Fecal Contamination of Shanty Town Toddlers in Households with Non-corralled Poultry, Lima, Peru

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Abstract: We used direct observer techniques to measure the frequency with which toddler-aged children were contaminated by poultry feces in homes in a peri-urban shanty town in Lima, Peru. The mean number of fowl was 5.4 (SD 3.1), with 10.0 (SD 10.7) poultry defecations per 12 hours. Toddlers' hand contact with poultry feces occurred a mean of 2.9 (SD 3.0) times/12 hours. A mean of 3.9 (SD 4.6) feces-to-mouth episodes per household/12 hours occurred both by direct hand-to-mouth contamination and indirectly by handling soiled objects which were then placed in the mouth. There was a strong correlation between feces-to-hand contamination and feces-to-mouth contamination (r = 0.94). There was also an association between feces-to-mouth contamination and the number of stools deposited in the house (r = 0.66). For each additional chicken stool deposited during the day, there was an average increase of 0.27 in feces-to-mouth episodes.

We collected feces from 68 infected chickens and found viable *Campylobacter jejuni* for up to 48 hours after deposition. Yet, a survey of 108 families demonstrated that free-roaming poultry were often not thought of as a health risk for children. An intervention program to reduce oral-fecal contamination should emphasize that all poultry be corralled and not allowed access into the house. (*Am J Public Health* 1990;80:146–149.)

Introduction

Diarrheal disease is an important factor in the infection-malnutrition cycle of infants and young children in developing countries. In Peru, children under three years of age have a diarrheal incidence of 10 episodes per child-year, which can significantly affect their growth rates.[1] One important cause of diarrhea in Lima children less than one year of age is *Campylobacter jejuni*. This organism was found in 15 percent of diarrhea stool samples[2] and accounted for the majority of dysenteric diarrheas.[3]

In Peru, *C. jejuni* has been isolated from 88 percent of commercial chickens and 50 percent of free-ranging domestic chickens in a pueblo joven (a peri-urban shanty town community).[4] In an aged-matched case-control study of Lima peri-urban households, children in families with chickens had a three-fold relative risk of having *C. jejuni* diarrhea which increased to 12.5 in families with *C. jejuni* infected chickens.[2] These risk factors suggest that direct contact with free-roaming *C. jejuni*-infected chickens that defecate on household surfaces is an important transmission vehicle for young children.

Direct observation of the personal hygiene of small children and mother-child behavioral patterns is the most reliable method for obtaining data.[5] We used directed observer techniques to measure the rate at which toddlers in a shanty town contaminate themselves with domestic poultry feces.

Methods

Study Sites

The study was done in two pueblos jovenes (recent shanty towns): Huascar, Canto Grande[6] and Las Pampas de San Juan, San Juan de Miraflores, in Lima Peru. The majority of the study population are rural immigrants who are daily laborers or street vendors with low, unstable incomes. Housing materials in Huascar and San Juan range from woven cane matting to permanent structures of brick and cement. Although the majority of pueblos jovenes do not have electrical installations, most of our study households had them. Water is scarce in both pueblos. It is provided through tanker trucks, and in half of San Juan through piped communal water spigot. In-house sewage systems are not available.

Direct Observation Data

Ten families from Huascar participated in an in-depth behavioral observation study, with a total of 21 children under five years of age. All the families had at least one child under two years of age, and domestic chickens which were not corralled at least part of the day. They gave informed verbal consent prior to their participation. The study received ethical approval by all involved Peruvian institutions (Universidad Peruana Cayetano Heredia, Instituto de Investigación Nutricional, and PRISMA - Proyectos en Informática, Salud, Medicina y Agricultura).

To gather the direct observation data, a field worker remained in the toddler's home for one 12-hour observation period (7am to 7pm). At the beginning of the visit, a descriptive inventory of the domestic animals was completed. During the 12-hour period the observer noted all activities in the house for each fowl, including the number of times the fowl entered the home, the duration of time spent inside, and how frequently and where the poultry defecated. The observer also tabulated the activities of the toddler, specifically noting the number of times the child's hands were contaminated with poultry feces (defined as feces-to-hand episodes) and the number of times that his/her hands, or other objects contaminated with poultry feces, were introduced into his mouth (defined as feces-to-mouth episodes). Feces-to-mouth episodes were considered to have been interrupted and were not tabulated if the child's contaminated hands had been washed before he placed them in his mouth.

