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A Study of Epidemic of Typhoid Fever in the Souf Oasis (Eastern South of Algeria).

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ABSTRACT

In this study, we followed the spatiotemporal and demographic development of typhoid fever disease in the oasis of Souf, by analyzing the details of 723 confirmed cases during the period extended from 1998 to 2015. The results of the study showed that, among the 18 towns of Souf, the most affected ones were Reguiba and El-Oued. Furthermore, nearly 60% of all recorded cases were during the period that extended from2005 to 2008. From a demographic perspective, we found that the age of the most affected groups was from 6 to 18 years old, followed by 31 to 60 years old. Also, working men were more prone to this disease than women. In the majority of these cases, water was found to be the essential source of contamination. The effective fight against this disease should be done by the contribution of all private and public actors to improve the living and environmental framework of populations, through providing clean drinking water sources and effective sanitation services. Also it should be done by the development of health awareness in all society categories, particularly among children and adolescents at schools. Surely, if we adopt these solutions, we might help eliminating the causes, not only for typhoid fever, but also for all diseases that could spread in degraded environmental conditions, especially water-borne diseases.

Keywords: Souf, Oasis, Typhoid fever, Sanitation, Pollution, Environment, Water-borne

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INTRODUCTION

Bacterial infections are responsible for a third of all worldwide deaths [1]. Typhoid fever is one of these diseases [2, 3].It is a known pathology that has already been the subject of several studies in various aspects [4]. The pathogenic responsible for this disease is virulent bacteria called Salmonella (Salmonella entericasero type Typhior Paratyphia, b and c) [5-8]. The first is strictly adapted to humans only [9, 10], but other species infect domestic animals as well as humans [11].

A case is considered positive for typhoid or paratyphoid fever, when a fever of at least 38°C persists for 3 days, and Salmonella enteric as erovar Typhi or Paratyphi is isolated from blood, bone marrow or stool [12, 13].

The typhoid bacillus is transmitted by indirect ways as consumption of foods or waters that is contaminated by the feces [6, 12, 14]. Also, this pathogenic can be directly transmitted through connection between a healthy person and an infected person [5, 15].

Because this epidemic is counted among the infectious diseases of great importance mainly in developing countries [16], typhoid fever is a major public health problem[12, 17, 18]. It is responsible for high rates of morbidity and mortality worldwide, especially in developing countries [6, 19]. The World Health Organization estimated that 15 to 30 million people around the world are attacked by this disease., and about500 000 to 600000 persons of them die each year because of the disease[20].

Concerning its frequency and distribution, typhoid fever is a public health problem in Algeria [6, 21, 22]. The statistics of the National Institute of Public Health recorded 3218confirmedcasesin 2002. Later, this number decreased to945 cases in 2006, then to232 cases in 2012.

The Annex of Decree179/MS of 17 November 1990,concerning the list of compulsory declaration diseases and notification procedures, added the epidemic of typhoid and paratyphoid fever in the second ranksafter cholera.

The purpose of this study is to follow the spatiotemporal and demographic development of this disease in Souf oasis. Furthermore, it aims at identifying the causes and environmental factors which help in the spread of this epidemic.

MATERIALS AND METHODS

Study Area

Souf represents the central part of El-Oued province. It extends over an area of 11738.4km^2[23], with its 18 towns. Souf presents nearly 26 % of the total territory (Fig. 1). According to statistics of the year 2013, Souf contains 538200 inhabitants. This number represents about 72% of the total population. The average of the population density is about 45.84 inhabitants per square kilometer. Life in this oasis is based on irrigated farming from the ground water, in the standard state; his deep does not exceed a few meters from the surface.

The climate of the studied area is hyper-arid [24, 25], characterized by a hot and dry summer, and a mild winter[26]. According to the climatic data provided by the National Office of Meteorology [27], rainfall is low and oscillatory, with an annual average of 73mm (period from1971 to 2013). Evaporation is about 2163.55mm,(period from1995 to 2004). The temperature varies from season to another. The maximum of monthly temperature average is recorded in July with 35 °C, while the minimum is observed in January with 10.9 °C (period from 1995 to 2004). Winds are usually weak, but in the spring they become violent. All these indicators are witnesses to the dryness and cruelty of the climate in the region of our study.

Typhoid Data Cases

Our study was adopted to statistical data provided by Direction of Health and Population (DHP) of El-Oued province during the period extended from 1998 to 2015.

