Salmonellosis in Saudi Arabia; an underestimated disease?

Abdullah F. Alsayeqh
Veterinary Medicine, College of Agriculture and Veterinary Medicine, Qassim University
6622, Buraidah, 51452, Saudi Arabia

ABSTRACT

Salmonellosis is one of the most commonly reported foodborne diseases that affect human health with subsequent economic losses. Salmonellosis is considered a disease with public health burden globally. Efficient surveillance systems for diseases monitoring and reporting are important for measuring health burden and planning controlled measures based. In this study, characterization of salmonellosis in KSA from 2013-2017 is presented. Incidence data were obtained from the Ministry of Health’s (MoH) data for laboratory-confirmed cases. Extracted incidence data were analyzed according to the nationality of the patients (Saudi and non-Saudi), gender (male and female), age, health provinces (20 health provinces throughout KSA), and months. From 2013-2017, there were 5202 (mean; 1040.4) cases of salmonellosis reported. Average incidence rate over 5 years period per 100000 people (A.I.R/5YR) was 3.30. A.I.R/5YR was 3.451 for Saudi patients and 2.995 for non-Saudi patients (p-value: 0.0032). Among male and female, A.I.R/5YR was 3.429 for male and 3.316 for female (p-value; 0.014). Among < 15 and ≥ 15 age groups, A.I.R/5YRs were 6.04 and 2.221 for < 15 and ≥ 15 (p-value: 0.613), respectively. Salmonellosis highest A.I.R/5YR according to health provinces 14.13 in the Eastern province. The highest incidences by months were reported from August to October. In comparison to the reported regional and global incidence rates for salmonellosis, reported rates in KSA are likely to be underestimated. In estimating salmonellosis incidence, and in where a country-specific multiplier is not available, it is possible to apply a multiplier of neighbouring country or of the region to calculate a more accurate disease incidence. Thus, and by re-estimating incidence according to regional and global multipliers, the officially reported incidences of salmonellosis in KSA are likely to be underestimated by 37.6 to 345.36 folds.

*Correspondence to: Dr.abdulah@hotmail.com

Article History
Received: 01 Sep 2020
Accepted: 01 Oct 2020

1. INTRODUCTION

Globally, in developed and developing countries, human are affected by more than 200 foodborne (caused by microbial and/or chemical contaminants) diseases resulting in high public health burden in terms of morbidity and mortality with the subsequent health complications, reduced productivity, and economic losses (Kirk et al., 2015). Therefore, and in order to improve food safety by preventing and controlling foodborne diseases, it is of importance that national, regional, and global estimates such diseases’ burden are measured.

Of the disease burden measures, are the disability-adjusted life years (DALY) and quality-adjusted life years (QALY). Both DALY (measures a disease burden or risk factor) and QALY (measures intervention results) rely on availability of morbidity and mortality data. DALY metric measures burden of disease (BoD) in a population (Sassi, 2006, Murray & Lopez, 2013). It accounts for not only premature mortality but also disability caused by a specific disease or injury. DALY, which is a time-based indicator, measures years of life lost because of premature mortality combined with years of life lost because of time lived suffering from the disease (Murray & Lopez, 2013).

Accurate incidence rates are considered a prerequisite for DALY estimation (Gibbons et al., 2014). Incidences are estimations are confounded by the fact that only a small portion of all foodborne diseases that occur every year are related to reported outbreaks. However, data obtained by national foodborne outbreaks surveillance systems provide useful information for identifying/removing food from the market, prevent additional disease incidence, and address gaps in the food safety plans to prevent feature outbreaks.

In human, non-typhoidal Salmonella spp. (NTS) cause 153000000 (range: 64700000-
SPECTOR AND KENYON, 2012; JARVIS ET AL., 2010). The majority (86%) of cases are foodborne (MAJOWICZ ET AL., 2010). S. ENTERITIDIS and S. TYPHIMURIUM cause 80% of human salmonellosis cases (SCALLAN ET AL., 2011).

The infection can be acquired through ingestion of contaminated foods of animal origins including poultry, eggs (MARCUS ET AL., 2007), beef (HAEGHEBAERT ET AL., 2001), and pork (HAUSER ET AL., 2010). Raw milk (JAYARAO ET AL., 2006), contaminated fresh produce (HANNING, NUTT, & RICKE, 2009), spices and herbs (ZWEIFEIL AND STEPHAN, 2012), contact with pets, rodents, livestock (SANCHEZ ET AL., 2002), and contaminated environment are also sources for infection (WILLIAMS ET AL., 2016). Salmonella spp adaption, survival, and growth at a wide range of environmental parameters represent a food safety concern during processing, storage, and preparation of various foods (SPECTOR AND KENYON, 2012; JARVIS ET AL., 2016). Acute salmonellosis symptoms include fever, chills, nausea, diarrhea, abdominal cramps, myalgia, and headache (ACHESON AND HOHMANN, 2001). Grossly bloody gastroenteritis usually lasts for 7-10 days or less. The disease may rarely develop into bacteremia, focal, and endovascular infections (JONES ET AL., 2008).

