

Brucellosis in the West Bank, Palestine

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ABSTRACT

Objective: To identify the risk factors for brucellosis in Palestine, to estimate their association with the disease and to recommend appropriate prevention measures.

Methods: An unmatched case-control study was conducted in the West Bank of Palestine. A total of 450 subjects (150 cases and 300 controls) chosen from all districts were investigated. Data were collected during the year 2000. Subjects were interviewed using a standard questionnaire acquiring demographic and risk factor information. Laboratory results were also recorded on the questionnaire. Data were analyzed calculating the odds ratio and the confidence intervals for the studied variables. A logistic regression model was used to explore the association between disease status and the

studied variables.

Results: Several variables were significantly associated with brucellosis involving both direct and indirect transmission such as consumption of unpasteurized milk and dairy products, herding, lambing and others.

Conclusion: Most of the risk factors for being infected with brucellosis are modifiable. Efforts should be directed to the prevention of this major public health problem in Palestine utilizing the information obtained in this study.

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Brucella melitensis (*B. melitensis* a true zoonosis where nearly all cases are transmitted either directly or indirectly from animals to humans. It is a major source of disease in humans worldwide especially in the Mediterranean region,¹ which is considered to be endemic with this disease.² The main foci of infection were detected in the Mediterranean basin, Central and South America, Africa and the Middle East.^{3,4} Brucellosis is endemic in Israel.⁵ Prevalence of brucellosis in humans and animals and its risk factors is well studied in this region. Several studies were performed in the Kingdom of Saudi Arabia (KSA),⁶⁻⁸ Jordan,⁹ Gaza Strip,¹⁰ Lebanon,¹¹ Israel,⁵ and in Yemen.¹² Seroprevalence of brucellosis in high risk groups in Northern Jordan was 8.2% in 1992, and was significantly higher in sheep farmers and meat handlers than in other occupations tested.¹³ In Saudi Arabia childhood brucellosis is a major health

problem in both urban and rural areas.⁸ In 1994 *B. melitensis* was the only type detected in Israel.¹ In 1996 a high occurrence of brucellosis was reported in Israel and between 1988 and 1996 8 outbreaks of *B. melitensis* in large dairy cattle farms were reported in Israel.¹⁴ Brucellosis which is considered one of the major zoonosis in Palestine,^{10,15} was introduced to the West bank and Gaza Strip only recently and the first case was reported in 1973 in Hebron area.¹⁶ The magnitude of brucellosis as an endemic disease in Palestine should not be underestimated. Due to its zoonotic nature this disease has severe health and economic impact on Palestinians. In 1998 Hebron region had the highest incidence rate in Palestine (139.9/100,000), followed by Jericho and Bethlehem.¹⁵ A total of 837 cases were reported to the Ministry of Health (MOH) surveillance system, with 546 of those coming from Hebron district.¹⁵ The economic impact

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of brucellosis is grave. In 1994 the direct loss suffered by livestock was estimated in excess of \$10 million.¹⁷

Risk factors for Brucellosis. Consumption of contaminated food and animal contact are the main sources of infection.¹ Consumption of contaminated milk, dairy products and animal contact were the main risk factors associated with brucellosis in studies conducted in KSA.⁶⁻⁸ Among south Jordanian children aged 3-14-years, consumption of unpasteurized milk and dairy products were identified as the most common source of brucella infection.⁹ A review of 54 cases in the performed in the Gaza Strip showed that a high percentage of cases reported consumption of milk and milk products and contact with animals.¹⁰ Seroprevalence of brucellosis in Jordan was significantly higher among sheep farmers and meat handlers than in other occupations.¹³ Similar results were obtained in Lebanon where a high risk occupation study was conducted showing that farmers and butchers had the highest prevalence of brucellosis.¹¹ In a brucellosis outbreak study conducted in a kibbutz in Israel, animal contact especially involvement in calf delivery and consumption of unpasteurized milk was identified as factors associated with brucella infection.⁵ Identifying the major risk factors (exposures) for brucellosis in Palestine is a vital component of reaching a comprehensive understanding of the nature of the disease and its transmission routes in this part of the world. It is only by achieving such understanding of brucellosis, appropriate interventions aiming to reduce the risk of infection and ultimately to eradicate the disease can be recommended and implemented.

The aim of the study was to explore various exposures associated with brucellosis in the Palestinian population using a simple cost-effective case control study.

