Incidence rates of dysentery among humans in Lemghaier province, Algeria

Bachir Khezzani[1], Magdalena Baymakova[2,], El Amine Khechekhouche[3], Khadidja Ghezal[4], Zineb Meziou[5], Aida Bousbia Brahim[6]*

Abstract

Introduction **Dysentery is an infectious clinical syndrome which can cause high morbidity and mortality, especially in developing countries. This research highlights the epidemiological features of dysentery in Lemghaier province, Algeria.**

Methods **A retrospective study of the incidence rates of dysentery in Lemghaier province, Algeria and overall for the whole country for the period from January 2001 to December 2018 was carried out. On a local level data were provided by the Directorate of Health and Population of El-Oued province, Algeria. At the national level data were provided by the National Public Health Institute, Algeria.**

Results **An overall number of 1,786 cases of dysentery were notified, with an incidence rate of 58.5 cases per 100,000 population (mean±SD: 58.54±47.20; 95% CI: 36.73-80.35). The high incidence rate was reported in autumn and summer, respectively, with 23.4 and 20.1 cases per 100,000 population. The high incidence rate observed in the persons aged 20–44 years with 76.4 cases per 100,000 population. Females were more likely to have dysentery than males, respectively, with 63.6 against 53.7 cases per 100,000 population. The highest incidence rate was reported in Lemghaier municipality (capital of the province) with 176.9 cases per 100,000 population.**

Conclusions **The results from this research showed high incidence rates of dysentery in Lemghaier province, Algeria. This fact is a serious reason for national public health organizations to take adequate and timely measures to reduce the incidence rates of dysentery in this part of the country.**

Keywords **Algeria, dysentery, incidence rate, Lemghaier province.**

Introduction

Shigellosis is an infectious disease which is caused by the bacteria *Shigella*. Most patients with shigellosis have diarrhea, fever, and stomach cramps. *Shigella* cause an estimated 450,000 cases in the USA each year.[1] *Shigella* is a Gram-negative, non-motile bacillus belonging to the Enterobacteriaceae family. Until now, from the scientific literature four species of *Shigella* are known: *Shigella boydii*, *Shigella dysenteriae*, *Shigella flexneri*, and *Shigella sonnei*.[2] While *S. boydii* and *S. sonnei* most often generate a relatively mild clinical form of disease (watery or bloody diarrhea only), *S. flexneri* and *S. dysenteriae* are mostly

Received: 17 January 2022; revised: 10 April 2022; accepted: 12 April 2022.

[1]PhD, Faculty of Natural Sciences, El-Oued University, P.O. Box: 789, El-Oued, Algeria and Laboratory of Biology, Environment and Health, Faculty of Natural Sciences, El-Oued University, P.O. Box: 789, El-Oued, Algeria; [2]MD, PhD, Department of Infectious Diseases, Military Medical Academy, P.O. Box: 1606, Sofia, Bulgaria; [3]PhD, Faculty of Natural Sciences, El-Oued University, P.O. Box: 789, El-Oued, Algeria and Laboratory of Biology, Environment and Health, Faculty of Natural Sciences, El-Oued University, P.O. Box: 789, El-Oued, Algeria; [4]MSc Student, Faculty of Natural Sciences, El-Oued University, P.O. Box: 789, El-Oued, Algeria, and Laboratory of Biology, Environment and Health, Faculty of Natural Sciences, El-Oued University, P.O. Box: 789, El-Oued, Algeria; [5]MSc Student, Faculty of Natural Sciences, El-Oued University, P.O. Box: 789, El-Oued, Algeria and Laboratory of Biology, Environment and Health, Faculty of Natural Sciences, El-Oued University, P.O. Box: 789, El-Oued, Algeria; [6]PhD Student, Faculty of Natural Sciences, El-Oued University, P.O. Box: 789, El-Oued, Algeria and Laboratory of Biology, Environment and Health, Faculty of Natural Sciences, El-Oued University, P.O. Box: 789, El-Oued, Algeria.

*Corresponding author: Magdalena Baymakova, dr.baymakova@gmail.com

Article downloaded from www.germs.ro
Published June 2022
© GERMS 2022
ISSN 2248 – 2997
ISSN – L = 2248 – 2997

responsible for shigellosis endemic and epidemic in developing countries, which associates high transmission rates and important case fatality rates (CFR).

