

## Salmonella burden in Lebanon

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### SUMMARY

Salmonellosis is a disease that represents a major public health concern in both developing and developed countries. The aim of this article is to evaluate the public health burden of *Salmonella* illness in Lebanon. The current scope of the *Salmonella* infection problem was assessed in relation to disease incidence and distribution with respect to age, gender and district. Factors that provide a better understanding of the magnitude of the problem were explored and highlighted. Data reported to the Epidemiologic Surveillance Department at the Lebanese Ministry of Public Health between 2001 and 2013 was reviewed. Information obtained was compared to information reported regionally and globally. The estimated true incidence was derived using multipliers from the CDC and Jordan. A literature review of all published data from Lebanon about *Salmonella* susceptibility/resistance patterns and its serious clinical complications was conducted. The estimated incidence was 13.34 cases/100 000 individuals, most cases occurred in the 20–39 years age group with no significant gender variation. Poor and less developed districts of Lebanon had the highest number of cases and the peak incidence was in summer. Reflecting on the projected incidence derived from the use of multipliers indicates a major discrepancy between what is reported and what is estimated. We conclude that data about *Salmonella* infection in Lebanon and many Middle Eastern and developing countries lack crucial information and are not necessarily representative of the true incidence, prevalence and burden of illness.

**Key words:** *Salmonella*, *Salmonella* Typhi, *Salmonella* Paratyphi, *Salmonella* Typhimurium salmonellosis.

### INTRODUCTION

Salmonellosis is a foodborne disease that represents a major public health concern in both developing and

developed countries [1]. The illness ranges from a self-limiting gastroenteritis by non-typhoidal *Salmonella* that usually resolves in 4–7 days [2], to a more protracted life-threatening typhoid fever [3].

Gastroenteritis caused by non-typhoidal *Salmonella* spp. is usually a self-limiting illness, but in 1–4% of patients, mainly the elderly and the immunosuppressed, bacteraemia may occur resulting in serious complications such as osteomyelitis, endocarditis or

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visceral abscesses [4]. In the United States, most food-borne illnesses are caused by norovirus (58%) and non-typhoidal *Salmonella* spp. (11%). Both agents are the leading cause of hospitalization (35%) and death (28%) in those with gastroenteritis [5]. Majowicz *et al.* [6] estimated the international burden of non-typhoidal *Salmonella* gastroenteritis to be 93.8 million cases per year, resulting in 155 000 deaths. This reflects the enormous economic burden of the disease in both developing and developed countries [6]. The emergence of multidrug-resistant (MDR) *Salmonella* spp. to frequently used antibiotics tends to exaggerate the problem further. The rise in antimicrobial resistance has reduced the choice of effective treatment options and subsequently increased the treatment cost and risk of complications [7].

The clinical illness caused by *Salmonella enterica* serovar Typhi (*S. Typhi*) infection manifests as typhoid fever, a major public health problem in developing countries, particularly in the Indian subcontinent and South East Asia [8]. In endemic areas, the majority of cases occur in individuals aged <5 years. Clinical presentation varies from septicaemia in neonates, to diarrhoea in infants and to lower respiratory tract infections in older children [9]. Typhoid fever is an endemic disease in Lebanon and the risk of outbreaks is still present [10]. Antibiotics have a confirmed and beneficial role in the treatment of typhoid fever; however, their role in the management of non-typhoidal *Salmonella* gastroenteritis is questionable [11, 12]. The emergence and worldwide spread of MDR *S. Typhi* strains has led to an increase in morbidity, mortality and treatment failures [9].

The aim of this article is to estimate the incidence of *Salmonella* infections in Lebanon in relation to age, gender, district and seasonal variation. The current Lebanese reporting system was assessed for its adequacy and reflection of the true burden of *Salmonella* illness in the country. The problem of antibiotic resistance in *Salmonella* isolates was addressed as well as the serious complications associated with salmonellosis.

## METHODS

This is a descriptive epidemiological study based on records found at the Epidemiologic Surveillance Department at the Lebanese Ministry of Public Health (LMPH) between 2001 and 2013. *Salmonella* illness was defined as a patient with diarrhea, fever, and abdominal cramps and a positive fecal culture

[2]. Cases were reviewed for the following information: annual incidence, age, gender, district and seasonal variation. Statistical analysis was done using the two-tailed t-test to determine if there was any statistically significant difference in the incidence between males and females. Results with a *P* value of  $\leq 0.05$  were considered statistically significant. Since 2009 data related to *S. Typhi* were separated from non-Typhi as per the records of LMPH. An estimation of the annual incidence was done using the total yearly number reported divided by the estimated number of the population residing in the country. The burden of *Salmonella* illness was assessed through adjusting the reported incidence to account for the unreported cases using data from CDC, England and Jordan. A literature review of all published data from Lebanon about *Salmonella* susceptibility/resistance patterns and its serious clinical complications was conducted.

