

NOTE
**Characteristics of Mothers of Infant Salmonellosis and
Shigellosis Patients in Guam**

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Abstract—Using data taken from birth certificates, we document differences in the sociodemographic characteristics of mothers of infant salmonellosis and shigellosis patients in Guam. The results of an analysis of covariance indicate that mothers of salmonellosis infants are more likely to be Caucasian and less likely to be Filipino. Mothers of shigellosis infants appear to be from lower socioeconomic status levels. Our analysis also reveals a relationship of mothers' ethnicity to educational attainment levels, and indicates that unmarried Chamorro mothers who have not graduated from high school are more likely than others to have infants with shigellosis. The results suggest that risk factors for infant salmonellosis and shigellosis are dissimilar and that measures that may be useful in reducing the incidence of infant shigellosis in Guam may not be effective in controlling infant salmonellosis.

Introduction

The annual incidence of salmonellosis in Guam often exceeds comparable rates for the mainland United States by a factor of 10, with infants generally accounting for about 50% of Guam cases (Haddock & Delon 1980). While food-borne outbreaks of salmonellosis occur in Guam, here, as elsewhere, these incidents typically affect only older children and adults (Haddock & Kampelmacher 1986; Haddock 1993). Studies in Guam have failed to link infant salmonellosis cases with family preference for particular animal-origin foods (Haddock et al. 1985), with secondary spread from infected family members (Haddock & Malilay 1986a), or to the ownership of pets or domestic animals (Haddock 1986). Other findings suggest that the incidence of infant salmonellosis is highest during the

island's rainy season (Haddock & Malilay 1986b), and show that vacuum cleaners from the homes of infant salmonellosis cases are more likely to contain *Salmonella* bacteria than are vacuums from the homes of control infants (Haddock & Nocon 1994).

Field investigations of infant shigellosis cases in Guam have frequently led to the discovery of severe home sanitation problems, including sanitary code violations previously thought to be rare or nonexistent. In contrast, investigations of infant salmonellosis cases have often shown their parents to be professionals such as lawyers, physicians or nurses who have provided a home environment apparently ideal for infant care (Haddock, unpubl. observations).

These observations suggest the hypothesis that personal hygiene and home sanitation are important factors in the transmission of infant shigellosis but are less likely to be important in the transmission of infant salmonellosis. By studying available data on the characteristics of mothers of infant cases and controls, we hope to support or disprove this hypothesis and perhaps identify other clues to the origin and spread of these diseases. The present analysis, therefore, has three purposes: (1) to identify sociodemographic differences in the characteristics of mothers of infant salmonellosis and infant shigellosis patients, and controls; (2) to determine if the field impressions described above have some basis in fact; and (3) to generate hypotheses for future tests. Because Asian and Pacific Islanders constitute the fastest growing ethnic minorities in the United States (Yu & Lu 1992), it is important to elucidate the health status and characteristics of this little-studied population (Lin-Fu 1993).

Methods

Data were gathered from 1977 through 1991 for a case-control study, utilizing as cases infants born in Guam who developed laboratory-confirmed salmonellosis or shigellosis prior to their first birthday. We enrolled cases in the study as reports were received by the Territorial Epidemiologist from the Guam public health reference laboratory. Since virtually all medical laboratories in Guam, including military facilities, routinely submit isolates of *Salmonella*, *Shigella*, and *Vibrio* organisms to the Guam public health reference laboratory for confirmation and serotyping, all island populations are represented in the study.

We enrolled control infants in the study by selecting the next two births listed in the Guam birth registry following each case birth, thereby matching for season of birth and age. If an infant selected as a control was deceased, had been previously selected as a control, or was a salmonellosis or shigellosis case, we selected the next registered birth as a replacement. After case-wise elimination for missing data, this procedure yielded 1,390 usable cases for analysis.

Data on mothers' ethnicity, marital status, age, educational level, number of previous births, and number of prenatal visits were extracted from case and control birth certificates. We also extracted Apgar scores for case and control infants.

We employed analysis of covariance to compute means for mothers' age, educational level, previous births, prenatal visitations, and infant Apgar scores. Computations for dummy variables (ethnicity and marital status) were performed with the same procedure where it is similar to the binary variable multiple regression approach described by Feldstein (1966). We conducted all analyses with appropriate adjustments.

Results

Caucasian mothers in Guam are at greater risk of having *Salmonella*-infected infants than are mothers from other ethnic groups (Table 1). Infants born to Filipino mothers are significantly less at risk than others for salmonellosis. Salmonellosis infants have significantly lower Apgar-1 scores than controls.

Chamorro women and mothers with lower educational levels appear to be at greatest risk of having infants with shigellosis (see Table 1). Unmarried mothers who have not graduated from high school and those who have significantly more children to support are also more likely to have *Shigella*-infected infants.

These results led us to consider the relationship of mothers' ethnicity to education, our only indicator of socioeconomic status (SES). Binary correlations of mothers' ethnicity with education reveal that Chamorro women have significantly lower educational levels ($r = -.266$; $p < .001$); Filipino and Caucasian mothers have significantly higher levels of education ($r = .295$; $p < .001$ and $r = .058$; $p < .05$ respectively). The relationship of education to ethnicity is weak and not significant for mothers in "other" Asian and Pacific Islander ethnic groups ($r = -.012$). In separate logistic regression analyses (not presented here), these statistically significant ethnic effects remained even when mothers' education and the other controls were included in the models.