The severe clinical form of shigellosis is known as dysentery. Dysentery can occur through the oral uptake of the pathogen via contaminated water or food, also from poor personal hygiene when coming in contact with infectious material or infected persons.[3] Dysentery remains a serious public health problem worldwide, especially in developing countries. Annually, more than 165 million cases of dysentery are reported worldwide, of which 1.1 million deaths, with approximately 99% of cases occurring in developing countries.[4] Besides, about 50 million confirmed cases annually are notified related to the other infection causing dysentery – amebiasis (*Entamoeba histolytica* infection), of which 40,000 to 110,000 death cases.[4]

The study of Ferrer et al. concluded that the socioeconomic factors followed by interpersonal contact were the most important drivers of dysentery occurrence, while factors regarding food preparation, the environment and the water, along with sanitation, played a secondary role.[5] Although many studies focus on sanitary and water supply as traditional factors of the dysentery incidence rate, some modern research in this field demonstrated that human behaviors have a considerable proportion in determining the incidence of this disease, and may sometimes outweigh the effect of the traditional factors.[6,7]

Dysentery control includes improved personal hygiene and avoiding contamination of food and water with infected feces. A survey carried out in the Volta region, Ghana, found that dysentery incidence can be reduced by 11% in children under 5 years if a clean water source is guaranteed.[8] Homemakers can play an essential role in limiting dysentery by providing a safe house environment to their families, especially children. In this regard, an educative and awareness program can play an active role in this process.

In Algeria, the Ministry of Health and Population classed dysentery among obligatory notifiable diseases. From 2001 to 2018, the national public health institute reported more than 16,300 confirmed dysentery cases. The aim of the present study was to highlight the epidemiological features of dysentery in Lemghaier province, Algeria. Until now, such a survey has not been conducted for this part of the country.

Methods

Dysentery is characterized by frequent small bowel movements accompanied by blood and mucus, with tenesmus or pain on defecation.[9] This clinical syndrome (with fever or without fever) implies an inflammatory invasion of the colonic mucosa resulting from cytotoxic, parasitic or bacterial destruction.[9] This survey has basically epidemiological characteristics because of which no data were collected for the main etiological reasons (pathogens) for dysentery.

A retrospective study of the incidence rates of dysentery in Lemghaier province, Algeria and overall for the whole country for the period from January 2001 to December 2018 was carried out. On a local level data were provided by the Directorate of Health and Population of El-Oued province, Algeria. At the national level data were provided by the National Public Health Institute, Algeria. The dysentery data include year and month distribution; municipality incidence rate; patient's gender and age group. In addition, the Directorate of Water Resources, El-Oued province, Algeria provided us the data concerning the percentages of homes connecting with drinking water and the sewerage networks. The incidence was calculated as the number of cases per 100,000 population corresponding to each year, municipality, gender, and age group.

The Republic of Algeria is divided into 58 provinces. Lemghaier province is a group of oases locates in the Northeastern Algerian Sahara (Figure 1). This province locates approximately on 5°11′ E and 6°09′ E longitude; 33°25' N and 34°30' N latitude. The elevation decreases from the Southwest in the Marrara municipality (225 m) to the Northeast in Chott Merouane (–27 m). In the past, the research area administratively belonged to El-Oued province. However, the new administrative division for the year 2019 separated this region to become a province alone. This new province includes eight municipalities