Methods. A case-control study design was used in this study. Clear definition of cases was established. Only incident cases were used. Controls fulfilled the criteria defining cases, except for having the outcome. Inclusion and exclusion criteria were equally applied to cases and controls. Selection of cases and controls was independent of their exposure status. Cases were identified by the MOH surveillance system according to the case definition adopted by the MOH. One hundred and fifty cases and 300 controls were chosen from 8 districts in the West Bank. All cases detected from the surveillance system were used in this study. All cases and controls were interviewed using a standard questionnaire. For convenience purposes controls were drawn from the clients of the MOH health centers coming for any other reason at the end of the study period. For every case identified 2

controls were picked. The 2 controls will be the first 2 clients coming to the clinic and agreeing to participate after being invited. Although matching was not performed, the controls were picked in the same broad age group of the case as follows: (<5), (5-14), (15-24), (25-64) and (>5) years. The seronegativity of controls was tested using Rose-Bengal test, and if positive confirmed by antibody titration test. Selected controls with a positive test were excluded. All controls were asked before selection, if they had ever been diagnosed with Brucellosis, if the answer was yes, they were excluded. This is an unmatched case-control study and an odds ratio of the odds of exposure of cases and controls and the confidence interval (95% CI) around the point estimate (OR) for the studied risk factors were calculated. Data regarding the major expected associated factors was obtained and the results were statistically analyzed. Proportions, Chi-square test, and crude odds ratio (OR) were calculated for those factors. More complex statistical analysis utilizing more advanced statistical methods including logistic regression, which examines account of several risk factors at the same time, and controls for confounding were performed. A one day training session for the ministry staff who were involved in data collection was completed in July 2000. Doctors and epidemiology nurses conducted interviews and filled the questionnaires. Initial coding and data entry was carried out by MOH personnel. This study was implemented by MOH and coordinated by the Preventive Medicine Department (Brucellosis prevention and control program).

Results. The total study sample size was 450 participants. Of those 221 were males and 229 were females. The (mean \pm SE) age for the participants was 30.92 \pm 0.87 years, with an age range of (1-90) years. The (mean \pm SE) age for the males was 29.40 \pm 1.32 years, and 32.37 \pm 1.13 for females. Approximately 65% of the females participating in the study were housewives, while 15.3% were students. In males the proportion of students was the highest (26.2%), followed by workers 19%, while farmers were 7.7%. The unemployment rate among males was 16.3%. A total of 150 cases and 300 controls were studied. The (mean \pm SE) age for the cases was 31.14 \pm 1.58 years, while it was 30.80 \pm 1.04 years for the controls. The sex distribution for cases (M/F) was 75/75, and 146/154 for controls. The largest proportion of participants came from Hebron district (**Table 1**). A statistically significant association between place of residence and disease status (case/control) was detected using a simple Chi-square test. Of the 17 factors measured, 16 had significant statistical association with disease status

(case/control), when Chi-square and crude OR were used (Table 2). Indirect methods of disease transmission such as consumption of unpasteurized milk and, dairy products, drinking camel milk, eating raw meat (liver, spleen,...), dairy production and selling were significantly associated with disease status (Brucellosis). Direct contact with animals, including lambing, herding, milking, slaughtering were also significantly associated with brucellosis. Other factors included animal ownership, positive family history of brucellosis, presence of infected animals in the vicinity, occupation (farmer/non farmer) and residence (rural /non rural) were also associated with the disease (Table 2). Handling raw meat was not significantly associated with brucellosis. The effect of boiling milk was tested among all those who produced various dairy products. Table 3 shows the protective effect of boiling milk in the production of certain dairy products. Cheese, laban (yogurt), labaneh, jameed and makheed are among the products which most benefits from boiling as its reduces its ability to transmit brucellosis significantly.

Logistic regression. Further statistical analysis of these risk factors was conducted after testing for correlation between them. A logistic regression models was used to control for confounding in this study. Various models of logistic regression using the (Enter) and (Backward elimination methods) were used to explore the relations between different factors and the disease. In a logistic regression model using disease status (case/control) as the dependent variable and practices involving direct animal contact namely (herding, slaughtering and lambing) as the independent (explanatory) variables, lambing and herding were the 2 factors that stayed significant after controlling for the other factors with an OR=2.5 and OR=2.4. Milking was not included in this model as it yielded a strong correlation coefficient =0.74 with herding. Another model utilizing the same dependent variable with the following independent variables (consumption of unpasteurized milk, consumption of unpasteurized dairy products, animal ownership, presence of infected animals in the vicinity, occupation = farmer/non farmer, and positive family history), both consumption of unpasteurized milk and positive family history were significantly associated with brucellosis after controlling for other factors used in this model. Consistently, most of the models used showed that consumption of unpasteurized milk was significantly associated with brucellosis.

Discussion. It is important to indicate that this study was not only a purely theoretical scientific exercise. The results were used to plan effective interventions against brucella, after identifying the

Table 1 - The distribution of cases and controls among the 9 districts of the West Bank - Palestine.

District	Case	Control
Hebron	105	210
Bethlehem	18	36
Jericho	9	18
Ramallah	6	12
Jenin	5	10
Nablus	3	6
Tulkarm	2	4
Salfeet	2	4
Total	150	300

Table 2 - Association between brucellosis and associated factors.

