as access to education) and indicators of social capital (through networks of family structure and *favela*-residence) in order to investigate whether any of these factors exert an impact on the risk of child and adolescent mortality among vulnerable populations in Rio de Janeiro, Brazil.

Data and Methods

The 1991 Brazilian Census data used were 121,060 women aged 15-49 who reside in the city of Rio de Janeiro. This sample was selected from the Demographic Census Sample, which constitutes 10 % of the population in 1991 for the Municipality of Rio de Janeiro (IBGE, 1998). The variables calculated from the 1991 Census data used in this study are: women categorised in 5-year age groups (from15-19 up until 45-49); children born alive, and children surviving grouped by the age of the mother. These are categorised according to family income per capita, the level of mother's education, the place of dwelling, the structure of the family (whether or not the woman is the head of the family) and religion, grouped into 6 categories that represent numerically large religious denominations in Brazil, namely the Catholics, Traditional Protestants, Pentecostal Protestants, Mediunics, atheists and others.

In order to examine the impact of socio-economic factors on the risk of child and adolescent mortality, the analysis conducted adopted two techniques: first, *indirect estimates* of the probability of death at young ages (q0, 4q1 and q20) was calculated. For the indirect estimates data on 121, 060 women aged 15-49 are used. Second, a *case control-study* of the proportion of mothers who have at least one child not surviving, grouped according to the age of the mother, was also conducted. For the case-control analysis, data on 73, 053 women aged 15-49 that have at least one child born alive are used.

The impact of human capital investment is measured in terms of the number of years of education for mothers aged 15 to 49 who had a child born alive. For the purpose of calculating the indirect estimates, monthly family income per capita and maternal education have been clustered into one variable with two categories: the category 'poor' represents the most vulnerable populations i.e. those populations which fall below the median level of income and education. A second category, 'rich', comprises the population that lies above the median level of income and education, and denotes a less vulnerable population.

One group of social researchers have emphasised social disorganisation as the primary cause of violent behaviour among children, particularly when the family has a paternal figure absent (Merton, 1938). In order to take this factor into account in the analysis, family type was classified for comparative purposes into two categories: first, those households in which mothers are the head of the family; and second, those households in which mothers are not the head of the family.

Residence in the shantytowns of Rio de Janeiro, as discussed above, could significantly affect the level of mortality among the very young. In order to measure whether or not this factor was significant, for the whole municipality the sample was divided by place of residence into two categories, in order to obtain a measure of the difference in the risk of mortality between those living in the '*favela*' (shantytowns) and those dwelling in the 'normal' districts. As discussed above, a *favela* is a special agglomerate of census tracts associated with shanty areas. Those households which were not located in a *favela* are classified as a normal agglomerate in the 1991 Census.

Religion may also have an impact on the risk of mortality in that adherence to certain religions and religious norms may ensure that some adolescents are less likely to engage in illegal activity. Alternatively, some religious groups might have better access to education or income which may account for differences in demographic behaviour between them, as has been argued in studies of other countries such as India (Iyer, 2002). In the analysis conducted here, there were 6 religious groups considered: Catholics, Traditional Protestants, Pentecostal Protestants, Mediunic, atheists and others (which acted as the residual category).

The technique for calculating the indirect estimates of mortality used are as described in Brass and Coale (1968), and also in other studies (Brass, 1975; Coale and Trussell, 1978; Feeny, 1980; Palloni and Heligman, 1985; Shryock and Siegel, 1976; Sullivan, 1972; Trussell, 1975;United Nations, 1983). As is also widely-used in these studies, the mortality ratio is calculated as a ratio of the difference between children ever born and children surviving:

$$\text{Mortality Ratio} = \frac{\text{Children ever born - Children surviving}}{\text{Children ever born}}$$

The indirect estimates of early-age mortality are contrasted with a case-control study of mortality behaviour for this sample population. The indirect estimates of mortality measure risk at an aggregate level – in essence they are estimates of population risk. By contrast, the case-control study measures mortality risk at the level of the individual. In order to assess the risk of death, we define the 'cases' as those mothers, aged 15 to 29 years, who have lost at least one child. We define the 'controls' as mothers of the same age group who have had children born alive, and for whom all children are still alive. Defining the control in this way implies that the number of children born alive is equal to the number of children surviving on the date at which the Census of 1991 was held in the Municipality of Rio de Janeiro. For the case-control study, there were 73, 053 women aged 15-49 years who had at least one child born alive, compared to 48, 007 women who had no child born alive. In keeping with the theoretical arguments (outlined above), we investigate the impact of exposure to the following factors on the risk of death: monthly nominal family income per capita, education

measured by the number of years of the mother's education, households in which mothers are the head of family, and religion measured by religious affiliation.

As the number of cases is small compared with the number of controls, we assume that the odds ratio is also the 'approximate relative risk', as is customary practice in case-control studies (Anderson et al.1980; Armitage, 1971; Breslow and Day, 1980; Monteiro, 1990; Schlesselman, 1982). The statistical significance of the association of a risk factor with an infant mortality differential is calculated by means of confidence limits for the relative risk, and tested at the 95% level of significance. The null hypothesis is that the relative risk is unity (Ho: relative risk = 1, with $\alpha = 0.05$). The analysis of the case-control study is undertaken by a statistical analysis of logistic models, using the generalised linear interactive modelling system, GLIM (Royal Statistical Society, 1984). The logistic model, derived from the logit transformation, $y = logit\ p = log[p\ /(\ 1-p\ )]$, has frequently been adapted to case-control studies in which p is the proportion of cases, and $1-p$ the proportion of controls (Armitage 1971; Cox 1970; Everitt 1977; Fienberg 1977; Anderson et al. 1980; Breslow and Day 1980; Schlesselman 1982; McCullagh and Nelder 1983).

The logistic model is expanded to incorporate several factors. One is the risk factor under study (the exposure factor) and the others are potential confounding factors. This expansion of the logistic regression can be represented by the linear prediction:

Logit probability (y given x) = $\alpha + \beta . x + \gamma (i) . c(i)$

where c(i) are the coefficients of potential 'confounding' factors i.e those extraneous variables that are associated with the study exposure but are not a consequence of that exposure (Schlesselman 1980; Miettinen 1974; Breslow & Day 1980). The logistic analysis is conducted on the whole sample (women aged 15-49), on a younger age cohort of mothers (women aged 15-29), and on an older cohort of mothers (women aged 40-49).

