# Epidemiology and risk factors of brucellosis in Alexandria governorate

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## وبائيات داء البروسيلات وعوامل اختطاره في محافظة الإسكندرية

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**الخلاصة:** تـَمثَّل الغـرض مـن هـذه الدراسـة في بيـان الاتجـاه وتحديـد عوامـل الاختطـار المحتملـة للإصـابة بـداء البروسيلات، في محافظة الإسكندرية، شماليَّ مصر. وقام الباحثون في هذه الدراسـة بـإدراج 72 مريـضاً ممـن لـديهم إصابة مؤكَّدة بداء البروسيلات، و144 من الشواهد من نفس الفئة العمرية. وأُجريت مقـابلات مـع المـشاركين في الدراسة تمت في منازلهم، باستخدام الاستبيان الـمُعَدُّ لهذا الغرض. وكانت العوامـل المتمثِّلـة في مخالطـة الحيوانـات، وتربية الماعز، وتناول المثلجات المشتـراة من الباعة الجائلين، مرتبطة ارتباطاً يُعْتَدُّ بـه إحـصائياً (P<0.05) بالإصـابة بداء البروسيلات، وذلك من واقع التحليل الوحيد المتغيِّـر والعديـد المتغيِّـرات. ومثَّلـت مخالطـة الحيوانـات المـصابة ومنتجاتها أهم الوسائل في انتقال هذا المرض.

ABSTRACT This study aimed to describe the trend and to identify possible risk factors for brucellosis in Alexandria in northern Egypt. We enrolled 72 confirmed cases of brucellosis and 144 age-matched controls in this study. Participants were interviewed at home using a structured questionnaire. Working with animals, breeding goats and eating ice cream bought from street vendors were significantly associated ($P < 0.05$) with brucellosis by univariate and multivariate analysis. Contact with infected animals and their products was the most important method of transmission.

**Épidémiologie et facteurs de risque de la brucellose dans le gouvernorat d'Alexandrie**

RÉSUMÉ Cette étude avait pour objectifs de décrire l'évolution de la brucellose à Alexandrie, ville située au nord de l'Égypte, et d'identifier les éventuels facteurs de risque de cette maladie. Ont été enrôlés dans cette étude 72 cas confirmés de brucellose et 144 témoins appariés selon l'âge. Les participants ont été interrogés à leur domicile à l'aide d'un questionnaire structuré. Les analyses uni- et multi-variées ont mis en évidence l'existence d'une association significative ($p < 0,05$) entre le travail avec les animaux, l'élevage de chèvres et la consommation de glaces achetées à des vendeurs ambulants et la brucellose. Le contage avec des animaux infectés et leurs produits s'avère être le mode de transmission prédominant.

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## Introduction

Brucellosis is a zoonotic infection caused by bacteria of the genus *Brucella*; species considered important agents of human disease are *B. melitensis*, *B. abortus* and *B. suis* [*1*]. Brucellosis has worldwide distribution; but nowadays the disease is rare in the United States of America and in many other industrialized nations because of routine screening of domestic livestock and animal vaccination programmes [*2–4*]. This disease is, however, still a leading zoonosis in the countries of the Eastern Mediterranean Region and a disease of economic importance [*5*]. Additional losses result from human infection (undulant fever) with its prolonged misery, debility and generalized aching, which may last for months or years [*5,6*]. Sheep and goats and their products are the main sources of infection. Consequently, brucellosis has been an occupational risk for farmers, veterinary surgeons and employees in the meatpacking business [*1*]. Non-occupational sources of infection include consumption of fresh, unpasteurized goat cheese and raw fresh (untreated) milk [*7*].

In Egypt, the infection is mostly caused by *B. melitensis* and *B. abortus* [*2*]. The Epidemiology and Surveillance Unit of the Egyptian Ministry of Health and Population has recorded a substantial increase in the number of patients with brucellosis in the recent past, from 24 cases in 1988 to 1429 in 1998 [*8*]. An earlier report (1992) described the distribution pattern of human cases of brucellosis during the period 1982–91: the infection rate was generally low except in 1987 and 1991, when there were marked increases in numbers of cases. This was clearly observed in Alexandria and Menofiya, and also in Giza and Domiyat [*9*].

A full description of the epidemiology of the disease is needed for planning of any intervention for its control. Therefore, the objectives of this study were to define the trend of brucellosis in Alexandria governorate over a 16-year period and to determine the risk factors.