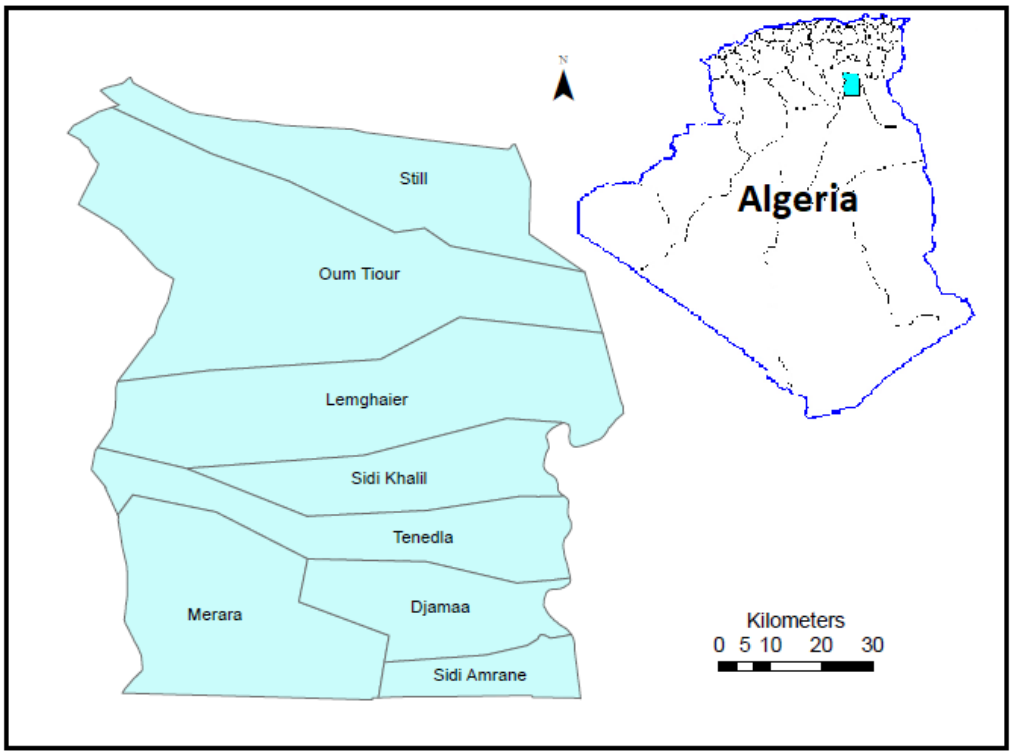


Figure 1. Geographical location of Lemghaier province, Algeria

and occupies an area of 8,835 km^2, and also, it counted about 231,000 population in 2018. The climate is typically Saharan, with a dry period extending throughout the year. January is the coldest month, and the warmest month is July, where temperatures can reach 45.0°C. The annual mean of temperature is around 25.0°C.

In the present study we applied descriptive statistical analysis (percentages, confidence intervals, standard deviations, box plots, etc.). Statistical analysis was performed by MS Excel 2007 (USA) and IBM SPSS Statistics version 20.0 (USA). A p value <0.05 was considered statistically significant.

The present research was performed in accordance with the ethical principles of the Declaration of Helsinki (June 1964; last revision in October 2013). The information and documents were processed and protected according to national legislation of Republic of Algeria. The information included in this survey is public and does not contain state secrets or other data connected with national security on the country.

Results

A total of 1,786 confirmed cases of dysentery were notified in Lemghaier province, Algeria, from January 2001 to December 2018. The annual overall number of cases ranged between 8 and 244, with mean of 99.2 cases per year (95% CI: 62.14-136.29). The highest incidence rate was reported in 2011, with 138.5 cases per 100,000 population, followed by 2007 with 137.6. On the other hand, the lowest incidence rate was notified in 2013 and 2012, respectively 4.3 and 4.4 cases per 100,000 population. The mean of the period was 58.5 cases per 100,000 population (mean±SD: 58.54±47.20; 95% CI: 36.73-80.35). Thus, starting 2012, the incidence rate of dysentery has undergone an evident decrease compared to the first part of the research period (Figure 2). At the national level, the results show that the incidence rate values ranged between 0.40 per 100,000 population (2012) and 9.17 (2001), while the national mean of dysentery incidence was estimated at 2.75 (95% CI: 1.54-3.95) (Figure 3).

The monthly distribution of dysentery has a seasonal trait (Figure 4). The dysentery incidence

