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Human Brucellosis: Seroprevalence, Risk Factors, and Barriers of Protection among Slaughterhouses' Workers in El-Menia Governorate, Egypt

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Abstract

Background: Brucellosis is a disabling occupational disease and an important public health problem.

Aim: To define the seroprevalence of brucellosis among slaughterhouses workers in El-Menia governorate and to define their personal risk factors.

Subjects and methods: The study was conducted on 211 subjects of different occupations, working in 11 slaughterhouses in six districts in El-Menia governorate. These districts and slaughterhouses were chosen randomly. A cross-section, analytic study design was chosen to perform this research. Subjects were submitted to interviewing, physical examination, and lab tests (standard agglutination test (SAT) and ELISA).

Results: *Brucella* seroprevalence, among slaughterhouses workers, using SAT and confirmed by ELISA was 31.3%. Most of +ve *Brucella* Abs were males (92.4%) with infection rate 31.4%. The infection rate was more in the age group 40-49 years (37.9%). Also, it was more among veterinary workers (37.0%). The study showed although there was no significant risk regarding seroprevalence in relation to duration of exposure, there was a tendency towards increase in seroprevalence with an increase in duration of exposure. The only significant risk factor for +ve serology of *Brucella* was working in rural slaughter-houses (OR=1.92). Fever, back pain, myalgia, fatigue, abdominal pain and hepatomegaly were statistically significant differ between +ve and -ve *Brucella* serology subjects. But, fever and hearing loss were statistically significant differ among +ve *Brucella* species serology cases.

Conclusion and recommendation: Brucellosis is a prevalent occupational disease in Egypt. Further studies need to be done to understand the epidemiology of brucellosis in different areas and occupations in Egypt.

Keywords

Human brucellosis; SAT; ELISA; Risk factors; Barriers of protection; Slaughter-houses workers; Egypt

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Introduction

Brucellosis is a systemic bacterial infection caused by gram negative cocco-bacilli. Its incubation period is 1-6 weeks [1]. *Brucella* has main 4 different species; *Br. abortus* of cattle, *Br. melitensis* of goats and sheep, *Br. suis* of pigs, and *Br. canis* of dogs [1,2].

Brucellosis is a common neglected zoonosis with a global geographical distribution, and as such jeopardizes human health and animal production [3]. It affects those who work is in close contact with infected animals or their tissues or secretions [1,4,5]. Humans can acquire brucellosis via consumption of animal products, mostly unpasteurized milk and milk products [5]. Seroprevalence of brucellosis in humans in contact with animals is 5.0%-8.0% [6].

In Egypt, brucellosis is documented to be an endemic disease [7,8] and it still uncontrolled public health problem [6]. The annual incidence of human infection, in Egypt, increased from 0.5/100,000 in 1994 to 70/100,000 population in 2003 [9]. The control measures are unsuccessful because of the economic implications [10]. Prevention of the disease in man depends mainly on the eradication of the disease in animals. So, hygienic measures and increased awareness about the disease are recommended to minimize the spread of infection from animals to humans [7].

Brucellosis has profound impact in developing countries where public and animal health programs are weak [8]. It is a neglected zoonosis in most African countries, due to limited efforts directed to brucellosis control [11] and because of category of the affected people; particularly the poorly educated [12]. The public health importance of brucellosis is significant because of economic losses from abortions in domestic animals and declining milk and meat products. The disease in humans is incapacitating, causes considerable debility and loss of active workdays [13]. Human brucellosis is considered a disabling occupational disease; in the Egyptian schedule under the title of infectious fevers [14].

In Egypt, prevalence of animal and human brucellosis has increased in the last decades as rapid urbanization and improved transportation have concentrated herds that were traditionally small and dispersed [15]. The prevalence of occupational brucellosis in Upper Egypt, in Sohag governorate is 18.7% [16] and in Lower Egypt, in Qulioubia governorate prevalence of brucellosis among animal farm workers is 23.4% [17].

Clinically brucellosis appears either as an acute or chronic disease and it may be generalized or localized [18]. Only 50.0% of cases are recognized and recorded due to variability in clinical manifestation [19]. Human brucellosis could be diagnosed by different laboratory procedures including blood culture, serological and skin tests [1,20]. However, there has been increasing reliance on serological tests for diagnosis [21,22]. Serological test detects *Brucella* antigen (Ag), which appears in serum 1-2 weeks after infection [23]. Optimal antibiotic therapy is still under debate [24]. While, the classical recommended regimen in brucellosis treatment is the combined regimen [25].

Aim of the Study

The aim of this study is to define the seroprevalence of brucellosis among workers in slaughterhouses in El-Menia governorate, to define

workers' personal risk factors and clinical findings, and to define barriers of protection among these workers.

Subjects and Methods

Study design

A cross-section, analytic study design was chosen to conduct this research.

Administrative design

Approval to conduct this study was obtained before starting the field work from the Directorate of Veterinary Medicine in El-Menia governorate.

Study setting and population

This study was conducted at 11 slaughterhouses in six districts in El-Menia governorate. The districts and slaughterhouses were selected randomly; 6 districts out of 9 in El-Menia governorate (2/3 of the districts) and 11 slaughterhouses out of all 33 in El-Menia governorate (1/3 of the slaughterhouses). All workers (236) in the selected slaughterhouses were the target population in this study.