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To find out the factors that control the distribution and spread of this disease, we have taken into accounts ever all variables represented by the temporal distribution(annual and monthly), the spatial distribution(the origin of patients) and finally the demographic distribution(age and sex of patients).

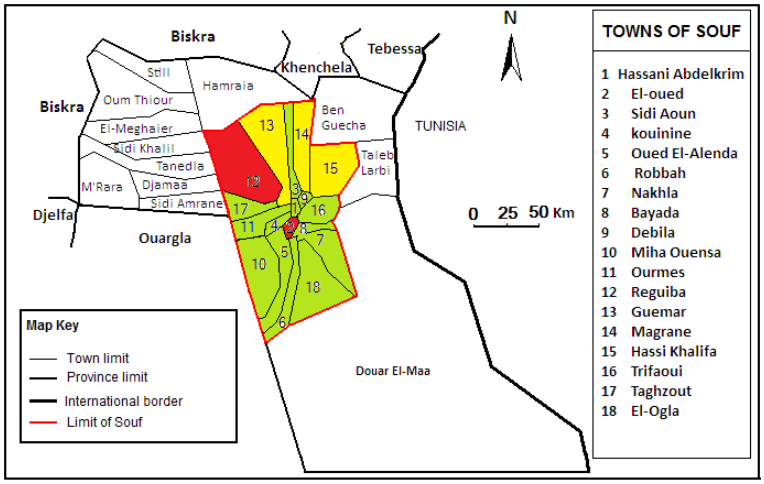

Figure 1: Study area location

RESULTS AND DISCUSSION

Firstly, typhoid fever is not a new subject in our region. According to the study of Papa and Peyron in 1970[28]which was the only research that looked into this subject in the sixties of the last century, Just in the period of five years, there were about 337 confirmed cases, including 11 deaths.

Throughout the period of ours study which lasted for 18 years, the various health services of Souf recorded 723confirmed cases of typhoid fever, with an average estimated at40.16cases per year.

Temporal Distribution of Typhoid Fever

Annual Distribution

Statistical analyses showed that the annual distribution of typhoid fever is heterogeneous (Fig. 2), the maximum recorded in 2007 with 150 cases (20.74 %), while the minimum was recorded in 2015with only 1 case. The period of 18 years can be divided in 3 different phases as follows:

First phase (1998 to 2004)

Throughout the period of 7 years, public health services recorded250cases (34.57%) with an averageof35.71cases per year(less than the general average estimated at40.16). The maximum was in 1998 with44 cases, and the minimum was observed in 2003 by29 cases.

This was the inevitable result of the degraded environment state, presented by the lack of a sewerage system, contaminating groundwater by raw sewage through several septic wells and the use of human and animal excreta as a horticultural fertilizer. The usage of groundwater for drinking is very limited in the region of Souf, because of its chemical properties. For this reason, the local population uses water brought from the neighboring provinces like Tebessa and Biskra by trucks and tankers. However, these ways were often unhealthy and uncontrolled which may have increased the risk of the spread of the disease.

Second phase (2005 to 2008)

Although this phase did not exceed 4years,the study showed that432cases (59.75%) were recorded during this period, with an average of108cases per year(greatly exceeded the general averageof40.16). The

year 2007was the most disastrous with 150 cases, of which 40.66% for Reguiba town. As an indicator of this disease, infection by typhoid fever increased 254.92 % compared to the previous period.

The terrible rise in the casualties' number in this period has clearly showed that the deteriorating environmental situation has become further complicated due to the absence of any sanitation system and the augmentation in septic wells that pollute the ground water with human excreta. Therefore, according to Meziani, Dridi and Kalla[29] the number of wells exceeds a value of100 000units. Also, do not forget the evolution in the agricultural sector, which completely depended on groundwater and organic fertilizers.

Third phase (2009 to 2015)

Generally, during this phase, health services have recorded only 40cases (5.53 %), with an average of 5.71 cases per year. Where several towns, such as Nakhla, El-Ogla, OuedEl-Alalenda and others, did not record any case.

The decline in the number of cases is mainly due to the improved environmental and health conditions. The most important of them is the establishment of a sewage system, supported by 4 station of wastewater treatment which started working from the year 2009. Concerning drinking water supply, we found that the situation has improved through the implementation of more than7 desalination stations under control and supervision of health and hydraulic authorities. The latter made efforts to promote awareness, prevention and counseling. For these reasons, in 2015, there was only 1 case affected by typhoid fever epidemic in the region.