Results

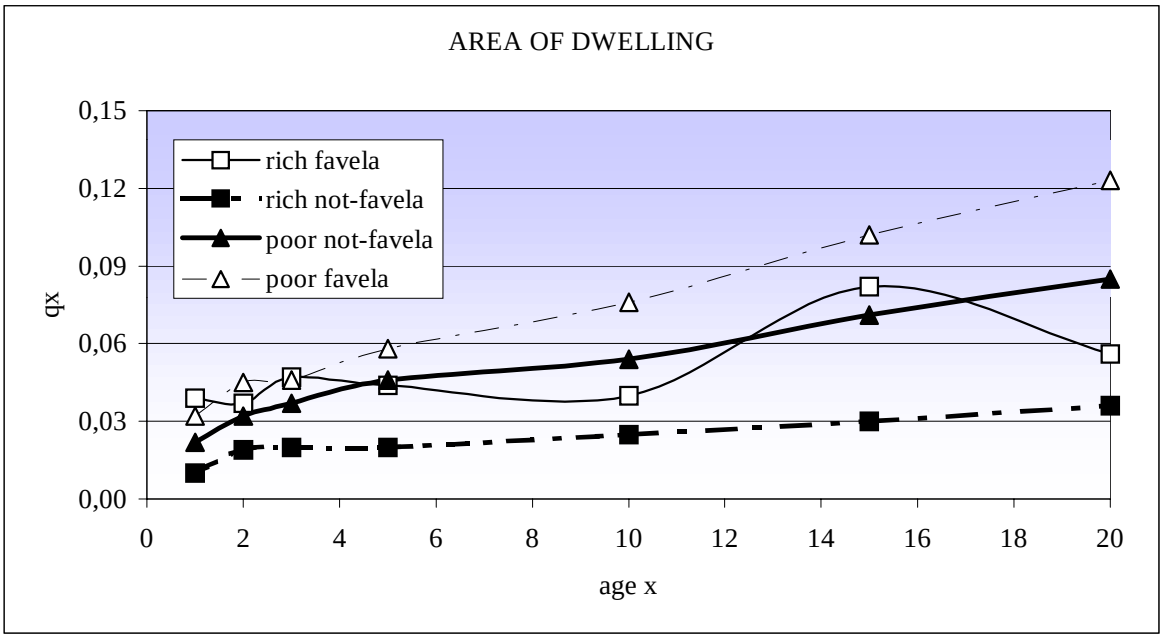
As discussed above, we define a population as 'poor' or vulnerable to low income and poor maternal education if it resides both below the median of nominal family income per capita and below the median of maternal education. A population is defined as not vulnerable (or 'rich'), if it lies above the median of nominal family income per capita and also above the median of maternal education. The probability of dying before age x ($x<20$) when the household is vulnerable both to low family income and to low levels of maternal education, is considered for three characteristics that may have relevance for vulnerable populations in Rio de Janeiro – the area of dwelling, family structure, and religion.

Indirect estimates by area of dwelling

In Figure 1, the gradient shows the level of vulnerability (qx). Figure 1 shows that a child who was from a poor family living in a *favela* is 4 times more likely to have a higher risk of mortality than one who is rich and not living in a *favela*. The only exception are those who are rich and living in *favelas*, but this is probably due to the very small size of this particular subset of the

sample. However, if we compare the poor living in a *favela* with the poor not living in them, most of the difference in mortality can be attributed to whether or not the child is living in a *favela*. This implies that there is an additional impact of living in a *favela* that exerts an influence on the risk of mortality even after the level of income is stratified and accounted for. This '*favela*-effect' suggests that this unique form of social organisation in Rio de Janeiro, is important in influencing the risk of mortality, a factor that is important independently of the level of poverty.

Figure 1. Indirect estimates by area of dwelling

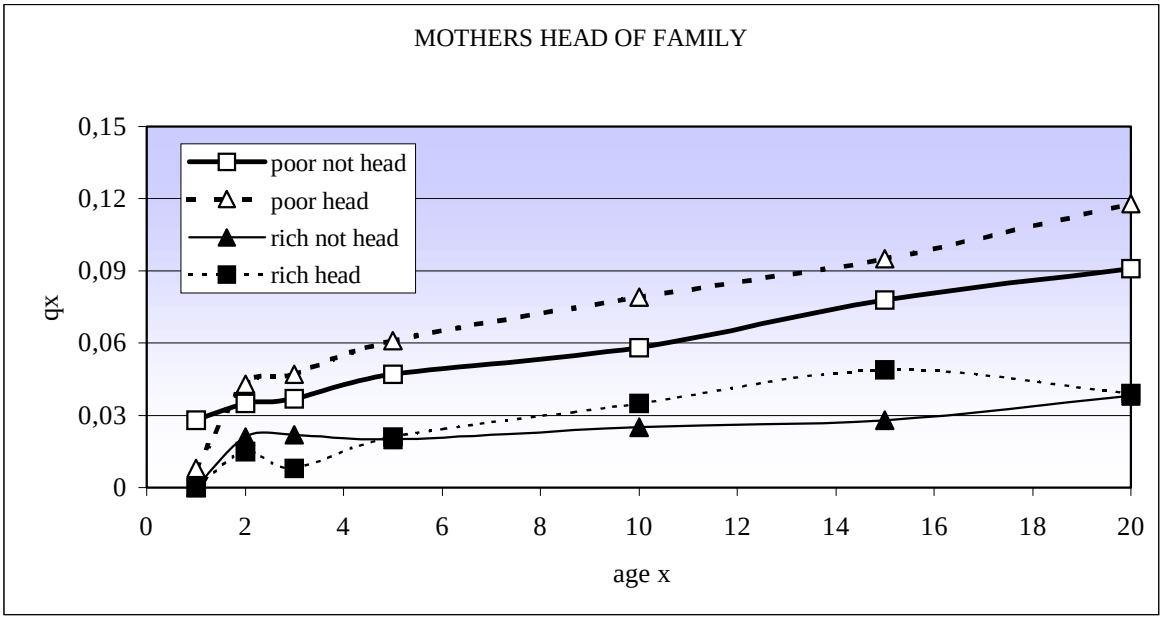


	Age x	1	2	3	5	10	15	20
rich	favela	0,039	0,037	0,047	0,044	0,040	0,082	0,056
	not favela	0,010	0,019	0,020	0,020	0,025	0,030	0,036
poor	favela	0,032	0,045	0,046	0,058	0,076	0,102	0,123
	not favela	0,022	0,032	0,037	0,046	0,054	0,071	0,085

Indirect estimates by family structure

As discussed above, family structure might constitute an important social network in Brazil that has relevance for the risk of mortality. Figure 2 provides indirect estimates of mortality stratified by whether the mother is the head of the family. These estimates show that the 'poor' are subject to a consistently higher mortality risk for those families in which the mother is the household head, compared to the rich in which the mother is not the household head. If we examine poor families only, comparing families in which mothers are the household head with those who are not, it is clear again that if the mother is the head of the household, then this increases the risk of mortality for children. The situation for the rich is however not as clear-cut: if the family is rich, then whether or not the mother is the household head appears not to be a problem; it is only when the household is poor that this effect is significant. These estimates show therefore that low-income vulnerable populations are particularly susceptible to a higher risk of mortality if mothers are the head of the household.

