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Original Article

Brucellosis: A Retrospective Sero-epidemiological Study

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ABSTRACT

Introduction: Brucellosis is one of the most important worldwide zoonotic diseases caused by the bacterial genus *Brucella*. It is frequently misdiagnosed and can therefore lead to inappropriate treatment and prolonged disease. This study aimed to investigate the seroprevalence of human brucellosis cases and compare it with the national average and the number of goat brucellosis cases in Algeria.
Materials and methods: A total of 3223 patients suspected of brucellosis were collected during 2008-2015 in Djelfa, central Algeria. Rose Bengal test and Wright's serum agglutination were used for the diagnosis.
Results: The number of positive cases was 1281 (39.74%), including 743 (58.04%) men and 537 (41.96%) women, resulting in a ratio of 1.38. Men were infected more than women. The number of positive cases was observed frequently between April and September. However, there was no significant difference among the investigated years in terms of infection. The highest prevalence was observed in individuals aged between 11 and 30 years (21.62-22.32%). The seroprevalence of human brucellosis in the current study in Djelfa was significantly higher, compared to the national level. The number of animals (goats) and human cases reported at the national level and Djelfa followed a similar trend.
Conclusion: Brucellosis still remains a serious public health threat in the study area. Epidemiological surveillance of brucellosis should be considered a priority in order to reduce the prevalence of human and animal brucellosis.

1. Introduction

Brucellosis is a bacterial infection caused by a bacterium of the genus *Brucella* which is distributed worldwide and transmitted to humans from infected animals[1, 2]. *Brucellaabortus*, *Brucella suis*, and *Brucella melitensis* are species that infect cattle, pigs, sheep, and goats and are responsible for most human cases[3, 4, 5].

Brucellosis may cause considerable economic losses. It is considered a significant public health threat in some countries of the Mediterranean basin and many developing countries[1]. Due to the complexity of the epidemiology of brucellosis, disease control in these regions has faced many obstacles[6].

Human brucellosis is related to the lifestyle of people, especially those living in rural regions, where the consumption of food and milk of animal origin is more frequent and less controlled[7]. The symptoms of brucellosis vary from acute to chronic form with continuous or non-continuous fever[8]. However, misdiagnosis usually occurs due to the similarity of symptoms with other diseases[9].

Human brucellosis is widespread in many areas of the world, but the number of reported cases has decreased significantly in some countries due to mandatory pasteurization of milk, elimination of infected animals, and vaccination[10].

Brucellosis is endemic in North African countries[11], including Algeria. It is only since the 1980s that several outbreaks of human and animal brucellosis have been reported in Algeria (Ghardaia in the south, Tlemcen in the west, Setif in the east). Although the public health services have introduced control and eradication measures for both

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animal and human brucellosis[11, 12], little investigation of brucellosis has been conducted[6].

This study aimed to participate in a more specific estimation of the epidemiological situation of human brucellosis in Algeria, via a retrospective study of reported cases between 2008 and 2015 in the hospital of the Wilaya of Djelfa, central Algeria. The prevalence reported in Djelfa was compared with the rate of human and animal (goat) brucellosis at the national level.

2. Materials and Methods

2.1. Study area

This study was conducted between 2008 and 2015 in the Wilaya of Djelfa, central Algeria. This province is located in the central part of Algeria beyond the southern boundary of the Tellian Atlas (Figure 1). The study area is located between 2°and 5° of longitude East and 33°and 35° of North latitude [13].

2.2. Data collection

Human brucellosis data (date, age, sex, residence, month of onset) were reported during 2008-2015. Private or public sector doctors routinely report all suspected cases of brucellosis to the prevention service based on the residential area of each patient. Age groups were identified as <10, 10-20, 21-30, 31-40, 41-50, 51-60, 61-70, 71-80, and >81 years. Moreover, case frequency was expressed in months.

At the national level, the number of human and animal brucellosis were respectively obtained from published data[11, 14].

2.3. Serological tests

The diagnosis of brucellosis in suspected cases was performed by serological methods, including the Rose Bengal agglutination technique and Wright's serum agglutination as reported previously[3]. The blood samples were collected simultaneously as brucellosis was diagnosed prior to the initiation of treatment.

Patients diagnosed with brucellosis had a positive reaction to at least one test (Rose Bengal or Wright's reaction). Human brucellosis cases were diagnosed based on symptoms and serological Ac titer of 1:160 and more.

2.4. Data analyses

R i386 3.0.2 for Windows GUI front-end was the statistical program used in the present study. ANOVA, Chi-square, and multiple range tests were used for the statistical analysis. The threshold value of different tests was $p < 0.05$.