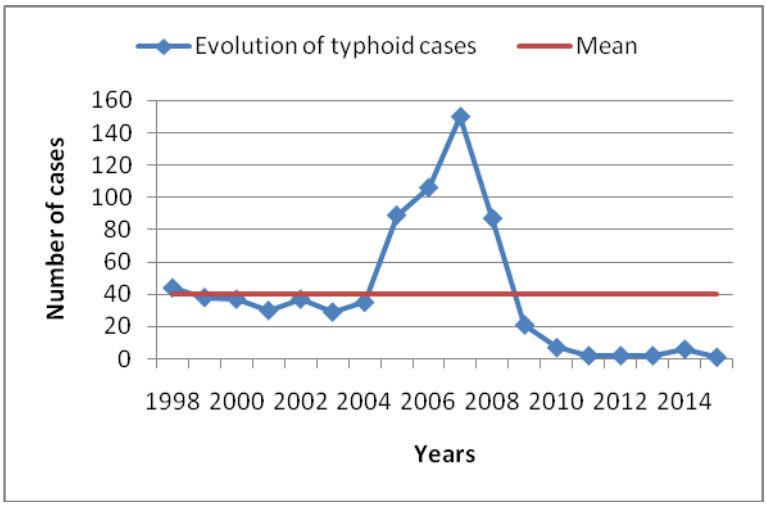

Figure 2: Annual distribution of typhoid cases.

Monthly Distribution

The detailed statistical data clearly showed that the monthly distribution of the incidence of typhoid fever disease is also heterogeneous (Fig. 3), we have registered 529 cases (73.16%) in the dry period between May and September, while 142 cases (19.64 %) were recorded before and after the dry period (transitional dry period) (Mars, April and October). In the end, only 52 cases (7.19%) were observed in the cold period from November to February.

This pattern of distribution has a strong relationship to the prevailing climatic conditions. In the dry and hot season which corresponds with summer, the demand for water increases, both for domestic use (washing, drinking and swimming) or agricultural use (irrigation). Because water is the preferred milieu for living this pathogen, the probability of infection in these conditions is high compared with winter or another season.

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This result was confirmed by several similar studies as Benkortbiin Medea hospital (Algeria) [22], and a study of Akullian in Kibera (Kenya)[30].

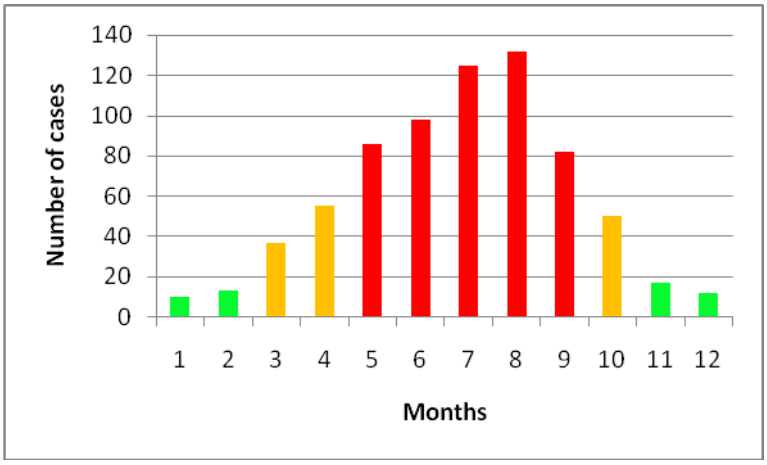

Figure 3:Monthlydistribution of typhoid cases.

Spatial Distribution of Typhoid Fever

In the Souf region, the spatial distribution of typhoid fever and patient's origin are not homogeneous. Depending on the number of victims, these towns can be classified in 3 different groups as follow (Fig. 4):

Heavily Infected Towns

The study clearly showed that both Reguiba and El-Oued towns represent the hot spots of this epidemic, where 285 cases (39.42%) have been registered in Reguiba, including 61 cases in 2007. For El-Oued town, we have detected153 cases (21.16%) including 49 cases in 2005.

Although the population density of the Reguiba town is in the range of 24.23 inhabitants per square kilometer, the considerable presence of nomadic and semi-nomadic groups within the population, the agricultural character of this town and direction of the movement of pollutants in the groundwater from south to north, are the most obvious factors that explain the high incidence of typhoid fever in this zone.

