Original Article

Epidemiological study of shigellosis in an urban area of Argentina

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Abstract

Introduction: Shigellosis represents one of the main causes of bloody diarrhoea in South America. This study aimed to establish the incidence of shigellosis in an urban zone of Buenos Aires, Argentina, by examining the type of *Shigella* and living conditions associated with this infection.

Methodology: Between January 2009 and December 2010 we analyzed shigellosis in children admitted to the public health service with bloody diarrhoea from La Plata, the capital of Buenos Aires, Argentina. A total of 372 children under 15 years old with *Shigella* present in their stool samples were admitted to the study. Variables studied were patient age, type of *Shigella*, family economic status, and access to sewage services and safe drinking water.

Results: *Shigella flexneri* was found to be present in 66.8% of the cases. Incidence was 187 cases/year/100,000 children under 15 years old. Cases were mainly observed during the summer (38.5%) in the population of under 5 years old (69.1% of all cases). The risk of shigellosis increased 12 times in those children who lacked safe drinking water and this risk increased 1.5 times in the population without sewage services. Fewer cases of shigellosis were noted in downtown areas, while hot spots were identified in the suburbs. Treating one case of shigellosis has a local cost of US $976 while assuring safe drinking water and sewage services for one family costs US $634.

Conclusion: Incidence of shigellosis in urban areas is associated with quality of water and sewage services. Policies aimed at providing education and improving public utilities networks can help to reduce the incidence of shigellosis.

Key words: *Shigella*; urban; risk factors; drinking water

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Introduction

Shigellosis is a disease that causes an acute intestinal infection. *Shigella* bacteria multiply within colonic epithelial cells and cause inflammation, mucosal ulceration, and bleeding. Symptoms associated with this pathogen vary from mild watery diarrhoea to bacillary dysentery characterized by severe abdominal pain, cramps, fever and stools containing blood and mucus. This disease is mainly transmitted by fecal-oral contact.

Worldwide, the incidence of shigellosis is estimated to be 164.7 million cases per year, of which 163.2 million were in developing countries, where 1.1 million deaths occurred [1]. More than half of all these deaths attributable to shigellosis involved children younger than 5 years. The incidence in developing countries could be up to 20 times greater than those in developed countries; however incidence varies within the same region [2], or even inside each country [3,4].

The genus *Shigella* comprises four species or serogroups. The most common in developing countries is *Shigella sonnei*, which is responsible for 60% to 80% of cases reported worldwide. In South America, however, the most common species is *Shigella flexneri*, particularly of serotype 2, followed by *S. sonnei* [4-7]. With regard to Paraguay [8] and Chile [9], *S. flexneri* is also more prevalent than *S. sonnei.*

Studies undertaken in Argentina showed that this type of infectious diarrhoea is found mainly among residents of semi-rural areas and low-income settlements in the outskirts of the cities [10].

This epidemiological study aimed to assess the incidence and characteristics of acute diarrhoea caused by *Shigella* spp. in an urban area of Argentina.

Methodology

Study type

This was a descriptive-analytical study of cases of shigellosis and factors associated with them.

Data collection tool

We analyzed databases from the major hospitals in the region serving the pediatric population, as well as data from the State Department of Bacteriology which diagnose and study this disease.

Period of study

Cases of shigellosis in children under 15 years of age for the period of 1 January 2009 through 31 December 2010 were recorded. Also, a comparative group, assessed from historical cases recorded in 2001, 2003, 2005 and 2007, was used to compare the actual incidence of shigellosis.

Unit of analysis

Patients were residents of La Plata under fifteen years of age who suffered from acute diarrhoea during the study period, from which *Shigella* was isolated when patients were admitted to the study at the Public Health assistance.

Case definition

A case was considered as a unit of analysis when an individual, who was a resident of the city of La Plata, under fifteen years of age, submitted three or more watery stools in a 24-hour period, bloody stools (WHO 1996), and showed any of the following symptoms: fever, abdominal pain, bearing down and/or rectal tenesmus.

Diagnosis of Shigella

Identification of *Shigella* was performed by standardized biochemical and serological tests. All stool samples were cultured on Eosin Methylene Blue (EMB) agar, *Salmonella-Shigella* agar, cefsulodin-Irgasan-novobiocin agar and MacConkey agar with sorbitol (Biomérieux, Marcy l´Etoile, France). Specimens testing positive for *Shigella* were serotyped by agglutination using polyvalent antisera (Difco, BD, Franklin Lakes, NJ, USA).

Health data

Both the safe drinking water supply and sewage disposal system were analyzed, and the progression of these networks in the past ten years was compared with the 2010 map.