Figure 2. Indirect estimates in which mothers head the household



	Age x	1	2	3	5	10	15	20
poor	not head	0,028	0,035	0,037	0,047	0,058	0,078	0,091
	head	0,008	0,043	0,047	0,061	0,079	0,095	0,118
rich	not head	0,000	0,021	0,022	0,020	0,025	0,028	0,038
	head	0,000	0,015	0,008	0,021	0,035	0,049	0,039

Indirect estimates by religious affiliation

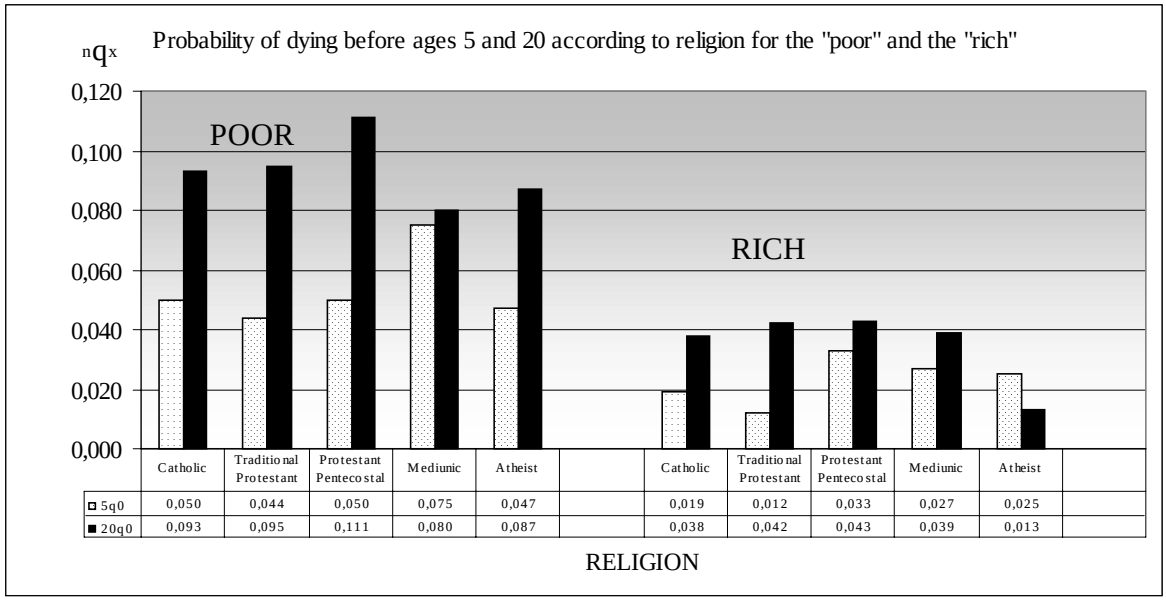
A key social network that has relevance for demography is religion (Iyer 2002). Table 1 and Figure 3 show the impact of religious affiliation on the risk of mortality in the Rio de Janeiro sample. In the sample, over 70% of respondents in the sample are Catholic. The findings show that religion is an important factor for Pentecostal Protestants who are poor, and significantly influences their risk of mortality. This result also holds for the rich, but the different q5s are more dramatic for the poor. For the atheists the results are not consistent, probably on account of the fact that many of the atheist respondents are younger, and are thus perhaps less influenced by the content of religion. For the Mediunics, q5 is higher. On balance therefore, we can conclude that the effect of religion on the risk of mortality is not as important for the rich as it is for the poor. It is possible to speculate that this might be on account of various anthropological factors such as a greater tendency among the poor to attribute death to divine intervention, the greater misintepretation of the cause of disease among the poor than among the rich, and the greater accessibility of medical care for the rich; hence their ability to take better precautions to avoid disease, and so forth.

Table 1. Indirect estimates by religion

AGE X	Probability of dying before age x (x<20) for the vulnerable population (poor)					
	Catholic	Traditional Protestant	Pentecostal Protestant	Mediunic	Atheist	Other
1	0,023	0,000	0,025	0,077	0,037	0,027
2	0,040	0,017	0,032	0,035	0,036	0,023
3	0,042	0,057	0,032	0,048	0,034	0,031
5	0,050	0,044	0,050	0,075	0,047	0,037
10	0,057	0,058	0,060	0,071	0,086	0,056
15	0,078	0,068	0,078	0,083	0,101	0,065
20	0,093	0,095	0,111	0,080	0,087	0,143

AGE X	Probability of dying before age x (x<20) for non vulnerable population (rich)					
	Catholic	Traditional Protestant	Pentecostal Protestant	Mediunic	Atheist	Other
1	0,000	0,000	0,000	0,000	0,000	0,000
2	0,010	0,024	0,050	0,066	0,066	0,037
3	0,023	0,010	0,010	0,019	0,021	0,032
5	0,019	0,012	0,033	0,027	0,025	0,004
10	0,024	0,019	0,022	0,027	0,035	0,029
15	0,029	0,026	0,041	0,041	0,029	0,037
20	0,038	0,042	0,043	0,039	0,013	0,031

