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Epidemiological trends and patterns of antimicrobial resistance of *Shigella* spp. isolated from stool cultures in two different populations in Southern Israel☆

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ABSTRACT

Southern Israel is inhabited by Bedouins, living in conditions similar to developing countries and Jews, living in conditions similar to developed countries. We determined the epidemiology of *Shigella* spp. in these populations. We retrospectively reviewed *Shigella* spp. stool isolations between 2005–2009. Overall, 3295 isolates were analyzed. *S. sonnei* was isolated in 2057/3295 (62.4%) and *S. flexneri* in 1058 (32.1%). *S. sonnei* was isolated in 1567/1707 (91.8%) from Jewish patients and *S. flexneri* in 931/1542 (60.4%) from Bedouin patients. Ampicillin resistance increased linearly from 217/373 (58.2%) in 2005 to 186/256 (72.7%) in 2009, ($P < 0.001$). Trimethoprim-sulfamethoxazole resistance decreased linearly from 328/373 (87.9%) in 2005 to 133/256 (51.9%) in 2009 ($P < 0.001$). Higher resistance of *Shigella* spp. to ampicilin and trimethoprim-sulfamethoxazole were found in Jewish patients: 1527/1706 (89.5%) versus 977/1542 (63.4%) ($P < 0.0001$), 1635/1706 (95.8%) versus 1026/1542 (66.5%) ($P < 0.0001$). The epidemiology of *Shigella* spp. infections can differ in populations residing in the same geographical area.

1. Introduction

Shigella spp. are known to be an important cause of acute dysentery worldwide (Kotloff et al., 1999). *S. flexneri* is more common in developing countries (Kotloff et al., 1999, Zafar et al., 2009), whereas *S. sonnei* is more frequently isolated in developed countries (Vrints et al., 2009). Improved sanitary conditions in Thailand, Iran and Turkey have been shown to be associated with a shift of shigellosis from *S. flexneri* to *S. sonnei* predominance (Bangtrakulnonth and Vieira, 2008, Ceyhan et al., 1996, Ikkah and Mehr-Movahead, 1988, Ranjbar et al., 2008).

The Negev region of Southern Israel is a heterogeneously populated area, inhabited by two major populations, Jewish and Moslem Bedouin. The Jewish population's lifestyle and standards of living are comparable with those of developed countries, whereas the Bedouin population is still in transition from a semi-nomadic lifestyle to permanent settlement. The Bedouin population has larger families, less income/capita, live in crowded housing conditions. The educational and socioeconomic conditions of the Bedouin population are considered less favorable compared with the Jewish population. The Bedouin population life style is comparable with that of a developing country. The two populations have access to the same medical services. Medical insurance in Israel is universal and there are no financial barriers in availability of hospital services in southern Israel. In a study delineating *Shigella* spp. isolation patterns from stool cultures in southern Israel between 1988–1992, *S. flexneri* was more common in the Bedouin population whereas *S. sonnei* was more common in the Jewish population (Finkelman et al., 1994). Two separate peaks of isolation of *Shigella* spp. were identified in summer and winter in the Jewish population versus only one annual peak in the summer in the Bedouin population (Finkelman et al., 1994).

During the last decade, the sanitary infrastructure in many of southern Israel towns inhabited by the Bedouin population has developed considerably. This development may have the potential to alter the epidemiology of *Shigella* spp. infections in the Bedouin population. In the present study, we performed a retrospective analysis of microbiological data on *Shigella* spp. isolations between 2005–2009 and sought to determine if the epidemiology of *Shigella* spp. in southern Israel has changed in accordance to the improved local sanitary conditions of the population.

2. Methods

The Soroka University Medical Center is the only referral hospital for the Negev area of southern Israel. All the patients with an acute gastrointestinal disease requiring hospitalization, rehydration or further evaluation are referred to this hospital. Approximately 60%

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of the population in southern Israel is insured by Clalit Health Services and all stool cultures from its primary care clinics in southern Israel are referred to the microbiology laboratory at Soroka University Medical Center.

Data on *Shigella* spp. recovered from stool cultures at the microbiology laboratory of the Soroka University Medical Center, Beer-Sheva, Israel, between 2005–2009 were analyzed retrospectively; species distribution, ethnicity, antibiotic resistance patterns and isolation seasonality were recorded. Duplicate *Shigella* spp. isolations from the same patient within a 30 days period were excluded as well as those cases where the speciation of isolates was not available. The peak seasonal isolation of the common *Shigella* spp. (*S. flexneri* and *S. sonnei*) was calculated by comparing the average proportions of *Shigella* spp. isolations in specific bi-monthly periods with the average isolations during the other bi-monthly periods of the year.

Shigella spp. isolation was performed as previously published (Finkelman et al., 1994).

The study was approved by the Soroka University Medical Center ethical committee.

2.1. Statistical analysis

Data on antibiotic resistance were analyzed using Chi square or Fisher tests as required. Analysis of the proportions of the different *Shigella* spp. were done using the Two-sample test for binomial proportions. Linear trends of *Shigella* spp. isolations were analyzed by the extended Mantel-Haenszel Chi square analysis of linear trends in proportions.