## Methods

The study was conducted at the Alexandria Fever Hospital. This hospital was selected because it has well-trained staff and well-equipped laboratories and because of its accessibility. Although the hospital is located in an urban area, its catchment area includes not only districts from Alexandria city, but also from nearby rural areas such as El-Amriya and Abis. Although these areas are administratively related to El-Beheira governorate, they are near enough to Alexandria that, for any case of fever, it is easier to go to Alexandria Fever Hospital than Damanhour Fever Hospital in El-Beheira [*8*].

The logbooks of the health directorate over the 16 years 1988–2003 were reviewed to detect the annual number of brucellosis cases. The reliability of data from the logbooks was checked by comparing with the same data collected by the Department of Communicable Diseases in the Ministry of Health and Population.

A case–control study was also conducted in 2001 to determine the epidemiologic risk factors of brucellosis. Cases of brucellosis were identified from the admission logbooks of the Alexandria Fever Hospital. Basic demographic data such as name, age, sex and address were collected from the logbooks.

For this study, a case of brucellosis was defined as any case hospitalized with a physician's diagnosis of brucellosis between January 1999 and October 2000. Diagnosis depended on the presence of clinical symptoms such as recurrent fever, profuse sweat-

ing, headache and generalized bone pain, with rising titre of brucella IgG antibody > 1/160 using a serum agglutination test (tube and slide). Diagnosis was confirmed by performing a blood culture.

The total number of confirmed cases was 120, but only 72 were included in the study (all districts). Of the 48 patients not enrolled in the study, 20 lived in another governorate, 10 were abroad, the address was unclear for 12 and 6 refused to participate.

For each case, 2 age-matched (± 2 years) controls were selected from households within the same neighbourhood.

Informed consent was obtained from all participants following explanation of the aims and importance of the study.

Cases and controls were interviewed in their homes by one of the authors using a standardized questionnaire, which covered demographic data (marital status, occupation, educational level and family size), date of onset of symptoms, infection of other members of the family and the main risk factors. These included contact with animals (goats, cattle, sheep, camels, pigs and dogs), mode of contact (cleaning farms, delivery or handling of abortus and slaughtering animals), consumption of unboiled milk and milk products (cottage cheese and ice cream) and knowledge about brucellosis.

Data were analysed using *Epi-Info*, version 6. Odds ratio, chi squared, and Student *t*-test were used in analysis of data. Test results were considered significant if *P*-value was $\leq 0.05$. Factors found to be significant in the univariate analysis were included in the multivariate analysis.

## Results

The number of reported cases is shown in Figure 1. A mean of 61 cases has been reported annually during the period 1988–

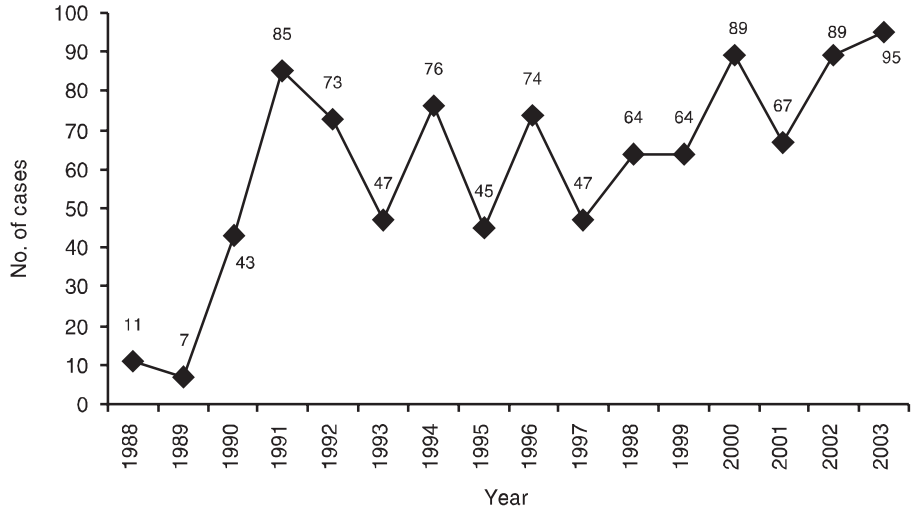


Figure 1 **Reported cases of brucellosis in Alexandria governorate, 1988–2003**

2003, with an increase in the number of reported cases, particularly in 1991, 2000 and 2003.