Demographic data

The population of La Plata is located mostly downtown (Urban Square, population (P) 201000 [7] with 26622 young residents (YR) under 15 years of age). However, La Plata's suburban areas are located in the same geographical region, sharing the same environment, and therefore included in the study. These suburban areas were Abasto (P 7577; 2167 YR); A. Segui (P 9894; 2012 YR); C. Bell (P 26612; 8688 YR); Etcheverry (P 3671; 936 YR); El Peligro (P 2984; 679 YR); Gonnet (P 21416; 5576 YR); Gorina (P 6857;1769 YR); Hernandez (P 5333; 1992 YR); L. Olmos (P 19059 with 4753 YR; Los Hornos P 120000 with 15023 YR; M. Romero P 98000 with 7772 YR; Ringuelet: P 15312 with 3,259; San Carlos P 83000 with 12300 YR; San Lorenzo P 60000 with 9004 YR; Tolosa: P 44,977 with 9929 YR; Villa Elvira (P 103000 with 16076 YR), and Villa Elisa: P 22229 with 5009 YR. Population data were assessed with reference to 2001-2010 censuses [7], taking into account the number of inhabitants, age, and gender.

Statistical analysis

This study was conducted using the calculation of means and standard deviations for continuous variables and proportions for categorical variables. The comparison between two categorical groups was performed using χ^2. The software used was SPSS version 15 for Windows (IBM, Chicago, USA). A p value < 0.05 was considered as significant.

Results

During the study period, 372 cases of diarrhoea associated with shigellosis were recorded in the paediatric population. Incidence was 187 cases/year/100,000 children < 15 years old (Table 1).

Table 2 shows the prevalence of diarrhoea associated with *Shigella* according to age: 69.1% of the cases were detected in children under five years old, 22.8% in children between five and nine years old, and 8.1% in children over ten and under fifteen years old. Differences in infections between these three age groupings were statistically significant: under five years old compared to five to nine year olds, $p = 0.04$; and five to nine years olds compared to the oldest group $p = 0.01$.

Table 1. Study population and number of cases of shigellosis by location (according to National Census 2001)

Area	Males	Females	Population under 15 years old	Cases (2009)	Cases (2010)	Cases* (average)	Incidence*
Downtown (Urban square)	13572	13050	26622	13	9	11	0.4131921
Abasto	1078	1089	2167	6	4	5	2.30733733
A. Seguí	1028	984	2012	1	1	1	0.49701789
C. Bell	4394	4294	8688	2	2	2	0.23020258
Etchevery	450	486	936	5	3	4	4.27350427
El Peligro	345	334	679	1	1	1	1.47275405
Gonnet	2798	2778	5576	0	0	0	0
Gorina	886	883	1769	1	1	1	0.56529112
Hernández	1025	967	1992	3	3	3	1.5060241
Lisandro Olmos	2382	2371	4753	9	5	7	1.47275405
Los Hornos	7689	7334	15023	40	36	38	2.52945484
Melchor Romero	3999	3773	7772	14	20	17	2.18733917
Ringuelet	1649	1610	3259	2	2	2	0.61368518
San Carlos	6282	6018	12300	20	22	21	1.70731707
San Lorenzo	4603	4401	9004	33	27	30	3.33185251
Tolosa	5001	4928	9929	5	1	3	0.30214523
Villa Elvira	8281	7795	16076	24	28	26	1.61731774
Villa Elisa	2549	2460	5009	1	1	1	0.19964065

* average of the years 2009 and 2010 (From a total number of 372 cases, in 26 of them, location was not able to be confirmed)

A peak in cases was observed during the months of January and February, when summer falls in the southern hemisphere. During those months, local temperatures reach up to 40ºC (104ºF) and average rainfall is 115 mm each month.

Shigella spp. identified in study patients were *Shigella flexneri* in 66.8% of cases, *S. sonnei* in 25.5% and *S. boydii* in the remaining 7.7%. No significant differences in these proportions of *Shigella* spp. were found, either with regard to the geographical areas studied or with regard to the seasonal fluctuations (data not shown).

Although the highest population density is concentrated in the downtown area, the cases were found mostly in the suburban areas (Table 1). Even though the downtown area and the suburbs have similar architectural characteristics, there are noticeable differences between these two areas with regard to access to adequate sewage disposal and safe drinking water. In the downtown area, 100% of the households have both services, while in the suburbs, access to sewage disposal and drinking water is reduced to 40%-60% of the households. Statistical analysis shows that children under 15 years of age have a 54% additional risk of shigellosis if they live in a household without a sewer ($p = 0.0064$) (Table 3). Further analysis shows that if this risk factor were addressed, and sewers were built in those areas which are lacking them, the probability of children under 15 years of age being infected by shigellosis would be reduced by nearly 35% (etiological fraction among the exposed cases), while the prevalence of the disease would be reduced by 26% for the target population < 15 years (table 3).