## RESULTS

According to LMPH records, the average number of reported cases of *Salmonella* infection over the last 13 years was 611 (range 398–891) cases per year (Fig. 1). The estimated number of the Lebanese population residing in the country in 2013 was about 4.13 million [13], in addition to around 450 000 Palestinian refugees [14]. Thus, the estimated incidence of reported *Salmonella* cases per year was about 13.34 cases/100 000 individuals.

Since 2009, the epidemiological surveillance department at LMPH started to differentiate between *S. Typhi*/Paratyphi and non-Typhi *Salmonella* spp. (Fig. 2). Their data revealed that the number of non-typhoid *Salmonella* cases reported is consistently lower than that of *S. Typhi*/Paratyphi.

The 20–39 years age group was most affected by *S. Typhi* and non-Typhi, with an average of 151 cases per year (around 25% of reported *Salmonella* cases). Infants and toddlers as well as those aged between 10 and 19 years were also commonly affected. The lowest incidence was seen in individuals aged 5–9 years and those aged >40 years (Fig. 3).

There was no significant gender difference in the incidence of salmonellosis over the last 13 years ( $P = 0.834$ ). The annual average number of reported *Salmonella* cases in males was 291 compared to 298 for females (Fig. 4).

The distribution of cases along the six governorates of Lebanon is shown in Figure 5a. The North had the largest number of cases (178 cases per year) followed by Bekaa (149 cases per year) then Mount Lebanon

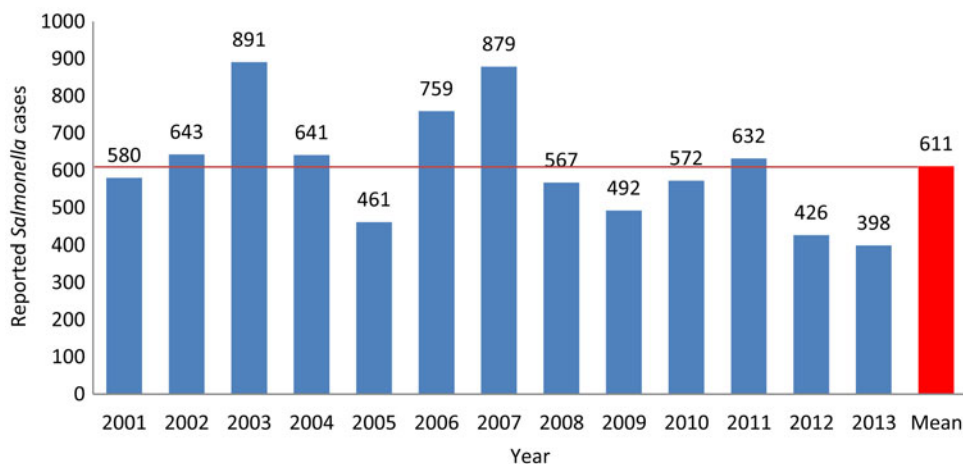


Fig. 1. Reported *Salmonella* cases per year 2001–2013.

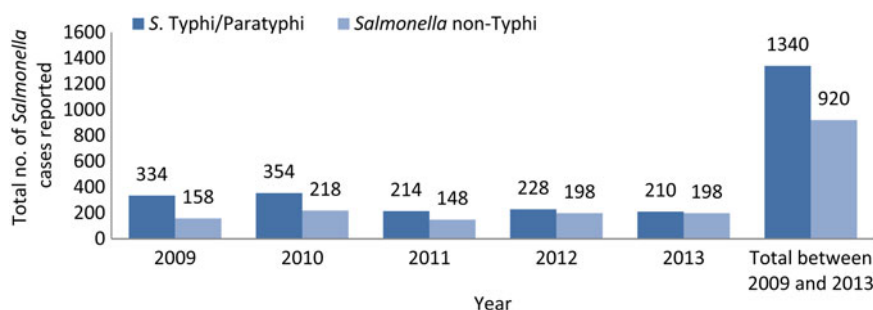


Fig. 2. Reported *Salmonella* infections in Lebanon between 2009 and 2013 classified into Typhi and Paratyphi vs. non-Typhi.