Figure 3. Indirect estimates by religion

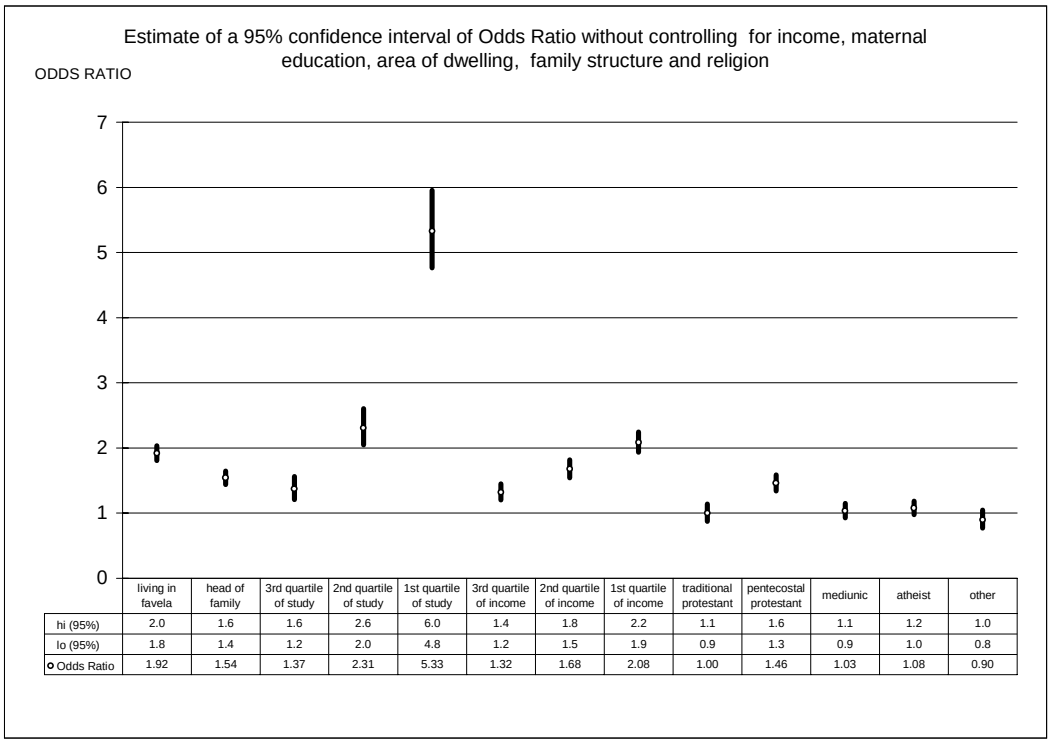


In summary therefore, the indirect estimates of mortality show that if the family lived in a *favela*, was primarily female-headed, or belonged to the Pentecostal Protestant denomination, the risk of mortality for its vulnerable members (children and adolescents) would be higher than for families that did not share these characteristics.

Case-control study results

For women aged 15-49 without controlling for other factors, as shown in Figure 4, the odds ratio shows a large statistically significant disparity between women with an education compared to those who did not have one. The change is not as dramatic for differences between households at lower versus higher incomes. When other factors are not controlled for, for those residing in *favela*s, and for those families in which mothers are the household head, there is a significantly higher risk of mortality. As with the indirect estimates, only one religious group showed a significantly higher risk of mortality and that was the Pentecostal Protestants.

Figure 4. Estimate of the Odds Ratio for women aged 15-49 without controlling for other factors

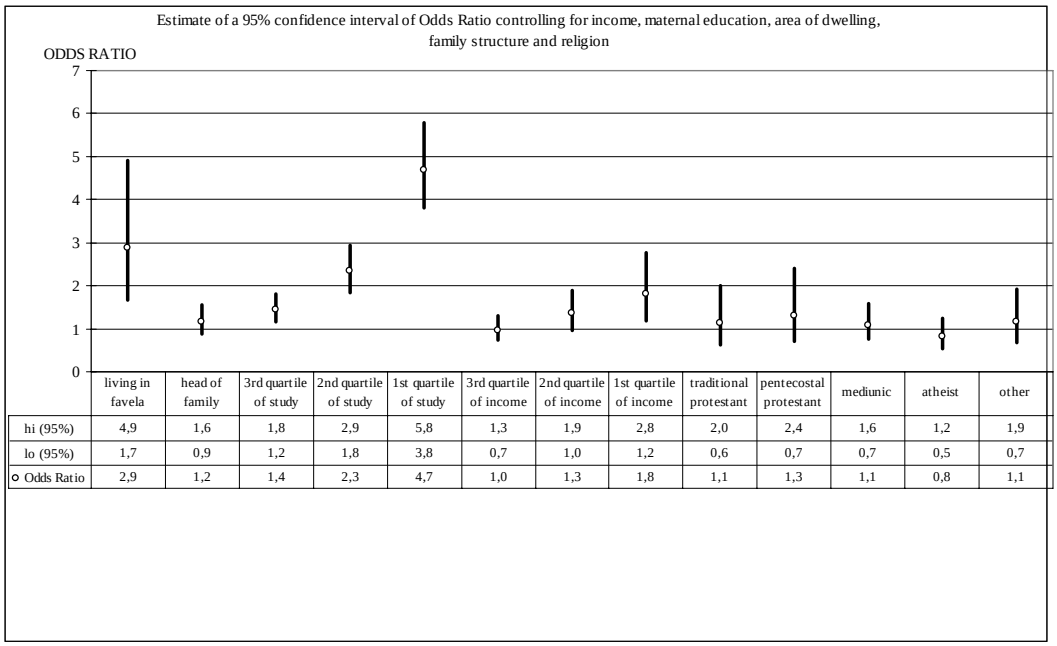


	living in favela	head of family	3rd quartile of study	2nd quartile of study	1st quartile of study	3rd quartile of income	2nd quartile of income	1st quartile of income	traditional protestant	pentecostal protestant	mediunic	atheist	other
hi (95%)	2.0	1.6	1.6	2.6	6.0	1.4	1.8	2.2	1.1	1.6	1.1	1.2	1.0
lo (95%)	1.8	1.4	1.2	2.0	4.8	1.2	1.5	1.9	0.9	1.3	0.9	1.0	0.8
Odds Ratio	1.92	1.54	1.37	2.31	5.33	1.32	1.68	2.08	1.00	1.46	1.03	1.08	0.90

When different factors are controlled for in a logistic model, as shown in Figure 5, the number of factors that cause vulnerability are decreased. Residence in a *favela* continues to be significant for higher mortality. Three out of the four levels of education are important for the risk of mortality. Families at the lowest level of income are also likely to display a significantly higher risk of mortality than those at higher income levels. When the effect of other socio-economic

factors are controlled for, the behaviour of different religious groups are not significantly different from each other.

Figure 5. Estimate of the Odds Ratio for women aged 15-49, controlling for other factors



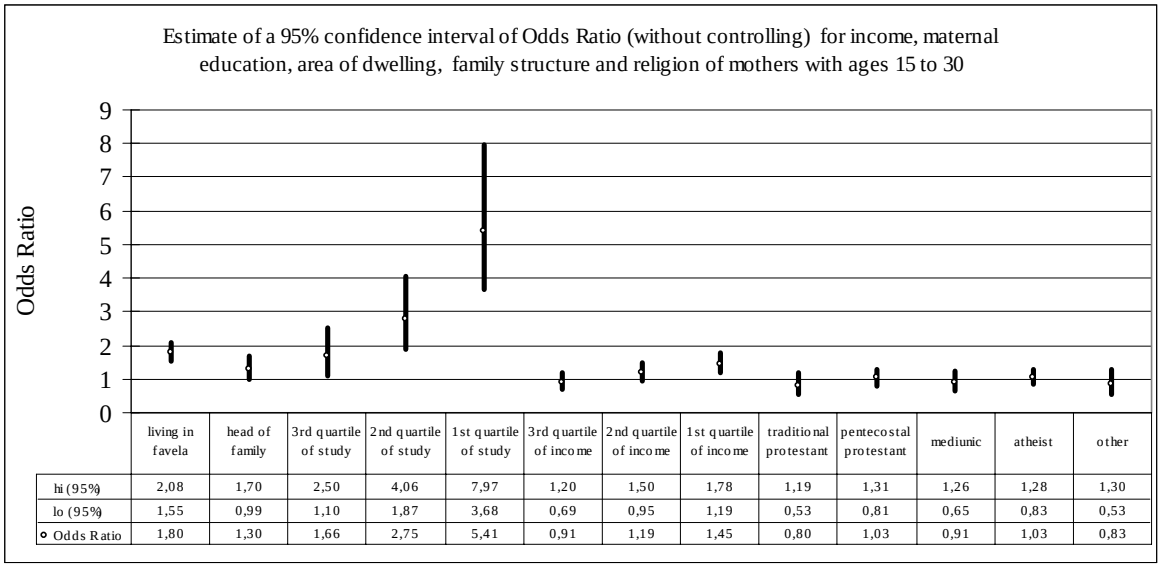
	living in favela	head of family	3rd quartile of study	2nd quartile of study	1st quartile of study	3rd quartile of income	2nd quartile of income	1st quartile of income	traditional protestant	pentecostal protestant	mediunic	atheist	other
hi (95%)	4,9	1,6	1,8	2,9	5,8	1,3	1,9	2,8	2,0	2,4	1,6	1,2	1,9
lo (95%)	1,7	0,9	1,2	1,8	3,8	0,7	1,0	1,2	0,6	0,7	0,7	0,5	0,7
Odds Ratio	2,9	1,2	1,4	2,3	4,7	1,0	1,3	1,8	1,1	1,3	1,1	0,8	1,1