All feces-to-hand and feces-to-mouth episodes were tabulated for each family and analyzed as episodes per child. Correlations and linear regressions for the feces-to-hand and feces-to-mouth episodes were performed with the following variables: number of fowl, hours in the house/12 hours, and number poultry stools/12 hours.

Poultry Raising Practices and Beliefs

We surveyed a group of 108 families living in Las Pampas de San Juan to document their practices and beliefs regarding the raising of chickens and other fowl. The survey identified the reasons families gave for raising or not raising poultry, their beliefs about corralling the poultry, and the effect that confinement has on the growth and the health of the animal, the perceived advantages of raising chickens in the home compared to buying them commercially, and the mothers' perception concerning whether poultry roaming within the house presented a health risk to young children.

Socioeconomic Data

As part of a longitudinal study of *Enterobius vermicularis*, 121 randomly selected families from Huascar were included in a socioeconomic survey. The same data were collected for the Pampas families that participated in the poultry raising practices survey. The socioeconomic survey detailed age, sex, level of education, and occupation of all members of the family. Questions on housing quality included the materials used to build the house, number of rooms, ownership of functioning radios, televisions, and refrigerators, and presence or absence of a latrine. Finally the number and types of animals belonging to the home owners were also registered.

The practices and beliefs of mothers who did and did not raise poultry were compared using Chi square analysis. Each socioeconomic data set from the two pueblos jovenes was analyzed individually, and compared for socioeconomic indicators, using Student t test and Chi-Square analysis.

Survivability of *C. jejuni* in Deposited Chicken Feces

Stool samples were taken from *C. jejuni*-positive chickens, raised in a household in Huascar, Canto Grande. A cloacal swab was taken immediately after the chicken defecated and another swab was taken from the stool on the ground. These served as baseline samples. The stool sample, on the ground of a sun-exposed patio, was fenced in with a metallic wire and marked with its respective identification number and code. After 24 and 48 hours, additional samples were taken. All the samples were immediately placed in Cary Blair media containing Skirrow's antibiotic supplement,[7] and processed by direct plating on blood agar with Butzler's supplement.[8] Another sample was inoculated into thioglycolate broth supplemented with iron and the following antibiotics: vancomycin 10 μg/ml, polymyxin B 2.5 I.U./ml and trimethoprim lactate 5 μg/ml. The plates were incubated immediately while the broth was refrigerated for 24 hours and then plated with Butzler's agar. All plates were incubated at 37°C under microaerophilic conditions. Campylobacter species were identified based on colony morphology, oxidase production, and spiral appearance in the Gram stain.

Results

Direct Observation in the Homes

The interaction between toddlers and poultry was observed for a total of 119 hours in 10 Huascar households. The majority of the poultry were chickens (fowl/house = 5:4, chickens/house = 4.4). Three out of 10 families also had ducks and turkeys. Chickens and ducks only were allowed to roam freely through the house for about one-third of the 12-hour observation period (Table 1). The number of poultry and the time they were in the house were correlated (r = 0.64), as were the number of observed stools and the time the animals spent within the house (r = 0.86).

The children had approximately three feces-to-hand episodes per 12 hours (Table 1). The risk of feces-to-hand contamination was from both fresh stool and from that deposited several days previously but not removed from the household surfaces. In three households where no observed defecations occurred, hand and oral contamination still happened with stools that had been deposited prior to the day of observation. The two most important variables were number of droppings and number of minutes chickens were in the house.

There were about four feces-to-mouth episodes per child (Table 1). Children only rarely washed their hands after touching feces, and often put their fingers in their mouths, so feces-to-hand and feces-to-mouth episodes were highly correlated (r = 0.94); feces-to-hand episodes and the number of poultry accounted for 93 percent of the variation in the dependent variable—the number of feces-to-mouth episodes. Neither feces-to-hand nor feces-to-mouth episodes were related to the number of young children in study families. For each additional chicken stool deposited during the day, there was an average increase of 0.27 in feces-to-mouth episodes.

Poultry Raising Practices

One hundred and eight mothers from the Pampas de San Juan participated in the poultry raising practices survey. Eighty-one (75 percent) of the mothers were migrants, usually from the sierra zones. Whereas 88 percent (14/16) of the Lima-born mothers raised multiple types of poultry, only half of the migrant mothers raised other types of poultry in addition to chickens (27/54).