Table 1. Differences in Selected Characteristics Between Salmonellosis and Shigellosis Mothers, Infants, and Controls

	Salmonellosis (n = 198)	Salmonellosis Controls (n = 391)	Shigellosis (n = 227)	Shigellosis Controls (n = 574)
Chamorro (%)	43.0	47.7	76.6***	49.7
Filipino (%)	14.0*	21.9	6.9***	25.3
Caucasian (%)	28.0***	13.8	5.6**	11.7
Other (%)	15.0	16.6	10.8	13.4
Married (%)	72.5	74.7	60.6**	71.1
Mean age	25.4	25.9	24.8	25.3
Mean years of education	12.2	12.4	11.5***	12.2
Mean prenatal visits	9.5	9.3	8.4	8.9
Mean previous births	1.3	1.4	1.9***	1.3
Mean Apgar-1	7.9**	8.2	8.1	8.1
Mean Apgar-2	8.9	9.1	8.9	9.0

* $p < .05$; ** $p < .01$; *** $p < .001$

We also considered the possibility that covariates in the logistic regressions were differently related to the occurrence of infant salmonellosis and shigellosis. Tests for interactions indicate that unmarried Caucasian mothers and married Chamorro mothers have significantly greater risks for infant salmonellosis, and that Chamorro mothers with lower educational levels are at greater risk for infant shigellosis.

Discussion

Health authorities have been aware of an unusually high incidence of infant salmonellosis in Guam for nearly 20 years. The apparent random nature of these infections, however, has obscured their cause and frustrated efforts to develop specific control strategies. Earlier studies have shown that Guam's outdoor environment is highly contaminated with *Salmonella* bacteria (Haddock et al. 1986, 1990). This, in turn, led to the observation that Guam homes are also frequently contaminated with *Salmonella* bacteria (Haddock & Malilay 1986a), and that sampling the contents of vacuum cleaner collection bags may be an efficient means of evaluating indoor environments for the presence of *Salmonella* contamination (Haddock & San Nicolas 1989).

While *Salmonella* bacteria appear to be ubiquitous on Guam, in contrast, *Shigella* bacteria have never been isolated from environmental samples here. Humans are the only significant reservoir of *Shigella* bacteria (Benenson 1990), while *Salmonella* bacteria can be found in virtually all animals and are common in many species. It seems safe to surmise, therefore, that shigellosis is most frequently spread by contact with infected persons and, in contrast with salmonellosis, is unlikely to be spread through the environment.

Infant salmonellosis cases had Apgar scores lower than those of controls or shigellosis case infants ($p < .01$). Since the peak incidence of salmonellosis in Guam occurs at age 2–3 months while incidence rates for shigellosis peak during the third year of life we suspect that all infants are exposed to at least low levels of *Salmonella* bacteria very early in life and that those with the least natural resistance are those most likely to develop symptomatic disease. Older children, on the other hand, are most likely to be exposed to *Shigella* bacteria only as they mature and have more intimate contact with an increasing number of "strangers" among playmates, at day-care centers, and during other group activities.

Our analysis also links the occurrence of infant salmonellosis with Caucasian ethnicity. We are not aware of previous studies linking infant salmonellosis with specific ethnic groups, and therefore sought alternate explanations for this finding. One obvious alternative is that Caucasian mothers with greater schooling are more likely to seek medical care for infant children, thus increasing the incidence of diagnoses for this disease. This explanation gains support from earlier analyses showing that Caucasian mothers in Guam are more likely than others to seek prenatal health care services (Pinhey et al. 1994). This effect may be most important for illnesses such as salmonellosis that are frequently mild and self-limiting and less important in the case of illnesses such as shigellosis that are more

likely to cause severe symptoms. However, if educated Caucasian mothers are more likely to seek medical care for minor infant illness, thus inflating the incidence of certain diagnoses, the statistical interaction of Caucasian ethnicity and education should have been statistically significant—but it was not. Instead, interactions were significant for unmarried Caucasian mothers and married Chamorro mothers. Because marriage is known to increase the use of health care services for women in Guam (Pinhey et al. 1994), it appears that married Chamorro mothers are those who are most likely to seek treatment for infant illnesses. In contrast, unmarried women typically have lower incomes, suggesting an association of SES and higher rates of infant salmonellosis for Caucasian mothers. Since additional indicators of SES (i.e., occupational status, income) are not available in our dataset for the further “teasing out” of associations, we encourage future researchers to systematically test the relationships of income and occupational status to ethnicity and higher rates of infant disease.

Our results also appear to link the occurrence of shigellosis in Guam to lower SES levels. The data suggest that unmarried Chamorro mothers in Guam who have not graduated from high school and who have several children may be more likely than other women to live under conditions that increase significantly the likelihood of their infant developing shigellosis.

We also argue that the findings of the present analysis are consistent with earlier field observations and that useful measures in reducing the incidence of infant salmonellosis in Guam may be fundamentally different from those that are effective in controlling adult salmonellosis. If infant salmonellosis truly is an “environmental” disease, then steps taken to limit the introduction of outdoor contamination into living quarters and minimizing the exposure of infants to indoor dust aerosols may be effective in preventing these infections. Such measures might include leaving outdoor footwear at the entrance to the home, especially during the rainy season (Haddock & Malilay 1986b, Haddock & Nocon 1994), and not performing dust generating tasks such as vacuuming or sweeping when an infant is present (Haddock & Nocon 1993). Given our finding of the relationship of lower Apgar-1 scores to greater risk for salmonellosis, practices that may improve resistance to infection during the first 6 months of infancy, including breastfeeding or the use of low-iron infant formulae, may also be effective in combating infant salmonellosis (Haddock et al. 1991). Since we are not aware of other studies linking ethnicity and breastfeeding to greater risks for infant salmonellosis, we encourage future researchers to explore these associations. Finally, drawing from the literature and the results of the present study, we encourage future researchers to examine possible associations between various measures of SES, ethnicity, and greater risks for infant salmonellosis and shigellosis.

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