Next, the risk of mortality is considered by dividing the sample of mothers into younger (15-29) and older (40-49) age groups in order better to understand the interaction between socio-economic factors and mortality risks.

Restricting the sample to younger women aged 15-29

For younger women aged 15 to 29, as shown in Figure 6, without controlling for education and income, living in a *favela* is found important and significant for affecting the risk of mortality. The mother being the household head is at the limit of not being significant. If a household was located in the lowest income quartile, this is associated with a significantly higher risk of mortality. There are no significant differences in mortality risks by religion.

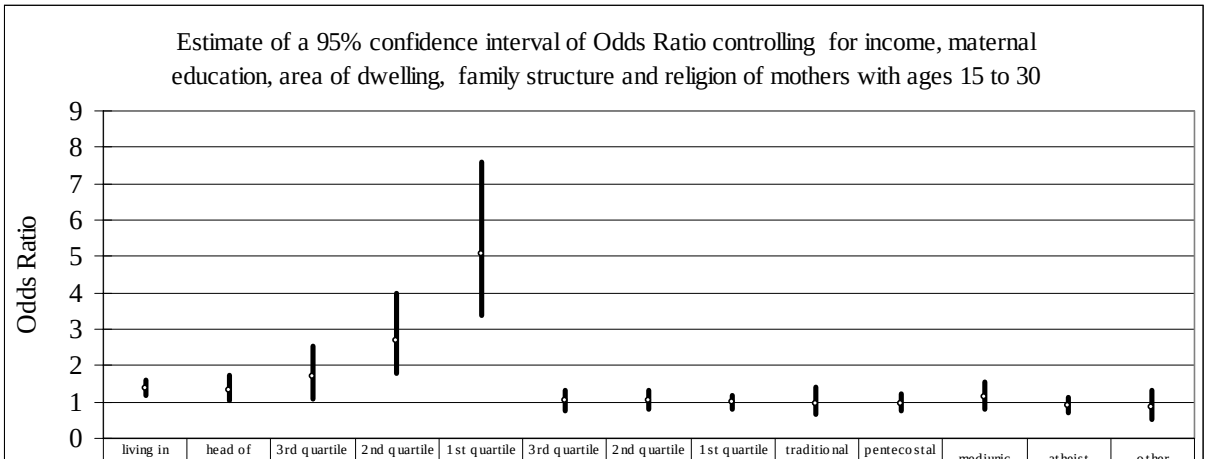
Figure 6. Estimate of Odds Ratio for women aged 15-29 without controlling for other factors



	living in favela	head of family	3rd quartile of study	2nd quartile of study	1st quartile of study	3rd quartile of income	2nd quartile of income	1st quartile of income	traditional protestant	pentecostal protestant	mediunic	atheist	other
hi (95%)	2,08	1,70	2,50	4,06	7,97	1,20	1,50	1,78	1,19	1,31	1,26	1,28	1,30
lo (95%)	1,55	0,99	1,10	1,87	3,68	0,69	0,95	1,19	0,53	0,81	0,65	0,83	0,53
∘ Odds Ratio	1,80	1,30	1,66	2,75	5,41	0,91	1,19	1,45	0,80	1,03	0,91	1,03	0,83

However, as shown in Figure 7, for women aged 15-29, a logistic model estimated with first-order interactions and an adjustment chi probability of 0.89, shows that living in a *favela* and female-headed households are significant at the 95% level for increasing the risk of mortality (even after controlling for the effects of other socio-economic factors). All levels of education are also significant in their ability to affect the risk of mortality. Education thus appears to play a critical role in explaining the risk of infant mortality among these younger women in the sample. Religion again is unimportant for these younger age cohorts, possibly because religious differences are counteracted by the influence of education. The effect of the lowest quartile of income is also found not to be statistically significant.

Figure 7. Estimate of Odds Ratio for women aged 15-29 controlling for other factors