The rising of the number of cases in El-Oued town is due, firstly to the high population density, which amounted in 2013 a value of 2014.58 inhabitants per square kilometer. This means that 29% of people were living in a territory of 0.65% of the total area. Secondly, this town was scene and center of the ascending polluted groundwater problem. The submerged Ghouts used by children and adolescents as swimming pools especially in summer might have led to the affection of many of them by pathogen factor.

Moderately Infected Towns

Moderately infected towns are Magrane, Guémar and HassiKhalifa. They have a rate of 169 cases (23.37%) of total cases. These 3 towns are also characterized by its agricultural practice, presence of nomads and semi-nomads within the demographic that are located in the northern part of the studied area, and these are the principal factors that led to the spread this disease.

Slightly Infected Towns

The 13 remaining towns of the Souf are slightly infected. The total number of cases recorded was about 116 people, they did not exceed 16.04%. The lowest rate recorded was 1 case in the Nakhla and Ouermes towns, flowed by 4 cases in Kouinine, Hassani Abdelkrim and Oued El-Alenda towns. The limited number of casualties in these towns could be attributed to various factors. The most important is the low population density that does not exceed 33.5 inhabitants per square kilometer. Also, most of these towns are

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located in the southern part of the area of study, where the pollutants concentration in the ground water is low compared to other regions.

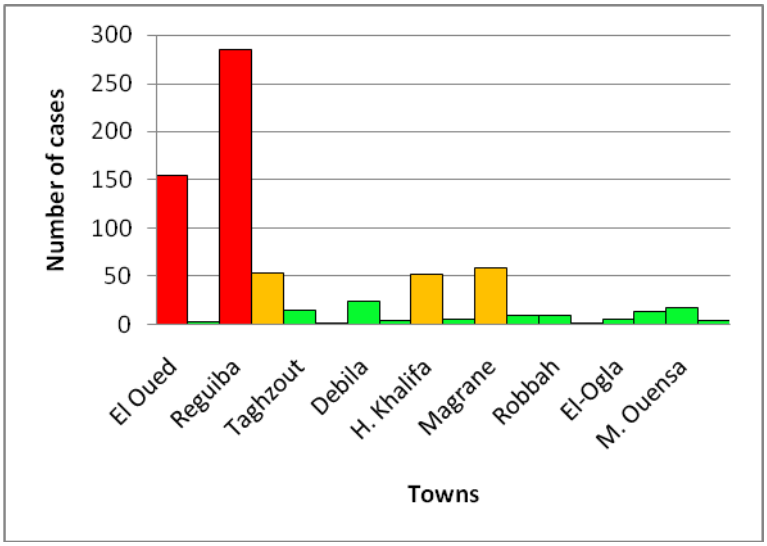

Figure 4: Distribution of typhoid cases according to origin of patients (towns).

The Demographic Distribution of Typhoid Fever

According to Patient's Age

To determine which are the most population categories targeted by this epidemic, we must classify patients in 5 different age groups. The results are displayed in(Fig. 5).Through the analysis of these data, we noticed that the most affected group by this epidemic were school age children and teenagers of age(6-18) years oldwith310cases (42.87%), followed by adults (31-60) years old with216cases (29.87%) and in the end, young adults(19-30) years old with127cases (17.56%). The remaining categories were children less than 6 years old with 38cases (5.25%) and aged over 60 years old with 32cases (4.42%) were generally the least targeted ones.

The contact between the children, the lack in hygiene in the schools and the low awareness among this category, were the main factors helping the spread of disease in this category. Also, in adults (31-60) years old and younger adults (19-30) years old, the bad working conditions, particularly in agriculture and construction sites, are the main factors responsible for spread of this disease.

The low affection in the two remaining age groups could be interpreted by preventive health conditions provided by the parents and family for children younger than 6 years old, and most adults over age 60 years old are generally retired and do not practice any activities.

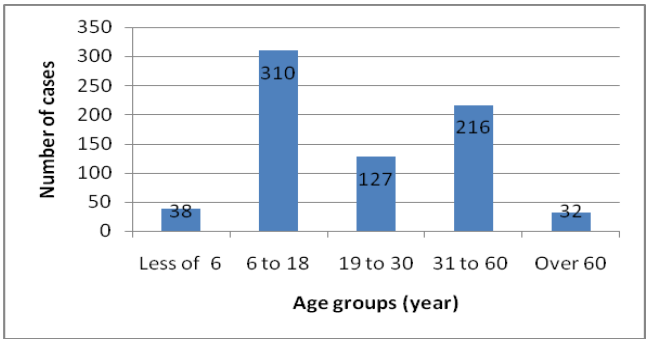

Figure 5: Distribution of typhoid cases according to patient's age.