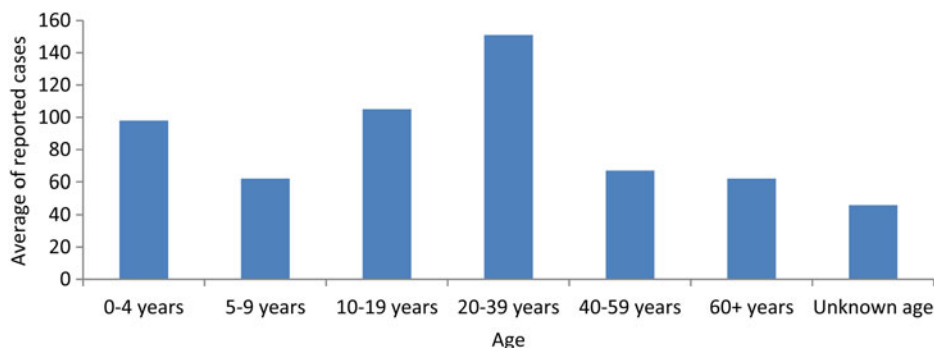


Fig. 3. Distribution of reported *Salmonella* cases in Lebanon according to age during 2001–2013.

(122 cases per year), while the lowest was in Beirut (26 cases per year).

Monthly distribution of reported *Salmonella* infections is shown in Figure 6. The peak incidence was in summer, mainly July and August (77 and 73 cases per year, respectively). The incidence decreases in autumn and winter and starts rising again in spring, peaking in the hot season.

According to CDC it is estimated that for every one reported laboratory-confirmed *Salmonella* case, there are 29 unconfirmed cases [15]. Attempting to project this multiplier to the available Lebanese data will render the annual number of cases to be  $\geq 4/1000$  individuals. Meanwhile, in Jordan it is believed that for each laboratory-confirmed *Salmonella* infection case there are about 273 infected persons in the

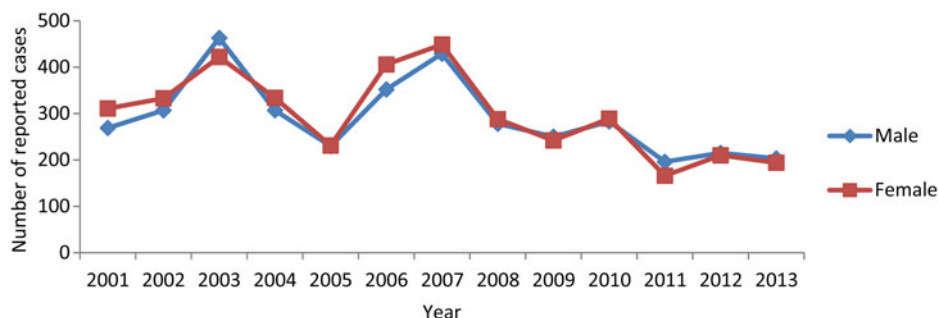


Fig. 4. Distribution of reported *Salmonella* cases in Lebanon according to gender.

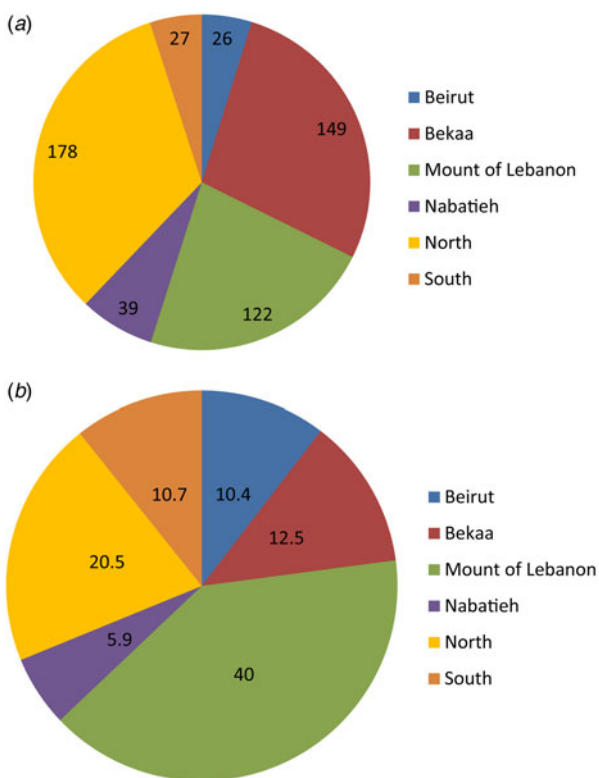


Fig. 5. (a) Percentage distribution of *Salmonella* cases along the six governorates of Lebanon between 2001 and 2013. (b) Percentage distribution of individuals residing in each of the six governorates of Lebanon [21].