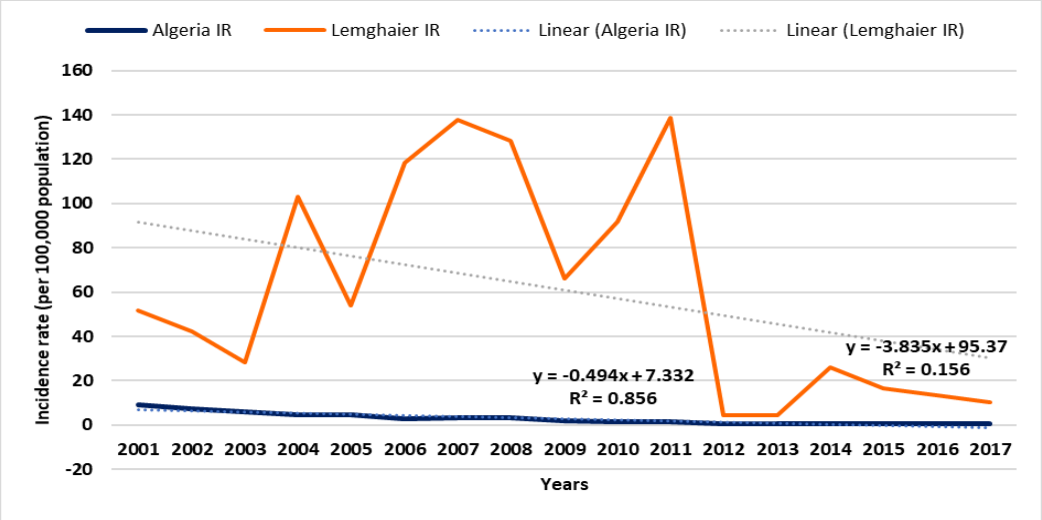


Figure 2. Annual distribution of dysentery incidence rate in Lemghaier province and at national level (2001-2018)

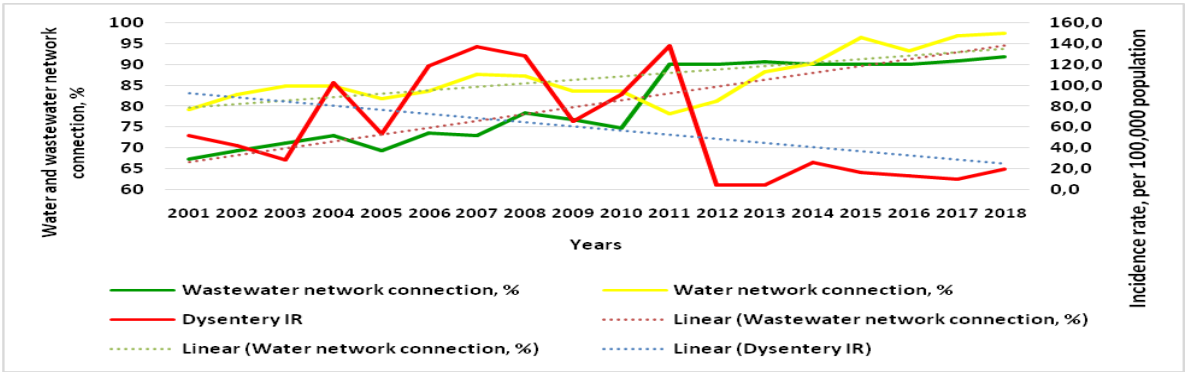


Figure 3. Annual development of dysentery incidence rate in Lemghaier province according to drinking water and wastewater networks connection (2001-2018)