Sociodemographic characteristics of the 2 groups are described in Table 1. Age range was 8–69 years for cases [mean 37.1 years, standard deviation (SD) 15.4] and 9–67 years for controls (mean 36.7 years, SD 15.1) ($P = 0.8$). Those with brucellosis ($n = 72$) were distributed by age as follows: ≤ 10 years 2.7%, 11–20 years 15.2%, 21–30 years 19.4%, 31–40 years 19.4%, 41–50 years 26.3%, 51–60 years 8.3% and > 60 years 8.3%. Male to female ratio was 2:1.

The most frequent symptoms were recurrent attacks of fever (100%), profuse sweating at night with no prior antipyretic (82%) and headache (75%). The overall case fatality rate was 0.0%. Recurrence of symptoms was experienced by 36% of patients (16 males and 10 females; 4 under the age of 15 years) during the first 6 months of illness. Onset of illness was greatest in spring, 44% of cases, followed by summer, 29%.

The association between brucellosis and some risk factors is shown in Table 2. Occupation was an important risk factor for

Table 1 **Demographic characteristics**

| Characteristic | Cases ($n = 72$) | | Controls ($n = 144$) | | $P$[a] |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| *Education* | | | | | |
| Illiterate | 29 | 40.8 | 59 | 41.0 | 0.82 |
| Read and write or primary school | 21 | 29.6 | 34 | 23.6 | |
| Preparatory school | 14 | 19.7 | 33 | 22.9 | |
| Secondary school or university | 8 | 9.9 | 18 | 12.5 | |
| *Marital status* | | | | | |
| Single | 15 | 20.8 | 49 | 34.0 | 0.096 |
| Married | 47 | 65.3 | 86 | 59.7 | |
| Widowed | 6 | 8.3 | 6 | 4.2 | |
| Divorced | 4 | 5.6 | 3 | 2.1 | |
| *Occupation* | | | | | |
| Farmer | 17 | 22.5 | 19 | 13.6 | 0.011 |
| Housewife | 17 | 22.5 | 56 | 40.0 | |
| Skilled worker | 13 | 18.3 | 31 | 22.1 | |
| Student | 7 | 9.9 | 20 | 14.3 | |
| Clerical worker | 2 | 2.8 | 4 | 2.9 | |
| Butcher | 4 | 5.6 | 2 | 1.4 | |
| Meat transport and vehicle driver | 2 | 2.7 | 0 | – | |
| Other[b] | 10 | 13.8 | 8 | 5.7 | |

[a] *P value based on $\chi^2$ test for categorical variables and Student t-test for continuous variables.*

[b] *Includes professional, veterinary surgeon, nurse, fisherman, street vendor (milk and milk products), retired and unemployed.*

Table 2 **Univariate analysis of some risk factors for brucellosis**

| Variable | Cases (%) | Controls (%) | OR (95% CI) | *P*-value |
|---|---|---|---|---|
| Illiterate | 40.3 | 41.0 | 1.0 (0.5–1.9) | 0.9 |
| Occupation dealing with animals[a] | 29.6 | 14.7 | 2.4 (1.2–5.2) | 0.009 |
| Breeding animals | 40.3 | 22.9 | 2.3 (1.2–4.3) | 0.006 |
| Eating ice cream from street vendor | 42.3 | 28.6 | 1.8 (1.1–3.3) | 0.04 |
| Drinking raw milk | 6.9 | 6.0 | 0.9 (0.2–3.8) | 0.9 |
| Eating cottage cheese (unprocessed) | 85.9 | 82.5 | 1.3 (0.5–2.9) | 0.5 |
| Eating butter | 58.3 | 63.2 | 0.8 (0.4–1.5) | 0.4 |
| Dealing with unvaccinated animals | 73.6 | 65.5 | 0.6 (0.3–1.4) | 0.2 |
| Knowledge about the disease | 29.2 | 29.9 | 0.9 (0.5–1.9) | 0.9 |
| Slaughtering animals 4 weeks before onset of illness | 19.6 | 10.4 | 1.8 (0.7–4.2) | 0.1 |

[a]*Includes farmer, slaughterhouse worker, butcher and veterinary surgeon. Occupations not dealing with animals include housewife, skilled worker, clerical worker, student and other.*
*OR = odds ratio; CI = confidence interval.*

brucellosis. Workers in occupations dealing with animals (including farmers, slaughterhouse workers, butchers and veterinary surgeons) had a 2.4-fold higher risk of brucellosis than those in occupation not dealing with animals ($P = 0.009$). Breeding animals was a significant risk factor, but when the type of animal was considered, the odds for presenting with brucellosis was significantly higher only for goats ($P = 0.006$). Other animals (cattle, sheep, camels, pigs and dogs) were not associated with the risk of disease. Eating ice cream from street vendors was also significantly associated with brucellosis: the odds were 1.8 times higher among those who ate ice cream from street vendors than those who did not ($P = 0.04$).