community. If we use this multiplier which is the only one used to reflect the incidence in the Eastern Mediterranean Region (EMRO), the estimated annual incidence will be about 4/100 individuals [6, 16] in the absence of similar multipliers from Lebanon.

**DISCUSSION**

The estimated incidence of reported *Salmonella* infection in Lebanon is 13.34/100 000. It is lower than that

reported by the CDC in the United States in 2012 (16.42/100 000) [17] and from Israel 30.3/100 000 in 2009 [18]. This can be attributed to differences in the reporting systems and the adequacy of the surveillance measures in those countries compared to Lebanon. Reporting of *Salmonella* infections in Lebanon is based on clinicians’ and hospitals’ reports where patients with clinical symptoms and positive microbiology are reported. Clinical microbiology laboratories are not instructed by Lebanese health authorities to report their positive *Salmonella* results. Lower incidences were also reported from some neighbouring Arab countries with 2.3 and 13 cases/100 000 in Jordan and Egypt, respectively. The greatest burden of the illness is in India with 980 cases/100 000 [19].

The surveillance system in Lebanon compared to that in the United States is less developed and less efficient and the Lebanese laboratories do not report their positive results to LMPH. This may indicate that the projected number derived from the CDC multiplier (4/1000) is an underestimate of the true incidence of the disease in Lebanon. As such, the reported cases merely represent the tip of a *Salmonella* infection pyramid. Similarly, data published from Jordan further support this concept where the discrepancy between confirmed cases and true incidence is explained by underreporting to the Ministry of Health and the suboptimal quality of laboratory specimen handling in relation to preservation and transportation [16]. It is very unlikely that the completeness and ascertainment of laboratory-confirmed cases of *Salmonella* would be the same across all EMRO countries given the varying methods of surveillance and levels of socioeconomic development. The Jordan multiplier remains the closest conservative estimate of the *Salmonella* incidence in Lebanon. This verifies the need for establishing a local Lebanese multiplier. According to Wheeler *et al.* [20], in England the ratio of cases in the

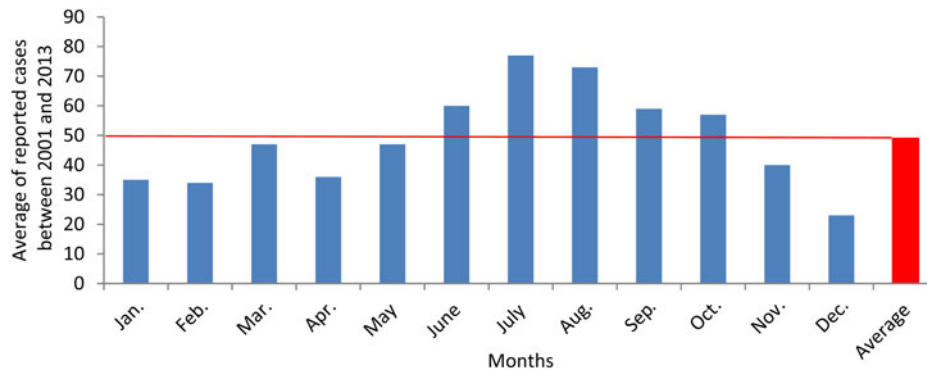


Fig. 6. Seasonal distribution of *Salmonella* infection in Lebanon.

community to cases reaching national surveillance is 3:2:1. He described a surveillance pyramid and estimated loss of cases at different levels, where in every 1000 individuals 2.2 *Salmonella* cases are encountered in the community. Of these cases 1.6 present to general practice, 0.8 are detected by positive stool sample and 0.7 are reported to national surveillance. Due to the absence of similar information in Lebanon, this reporting pyramid cannot be implemented.

Of the six governorates of Lebanon, the highest reported numbers were from the North and Bekaa; yet, the highest population concentration is in Mount Lebanon (Fig. 5b) [21]. This is not surprising since Bekaa and North are the most impoverished and deprived areas. Salmonellosis is a foodborne disease and its prevalence is associated with the standards of hygiene and public health infrastructure [22, 23].