3. Results

3.1. Epidemiological trends of Shigella spp. isolation

A total of 3498 *Shigella* stool isolates were recorded; 203 isolates were excluded from the study (170 duplicates from the same patient within 30 days and 33 lacking the details on the specific *Shigella* spp.). A total of 3295 isolates were analyzed; 374, 1022, 660, 983 and 256 in the years 2005, 2006, 2007, 2008 and 2009, respectively. *S. sonnei* was isolated in 2057/3295 (62. 5% of *Shigella* isolates), *S. flexneri* in 1058 (32.1%), *S. boydii* in 139 (4.2%) and *S. dysenteriae* in 41 (1.2%).

Analysis of the linear trends of *Shigella* spp. isolation revealed a decrease in *S. flexneri* isolation among the total population studied from 120/374 (32.1%) in 2005 to 62/256 (24.2%) in 2009 ($P < 0.002$). A linear increase in *S. boydii* isolation was recorded from 16/374 (4.3%) in 2005 to 72/256 (28.1%) in 2009 ($P < 0.001$). A non significant linear trend towards decreased isolation of *S. sonnei* was recorded from 235/374 (62.8%) in 2005 to 117/256 (45.7%) in 2009, $P = 0.059$. A non-significant linear trend towards increased isolation of *S. dysenteriae* was recorded from 3/374 (0.8%) in 2005 to 5/256 (1.95%) in 2005, $P = 0.091$ (Fig. 1).

Data on patient ethnicity were available in 3249/3295 (98.6%) *Shigella* spp. isolates; 1707/3249 (52.5%) isolates were obtained from Jewish patients and 1542/3249 (47.6%) were from Bedouin patients. *S. sonnei* was the most common isolate from Jewish patients (1567/1707, 91.8%), while *S. flexneri* was the most common isolate in Bedouin patients (931/1542, 60.4%), (Table 1).

Among *Shigella* isolates from Bedouin patients, the isolation of *S. flexneri* decreased linearly during the study period, from 99/187 (52.9% of all *Shigella* isolates) in 2005 to 52/196 (26.5%) in 2009 ($P < 0.001$). Increased isolation rates of *S. flexneri* were recorded in 2007: 339/380 (89.2% of all *Shigella* spp. isolates from Bedouins during 2007). Among Jewish patients, no significant linear trends were recorded in *S. flexneri* isolation, from 17/182 (9.3%) in 2005 to 9/55 (16.4%) in 2009 ($P = 0.101$).

No significant linear changes were recorded in the isolation rates of *S. Sonnei* among Bedouin patients: 77/187 (41.1%) in 2005 to 78/196 (39.8%) in 2009 ($P = 0.128$). No linear change in isolation of *S. sonnei* from Jewish patients was recorded: 157/182 (86.3%) in 2005 to 38/55 (69.1%) in 2009 ($P = 0.262$). A linear increase in *S. boydii* isolation in Bedouin patients was recorded during the study period from 9/187 (4.8%) of all *Shigella* spp. isolates in 2005 to 65/196 (33.2%) in 2009 ($P < 0.001$). No significant change was recorded in the isolation of *S. boydii* among Jewish patients: 7/182 (3.8%) in 2005 and 6/55 (10.9%) in 2009, $P = 0.270$.

3.2. Bi-monthly distribution of Shigella spp. isolates

The peak seasonal isolation of *Shigella* spp. was recorded during July-August for *S. flexneri* in both Bedouin (277/931, 29.8%, $P < 0.001$ compared to an average of 14.1% in the other bi-monthly periods of the year) and Jewish patients (37/106, 34.9% $P < 0.001$ compared to an average of 13% in the other bi-monthly periods of the year) (Fig. 2). The peak seasonal isolation of *S. sonnei* was recorded in July-August for Bedouin patients (171/468, 36.5%, $P < 0.001$ compared to an average of 12.7% in the other bi-monthly periods of the year) while in Jewish patients the peak occurred in 3 consecutive bi-monthly periods from March to August, with an average of 21.8% (349/1567 for March-April, 340/1567 for May-June and 334/1567 for July-August) versus an average of 11.6% in the other bi-monthly periods of the year ($P < 0.001$).

3.3. Shigella spp. antibiotic resistance patterns

Ampicillin, trimethoprim/sulfamethoxazole (TMP/SMX), nalidixic acid, ceftriaxone and ofloxacin resistance was present in 2536/3294

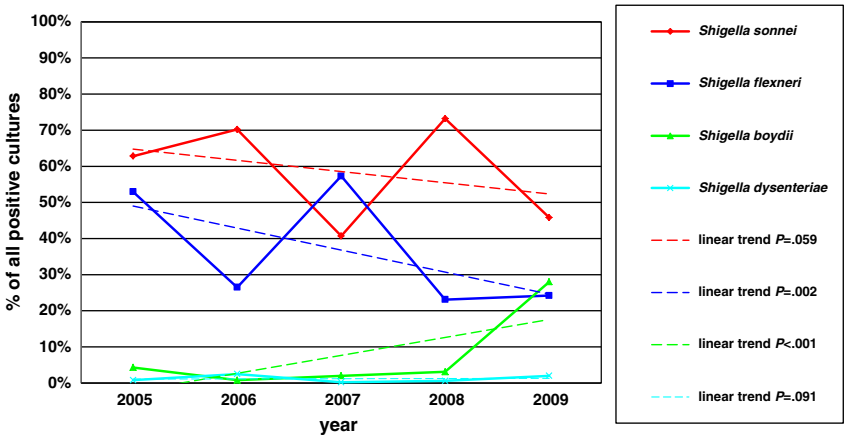

Fig. 1. Distribution of all *Shigella* spp. isolates in the total study population.