Risk factor	Cases (%) (n=150)	Controls (%) (n=349)	Odds ratio (95% CI)
Unpasteurized milk	54 (81/150)	19.7 (59/300)	4.8 (3.1-7.4)
Unpasteurized dairy product	81.9 (122/149)	69.7 (209/300)	2 (1.2-3.2)
Drink camel milk	5.4 (8/149)	1 (3/298)	5.6 (1.5-21.4)
Produce dairy	41.1 (60/146)	22.4 (67/299)	2.4 (1.6-3.7)
Self dairy	27.5 (41/149)	8.4 (25/298)	4.1 (2.4-7.1)
Positive family history	43 (64/149)	12.1 (35/290)	5.5 (3.4-8.9)
Animal contact	58 (87/150)	30.7 (92/300)	3.1 (2.1-4.7)
Animal ownership	57.7 (86/149)	38.3 (115/300)	2.2 (1.5-3.3)
Infected animals	15.5 (23/148)	3 (9/300)	5.9 (2.7-13.2)
Lambing	22.8 (34/149)	7 (21/300)	3.9 (2.2-7.1)
Herding	23.5 (35/149)	7.7 (23/300)	3.7 (2.1-6.5)
Milking	28.4 (42/148)	9.7 (29/300)	3.7 (2.2-6.3)
Slaughtering	18.8 (28/149)	11.1 (33/298)	1.9 (1.2-3.2)
Handle raw meat	57.7 (86/149)	61.4 (183/298)	0.9 (0.6-1.3)
Eat raw meat	20.1 (30/149)	10 (30/300)	2.3 (1.3-3.9)
Residence	60.7 (91/150)	49 (147/300)	1.6 (1.1-2.4)
Occupation (farmer)	7.6 (11/145)	2.4 (7/296)	3.4 (1.3-8.9)

Table 3 - Effect of boiling milk on the transmission of brucellosis from various dairy products among participants who produce such products.

Product	Cases (%)	Controls (%)	OR (95% CI)
Cheese	34.3 (12/35)	60.5 (23/38)	0.34 (0.13-0.88)
Yogurt (laban)	51.1 (23/45)	71.1 (33/46)	0.41 (0.17-0.98)
Labaneh	46.3 (19/41)	76.4 (42/55)	0.27 (0.11-0.64)
Jameed	34.8 (16/46)	57.5 (23/40)	0.39 (0.17-0.94)
Makheed	26.1 (12/46)	47.6 (19/40)	0.39 (0.16-0.96)
Ghee (samn baladi)	44.2 (19/43)	62.5 (25/40)	0.48 (0.20-1.14)
Butter (zibdah)	35.6 (16/45)	50 (20/40)	0.55 (0.23-1.31)

main exposures and their relative contribution to the transmission of this disease. The results obtained in **Table 2** shows that the risk factors for transmission of brucellosis in the West Bank are both direct and indirect, including consumption of contaminated milk, dairy products and raw meat, and direct contact with animals including lambing, milking, herding, and slaughtering.

A recent study from KSA showed that 63.5% of 137 detected cases in Tabuk district came from rural areas, which is comparable to our result of 61.1% of the cases being village dwellers. Other similarities were found in unpasteurized milk consumption, animal keeping and ownership, and working with animals.¹⁸ The already established control and prevention measures should be used in accordance with our findings. This includes: consumption of boiled or pasteurized milk, avoiding the consumption of raw meat, liver, washing hands and cleaning equipment and utensils used in milking, storage and transport of unpasteurized milk, dairy products and meat thoroughly using soap and water, taking appropriate protective measures such as wearing gloves when herding, feeding, milking, lambing, abortion, slaughtering and handling infected animals. Most of these variables are modifiable, and efforts should be directed towards changing specific practices, and taking appropriate measures to reduce the incidence of the disease through an effective prevention and control program. Since brucellosis is a true zoonosis and the vast majority of cases acquire the disease through direct or indirect relation with animals, the prevention and control program should be carried out in close cooperation with the veterinary services in the Ministry of Agriculture. Measures to reduce the incidence of brucellosis in animals, and finally to eradicate it are of utmost importance for the success of control and prevention program. However, the effect of a single intervention such as boiling milk before use in production of various dairy products should not be under-estimated. **Table 3** showed the protective effect of boiling milk in reducing the risk of being infected with brucellosis. In locally produced dairy products such as cheese, laban, labaneh, jameed and makheed, boiling milk before production had a statistically significant effect on being infected with brucellosis with OR ranging between (0.27-0.41). The effect was not

statistically significant in the production of Ghee (samn baladi) and butter (zibdah). In the future, it is important to evaluate the efficacy of various interventions used to prevent brucellosis or reduce its incidence.

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