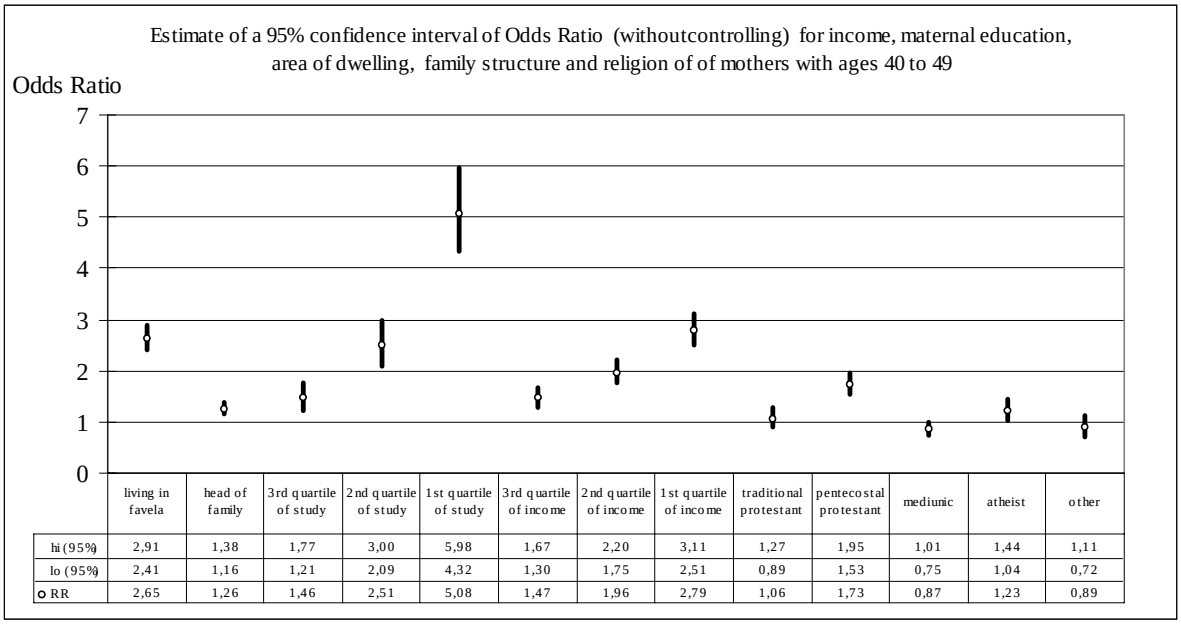


	living in favela	head of family	3rd quartile of study	2nd quartile of study	1st quartile of study	3rd quartile of income	2nd quartile of income	1st quartile of income	traditional protestant	pentecostal protestant	mediunic	atheist	other
hi (95%)	1,58	1,75	2,53	3,98	7,61	1,33	1,29	1,19	1,43	1,21	1,55	1,12	1,30
lo (95%)	1,17	1,02	1,10	1,78	3,39	0,77	0,81	0,78	0,64	0,74	0,80	0,72	0,52
∘ Odds Ratio	1,36	1,33	1,67	2,66	5,08	1,01	1,02	0,97	0,95	0,95	1,12	0,90	0,82

Restricting the sample to older women aged 40-49

For older women, child survival is more complex as it is influenced by three components: child mortality over the long-term, recent child mortality and recent adolescent mortality. Figure 8 depicts the risk of mortality for the children of older women aged 40-49 without controlling for the effects of other factors.

Figure 8. Estimate of Odds Ratio for women aged 40-49 without controlling for other factors



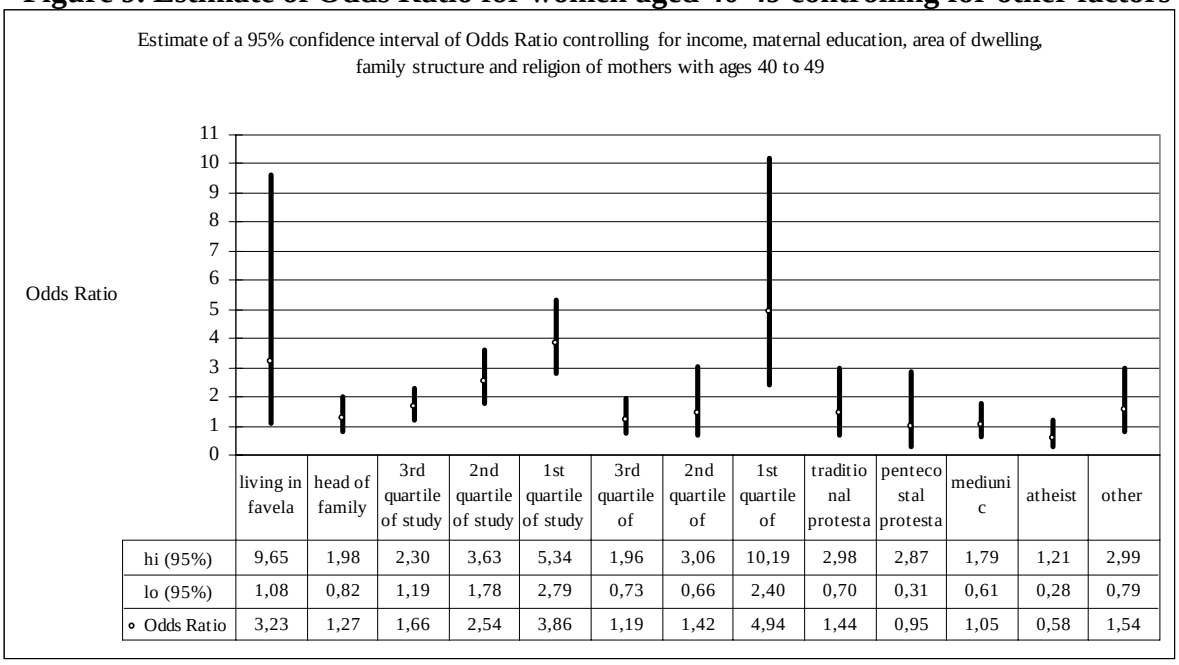
	living in favela	head of family	3rd quartile of study	2nd quartile of study	1st quartile of study	3rd quartile of income	2nd quartile of income	1st quartile of income	traditional protestant	pentecostal protestant	mediunic	atheist	other
hi (95%)	2,91	1,38	1,77	3,00	5,98	1,67	2,20	3,11	1,27	1,95	1,01	1,44	1,11
lo (95%)	2,41	1,16	1,21	2,09	4,32	1,30	1,75	2,51	0,89	1,53	0,75	1,04	0,72
RR	2,65	1,26	1,46	2,51	5,08	1,47	1,96	2,79	1,06	1,73	0,87	1,23	0,89

If the household was located in a *favela*, this increased the relative risk of mortality by 2.65. If older women are the head of the family, this also increases the risk of mortality. The main difference between younger and older mothers is that with the older age groups, we are now considering mainly the risk of mortality among adolescents. And if the mother is the head of the family in this situation, this represents a significant additional risk to the child. As also shown in Figure 8, education is important for mortality, as is income and membership of the Pentecostal Church.

A logistic model controlling for other factors and including second-order interaction terms as shown in Figure 9, depicted poor goodness of fit as represented by a chi probability of 0.06 and very large confidence intervals. This perhaps reflects the fact that this model combines several different mortality experiences, as discussed above. As is expected, this model does not have very great predictive power, illustrating again why it was necessary to conduct the analysis both

on the whole sample (women aged 15-49) and on the younger age cohort of mothers (women aged 15-29).