The major reasons given for a raising poultry (Table 2) included their use for home consumption and enjoyment of raising animals. The majority of mothers realized that commercial chickens were cheaper than those raised at home. When mothers were asked whether commercial or domestic chickens cost more, 77/108 (71 percent) thought the commer-

TABLE 1—Number of Domestic Poultry and Their Interactions with Toddler-Aged Children, Direct Observation Households (n=10)

	Mean	SD	Feces-to-Hand* Regr Coef	Feces-to-Hand* 95 CI	Feces-to-Mouth* Regr Coef	Feces-to-Mouth* 95 CI
# Foul per house	5.4	3.1	−0.0326	(−0.693+0.628)	0.2831	(−0.735+1.301)
# Min/12 hours fowl in house	14043.0	2099.8	0.0004	(−0.001+0.001)	0.0006	(−0.001+0.002)
# Stools/12 hours	10.0	10.7	0.1664	(−0.025+0.308)	0.2718	(+0.057+0.487)
# Feces-to-hand episodes	2.9	3.0			1.474	(+1.101+1.846)
# Feces-to-mouth episodes	3.9	4.6				

*Dependent variable in simple linear regression model

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TABLE 2—Pampas Family Practices and Beliefs Concerning the Raising of Domestic Poultry

Family Practices, Beliefs	Families with Poultry n	Families with Poultry % of total	Families without Poultry n	Families without Poultry % of total
Why they raise poultry:				
To have to eat	41	60		
Enjoy raising animals	17	24		
No response	11	16		
Why they do not raise poultry:				
Are filthy/carry disease			11	29
Not economic (more expensive/ are stolen)			8	21
Without infrastructure/time			12	32
Do not like it/not accustomed			7	18
Where poultry grow best:				
Corralled	27	39	22	58
Roaming freely	37	54	13	34
Either or both places	4	6	2	5
No response	1	1	1	3
Is there a health risk for the family, having poultry loose in the house?				
No	20	29	11	28
Yes, cause illness	16	23	15	38
Yes, dirty or bring flies	13	19	8	21
Don't know	20	29		13

TABLE 3—Huascar and Pampas Family Socioeconomic Status, According to Selected Variables

	Huascar families n	Huascar families % of total	Pampas families n	Pampas families % of total
Mean family size	6.5 S.D. 2.5		5.1 S.D. 1.8	
Mean age of mother(yrs)	31.5 S.D. 9.8		27.1 S.D. 5.8	
Mean number of years in Lima	—		15.8 S.D. 7.8	
% with radio	79/120	66	77/108	71
% with television	82/120	68	73/108	68
% with radio and/or television	108/120	90	93/108	86
% with refrigerator	22/120	18	19/108	18
% with bore hole latrine	80/120	67	73/108	68
Housing quality:				
% with noble materials (bricks)	42/120	35	18/108	17
Education of mother:				
% completing secondary	15/120	13	31/108	29
% completing primary	60/120	50	56/108	52
% not completing primary/none	43/120	36	21/108	19
% no response				
Education of father:	2/120	2		
% completing secondary	31/120	26	56/108	52
% completing primary	66/120	55	42/108	39
% not completing primary/none	14/120	12	3/108	3
% absent	5/120	4	4/108	4
% no response	4/120	3	3/108	3

cial chickens were cheaper while only 22/108 (20 percent) thought the reverse.

In 83 percent (58/70) of the families, the poultry roamed freely for much of the day, with access into the house. This practice was explained in part by the belief of more than one-half of the mothers that the animals grew better when they were allowed to wander freely. Seventy four percent of the mothers not raising poultry and 68 percent of the mothers with poultry thought that there was a health risk or a negative hygienic aspect associated with free-roaming poultry.

Socioeconomic Data

Table 3 shows the socioeconomic indicators studied in both pueblo joven communities. No socioeconomic differences were found in families that did or did not raise chickens and other poultry.

Microbiological Results

Forty percent (27/68) of the stool samples from *C. jejuni*-positive chickens deposited in sun-exposed patios still had viable organisms demonstrable after 24 hours. At 48 hours, only 18 percent (10/57) of the samples were positive.