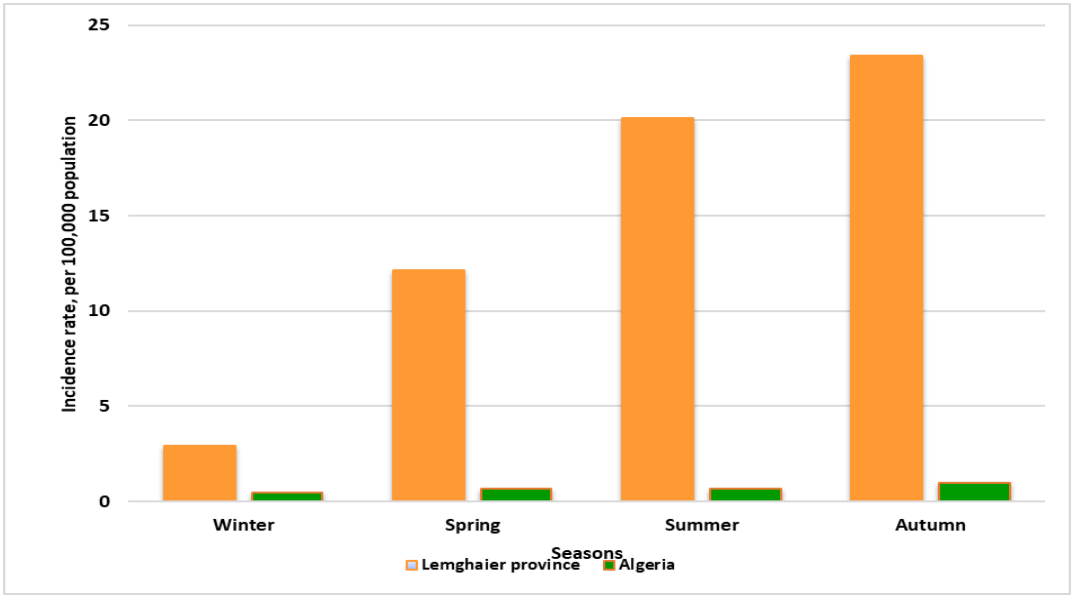


Figure 4. Seasonal distribution of dysentery incidence rate in survey area

rate increased as follows: winter – 2.9 cases per 100,000 population; spring – 12.1; summer – 20.1; and autumn – 23.4. The monthly mean is estimated at mean±SD 14.62±7.91 cases per 100,000 population (95% CI: 6.86-22.38). At the national level, dysentery incidence increases as follows: winter – 0.45 cases per 100,000 population; spring and summer – 0.67; and autumn – 0.95. The monthly mean is estimated at mean±SD: 0.68±0.17 cases per 100,000 population (95% CI: 0.51–0.85). A powerful and positive correlation was noted between these two seasonal distributions, in which the correlation coefficient reached 0.90.

Dysentery occurs in all age groups (Figure 5). However, a high incidence rate was observed in the persons aged 20-44 years, with 76.4 cases per 100,000 population, followed by children less than 9 years with 70.2. In other age groups, the incidence ranges between 26.4 (≥65 years) and 35.9 (10-19 years) cases per 100,000 population. Besides, females are more exposed to have dysentery than males, respectively with 63.6 versus 53.7 cases per 100,000 population.

All municipalities have been affected by dysentery. The highest incidence rate was reported in the capital of the research province, Lemghaier municipality – 176.9 cases per 100,000 population (about 93.5% of total reported cases). In the Still, Sidi Khalil and Oum Tiour municipalities, the incidence rate range between 13.1 and 28.8 cases per 100,000 population. In the remaining municipalities, the dysentery incidence rates are characterized by low values – between 0.6 and 2.3 cases per 100,000 population.

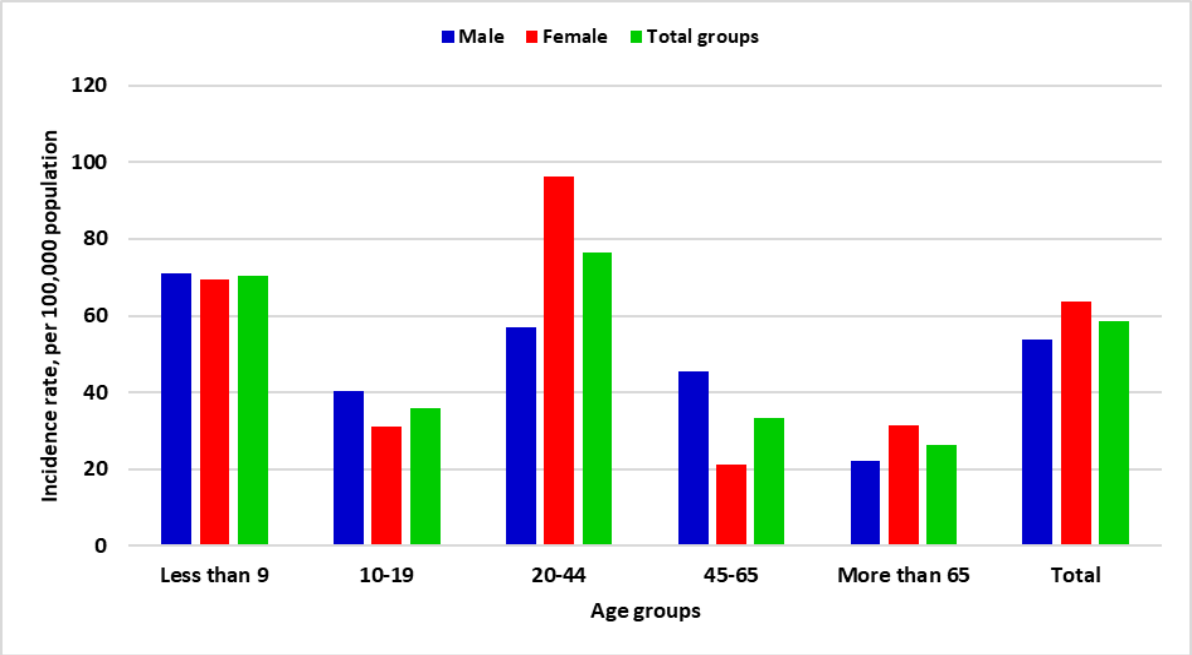


Figure 5. Incidence rates of dysentery in study province according to gender and age group

Discussion

The annual reports of the National Institute of Public Health, Algeria show that dysentery is widespread throughout the country. Furthermore, Southern Algerian provinces are more threatened by dysentery than the Northern part of the country.[10] This survey consists of a retrospective analysis of dysentery cases reported in Lemghaier province, Algeria. In fact, we can say that the actual number of dysentery cases is higher than what was reported in the official registers of health authorities. For example, some private physicians do not report dysentery cases discovered in their private practices. However, dysentery is listed among obligate reportable diseases by the health Algerian ministry.