2.5. Ethical approval

This is a retrospective study and no experiments were performed on humans or animals. The results of this study were obtained during the routine examinations at the hospital for the diagnosis of human brucellosis after gaining the patients' consent to take part in the study.

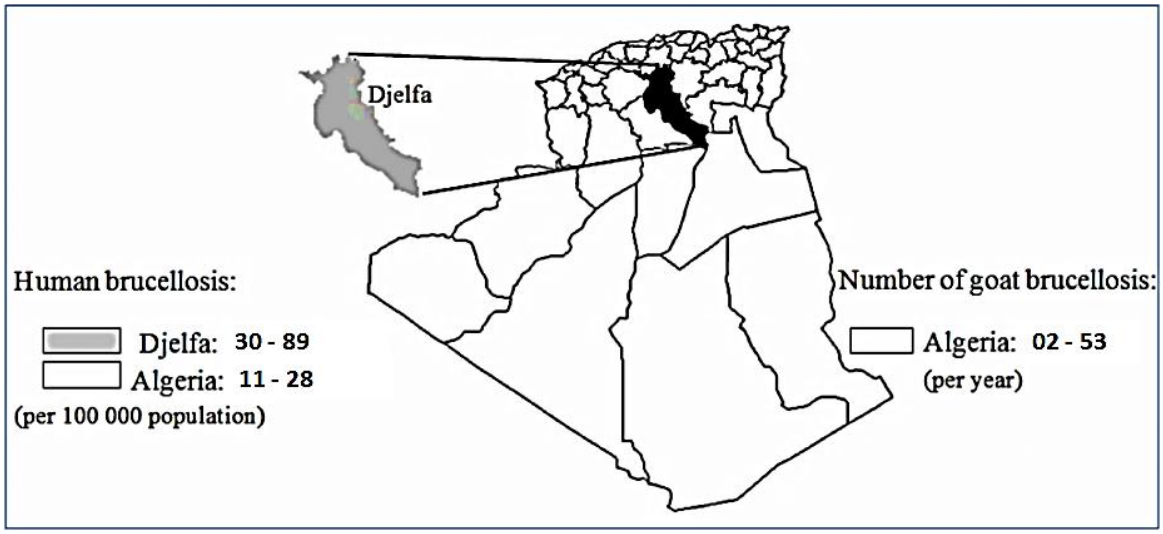

Figure 1. Presentation of the study area and number of human cases (Algeria and Djelfa) and goat brucellosis (Algeria) between 2008 and 2015

3. Results

From 2008 to 2015, of 3223 suspected cases of brucellosis, 1281 cases were which means a prevalence of 39.74%, including 743 (58.04%) men and 537 (41.96%) women. The results showed that the men were infected more than women at a ratio of 1.38 ($p < 0.05$).

All samples were positive by both tests except for two samples that were negative by the Rose Bengal test and positive by Wright's serum agglutination technique.

As can be seen in Table 1, positive cases were frequently observed between April and September ($p < 0.05$). However, there was no significant difference among different years. The age of 134 individuals was not

Table1. Annual and monthly number of human brucellosis cases in Djelfa between 2008 and 2015

Months	2 c	2009	2010	2011	2012	2013	2014	2015	Total
January	1	0	0	12	5	18	6	0	42
February	0	6	3	18	7	17	13	7	71
March	0	30	1	14	8	13	17	8	91
April	46	16	6	18	30	20	27	22	185*
May	14	26	6	22	25	25	1	29	148*
June	17	20	35	51	28	25	3	13	192*
July	10	7	22	40	16	20	0	32	147*
August	22	7	22	20	28	6	2	6	113*
September	11	6	29	20	22	12	13	2	115*
October	4	0	13	12	5	9	7	12	62
November	1	0	15	3	8	6	0	15	48
December	1	2	12	15	15	9	2	11	67
Total	127	120	164	245	197	180	91	157	1281

* P < 0.001

Table 2. Number of human brucellosis cases according to age groups between 2008 and 2015

Age group (years)	Number of cases	percentage
[0-10]	98	8.54
[11-20]	248	21.62*
[21-30]	256	22.32*
[31-40]	139	12.12
[41-50]	162	14.12
[51-60]	132	11.51
[61-70]	78	6.80
[71-80]	23	2.01
>80	11	0.96
Total	1147	100

*P < 0.001

indicated; therefore, the classification of age categories was performed for 1147 individuals. The highest prevalence was observed in individuals aged between 11 and 30 years (21.62-22.32%, p < 0.05, Table 2).