Discussion

Campylobacter jejuni infection most commonly occurs through human fecal-oral transmission or through contaminated food or water.[9–13] This transmission is difficult to document, unless direct observation of family hygienic practices is used. Stanton, *et al*, demonstrated that responses to 24-hour recall and knowledge-attitude-practices questionnaires do not reliably reflect observed hygienic household practices.[5] The direct observation method is a strength of this study. A limitation is that the sample size is small. These data nonetheless demonstrate that contamination of toddlers' hands with feces deposited in the house by free-roaming birds is extremely common in Peruvian pueblo jovenes. In Bangladesh, play areas of infants and toddlers were also seen to be contaminated with chicken feces in approximately 66 percent of the households.[14] Approximately one-half the Bangladeshi mothers claimed to have seen the child touching or eating animal feces during the previous two weeks.

Unwashed hands of toddlers in a pueblo joven are frequently contaminated with poultry feces. As 50 percent of the chickens in a pueblo joven are carriers of *C. jejuni*,[4] the health risk to these toddlers is evident. We found that few of these feces-to-hand episodes were interrupted by hand washing.

Many pueblo joven mothers do not believe that chicken stools provoke illness. Similar results were found in the Bangladesh study, where over one-half of the mothers also did not recognize animal feces as disease-producing.[14]

The absence of running water in pueblo jovenes and the high cost of the water used may be important factors discouraging hand washing. Even in developed countries where water is easily available, oral-fecal contamination is common. Direct observations in an English nursery school during an epidemic of shigellosis showed that 50 percent of the children had contaminated their hands with *Shigella sonnei* after using the school toilet. Moreover, one-third of the children handled their face or sucked their fingers after using the toilet.[15]

The risk of acquiring viable *C. jejuni* in the study area is augmented because the house floors are usually made of dirt or unfinished concrete, so the complete removal of poultry feces is difficult to achieve, and *C. jejuni* can survive in the ambient environment for several days. Even where water is plentiful, in homes with free-roaming chickens, it is not realistic to assume that mothers will be able to effectively interrupt transmission by handwashing.

In addition to *C. jejuni*, a small percentage (2 percent) of poultry were fecal carriers of *Aeromonas* species.[4] The relationship of this organism to diarrhea has not been established. None of the free-roaming chickens sampled excreted *Salmonella* species. In both Peru and Bangladesh,[1,16] *Salmonella* species is an infrequent cause of community epidemics of diarrhea.

The present study suggests similar socioeconomic background and characteristics of families with and without poultry in a pueblo joven population, making it difficult to identify a target population. In addition, an intervention program would have to overcome common beliefs that inherently encourage the transmission of *C. jejuni*. Many families raised uncorralled chickens even though they recognized that purchasing poultry was cheaper than home grown animals, believing that chickens grow better when they are corralled; and appreciated the risk in having chickens roaming freely through the house. This suggests that this behavior will be difficult to modify.

In Peru, as our data show, most individuals living in pueblo jovenes have access to mass media. Most children attend primary school. Both mass media and formal education in the school system could be utilized for intervention programs. These educational programs should emphasize the health risks to toddlers of raising free-roaming poultry within the household and the need to corral poultry and prevent their entrance into the house.

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8th Competition Announced for Health Professions Students

Dr. Louis W. Sullivan, Secretary of Health and Human Services, has announced the 8th annual national competition among health professions students for the "Secretary's Award for Innovations in Health Promotion and Disease Prevention." Winners will receive awards of $3,000 for first place, $2,000 for second, and $1,000 for third; up to 17 semifinalists will receive $250 each.

The competition is open to a broad range of health professions students enrolled in baccalaureate or higher degree programs affiliated with the Federation of Associations of Schools of the Health Professions, cosponsor of the competition. Those eligible to compete include students of medicine, osteopathic medicine, nursing, veterinary medicine, optometry, pharmacy, podiatric medicine, public health, health administration, health education, and allied health.

Papers should present innovative proposals for health promotion or disease prevention in the community, at the worksite, in an educational setting, or for a special population group.

The deadline for submitting entries is March 15, 1990. A paper must be submitted to the school attended by the author or authors. Papers will be judged first by the school and then by the professional associations. A departmental panel will make the final selections, and HHS Secretary Sullivan will announce the winners in July. For further information, contact Blake Crawford, Health Resources and Services Administration (HRSA), US Public Health Service, DHHS, 5600 Fishers Lane, Rockville, MD 20857; tel: (301) 443-3376.