Generally, many geographic, socioeconomic, environmental, and behavioral factors effectively contributed to large dysentery outbreaks, making Lemghaier province a critical focus for this epidemic for a long time. For example, low-income families often store water in traditional utensils placed in toilets to avoid disrupting the drinking water supply, which leads to contamination with various pathogens. A study by Khezzani and Bouchemal confirms that this behavior led to typhoid fever speared in the Souf oasis, Algeria.[11]

We can note that the situation of dysentery in the survey area is very complicated compared to the overall situation in the country. In the 1980s, the incidence rate has reached 65 cases per 100,000 population at the national level. So, this situation suggests the dysentery incidence rate in the Lemghaier province may have been in the range of 1,000 to 1,300 cases per 100,000 population in that period. Whether at the national or local level, the annually decreasing trend of dysentery incidence translates the Algerian health authorities' considerable efforts in combating water-borne diseases, especially dysentery.

During the period covered by the current research, the Directorate of Water Resources in Lemghaier province improved the service of connection to the water supply network, as the percentage of housing connected to this network increased from 73.3% in 2001 to reach 97.6% in 2018. In the same context, the National Sanitation Office improved the sanitation service, where the connection rate with this network reached 91.9% in 2018 after it was around 67.4% in 2001. On the other point of view, the decreasing curve of dysentery may be due to the rapid development of the economy and improved public health facilities at local and national levels.

Some studies indicate that the dysentery incidence rate is very sensitive to changed climate factors (between individual years).[12] Thus, this effect can explain to some extent the fluctuation noted in the yearly distribution of dysentery, of course, taking into account the rest of the other factors affecting it.

Dysentery pathogenesis is very sensitive to seasonal changes in climatic factors.[13] Thence, the incidence peak noted in some months could be linked to seasonal activities leading to a close relationship between human and infection sources. Therefore, the high incidence rate noted in the autumn and summer seasons can probably be explained by the interaction between climatic and socioeconomic factors and the biological features of the causative agents of dysentery. In the survey area, the autumn season (September and October) coincides with the spreading peak of house flies *Musca domestica*. According to Nazari et al., *Musca domestica* play an essential role in transmitting many disease causative agents, especially those that cause dysentery.[14] Greenberg mentioned some examples from different world regions, where he confirmed that the dysentery's spread peak always coincides with the height of the *Musca domestica* spread peak.[15] Besides, the study by Farag et al. in Mirzapur, Bangladesh, shows a positive correlation between *Musca domestica* population density and shigellosis incidence.[16] Besides, cockroaches *Blattella germanica* (abundant in the study country) can be a vector of many intestinal parasitic protozoa, especially *Entamoeba histolytica*.[13,17,18]

Some behavioral actions have a relationship to the spread on dysentery. During autumn is the season to collect fruits of the palm groves in Lemghaier province. In this regard, during this activity many of the citizens of the province often defecate indiscriminately in the bushes and nearby agricultural canal drain. Additionally, in this activity people eat their food on the floor and use irrigation water for washing (hands, vegetables, cooking utensils). These conditions increase the risk of dysentery incidence.

Furthermore, the rise in dysentery incidence rate at the beginning of September might be due to the children and students returning to the schools and universities after their summer holidays and the influx of new children to kindergartens. These findings were consistent with those of Sultanov in Dagestan, Russian Federation.[19]

Geographic location could play an essential role in the dysentery outbreak. The survey area contains many wetlands, which according to

Jorgensen et al., is a factor more favorable to the occurrence of various water-borne diseases.[20] Many prior scientific publications support this view, especially Ni et al. in Xinxiang city, China, which found a positive correlation between flood sand and increased dysentery risk.[21]

Generally, all age groups and both genders are susceptible to dysentery.[4] However, the high incidence rate noted among the female category compared to the male category is not due to the nature of the patient's biological characteristics, but it can be linked to the nature of the daily activities practiced. Most likely, males have more opportunities to be exposed to environments containing the pathogen.[22] At the same time, women's contribution cannot be ignored in rural communities to manage various agricultural activities in some regions and some periods. This increases the risks for infection of the female sex.