The seroprevalence of human brucellosis in the current study was significantly higher than the national level during 2008-2015 (p < 0.05, Table 3).

The number of animals (goats) and human cases reported at the national level and in Djelfa followed a similar trend. The peak of human brucellosis seroprevalence in all parts of Algeria (28.04 per 100,000 population) was observed in 2010 corresponding to the highest number of recorded cases of goat brucellosis (1847 cases, Figure 2). In the Djelfa region, the number of cases increased in the same year to reach its peak in 2011 (88.62 per 100,000 population, Figure 2).

Table 3. Seroprevalence of human brucellosis (per 100 000 population) in Djelfa and Algeria (NIPH, 2015) and the number of cases of goat brucellosis in Algeria between 2008 and 2015

Years	N° of cases in Djelfa / total population	N° of cases in Algeria / total population[1]	OR (95% CI)	Number of animal cases (goat)[2]
2008	127 / 251038 (50.58)^{c*}	5159 / 34536515 (14.94)^{c}	3.3 (2.77-3.94)	481
2009	120 / 259322 (46.27)^{c*}	6984 / 35106425 (19.40)^{b}	2.55 (2.13-3.05)	979
2010	164 / 267879 (61.22)^{b*}	10015 / 35718975 (28.04)^{a}	2.59 (2.22-3.02)	1847
2011	245 / 276437 (88.62)^{a*}	6089 / 36376646 (16.74)^{e}	7.25 (6.37-8.25)	355
2012	197 / 285559 (68.98)^{b*}	5278 / 37078280 (14.23)^{d}	4.85 (4.21-5.59)	140
2013	180 / 294983 (61.02)^{b*}	4170 / 37818781 (11.02)^{e}	5.78 (4.99-6.69)	110
2014	91 / 304717 (29.86)^{d*}	6132 / 38560235 (15.90)^{c}	1.88 (1.53-2.31)	87
2015	157 / 314773 (49.87)^{c*}	6779 / 39300427 (17.24)^{b}	2.89 (2.47-3.39)	NR

^{A,b,c,d} mean values with different letters in the same column are significantly different. NR: Not reported. [1] Data on goat brucellosis in Algeria is according to the report of Lounes et al. (2014). [2] Data of human brucellosisis according to the report of National Institute of Public Health (2015).

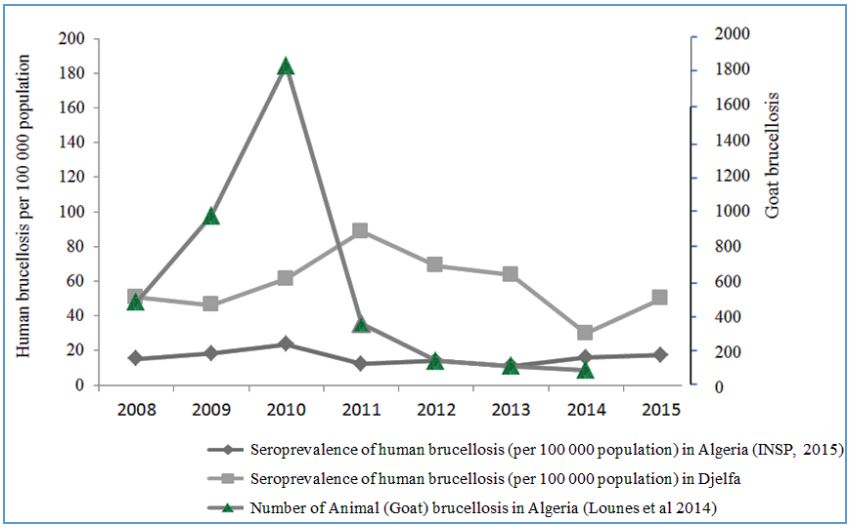

Figure 2. Seroprevalence of human brucellosis in Djelfa and Algeria and the number of cases of goat brucellosis in Algeria

4. Discussion

In the Mediterranean basin, brucellosis is known as an endemic disease, particularly in North Africa[11]. The present study aimed to highlight the prevalence scenario of human brucellosis in Djelfa through a retrospective study on 3223 samples for seven years. Moreover, this prevalence was compared with the national average of human brucellosis and the number of cases reported in animals in Algeria.

The serological diagnosis identified 1281 (39.74%) positive cases of human brucellosis. Males (58.04%) were subjected to this infection more than females (41.96%), which was consistent with other studies[15].