In human, salmonellosis have effects due to pain and complications, lost productivity (KIRK ET AL., 2015), products recalls (ZARE ET AL., 2017; SEYS ET AL., 2017), foodservice (ARNESEN AND FOSTER, 2016) and manufacturing disruptions (JOURDAN-DA ET AL., 2018) losses. It is estimated that salmonellosis causes a loss of 1.62 Quality Adjusted Life Day and costs $ 5337 per case (MINOR ET AL., 2015). It is estimated that human salmonellosis costs the US economy $ 2.4 billion a year (FOLEY AND LYNNE, 2008, SCHARFF, 2015). Globally, salmonellosis health burden was reported 4067929 (range: 2486092-6271290) foodborne DALYs (KIRK ET AL., 2015).

In restaurants in Saudi Arabia, and among consumers, risk factors for foodborne diseases such as salmonellosis include cross-contamination, undercooking, and incorrect holding temperature. Limited or no food safety training and poor personnel hygienic practices are of concern among foodservice sector’s workers (Alsayeqh, 2015).

Salmonellosis is the only zoonotic foodborne disease that is currently notifiable in KSA. In this study, and in order to compare salmonellosis incidence to that reported regionally and globally, a descriptive study of salmonellosis incidence in the country from 2013-2017 is provided presented. An underestimated disease conclusion may indicate an underperforming disease surveillance system.

2. MATERIALS AND METHODS

2.1. Incidence data source

Salmonellosis-related incidence data were obtained from Ministry of Health’s records for the period 2013 to 2017. Incidence data according to nationality (Saudi and non-Saudi), gender (male, female), age (< 1, 1-4, 5-14, 15-44, and ≥ 45 year old), months, and health provinces were extracted, grouped and analyzed. Data analysis was based on five- year population averages of 10.614, 10.515, 7.076, and 3.314 million for Saudi male, Saudi female, non-Saudi male, and non-Saudi female, respectively.

2.2. Case definition

Only laboratory-confirmed cases and reported as “salmonellosis” were considered in this study.

2.3. Outbreaks and presumptive foodborne disease cases

To reflect underestimation of foodborne diseases (un-notifiable and notifiable such as salmonellosis), the records also contain data for all registered foodborne outbreaks (of unidentified causes) as of the year 2015 (to 2017). The outbreaks were classified according to public-source and home-based, nationality, gender, and age. Data for patients admitted to hospitals emergency’s rooms with symptoms of presumptive foodborne illness were recorded were available for the year 2010 to 2012.

2.4. Health provinces information

The population data for health provinces in KSA were obtained records of the General Authority for Statistics (GAS, 2018). Riyadh, Jeddah, the Eastern, Makkah, and Madinah are the largest provinces in KSA with 63% of the Kingdom’s total population. Makkah, Madinah and Jeddah are located in western KSA where Riyadh is in the central.

2.5. Literature search

The databases (PubMed, ScienceDirect, SpringerLink, and Google Scholar) were searched in November, 2018, for salmonellosis-related data for the period 1997 to 2017. The search was performed to obtain articles that contain the terms Saudi Arabia and non-typhoidal...
Salmonella, salmonellosis; outbreak, incidence, in articles’ title and/or abstract.

2.6. Statistical Analysis

Statistical analysis was performed using SPSS software version 20. In addition to analyzing data to calculate means, percentages, and incidence rate, the two-tailed t-test was performed to test if there are statistical significance (at p-value: <0.05) differences in incidences according to nationality, gender, and age.

3. RESULTS

In KSA, during 2013-2017, there were 5202 total reported cases of salmonellosis. This represents average incidence rate over 5 years period (A.I.R/5YR) 3.30 (Table 1) of the disease in the general population. From 2013-2015, there were fluctuations in incidences then increases in 2017.

3.1. Nationality and Gender

According to nationality of patients, A.I.R/5YR for salmonellosis, 3.451 and 2.995 were A.I.R/5YRs for Saudi and non-Saudi patients, respectively (p-value: 0.0032). Among male and female, A.I.R/5YR for salmonellosis, A.I.R/5YR was 3.429 for male and 3.316 for female (p-value; 0.014) (Table 1).