The web of determinants for dysentery in children is complex. However, children under 5 years of age have been reported to be susceptible to dysentery because of a decreased immune function, combined with lack of previous exposure, and a higher likelihood of exposure to a pathogen in the contaminated environment through play-related activities.[23] Recent studies indicate that dysentery is the primary killer of children under 5 years, accounting for 9.2% of total child deaths.[8] For example, dysentery is responsible for 15% of all deaths in children under 5 years and is the third leading cause of childhood deaths in Mbour, Senegal.[24] Furthermore, Tulu et al. found that parents with a high educational level can provide better sanitation conditions for their children than those with a low educational level.[25]

A potential cause for the higher number of registered cases of dysentery in Lemghaier province can be increased reporting due to the interest of public health specialists about this clinical syndrome. Essentially this is a hypothesis which can be object of future research.

The current research has some limitations that need to be addressed. Our data series does not contain any details related to the species of pathogen that led to dysentery. Furthermore, the present survey included one province out of a total of 58 provinces in the country, so it was not a nationwide survey. Despite these limitations, this work represents the first study on the dysentery incidence rate among humans in this part of Algeria, enriching the knowledge on this infection for Northern Africa.

Conclusions

We have presented the first report on incidence rates of dysentery among humans in Lemghaier province, Algeria. The situation of the dysentery in this part of the country is alarming, so it must be remedied as soon as possible. Besides the environmental factors, humans have a significant part of the dysentery outbreak's responsibility. In this regard, we recommend adopting educational programs and campaigns to raise awareness, especially among at risk groups. Furthermore, the inclusion of programs related to public health subjects and disease prevention within the educational system will constitute a solid base that can be relied upon in the future in fighting infectious and dangerous diseases.

Authors' contributions statement: BK contributed to study design, data collection, data interpretation, statistical analysis, article preparation, and literature search. MB contributed to study design, data interpretation, statistical analysis, article preparation, and literature search. EAK, KG, ZM, and ABB contributed to data collection and literature search. All authors read and approved the final version of the manuscript.

Conflicts of interest: All authors – none to declare.

Funding: None to declare.

Acknowledgment: The authors would like to thank all Public Health specialists who helped complete this research, especially Mr. Mohammed Rahal from El-Oued University and Dr. Said Adouka from the Directorate of Health and Population, El-Oued province.

References

1. Centers for Disease Control and Prevention (CDC). *Shigella* - Shigellosis, questions & answers. Accessed at: 17 January 2022. Available at: https://www.cdc.gov/shigella/index.html
2. The HC, Thanh DP, Holt KE, Thomson NR, Baker S. The genomic signatures of *Shigella* evolution, adaptation and geographical spread. Nat Rev Microbiol. 2016;14:235-50. https://doi.org/10.1038/nrmicro.2016.10
3. Das SK, Chisti MJ, Malek MA, et al. Comparison of clinical and laboratory characteristics of intestinal amebiasis with shigellosis among patients visiting a large