Figure 9. Estimate of Odds Ratio for women aged 40-49 controlling for other factors



	living in favela	head of family	3rd quartile of study	2nd quartile of study	1st quartile of study	3rd quartile of	2nd quartile of	1st quartile of	traditional protesta	pentecostal protesta	mediunic	atheist	other
hi (95%)	9,65	1,98	2,30	3,63	5,34	1,96	3,06	10,19	2,98	2,87	1,79	1,21	2,99
lo (95%)	1,08	0,82	1,19	1,78	2,79	0,73	0,66	2,40	0,70	0,31	0,61	0,28	0,79
∘ Odds Ratio	3,23	1,27	1,66	2,54	3,86	1,19	1,42	4,94	1,44	0,95	1,05	0,58	1,54

Discussion

There is an increasing interest in understanding the causes behind surplus mortality among children and adolescents who live in poorer regions of the developing world. In the context of one developing society, Brazil, this interest has been reflected in studies that have focused on the very high risk of mortality among vulnerable populations aged less than 20 years in cities such as Rio de Janiero (Wood and Carvalho 1994; Formiga et al 2001). However, there are relatively few studies that have attempted to relate this increasing risk of mortality with socio-economic conditions which might underlie these risks (Arieira and Haynes 2001, Monteiro 2001). This study is an attempt to redress this gap, by examining the factors that influence the risk of mortality among vulnerable populations in Rio de Janeiro, Brazil. The primary focus was on investigating whether socio-economic determinants such as education, income, religion, family structure and *favela*-residence, could explain the increased risk of mortality among vulnerable populations aged less than 20 years in Rio de Janeiro. The data used were family-level data on 121,060 women from the 1991 Brazilian Census who live in Rio de Janeiro. Two alternative methods were used to calculate the risk of death: first, estimates of indirect mortality based on the Brass method. Second, a case control study which generated estimates of relative risk coupled with statistical logistic regression techniques was used to assess the influence of a particular socio-economic attribute on the risk of immature death. after controlling for a range of other factors also hypothesised to affect mortality. The case control study and logistic analysis was conducted for the sample of women aged 15-49, and also seperately by restricting the sample to women aged 15-29 and women aged 40-49, to obtain a more accurate understanding of the determinants of a child's risk of immature death for mothers in different age groups.

The results show that the role of human capital in the form of education is very significant in explaining mortality especially at very young ages. The indirect estimates showed that if households had low levels of maternal education, then the effects of *favela*-residence and mothers acting as household heads, significantly compounded the risk of mortality for children.
For women aged 15-49 without controlling for other factors, the odds ratio shows a large statistically significant disparity between women with an education compared to those who did not have one. When different factors are controlled for in a logistic model, three out of the four levels of education are important for the risk of mortality. Education also plays a critical role in explaining the risk of infant mortality for younger women aged 15-29 in the sample. The case control analysis thus showed that a higher median level of education lowers the risk of immature death.

The study also measured the effect of access to social capital among vulnerable populations in terms of whether or not the family lived in a favela, and whether or not the mother was the household head. Some of these other factors were found to significantly increase the risk of mortality. A child who was from a poor family living in a *favela* was 4 times more likely to have a higher risk of mortality than one who is rich and not living in a *favela*. There is an impact of living in a *favela* that exerts an influence on the risk of mortality even after the level of income is stratified and accounted for. This '*favela*-effect' suggests that this unique form of social organisation in Rio de Janeiro is important in influencing the risk of mortality, a factor that is important independently of the level of poverty. The case-control estimates and logistic regression analysis for women aged 15-29, and also for the restricted samples of women aged 15-29 and 40-49 respectively showed that residence in a *favela* significantly increased the risk of mortality even after controlling for the influence of other factors.

The indirect estimates also show that the 'poor' are subject to a consistently higher mortality risk for those families in which the mother is the household head, compared to the rich in which the mother is not the household head; this effect is also particularly significant even after controlling for the level of income. When other factors are not controlled for, for those families in which mothers are the household head, there is a significantly higher risk of mortality.When other factors are controlled for, the effect of female headship remains significant.

If the family possessed low-income, this significantly reinforced the impact of all of the charcteristics discussed above ie the effect of *favela*-residence or female headship on the risk of mortality was most particularly acute for poorer households than for richer ones. Families at the lowest level of income are also likely to display a significantly higher risk of mortality than those at higher income levels. For women aged 15-29, if a household was located in the lowest income quartile, this is associated with a significantly higher risk of mortality. However after controlling for the influence of other factors, the effect of income was not as important as the influence of other variables such as education.

The results show that religion is not as important a factor in influencing the risk of mortality in this sample. The indirect estimates show that religion is important for Pentecostal Protestants who are poor, and significantly influences their risk of mortality, but even for this group the effect of religion on the risk of mortality is not as important for the rich as it is for the poor. As with the indirect estimates, the case control estimates also showed that only one religious group

showed a significantly higher risk of mortality and that was the Pentecostal Protestants. However, when the effect of other socio-economic factors are controlled for, the behaviour of different religious groups are not significantly different from each other. Estimating the model on the restricted samples showed that while religion was an insignificant determinant of child mortality among younger mothers aged 15-29, it exercised an influence for older mothers who were also Pentacostal Protestants aged 40-49, before controlling for the influence of other factors. However, after taking other factors into account, the influence of religion was insignificant illustrating that the preliminary significance of religion was probably on account of the fact that it may also act as a proxy for other economic differences between groups such as education.

The analysis and the results promote our knowledge about immature death in large cities such as Rio de Janeiro in Brazil in a number of respects. First, we argue that the risk of mortality among vulnerable populations in Rio de Janeiro, Brazil, is significantly influenced by a range of socio-economic factors that are important both for mortality risk at the individual and at the population level. Secondly, the findings from this study suggest a framework in which mortality differences can be investigated for this region. Thirdly, there are significant implications for population policies in poor countries because the results provide guidance for how to reduce the risk of high mortality among vulnerable populations. These results suggest that in cities such as Rio de Janeiro, education needs to be targeted, specifically in order to improve the living conditions of *favela*-residents. This is all the more acute for female-headed households which are also subject to greater vulnerability. On balance therefore, this study shows that the surplus mortality found among children and adolescents in disadvantaged areas in large cities in the developing world will diminish only if the significant economic inequalities that persist in these regions are reduced.

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References

Anderson, S. et al.(1980). *Statistical Methods for Comparative Studies.* New York: John Wiley & Sons.

Arieira, C. & Haynes, K. (2001) – " Human and Social Capital Within Brazilian Families: some Contrary Findings" In. *Proceedings of the XXIV General Population Conference, Session 10, Poster 06. Salvador (Brazil).* Paris, International Union for the Scientific Study of Population.

Armitage, P. (1971). *Statistical Methods in Medical Research.* Oxford: Blackwell Scientific Publications.

Arriaga, E.E. (1983) - *Estimating Fertility from Data on Children Ever Born by Age of Mothers*. ISP-RD-II

Arriaga, E. E. and Associates. 1993. *Population Analysis with Microcomputers*. Volume I. United States Bureau of the Census, Washington, D.C.

Brass, W. (1975) *Methods for Estimating Fertiltiy and Mortality from Limited and Defective Data*. Chapel Hill, N.C.: Carolina Population Center, 1975.