When comparing the differences observed among the geographical areas with regard to cases diagnosed with shigellosis, we found a statistically significant difference between the downtown area and the suburbs (Table 4).

When we analyzed the relationship between access to safe drinking water and the incidence of shigellosis, we found that children under 15 years of age living in areas without safe drinking water have a twelve times higher risk of developing the disease, which is a highly statistically significant difference ($p = < 0.00001$).

Table 2. Case prevalence according to age groups

Age	**N**
Under 5 years old	257 (69.1%)
5 to 9 years old	85 (22.8%)
10 to 14 years old	30 (8.1%)
Total	372

Table 3. Prevalence ratio for households with and without sewers

PR*	**CHI square**	**P**	**Efe****	**PEF*****
1.53665891	7.43184754	0.00640795	0.349237497	0.25765072

*Prevalence Ratio for risk factor ** Etiological Fraction among exposed ***Population Etiological Fraction

Table 4. Shigellosis risk by comparing downtown to each suburb

Downtown versus main neighborhoods:	**PR**	**CHI square**	**P**
Abasto	5.58417586	12.9433768	0.000321055000
A. Segui	1.2	-	NS
City Bell	0.55713209	-	NS
Etcheverry	10.3426573	24.7688918	0.000000646322
El Peligro	3.56433257	1.69189284	NS
Gonnet	N/E	N/E	N/E
Gorina	1.37	-	NS
Hernández	3.64485214	4.5260706	0.033382187000
Lisandro Olmos	3.56433257	7.89655978	0.004952891110
Los Hornos	6.1217406	36.5975265	0.000000001452
Melchor Romero	5.29375848	23.2781454	0.000001401840
Ringuelet	1.48522971	-	NS
San Carlos	4.13201774	17.1516322	0.000034511310
San Lorenzo	8.06368887	49.8608339	0.00000000000165
Tolosa	0.73124639	-	NS
Villa Elvira	3.91420299	16.7856076	0.000041849501
Villa Elisa	0.48316666	-	NS

NS : Non significant risk ; PR Prevalence Ratio for risk factor; NE: Non Evaluable

Table 5. Analysis of shigellosis according to availability of safe drinking water

PR*	**CHI square**	**P**	**EFE****	**PEF*****
12.76	335.774	5.3113 E-75	0.9216	0.7089

*Prevalence Ratio for risk factor ** Etiological Fraction among exposed ***Population Etiological Fraction

(Table 5). More detailed statistical analysis shows that the provision of safe drinking water in critical areas would reduce the incidence of shigellosis by more than 92% among population younger than 15 years old, while for the general population the prevalence of the disease would be reduced in 70.9% (Table 5).

Discussion

Bacillary dysentery is one of the most communicable diseases among bacterial acute bloody diarrhoeas [12,13]. Shigellosis is transmitted by fewer than two hundred viable *Shigella* cells [14]. The low dose of microorganisms required for disease explains the frequency of interpersonal transmission as well as the fact that dysentery is a major health problem in crowded populations or in institutional care. Control of endemic cases or of a community outbreak of shigellosis is difficult because of the ease of its transmission among young children.

The present study clearly shows that the highest incidence of the disease is found in those geographical areas which lack sewers or safe drinking water. A

correlation was found between shigellosis and the absence of safe drinking water in households in urban areas, to the point that if such households had a safe drinking water supply, the incidence of shigellosis would be reduced in 92% of children under 15 years of age, while the incidence of shigellosis in the general population would be reduced by 71%.

Each standard case of bloody diarrhoea admitted to a hospital requires a monetary investment of US $976 [15]. This includes professional consultations, hospital supplies, diagnostics and hospital care. The installation cost of a sewer is US 245 per 100 feet, while the cost of a safe drinking water supply is US 323 per 100 feet. [16]. Thus public policies targeting direct access to safe drinking water for the inhabitants of the suburbs are not only desirable from a health status point of view, but also cheaper than the cost of treating the disease.

Individual household strategies such as backyard perforations, at a cost of USD 389 (197 feet deep) per household, [15] is an individual solution that still does not avoid the risk of contamination [17]. Instead, there should be an investment in public services that provide an adequate sewage disposal and safe drinking water to control infectious diarrhoea in urban areas.

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