Among Saudi male and non-Saudi male patients, A.I.R/5YRs for salmonellosis were 3.859 and 2.784 (p-value: 0.046), respectively. The A.I.R/5YRs for Salmonellosis were 3.039 and 3.445 (p-value: 0.0026), for Saudi female and non-Saudi female, respectively (Table 1).

<table>
<thead>
<tr>
<th>Table 1. Total cases, mean, and average incidence rate during 5 years (A.I.R/5YR) of salmonellosis in KSA 2013-2017 by nationality and gender.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2013</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>General population</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Saudi</td>
</tr>
<tr>
<td>Non-Saudi</td>
</tr>
<tr>
<td>Saudi male</td>
</tr>
<tr>
<td>Saudi female</td>
</tr>
<tr>
<td>Non-Saudi male</td>
</tr>
<tr>
<td>Non-Saudi female</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2. Total cases, mean, and average incidence rate during 5 years (A.I.R/5YR) of salmonellosis in KSA by health provinces.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Riyadh</td>
</tr>
<tr>
<td>Makkah</td>
</tr>
<tr>
<td>Jeddah</td>
</tr>
<tr>
<td>Taif</td>
</tr>
<tr>
<td>Madinah</td>
</tr>
<tr>
<td>Qassim</td>
</tr>
<tr>
<td>Eastern</td>
</tr>
<tr>
<td>Al-Ahsa</td>
</tr>
<tr>
<td>Hafr-Albaten</td>
</tr>
<tr>
<td>Aseer</td>
</tr>
<tr>
<td>Bishah</td>
</tr>
<tr>
<td>Tabouk</td>
</tr>
<tr>
<td>Hail</td>
</tr>
<tr>
<td>Northern</td>
</tr>
<tr>
<td>Jazan</td>
</tr>
<tr>
<td>Najran</td>
</tr>
<tr>
<td>Al-baha</td>
</tr>
<tr>
<td>Aljouf</td>
</tr>
<tr>
<td>Qurayat</td>
</tr>
<tr>
<td>Qunfudah</td>
</tr>
</tbody>
</table>
Table 3. Foodborne disease outbreaks (2015-2017) and foodborne presumptive patients visiting (2010-2012) hospitals’ ERs in KSA.

<table>
<thead>
<tr>
<th></th>
<th>Number (cases)</th>
<th>Public-source outbreaks (%)</th>
<th>Home-based outbreaks (%)</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Saudi/% (non-Saudi/%)</th>
<th>&lt; 20yr%/ (&gt;20yr/%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foodborne disease outbreaks</td>
<td>1020 (7385)</td>
<td>560 (55%)</td>
<td>460 (45%)</td>
<td>3806</td>
<td>3579</td>
<td>5292/71% (2093/39%)</td>
<td>3769/51% (3681/49%)</td>
</tr>
<tr>
<td>Foodborne illness’ patients visiting ERs</td>
<td>85063</td>
<td>N.S*</td>
<td>N.S</td>
<td>50029</td>
<td>35034</td>
<td>72885/85.6%</td>
<td>N.S</td>
</tr>
</tbody>
</table>

*: Not specified.

3.2. Health Provinces
Mean and A.I.R/5YRs for salmonellosis in KSA 2013-2017 by health provinces are shown in table 2. The A.I.R/5YRs were 14.13, 4.52, 4.1, 3.4, and 2.65 for the Eastern, Al-Alhsa, Jeddah, Najran, and Riyadh provinces, respectively. It is worth noting that Riyadh, Jeddah, the Eastern, Makkah, and Madinah are the largest provinces representing 63% of KSA’s population.

3.3. Age
Total reported cases according to age in 2013-207 are shown in figure 1. For < 15 and ≥ 15 years old age groups, the A.I.R/5YRs were 6.04 and 2.221 for < 15 and ≥ 15 (p-value: 0.613), respectively.

3.4. Seasonality
Monthly means of salmonellosis for 2013-2017 in KSA are shown in figure 2. The highest incidences for salmonellosis incidence, August, September, and October registered highest reporting. The hottest months in 2013-2017 in KSA with average high temperatures over 40°C were June, July, and August. The average temperatures recorded were 24.7, 36.9, 40.9, 29°C for Jan-Mar., Apr.-Jun., Jul.-Sept., and Oct.-Dec. yearly quarters, respectively. (GAS, 2018).