Male-to-female ratio of 1.38:1 was reported in the present survey. Other reports also have shown a similar male predominance[16,17]. The difference in the prevalence between men and women can be explained by the fact that most cases in the "at-risk" categories are men[18]. This group travels more than women and probably consumes raw milk in the spring and summer seasons[19]. The gender distribution is also related to the occupational factor[20]. Indeed, individuals working with domestic animals (farmers, farm workers, ranchers, shepherds, veterinarians, and inseminators) are exposed to the risk of contamination due to direct contact with infected animals[15,16] which justifies the One Health prevention strategy that targets humans and animals at the same time[21].

The clinical expression of brucellosis, such as the frequency and type of signs, symptoms, and complications, is dependent on the individual's age[22]. In the present study, brucellosis was detected in all age groups which was in agreement with other studies[23], and people aged 11-30 years presented the most infected age category, which corresponded to other studies[15,19, 24]. Childhood brucellosis infection was considered rare in the past, but more recent studies have shown that it is common among children in areas where brucellosis is endemic[25]. People aged 21-40 years were more infected in Saudi Arabia[26], Kenya[21], Iraq[27], and Uganda[28].

The prevalence of brucellosis in people under 10 years of age in the present study was lower (8.54%) than in people aged 11 to 60 years (11.51-22.32%). This may be explained by the little contact of children with the usual sources of infection, like infected animals and animal products[15,18]. Brucellosis can manifest itself in an asymptomatic/non-specific, milder, self-limiting form in infants[28]. This may also be because milk is less contagious than milk solids or because breast milk may have anti-*Brucella* activities which prevent infant exposure to infected milk[29].

The seasonal distribution of positive cases indicated that the period from April to September had more cases of human brucellosis. The current results are in agreement with those of other authors[17,18]. However, seasonality implies that the principal mode of human infection may be related to nutritional exposure. The warm season corresponds to the consumption of unpasteurized dairy products that are usually offered for sale fresh and pose a high risk of infection to humans[17]. This season coincides with the period of parturition and lactation of goats and cattle[6,16].

Serological tests are an important diagnostic tool because bacterial isolation methods take a long time, have low sensitivity, and pose risks to laboratory personnel[30]. In the present survey, the immunological diagnosis of *Brucella* infection was performed using serological methods of antibody detection based on the Rose Bengal agglutination and Wright seroagglutination technique. A simple adjustment of the serum dilutions of the test can improve its specificity and greatly decrease the necessity for additional serological testing. This simple change makes the Rose Bengal a nearly ideal test for small laboratories[3]. The serological screening of present results at the moment of admission to the hospital in Djelfa generally indicated high titers of anti-*Brucella* antibodies. In case of inconclusive serological results but high clinical suspicion of brucellosis, patients were retested after 2-4 weeks to assess possible

seroconversion[24]. In the present study, all samples were positive by both tests, except the two samples that were negative by the Rose Bengal test and positive by Wright's serum agglutination technique.

In the present investigation, the prevalence of human brucellosis was higher in Djelfa than at the national level. This is due to the location of the Djelfa region in the steppe, which is the most prevalent area in Algeria. The high density of the small ruminant population (especially goats) in this area was associated with the high number of infected cases[12].

During the period of the current survey, the brucellosis cases detected in small ruminants of Algeria included only goats, and no cases in sheep were reported[11]. The goats are considered as the main source of human contamination in Algeria since the citizens are used to consuming fresh uncooked goat milk[12]. In the present research, the number of goats and human cases reported at the national level and in Djelfa followed a similar trend highlighting the importance of the goats on public health, which is in concordance with other studies[11,12,17].

On the other hand, cows' milk is generally consumed by Algerians after cooking, which reduces the risk of contamination unlike goats' milk[11]. The same was observed in another study[16].

5. Conclusion

In conclusion, brucellosis remains a serious public health threat in the study area. The prevalence in humans may reflect the true epidemiological situation of brucellosis in animals. Epidemiological surveillance of brucellosis should be considered a priority in order to reduce the prevalence of human brucellosis and the sources of infection. It is, therefore, necessary to make appropriate control measures and eradication efforts in areas where the prevalence of animal brucellosis is high. It is also important to raise public awareness, especially among at-risk individuals, about the consumption of unpasteurized milk and milk products.

Declarations

Competing interests

The authors declare that they have no competing interests.

Authors' contribution

Ali Dahmani conceived and designed the research. Nassim Ouchene analyzed the data. Nadjet Amina Khelifi-Touhami and Manal Khelifi-Touhami wrote the manuscript.

All authors checked and confirmed the final draft of the manuscript.

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Availability of data and materials

The dataset generated and analyzed during the current study is available from the author on reasonable request.

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