There was no significant gender variation in reported cases, similar to reports from the United States and Canada [24, 25]. However, the age distribution in Lebanon was different from that of the United States. According to CDC, *Salmonella* infections are most common in children aged <5 years [24]. This is in concordance with information published from the EMRO region where the higher incidence in those aged <5 years was attributed to several factors including a higher likelihood of being more exposed to infected items by mouth and their immune system which is still developing [18]. The 20–39 years age group was that most commonly affected by *Salmonella* in Lebanon. This can be explained by the fact that salmonellosis is a foodborne disease with eating habits playing an important role in its transmission [2]. In a published report from Lebanon observing cases of typhoid fever between 2000 and 2008, drinking water was a less likely vehicle

of transmission due to the fact that most Lebanese consume bottled water. However, water used for bathing, washing and cooking, remained a possible explanation since it was widely contaminated [26]. According to PulseNet Lebanon, a foodborne diseases tracking network, 65% of 665 cases of food poisoning between 2011 and 2012 were attributed to *Salmonella*, and chicken and meat were the most frequent food product identified [27]. The very young and elderly population are less affected by *Salmonella*. This might be explained by the fact that they are less mobile than other adult categories. Besides being more housebound, they are more likely to consume bottled water and formula milk and escape the risks of eating outside home. Lebanon has been experiencing a nutritional transition in food choices during the past two decades from the typical Mediterranean home-prepared diet to the fast-food trend. The dietary habits of young adults are affected by the fast-food market [28]. The list of fast-food markets and restaurants violating health standards and regulations is increasing in Lebanon, necessitating an emergency and well publicized governmental initiative to maintain food safety [29]. The results and outcome of this campaign are too early to assess.

Our data show seasonality in the occurrence of *Salmonella* with increased incidence in the warm season of July and August. This is similar to reports from CDC [24] and Saudi Arabia where 64.5% of *Salmonella* outbreaks occurred during the summer months [30].

Information about the serotypes of *Salmonella* isolates encountered and their antimicrobial susceptibility/resistance profiles are lacking from LMPH data. Between 2009 and 2013 more typhoid cases than nontyphoidal *Salmonella* cases were reported. This finding contradicts results published from a tertiary-care

medical centre in Lebanon. Of all *Salmonella* isolates recovered between 2000 and 2011, Enteritidis and Typhimurium represented 18–44% and 12–34%, respectively, compared to Typhi (0–23%) [31]. In 2012, the CDC reported that Enteritidis (18%) and Typhimurium (13%) were the most common serotypes [17]. According to Somily *et al.*, the main serogroups found in Saudi Arabia were D1 (24%), B (24%) and C (11%) [32], which include the serotypes, *S. Enteritidis*, *S. Typhi* (from group D1) and *S. Typhimurium* (group B). According to LMPH data, reported *S. Typhi* cases appear to have declined since 2010. There is no obvious reason for this decline and it is unclear whether the trend will continue.

Antibiotic susceptibility/resistant patterns are not included in the information collected from the epidemiology surveillance unit in LMPH's records. Published literature from Lebanon reveals that antibiotic resistance in *Salmonella* isolates is a major problem. According to Araj *et al.* [31], *S. Typhi* remained uniformly susceptible to third-generation cephalosporins, trimethoprim/sulfamethoxazole, fluoroquinolones and ampicillin until 2004. Since then, resistance to ampicillin and trimethoprim/sulfamethoxazole has begun to emerge, with susceptibility ranging from 65% to 100% to ampicillin, 43–100% to trimethoprim/sulfamethoxazole and no resistance to third-generation cephalosporins or fluoroquinolones being detected [31].

The situation regarding non-Typhi *Salmonella* [31] is different from that of *S. Typhi*, showing higher resistant rates to antimicrobial agents. Fluctuation in susceptibility to ampicillin ranged from 65% to 90% and to trimethoprim/sulfamethoxazole from 82% to 98% between 2000 and 2011 [31]. Compromised susceptibility to third-generation cephalosporins and fluoroquinolones has been detected since 2005 where susceptibility to cefotaxime was 88–100% and ciprofloxacin 91–100% [31]. Between 2008 and 2011 nalidixic acid resistance was detected, ranging between 25% and 57% [31]. Extended spectrum beta-lactamases producing *Salmonella* isolates were reported from Lebanon by Moubareck *et al.* in 2005 [33] and by Matar *et al.* in 2008 [34] and 2010 [35].

