SOCIO-ECONOMIC STATUS AND MICRO-ENVIRONMENTAL FACTORS IN RELATION TO THE RISK OF JAPANESE ENCEPHALITIS: A CASE-CONTROL STUDY

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Abstract. In a population-based case-control study in Southern Henan Province, central China, children suffering from Japanese encephalitis (JE) were compared with neighboorhood controls matched by age and sex in terms of several social and environmental variables. Factors found by crude analysis to be associated with an increased risk of JE included lower family income, lower parental education, living in houses near the periphery of villages and poor quility of houses. When adjustment was made for confounding variables, only the association of house location within village remained of borderline significance (OR = 0.51, 95% CI = 0.15 ~ 1.03). It is suggested that the beneficial effect of higher family income and parental education was partly due to the fact that those parents might be more conscious about having their children vaccinated in the situation where there was a shortage of JE vaccine in the study area.

INTRODUCTION

Socio-economic status and environmental factors play a very important role in governing both Japanese encephalitis (JE) incidence and the population dynamics of vector mosquitos (Burke and Leake, 1986). Previous studies have investigated the effect of macro-environmental factors on the incidence of JE and its vector density (Umenai *et al*, 1985): for instance rainfall, irrigation, temperature and floods. However, to the authors' knowledge, no study has evaluated the role of socio-economic status and micro-environmental factors on the risk of JE around world. The lack of study data on the effects of family income, parental education, and other micro-environmental factors including house location and quality, and mosquito breeding sites around the house prompted us to investigate those factors in a population-based case-control study in a high JE endemic area of Henan Province, central China.

MATERIALS AND METHODS

The detailed methods and study population were described in elsewhere (Luo *et al*, 1994). In brief, the study was carried out in the highly JE endemic area of Gusi county, Henan, China (combined population about 1.4 million) where *Culex tritaeniorhychus* is the main vector of JE. JE is mainly transmitted in the summer from June to September. JE vaccine has been used for the last two decades, however, because of the shortage of the vaccine and the fact that it is not compulsory like polio vaccination, it was estimated that less than 30% of the total susceptible children were protected. In order to find all cases of JE among children under 10 years old, a monitoring system was set up which included twice weekly visits to all hospitals within the county to check case reports and collect specimens of sera and cerebrospinal fluid (CSF) from 1 June to 30 September 1991. JE was diagnosed according to the following case definition: (1) Patients with fever, temperature 39°C; (2) Abnormal mental state with focal neurological signs; (3) More than 5 leukocytes per cubic millimeter of CSF; (4) No alternative diagnoses from history or from physical examination; (5) Detection of fourfold or greater increases in antibody titer in paired sera, or IgM antibody positive in CSF. Two neighborhood controls matched by age (within one year) and sex were selected at random according to the birth lists in the villages. Cases and controls who were less than 6 months and over 10 years old were excluded from the study, as there were few JE cases in those age groups.

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Also excluded were cases and controls of non-permanent residents. Data were collected by 4 highly trained interviewers using a standard questionnaire by interviewing the child's parents regarding a number of demographic variables, socio-economic status, and micro-environmental factors as well as bed nets and JE vaccination. Socio-economic status was measured in terms of average family income compared with the national average level, and parental education was measured in terms of years of education in school. Information on environmental variables was collected by questioning the parents; where appropriate their replies were confirmed or supplemented by observation of the house and its surroundings. Data on the following micro-environmental variables were collected:

- House location within village: peripheral (peripheral two ranks at village); central (other than peripheral two ranks)

- Quality of house: good (including those made of cement bricks, or regular board); poor (built with earth bricks and straw roof); general (Quality between the good and the poor)

- Mosquito breeding sites near houses: Yes/No

- Type of mosquito breeding sites: No; Rice field; Others (including rivers, pools and streams etc).

The data were analyzed using conditional logistic regression methods for a matched case-control study (Storer *et al*, 1983). Several variables were studied which may be associated with both socio-economic status and micro- environmental factors and the risk of suffering from JE among the study population. Those included age, the JE vaccination, bednets, and bednets impregnated with pyrethroid insecticide. In the analysis, we examined whether adding the confounding variable and mutual confounding effect of social-economic and environmental variable on each other to the logistic model resulted in a more than minor change in estimates of the odds ratio. This is the case of the variables of vaccination and parental education. These variables did not have the same confounding effect for different exposures. Odds ratio and 95% confidence intervals were calculated and tests for trend where appropriate were computed using the EGRET statistical package.

RESULTS

During 3-month study period, a total of 51 cases fulfilled the case definition and exclusion criteria, of whom one could not be investigated because the child and her parents were unavailable for interview. Two neighborhood controls were selected for each of the remaining 50 cases. The age distribution of cases

Table 1

Effect of family income and parental education on risk of Japanese encephalitis among children under 10 years old.