All significant variables from the univariate analysis were included in multivariate analysis using a conditional logistic regression model. Most were not significantly associated with disease in the multivariate model, with the exception of male sex, jobs dealing with animals, breeding goats and eating ice cream bought from street vendors (unknown source) (Table 3).

## Discussion

Brucellosis has been recognized as one of the most common zoonoses in the Eastern Mediterranean Region, with more than 45 000 cases reported annually. The epidemiological data on the disease is frequently incomplete. This is partly explained by the lack of proper laboratory facilities in some remote areas as well as by poor cooperation and exchange of information between veterinary and health services [*10*].

In this study, a rise in the number of brucellosis cases was noticed in 1991 and this was in agreement with Wassif et al., who described the distribution of brucellosis cases in a number of Egyptian governorates: the highest number of brucellosis cases was in Alexandria governorate in 1991 [*9*]. A similar rise was reported in a neighbouring country, the Palestinian Territories, during the late 1980s (W. Tarazi, unpublished report, 1990). The increase in number of brucellosis cases in 1991 may be a true epidemic of brucellosis or a

Table 3 **Multivariate analysis of some risk factors for brucellosis**

| Variable | OR (95% CI) |
|---|---|
| Male sex | 2.2 (1.0–5.0)* |
| Age | 1.0 (1.0–1.0) |
| Education | 0.8 (0.4–1.5) |
| Occupation dealing with animals[a] | 2.4 (1.2–4.9)* |
| Breeding goats | 3.2 (1.2–8.7)* |
| Breeding cattle | 0.8 (0.3–2.2) |
| Breeding sheep | 0.6 (0.2–1.6) |
| Breeding dogs | 0.4 (0.2–1.2) |
| Knowledge about the disease | 0.6 (0.3–1.3) |
| Dealing with vaccinated animals | 2.1 (0.8–5.4) |
| Drinking unboiled milk | 1.5 (0.5–4.5) |
| Eating cottage cheese | 1.0 (0.4–2.4) |
| Eating ice cream from street vendor | 2.4 (1.2–4.6)* |
| Slaughtering animals 4 weeks before onset of illness | 2.0 (0.8–5.4) |

**Significantly associated with brucellosis (P < 0.05).*
*[a]Includes farmer, slaughterhouse worker, butcher and veterinary surgeon. Occupations not dealing with animals include housewife, skilled worker, clerical worker, student and other.*
*OR = odds ratio; CI = confidence interval.*

false increase because of the use of better diagnostic measures and more meticulous notification [*9*]. In fact, the number reported was probably much lower than the actuality as under-diagnosis and under-reporting of cases is a recognized problem in many developing countries [*10*]. It has been estimated that for each reported case, there are at least 2 additional cases that are not reported or not diagnosed [*11*]. Therefore, the actual number of cases may be up to 3 times as many as the reported number.

We also noted another increase in number of cases between 2000 and 2003. This could be related to improvement in the regulated surveillance system for notifying brucellosis cases accomplished by the Ministry of Health and Population in 2001 [*8*].

The age group 15–50 years was the most commonly affected with brucellosis in this study. Comparable findings have been reported from Kuwait (mean age 34.4, SD 11.5, years), Saudi Arabia (mean age 33.8, SD 13.9, years) and Djibouti (mean age 31.6 years) [*12–14*]. Brucellosis is predominately an occupational disease [*1*], so it would be expected that this age group would be the most affected, having been exposed longer to risk factors related to their occupation.

More males were affected than females (2:1) in our study and this is in accord with studies conducted in Sharkia governorate (Egypt), Kuwait, Saudi Arabia and India [*9,12,13,15*]. This sex distribution in the incidence of brucellosis infection may be because males are more concerned in activities such as slaughter and handling of carcases, and as a consequence they are at greater risk of exposure to infection. In both children (0–14 years) and adults, the disease was more prevalent among males. Abdou reported similar conclusions in a 1995 report [*16*]. Male children in the areas studied may be exposed to the same risk factors as male adults.