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According to Patient's Sex

Although there is no distinction between males and females in affection by the pathogen, but as an overall result, the study showed that men have a higher probability of this disease than women (60.85% for men and 39.15% for women) (Fig. 6). These reports can be modified, if we take into account a patient age as a factor (Fig. 7). At age groups (19 to 30 years old and31 to 60 years old), we noted that the incidence in men was higher than that among women; where the difference between the two sexes was clear (93 against 34, and 149 against 67 respectively).

These differences could be explained by the rate of work and its nature. Firstly, we found that the rate of employment for men was higher than women. Secondly, the majority of men worked in agricultural and construction sectors, where the risk of infection by pathogens is high.

Although the element of age group (6 to18) years, are in primary, middle or secondary school age, we noted that certain factors such as school dropout, family agriculture character and the economic situation of some poor families, were the major factors that required adolescents over 15 years old to integrate in the field of work, as the agricultural sector especially in planting and harvest periods, where sanitary conditions are usually poor.

For other age groups (under 6 years old and over 60 years old), the deference between the two sexes was not significant (18 against 20 and 15 against 17 respectively).

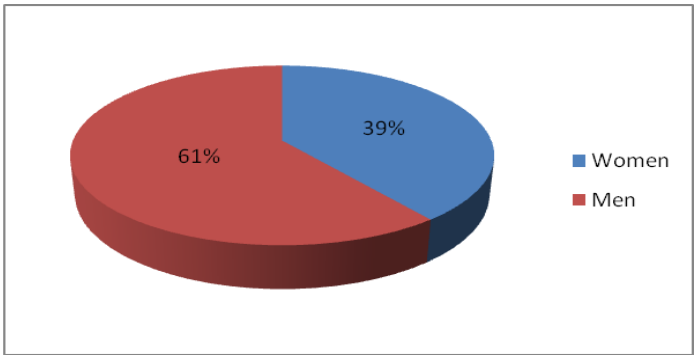

Figure 6: Distribution of typhoid cases according to patient's sex.

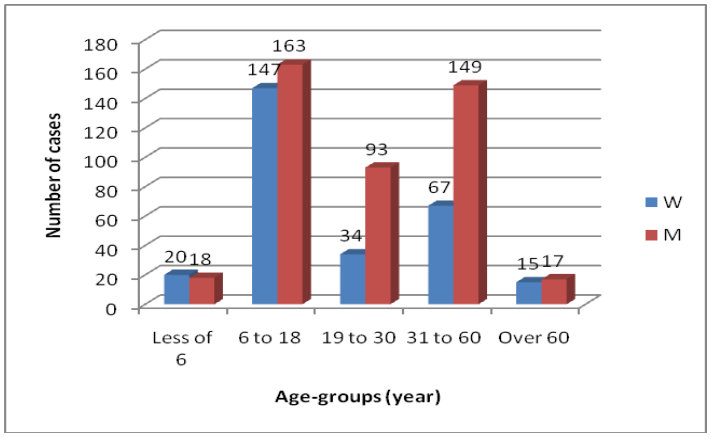

Figure 7: Distribution of typhoid cases according to patient's age and sex.

CONCLUSIONS

In arid and Saharan regions, water is a vital, rare and precious source to humans, animals and plants. Also, it is a key factor in any development of human activities. Agriculture in this zone is the main activity of the peoples.

In the Souf oasis, groundwater is nearly from the surface and the most of it is widely used particularly for agriculture. For a long time, and due to a lack of sanitation system, this groundwater table was used as a natural receptor and outlet for raw sewage, and this caused very high levels of pollution.

Diffuse pollution, lack of hygiene and health awareness especially among the no madic residents and farmers, are the responsible factors for the transmission and spread of typhoid fever. However, the number of 723 cases, reflect the deteriorated health situation of the environment in the study area.

To ensure an integrated fight against this epidemic, we must work to improve environmental conditions through several points of interventions. The most important is the protection of ground water against pollution. In addition to the role of health services which should be presented by the protection, awareness and guidance, especially in rural towns and schools.

Surely, these actions have significant positive effects not only in the fight against typhoid fever, but also to all diseases that can be transmitted by water or in bad environmental conditions.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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