*Salmonella* spp. with reduced quinolone susceptibility has also been reported from the Middle East. Nalidixic acid resistance was 46% and 59% in Saudi Arabia and Palestine, respectively [32–36]. Reduced susceptibility to ciprofloxacin in non-typhoidal *Salmonella* was also observed from Kuwait (14.2%) and the United Arab Emirates (7.4%) [37]. A CDC

report published in 2013 revealed that resistance or partial resistance to ciprofloxacin was 3% and 67% in *Salmonella* non-Typhi and Typhi isolates, respectively [38]. MDR *S. Typhi* is a major problem in the Indian subcontinent where many believe that what is observed merely represents part of a larger resistance problem [39]. As mentioned previously, antimicrobial resistance in *S. Typhi* isolates in Lebanon is still rare [26] but the situation is different for non-Typhi *Salmonella* spp. where higher resistance rates to antimicrobial agents are encountered. Peculiar to Lebanon is the haphazard distribution and easy availability of antibiotics, lack of stewardship programmes and occasional lack of proper record keeping in Lebanese hospitals [40]. There is extensive consumption of broad-spectrum antibiotics such as third-generation cephalosporins and quinolones where more than 15% of the total national consumption consists of quinolones [40], an aspect that has been shown to be a major risk factor for the development of resistance [41]. In this respect, tracking antibiotic consumption and the emergence of resistant strains throughout the year may provide valuable information in the struggle against resistance.

Few case reports have been published from Lebanon describing the extra-gastrointestinal complications associated with salmonellosis. These complications were noted in both the immunocompetent and immunocompromised and were associated with variable clinical disease spectrum and serious consequences. These extraintestinal complications of salmonellosis are associated with more protracted treatment courses and poorer outcomes [42]. The reported complications of *S. Typhi* included rhabdomyolysis [43], genital ulceration [44] and reversible encephalopathy [45], while septic arthritis with bacteraemia complicated *S. Enteritidis* infection [46]. Reports from Israel suggested that bacteremia and urinary tract infections were the main extraintestinal manifestations [47]. In Spain, extraintestinal non-typhoid *Salmonella* serotype infections accounted for 1.8% of all salmonellosis cases and most of these infections occurred in children and the elderly [48]. Reports of focal infections like meningitis, abscesses, osteoarthritis and arterial infections caused by non-typhoid *Salmonella* have been published from the UK [49], where immunosuppression was the main risk factor [47]. Less frequently encountered complications of typhoid fever include splenic and sub-phrenic abscesses, pancreatitis, acute acalculus cholecystitis and wound infection [50–52].

## CONCLUSION AND RECOMMENDATIONS

Salmonellosis is a major foodborne infectious disease with significant burden in both developed and developing countries. It is difficult to estimate the true burden of the illness in Lebanon and many Middle Eastern countries since available data lack crucial information and may not be fully representative. Despite their limitations, the existing information from the LMPH and the medical literature emphasizes the importance of salmonellosis in Lebanon and the problems associated with the infection, mainly of a socioeconomic and treatment-related nature. The emergence of antibiotic-resistant strains will complicate treatment and increase the cost of therapy. Despite the fact that those affected most in our study were aged between 20 and 39 years, it is the elderly, those with multiple chronic illnesses, the immunosuppressed, and those aged <5 years that remain at higher risk of serious complications if affected.

The epidemiological surveillance department at LMPH has to increase its surveillance efforts and start implementing mandatory periodic laboratory reporting of positive *Salmonella* cultures from various body fluids and sites. There is a need for a nationwide survey involving laboratories and general practitioners in order to estimate a multiplier more representative of the Lebanese situation. Information about antibiotic susceptibility/resistance patterns as well as *Salmonella* species must be included in the surveillance system. Antibiotic stewardship programmes are also urgently needed since their continued absence will only result in sustaining the increasing rates of resistance and an ever-increasing difficulty in the treatment.

The government has to engage in multiple campaigns to educate the public about food safety and the risk of foodborne diseases and maintain current efforts on food safety monitoring in order that they become standard procedure. There is a marked need for increased alertness to halt any disease propagation in the region. This concern stems from the fact that both the country and the region are passing through a period of drought and decrease in rain levels [53]. Another compounding factor is the mass population displacement due to political instability and the current crises in Syria and Iraq which is spilling over to neighbouring countries.

## DECLARATION OF INTEREST

None.

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