urban diarrheal disease hospital in Bangladesh. Am J Trop Med Hyg. 2013;89:339-44. https://doi.org/10.4269/ajtmh.12-0570
4. Williams PCM, Berkley JA. Guidelines for the treatment of dysentery (shigellosis): A systematic review of the evidence. Paediatr Int Child Health. 2018;38(sup1):S50-S65. https://doi.org/10.1080/20469047.2017.1409454
5. Ferrer SR, Strina A, Jesus SR, et al. A hierarchical model for studying risk factors for childhood diarrhoea: a case-control study in a middle-income country. Int J Epidemiol. 2008;37:805-15. https://doi.org/10.1093/ije/dyn093
6. Kotloff KL, Riddle MS, Platts-Mills JA, Pavlinac P, Zaidi AKM. Shigellosis. Lancet. 2018;391:801-12. https://doi.org/10.1016/S0140-6736(17)33296-8
7. Baker S, The HC. Recent insights into *Shigella*. Curr Opin Infect Dis. 2018;31:449-54. https://doi.org/10.1097/QCO.0000000000000475
8. Cha S, Kang D, Tuffuor B, et al. The effect of improved water supply on diarrhea prevalence of children under five in the Volta region of Ghana: a cluster-randomized controlled trial. Int J Environ Res Public Health. 2015;12:12127-43. https://doi.org/10.3390/ijerph121012127
9. Bennett JE, Dolin R, Blaser MJ (eds). Mandell, Douglas, and Bennett's principles and practice of infectious diseases. 9th ed., Elsevier, 2020.
10. Shkarin VV, Ouchfoun A, Minaev VI, Naceur D. [Epidemiology of bacillary dysentery in Algeria. I. The epidemiological aspects of dysentery in Algeria]. Zh Mikrobiol Epidemiol Immunobiol. 1983:49-53.
11. Khezzani B, Bouchemal S. A study of epidemic of typhoid fever in the Souf oasis (Eastern South of Algeria). Res J Pharm Biol Chem Sci. 2016;7:1299-307.
12. Wu X, Liu J, Li C, Yin J. Impact of climate change on dysentery: scientific evidences, uncertainty, modeling and projections. Sci Total Environ. 2020;714:136702. https://doi.org/10.1016/j.scitotenv.2020.136702
13. Bogitsh B, Carter C, Oeltmann T. Human parasitology. 5th ed., Academic Press, 2018, 422 pp.
14. Nazari M, Mehrabi T, Hosseini SM, Alikhani MY. Bacterial contamination of adult house flies (*Musca domestica*) and sensitivity of these bacteria to various antibiotics, captured from Hamadan city, Iran. J Clin Diagn Res. 2017;11:DC04-DC07. https://doi.org/10.7860/JCDR/2017/23939.9720
15. Greenberg B. Flies and disease: II. Biology and disease transmission. Princeton University Press, 2019, 464 pp. https://doi.org/10.1515/9780691196718
16. Farag TH, Faruque AS, Wu Y, et al. Housefly population density correlates with shigellosis among children in Mirzapur, Bangladesh: a time series analysis. PLoS Negl Trop Dis. 2013;7:e2280. https://doi.org/10.1371/journal.pntd.0002280
17. Kinfu A, Erko B. Cockroaches as carriers of human intestinal parasites in two localities in Ethiopia. Trans R Soc Trop Med Hyg. 2008;102:1143-7. https://doi.org/10.1016/j.trstmh.2008.05.009
18. Menasria T, Moussa F, El-Hamza S, Tine S, Megri R, Chenchouni H. Bacterial load of German cockroach (*Blattella germanica*) found in hospital environment. Pathog Glob Health. 2014;108:141-7. https://doi.org/10.1179/2047773214Y.0000000136
19. Sultanov GV. [Seasonal problems of bacterial dysentery in the Dagestan ASSR]. Zh Mikrobiol Epidemiol Immunobiol. 1979:98-103.
20. Jorgensen SE, Loffler H, Rast W, et al. Lake and reservoir management, volume 54. 1st ed., Elsevier Science, 2005, 512 pp.
21. Ni W, Ding G, Li Y, Li H, Jiang B. Impacts of floods on dysentery in Xinxiang city, China, during 2004-2010: A time-series poisson analysis. Glob Health Action. 2014;7:23904. https://doi.org/10.3402/gha.v7.23904
22. Xiao G, Xu C, Wang J, Yang D, Wang L. Spatial-temporal pattern and risk factor analysis of bacillary dysentery in the Beijing-Tianjin-Tangshan urban region of China. BMC Public Health. 2014;14:998. https://doi.org/10.1186/1471-2458-14-998
23. Chang Z, Zhang J, Ran L, et al. The changing epidemiology of bacillary dysentery and characteristics of antimicrobial resistance of *Shigella* isolated in China from 2004-2014. BMC Infect Dis. 2016;16:685. https://doi.org/10.1186/s12879-016-1977-1
24. Thiam S, Diène AN, Fuhrimann S, et al. Prevalence of diarrhoea and risk factors among children under five years old in Mbour, Senegal: a cross-sectional study. Infect Dis Poverty. 2017;6:109. https://doi.org/10.1186/s40249-017-0323-1
25. Tulu B, Taye S, Amsalu E. Prevalence and its associated risk factors of intestinal parasitic infections among Yadot Primary School children of South Eastern Ethiopia: a cross-sectional study. BMC Res Notes. 2014;7:848. https://doi.org/10.1186/1756-0500-7-848

Please cite this article as:
Khezzani B, Baymakova M, Khechekhouche EA, Ghezal K, Meziou Z, Brahim AB. Incidence rates of dysentery among humans in Lemghaier province, Algeria. GERMS. 2022;12(2):195-202. doi: 10.18683/germs.2022.1322