BRAZZIL in the United States. Site: http://www.brazzil.com/index.htm

Breslow, N.E. and Day N.E. (1980) *Statistical Methods in Cancer Research. Vol. I - The Analysis of Case-Control Studies.* IARC Scientific Publications No. 32, Lyon

Caldwell, J. C. (1979) – "Education as a factor in mortality decline: an examination of Nigerian data"". *Population Studies*, London, 33 (3): 395 - 413

Caldwell, J. C. and McDonald, P. (1981). Influence of maternal education on infant and child mortality: levels and causes. In: *Proceedings of the International Population Conference, International Union for the Scientific Study of Population*. Manila, vol. 2:79 - 96.

Carvalho, J. A. M. and Wood, C. H. (1978) Mortality, Income Distribution, and Rural-Urban Residence in Brazil. *Population and Development Review,* 4 : 405-20.

Coale, A. J. and Trussell, T. J. (1978). Estimating the time to which Brass estimates apply. In: Preston, S.H. & Palloni, A. *Five-tuning Brass-type mortality estimates with data on age of surviving children.* Populations Bulletin of the United Nations, vol. 10.

Cohen, B. (2001) The demography of vulnerable populations. In: *XXIV General Population Conference. Outline of session 48.* International Union for the Scientific Study of Population (IUSSP), Salvador, Brazil, 18-24 August.

Coleman, J. S. (1966). *Equality of Educational Opportunity*, National Center for Educational Statistics, U.S. Office of Education, U.S. Department of Health, Education and Welfare, Washington D.C.

Coleman, J.S. (1991). Parental Involvement in Education. *Policy Perspectives*. Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Coleman, J.S. (1988). Social Capital in the Creation of Human Capital. *American Journal of Sociology* 94: S94-S120.

Cox, D. R. (1970). *Analysis of Binary Data.* London: Chapman and Hall.

Dasgupta, P. and I. Serageldin (2000). *Social Capital: A Multifaceted Perspective.* World Bank, Washington D. C.

Das Gupta, M (1997) Socio-economic Status and Clustering of Child Deaths in Rural Punjab. *Population Studies,* 51(2): 191-202.

Espinoza, R. (1997) 100 years of favela.In: *BRAZZIL - Trying to understand Brazil*, Los Angeles, CA/USA , June, pp. 11-17.

Everitt, B. S. (1977). *The Analysis of Contingency Tables.* London: Chapman and Hall.

Feeny, G. (1980) Estimating Infant Mortality Trends from Child Survivorship Data. *Population Studies*, 81: 109-28.

Fernandes, D.M (1984) Diferenciais de mortalidade segundo instrução: regiões metropolitanas - Brasil – 1970". In: *Anais do 4º Encontro Nacional de Estudos Populacionais*. Águas de São Pedro-SP, ABEP, São Paulo, 2: 643-660.

Fienberg, S. E. (1977). *The Analysis of Cross-Classified Categorical Data.* Cambridge, Mass.: The MIT Press.

Folha de São Paulo – 08/01/2002 - *"Censo aponta complexo da maré como maior favela do rio"*, http://www.ibge.gov.br/censo/noticias.shtm

Formiga, M. C. C.; Ramos, P. C. F.; Monteiro, M. F. G. (2001) The Influence of Socioeconomic Factors in the Mortality of Children below 5 Years of Age: Indirect Estimates of the Mortality for the State of Rio Grande do Norte-Brazil. In: *XXIV General Population Conference. Brazilian Demography - Special Sessions and Poster.* Belo Horizonte, Associação Brasileira de Estudos de População - ABEP, 1: 101-112.

GLIM: User's Guide (1986). In C D Payne, ed. *The Generalised Interactive Modelling System - Release 3.77 Manual*. Oxford: Numerical Algorithms Group Ltd.

IBGE (1999) *"Censo Demográfico 1991 - Microdados da amostra Rio de Janeiro"* in CD ROM.

Iyer, S. (2002). *Demography and Religion in India.* Oxford University Press.

McCullagh, P. and Nelder, J. A. (1983). *Generalized Linear Models*. London: Chapman and Hall.

Merton, R. (1938). Social Structure and Anomie. *American Sociological Review*, 3: 672-68

Monteiro, M. F. G. (1990) *A case-control study of infant mortality determinants in the Metropolitan Region of Porto Alegre (Brazil).* PhD Thesis. Centre for Population Studies/University of London.

Monteiro, M. F. G. (2001) Socio-economic differentials of mortality at young ages (15q5) in the Municipality of Rio de Janeiro (Brazil). In *Proceedings of the XXIV General Population*

Conference, Session 48, Poster 08. Salvador (Brazil). Paris, International Union for the Scientific Study of Population.

Monteiro, M. F. G. and S. Iyer (2002) 'O Risco de Mães de 15 a 29 Anos de Perderem Pelo Menos um Filho' mimeo. Faculty of Economics and Politics, Cambridge.

Paim, J.S. et al. (1997) Spatial distribution of infant mortality and certain socioeconomic variables in Salvador, BA, Brazil. *Bulletin Paho,* 21(3):225-239.

Palloni, A, and Heligman, L. (1985) Re-estimation of structural parameters to obtain estimates of mortality in developing countries. *Population Bulletin of the United Nations*, n. 18 (United Nations publications. Sales n. E. 85.XIII.6: 10-33.

PNUD/IPEA/FJP (1998) *Desenvolvimento humano e condições de vida: indicadores brasileiros.* UNDP/ONU, Brasília.

Preston, S. H. and Mari Bhat, P. N. (1984) New Evidence on Fertility and Mortality Trends in India. *Population and Development Review,* 10(3): 481-503.

Royal Statistical Society (1984) *GLIM 3.77*, London.

Schlesselman, J.. J. (1982) *Case-Control Studies: Design, Conduct, Analysis*. New York: Oxford University Press.

Scrimshaw, S. C. M. (1978) Infant Mortality and Behaviour in the Regulation of Family Size. *Population and Development Review,* 4(3), 383-403.

Shryock, H. S. and Siegel, J. S. (1976 - abridged ed.) *The Methods and Materials of Demography.* New York, N. Y., Academic Press Inc.

Sullivan, J.M. (1972) Models for the Estimation of the Probability of Dying between Birth and Exact Ages in Early Childhood. *Population Studies,* 26: 79-97.

Trussell, T.J. (1975) A Re-estimation of the Multiplying Factors for the Brass Technique for Determining Childhood Survivorship Rates. *Population Studies,* 29: 97-107.

United Nations (1983) *Indirect Techniques for Demographic Estimation.* Manual X.

UNICEF (1996) *The state of the world's children.* Oxford and New York: Oxford University Press for UNICEF.

Vincent, I. (1993) *The republics of white powder*. Globe and Mail, Rio de Janeiro.

Wood, C.H. and Carvalho, J.A.M. de. (1994) *A demografia da desigualdade no Brasil*. Rio de Janeiro, IPEA.