	Case (%)	Control (%)	OR (95% CI)	
			Crude	Adjusted[a]
Income[b]				
< 50%	31 (62)	51 (51)	1.00	1.00
50-99%	15 (30)	30 (30)	0.66 (0.26 - 1.64)	0.96 (0.36 - 2.54)
≥ 100%	4 (8)	19 (19)	0.25 (0.06 - 1.02)	0.37 (0.09 - 1.57)
Likelihood ratio test[c]			p = 0.038	p = 0.235
Parental education (Years)				
≤ 5	40 (80)	67 (67)	1.00	1.00
6 - 8	9 (18)	19 (19)	0.49 (0.16 - 1.48)	0.55 (0.14 - 2.03)
≥ 9	1 (2)	14 (14)	0.09 (0.009 - 0.76)	0.26 (0.03 - 2.51)
Likelihood ratio test[c]			p = 0.006	p = 0.163

[a]Adjusted for vaccination
[b]Expressed as multiples of average income per capital in China (Chinese ¥800)
[c]Test for trend

was roughly similar to that of controls. The mean age of cases was 3.15 with standard deviation (SD) of 1.86, and of controls 3.20 with SD of 1.77. That more boys (58%) than girls (42%) suffered from JE suggested that boys might have a higher risk of JE.

The distribution of cases and controls according to family average income and parental education level are shown in Table 1. There was an excess of cases in the lower income and lower parental education levels compared with the controls. Crude analysis suggested that socio-economic status and parental education levels might be associated with the risk of JE. However, after adjusting for confounding variable of JE vaccination, the association were not statistically significant, although they still maintained same trend.

The distribution of those cases and controls in different categories of four environmental variables on which data were collected is shown in Table 2. Both crude odds ratio and odds ratios adjusted for child vaccination and parental education were estimated. In crude analysis, all relationships were in the direction that might be expected, *ie* those who lived in the peripheral part of the village, poor quality of house condition, house near mosquito breeding sites had higher risk of JE. However, when adjusted for confounding variables, only house location within villages remained of borderline of statistical significance (Table 2).

Table 2

Effect of micro-environmental factors on risk of Japanese encephalitis among children under ten years old.

	Case (%)	Control (%)	OR (95% CI)	
			Crude	Adjusted[a]
House location within villages				
Peripheral	40 (80)	64 (64)	1.00	1.00
Central	10 (20)	33 (33)	0.35 (0.13 - 0.91)	0.51 (0.15 - 1.03)
Likelihood ratio test			p = 0.02	p = 0.053
Quality of house				
Poor	30 (60)	50 (50)	1.00	1.00
General	15 (30)	30 (30)	0.71 (0.28 - 1.80)	0.85 (0.29 - 2.47)
Good	5 (10)	20 (20)	0.34 (0.10 - 1.15)	0.45 (0.12 - 1.72)
Likelihood ratio test[b]			p = 0.072	p = 0.26
Breeding site near house				
No	1 (2)	4 (4)	1.00	1.00
Yes	49 (98)	96 (96)	2.00 (0.22 - 17.89)	3.61 (0.21 - 63.1)
Likelihood ratio test			p = 0.51	p = 0.343
Types of breeding site				
No	1 (2)	4 (4)	1.00	1.00
Rice field	23 (46)	44 (44)	2.13 (0.23 - 20.14)	4.26 (0.24 - 74.9)
Others	26 (52)	52 (52)	1.94 (0.21 - 17.59)	3.25 (0.18 - 55.7)
Likelihood ratio test			p = 0.90	p = 0.89
Rice field	23 (47)	44 (46)	1.00	1.00
Others	26 (53)	52 (54)	0.88 (0.41 - 1.81)	0.75 (0.34 - 1.67)
Likelihood ratio test			p = 0.74	p = 0.174

[a]Adjusted for vaccination and parental education
[b]Test for trend

DISCUSSION

Lower family average income and less education are generally assumed to increase the risk of JE. In the present study, however, when adjustment was made for the confounding variable of JE vaccination, the associations were not statistically significant, although the trends remained. These findings suggest that the beneficial effects of higher family average income and higher parental education are partly due to those parents being more conscientious about having their children vaccinated in the situation of vaccine shortage in the study area.

Those living in near mosquito breeding sits and poor house quality were found to be possibly associated with increasing risk of JE on crude analysis. But these were not statistically significant after adjusting for confounding variables. This effect may reflect residual confounding if the adjustment for socio-economic or other factors was incomplete. On the other hand, the possibility that poor housing and living near mosquito breeding sites may increse the risk of JE cannot be ruled out. To provide further evidence, a large sample size is needed. Children living in periphery of the village were found to have an increased risk of JE in the present study; this may reflect greater exposure to mosquito vectors.

Clearly by choosing neighbors as controls there was a danger of 'over-matching' with respect to possible risk factors such as socio-economic status, parental education, and environmental variables. That is those who live in close proximity to each other are likely to have similar socio-economic status, education level and similar environmental factors. As a result, the odds ratio estimates would have been seriously biased toward unity. To avoid the bias, we adapted matching in analysis in the present study.

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