Other studies have, however, observed that the incidence of infection was greater in females than males (or roughly equal) [*17,18*]; in the study areas, those milking the cows, and thus having a higher chance of contact and acquiring infection, were mainly females.

Recurrent attacks of fever with profuse sweating at night with no prior antipyretic were the most prevalent symptoms in our study and in other studies carried out in south Jordan, Yemen and Greece [*18–20*]. The case fatality rate in our study was 0%; the same rate was reported in a 1998 study from Palestine [*11*]. The disease is insidious

in onset with long-standing fever, so there is more likelihood of diagnosis. In addition, the availability of well-known and effective therapy enhances the outcome of the disease. Recurrence of symptoms during the first 6 months of illness among cases we studied was 3 times higher than that reported by Awad and 11 times higher than reported by Shehata [*11,12*].

The onset of symptoms showed a seasonal pattern with high incidence in spring followed by summer. Several other studies have shown a similar seasonal pattern [*9,11,12*]. The increase is believed to be linked to the delivery (parturition) season of sheep and goats where there is a greater possibility for direct contact with vaginal discharge, foetuses and placentas, which may play a major role in increasing risk of exposure to infection.

People in occupations dealing with animals were at greater risk of developing brucellosis. A study conducted in several regions in Lebanon on 597 persons in high-risk occupations found overall prevalence of IgG and IgM antibodies for brucella was around 60%. Exposure to brucellosis was high among persons in high-risk occupations from all surveyed regions in Lebanon [*21*]. Similarly in a case–control study conducted in Yemen, occupation dealing with animals was a significant risk factor for infection; socioeconomic and educational factors were independent risk factors [*22*]. The majority of the participants in our study had not been educated beyond preparatory school level and were mostly of a low socioeconomic standard so we could not confirm these issues as independent risk factors.

Contact with goats was an important risk factor in the group we studied. In a Saudi Arabian case–control study, greater risk for brucellosis was associated with products derived from sheep and goats as opposed to camels and cattle [*23*]. Direct contact with domestic animals and consumption of raw products of animal origin have also been identified as major risk factors [*24*]. In a study done in Eritrea, the highest prevalence was among dairy farm workers and owners in randomly selected dairy-cattle farms, followed by veterinary personnel [*25*]. A higher risk was associated with the presence of sheep on the farm.

Eating ice cream from street vendors (i.e. unknown source, possibly made from the milk of infected animals) was an important source of infection in our study. Kolar also noted that there had been reports of transmission of the disease from eating ice-cream [*26*].

Consumption of unboiled milk appeared to have no association with brucellosis. In a study from Spain, no statistically significant relationship was demonstrated between consumption of dairy products and being seropositive for brucella antibodies [*27*]. This may be due to the fact that drinking fresh milk without boiling it is an uncommon practice in the study areas owing to fear of contracting other infections such as tuberculosis. Other studies have, however, found that milk and dairy products appeared to be associated with brucellosis [*19,28*]. In a study on 5726 blood specimens from children aged $\leq$ 14 years for serological evidence of brucellosis, > 60% had a history of both consumption of fresh goat's milk and close contact with animals [*15*].

Eating soft cheese and butter were not significantly related to brucellosis in our study; our cases were from urban areas, however, and cheese and butter were bought from sources which used pasteurized milk in manufacturing. Raw milk and milk products from infected sheep, goats and cattle have been cited as important sources of infection with brucellosis; soft cheeses made using traditional methods which do not ensure

killing of organism have also been implicated [*11,13*].

Occupation dealing with animals, breeding goats, male sex and eating ice cream bought from street vondors were the only significant risk factors in the logistic regression model in our study. Similarly, Bikas et al., using multivariate stepwise analysis, found that that occupation dealing with animals, place of residence, absence of stables and trauma during animal delivery were the most important risk factors remaining in the model [*29*].

## Conclusion

Our findings emphasize the importance of contact infections, i.e. contact with infected animals and their products, as method of transmission of brucellosis rather than ingestion of contaminated animal products. This means that prevention of brucellosis in man ultimately depends upon its control in the principal animal hosts. Therefore, information is needed concerning the present incidence of brucellosis in livestock (sheep, goats and cattle).

A control programme for human brucellosis would depend to a large extent on public health education about the disease and its risk factors, good administrative arrangement and ensuring the maximum cooperation of the community (particularly between health and veterinary authorities). Active cooperation between health services and veterinary services should be promoted.

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