3.5. Foodborne outbreaks and presumptive cases
In KSA, a total of 1020 (7383 cases) foodborne disease outbreaks (FBO) (2015-2017) and 85063 visits (2010-2012) to hospitals’ ERs by patients with presumptive foodborne disease’s symptoms (PFB) were recorded in MOH’s books. Public-source FBOs were 55% and home-based FBOs were 45% of the total. FBOs were higher among males and the < 20 year old groups (51%) where 71% of cases were among Saudi patients. Non-Saudi patients represented 14.4% of PFBs, and 58.8% of PFBs were among male patients. (Table 3). FBO and PFB statistics were included in this study to reflect Salmonellosis underestimation since no identified causes were reported.

3.6. Literature search
Salmonella spp. were found to be the most commonly identified bacterial cause of foodborne disease outbreak in many provinces in KSA (AlWaidy and Fontaine, 1996; Al-Goblan and Jahan, 2006; AlMazroua and Al-Hamdan, 2008; Alfara and Al Mazroua, 2008, AlHonazil and Chaudhry, 2008, AL-Alwy, 2009, Al-Elyani and Nooh, 2009, Alotaibi H. and AlMazroa M. 2010; AlGhamdi etl. Al., 2010; AlBakheet, 2010, AlJoudi et. al., 2010; AlJasser and AlMazroa, 2011). Cross-contamination, inappropriate holding temperatures, and poor food handler’s hygienic practices were commons risk factors for these outbreaks. Foods involved were meat and rice dishes, shawarma, raw milk, traditional sweets, and salads. Within KSA, salmonella spp. prevalence was 3 to 34% in samples from children with diarrhea in many provinces (Al-Freih et. al., 1993; Altayyar and Abdalla, 2015, Garaween, 2015).

4. DISCUSSION
In this study, the overall A.I.R/5YR of salmonellosis was 3.30. Of 5202 total cases reported from 2013-2017, 70.08% were in Saudi patients, and 29.92% in non-Saudis (p-value: 0.0032). Incidence among males patients was higher (58.3%) than in females (41.69%) but not statistically significant (p-value: 0.104). The observed no gender variations are similar to that reported in other studies (Varga et. al., 2013, Malaeb et. al., 2016).
Figure 1. Total cases of salmonellosis in KSA from 2013-2017 by age groups.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>SUM</th>
<th>A.I.R/5YR</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>134</td>
<td>130</td>
<td>80</td>
<td>98</td>
<td>310</td>
<td>752</td>
<td></td>
</tr>
<tr>
<td>1 to 4</td>
<td>302</td>
<td>294</td>
<td>194</td>
<td>159</td>
<td>242</td>
<td>1191</td>
<td></td>
</tr>
<tr>
<td>5 to 14</td>
<td>177</td>
<td>196</td>
<td>132</td>
<td>106</td>
<td>174</td>
<td>785</td>
<td></td>
</tr>
<tr>
<td>15 to 44</td>
<td>309</td>
<td>418</td>
<td>257</td>
<td>266</td>
<td>471</td>
<td>1721</td>
<td></td>
</tr>
<tr>
<td>45+</td>
<td>123</td>
<td>148</td>
<td>112</td>
<td>115</td>
<td>255</td>
<td>753</td>
<td></td>
</tr>
<tr>
<td>&lt;15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.04</td>
</tr>
<tr>
<td>≥15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.221</td>
</tr>
</tbody>
</table>

Figure 2. Total cases and mean of salmonellosis in KSA by months.

Ten health provinces representing 23.3% of KSA’s population reported salmonellosis A.I.R/5YR < 1/100,000 people. In Riyadh, Jeddah, and Eastern provinces, incidence during 2013-2017 represents 79.1% salmonellosis of total reported in the country. Health systems in these three provinces are more advanced and more likely to capture and report salmonellosis incidence more than in other provinces. It is unlikely that A.I.R/5YR <1/100000 persons reflects the disease burden in indicated ten provinces.

In Makkah and Madinah which are visited by millions of Muslims every year, only 300 cases of salmonellosis were reported in 2013-2017. During Ramadan month and Hajj season, high quantity of meals are prepared by personnel with no or limited

34
food safety training, and served in short time, usually during summer months (Dablool et. al., 2014). Thus, the occurrence of salmonellosis among visitors and pilgrims is likely to be underestimated by health authorities in these two holy provinces. No cases were reported in Hafr-Albaten, and 4 other provinces (Qassem, Northern, Najran, and Bishah) only reported 157 cases of salmonellosis during 5 year period. In these five provinces animals’ husbandry is a commonly practiced activity. Contact with animals (Hoelzer et. al., 2011) and drinking raw milk (Costard et. al., 2017) are also considered risk factors for salmonellosis. Therefore, it is highly possible that salmonellosis occur more frequently in these provinces than reported.

Seasonal pattern of salmonellosis in KSA trends to peak in hotter months, with 41.1% of reported cases occurred from July to October. This is in consistence with salmonellosis increasing incidence during summer in many countries (Aik et. al., 2018; Lal et. al., 2016; Jiang et. al., 2015; Seixas et. al., 2018; Ucijo, 2017; Yun et. al., 2016). With increase in the ambient temperatures salmonella multiplies in foods and in the environment and hence increases the possibility of infection risk (Akil et. al., 2014).

Among age groups, 52.44% of all salmonellosis cases were reported in < 15 year old (23.09% in <5 years old). In KSA (Al-Freih et. al., 1993; El-Sheikh and El-Assouli, 2001; Ismaeil et. al., 2002; AlAyed et. al., 2013) as in other regional countries (Sethi et. al., 1989; Youssef et. al., 2000; Howidi et. al., 2012; Al-Thani et. al., 2013; Al-Kubaissy et. al., 2015 ) and globally (Majowicz et. al., 2010; Kirk et. al., 2015), salmonella spp. are one the most prevalent and commonly identified cause of gastrointestinal diseases in children.

Worldwide, salmonellosis health burden and incidence are thought to be underestimated (Majowicz et. al., 2010). In many countries (Scallan et. al., 20111; Havelaar et. al., 2012; Haagsma et. al., 2013; Van Cauteren et. al., 2015; Morgado et. al., 2015; Huang et. al., 2016; Murray et. al., 2017; Kowaleycz et. al., 2018) incidence estimation studies have reported the use of multipliers to adjust for under-ascertainment and underreporting.

To establish a multiplier to estimate a disease incidence in a country or a region, numerical values are synthesized to construct a surveillance pyramid. The values are assigned for asymptomatic infection, not patients not seeking medical care, underdiagnosis, and underreporting. The accuracy of obtained values depends in part on availability of laboratory infrastructures, trained personnel, and on data supplied by authorities investigating foodborne disease outbreaks (Gibbons et. al., 2014).

In estimating salmonellosis incidence, and where a country-specific multiplier is not available, it is possible to apply a multiplier of neighboring country or of the region to calculate a more accurate disease incidence (Crump et. al., 2004; Majowicz et. al., 2010). According to CDC, it is estimated that for every laboratory-confirmed salmonella caused case, there are 29 underestimated ones. (Lutter, 2015). In Jordan, the number can reach 273 for every confirmed case (Gargouri et. al., 2009). Applying these multipliers to estimate salmonellosis in KSA would result in A.R.I/5YR ranging from 95.7 to 901.

The estimated means of non-typhoidal salmonella gastroenteritis in the Middle Eastern region were reported to be 124 (range: 58-267) per 100, 0000 (Majowicz et. al., 2010). And, in the WHO’s study to estimate burden of foodborne diseases, the median rate was reported to be 1610 (range: 147-14052) for EMR, and 1140 (range: 459-3065) globally (Kirk et al., 2015). Applying 124 and 1140 to estimate salmonellosis incidence in KSA, would result in 39084 to 359316 cases per year. This, may indicate that the officially reported incidence of salmonellosis in KSA is underestimated by 37.6 to 345.36 folds. And, is supported by the fact NTS spp. were identified as the causative agents in many foodborne outbreaks in KSA.

Attempting to measure DALY for salmonellosis in KSA based on the reported incidence rates will result in measurement of 0.17 DALY/100000 people for , respectively) which is well below regional (median 50 DALY) values for this disease (Majowicz et. al., 2010; Kirk et al., 2015).

5. Conclusions

This study shows that salmonellosis incidence is below regional and global averages and that might be due to underestimation factors. The extent of foodborne diseases including salmonellosis health burden cannot be currently determined in KSA for many reasons including; other major foodborne (bacterial, viral, and parasitic diseases) are not notifiable, improper practices during foodborne disease outbreak investigation, and insufficient food safety laboratories/trained personnel. The latter effect is evident by the fact that the causes of foodborne outbreaks reported in KSA during the study period and presumptive foodborne diseases cases visiting hospitals’ emergency rooms were not identified. Since foodborne disease risk factors were identified in restaurants and among consumers in KSA, salmonellosis incidence in the country is likely to be higher by many folds of that reported and
expected to increase with growing foodservices establishments and food consumption especially in absence of preventive and control measures (e.g. enforcing HACCP application at food manufacturing and services levels).

ACKNOWLEDGMENT
The author thanks Qassim University for supporting this study.

REFERENCES


Zare, S., Zheng, Y., Buck, S. 2017. Examining the Effect of Food Recalls on Demand: The Case of Ground Beef in the US(No. 1377-2016-109994).