Studied cases and controls

This study was conducted on 211 subjects (the agreed workers to participate; 89.41% participation rate) of the target population. The workers were encouraged to participate by clearing values and importance of disease diagnosis, freely giving treatment, clinical examination, investigations, and follow up. Brucellosis diagnosed cases were the studied group, while the negative participants were the control group.

Ethical consideration

The study protocol was approved by Council of the department of Public Health and Community Medicine. Aims and procedures of the study, security, and confidentiality were assured to the participants. An informed consent was taken from each subject to participate in the study.

Study Tools

Interviewing form

A specially designed, comprehensive interviewing form contains data relevant to topic of the study was prepared. The form was piloted on 20 participants, and then evaluated, reviewed, and accordingly modified and put in the final form.

Clinical examinations and investigations

All the participants were submitted to the following**:**

Full clinical examinations: general and local, stressing on the liver, spleen, and lymph nodes.

Pelvi-abdominal ultrasonography was done for subjects with hepato- and/or splenomegaly.

Laboratory tools and methods

Whole blood samples were collected, in 5 ml plain Vacutainer tubes and transported directly to the lab where samples were centrifuged, for 15 min at a speed of 1500 g, and sera were then separated and preserved at −20°C until tested [1,26].

Standard agglutination test (SAT): SAT was used according to Farrell [27]. Stained, standardized and smooth suspensions of killed *Br. abortus* suspension (SS14/30855501) and *Br. melitensis* suspension (SS15/ 30953501) were used (Remel Europe Ltd, UK). *Br.* suspensions were preserved in 0.25% formalin and 0.01% thiomersal. These suspensions were used to detect, identify, and quantitate specific antibodies to *Br. abortus* and *Br. melitensis* in sera. *Br.* suspensions and serum samples were brought to room temperature (18-25°C). The serial dilution method was used to quantify the antibody (Ab) titer for specific *Br.* Ag. They were incubated at 37°C in a water bath for 24 h before reading. Positive reactions and controls showed obvious granular agglutination. While, in negative reactions and controls the appearance of the suspensions showed no change. The highest final dilution of the serum showing agglutination was taken as the end point or titer of the serum [28]. The criterion for diagnosis of brucellosis (past infection not necessarily attended by definite disease, frequent infections, and latent or active infection) was suggested to be at a titer of 1/20 or more according to Sauret and Vilissova [29]. The test errors were suspected and dealt with according to Brooks et al. [1] and Bain et al. [26].

Detection of immunoglobulins IgM and IgG by Enzyme linked immunosorbent assay (ELISA): The principle of this technique is based on Ag-Ab reaction on a polystyrene surface. An enzyme labeled anti-human globulin binds the Ag-Ab complex in another step. Adding the substrate 3,3',5,5'-Tetramethylbenzidine forms a blue colored soluble conjugate that turns to yellow after adding the acid stopping solution. The absorbance is read at 450/620 nm within 1 h of stopping the reaction using plate reader according to Voller et al. [30]. ELISA technique was used to confirm results of SAT.

Statistical analysis

Analysis of data was performed with statistical package for the social sciences (SPSS) version 20. Data were presented as frequency and percentage for qualitative variables. Groups' comparison was done using Yates corrected Chi-square (χ^2) or Fischer's exact (FE) tests, as appropriate, for qualitative variables. To determine risk factors, odds ratio (OR) was used. To determine statistically significant results, P-value <0.05 was considered significant for χ^2 and FE tests. While, 95% confidence interval (CI) or exact confidence limits (ECL) were used for OR.

Results and Discussion

Brucellosis is one of the world's major zoonosis that continues to be of public health and economic concern. The disease is usually transmitted from infected animals to man [4].

As respect the results of SAT using *Br. abortus* and *melitensis* Ags among the studied sample (Table 1), which was confirmed by ELISA technique, we cleared positive subjects were 66 out of 211 (31.3%). This was in agreed with Abo El-Makarem [31]; she reported 32.2% prevalence of brucellosis in Alexandria and Giza governorates, Egypt. She attributed this high percent to the presence of *Brucella*

Table 1: Results of standard agglutination test (SAT) that confirmed by ELISA test.

Serology results	Number (n=211)	Percent
Negative (normal)	145	68.7
Positive:	66	31.3
Brucella abortus	19	9.0
Brucella melitensis	9	4.3
Mixed infection	38	18.0

infection in animals in all examined farms. While, Hashima et al. [17] in Qulioubia governorate (Egypt), Ding [32] in China, El-Shazly et al. [16] in Sohag (Egypt), Ghobshi et al. [33] in eight Egyptian governorates, Mahgoub [34] in four Egyptian governorates, El-Kady et al. [14] in Assiut (Egypt), and Refaat et al. [35] in Menoufiya (Egypt), Abdelbaset et al. [36] (Egypt), El-Diasty et al. [7] (Egypt) found prevalence's of brucellosis were 23.4%, 14.3%, 19.1%, 18.7%, 9.8%, 17.5%, 16.2%, 9.4%, and 21.0%; respectively. These investigators considered a titer of 1/60 or higher to be positive, in comparison to 1/20 used in our study. This may be the reason for low prevalence's of brucellosis in their studies. On the contrary, Nassif et al. [37] reported prevalence of brucellosis, in Sharkia, Egypt, was 73.3%. Respecting *Br.* species, we cleared prevalence's of *Br. abortus*, *Br. melitensis* and mixed infection were 9.0%, 4.3% and 18.0%; respectively. Our figures are lower than those of Refaat et al. [35] and Nassif et al. [37]; they showed prevalence's of *Br. abortus* and *melitensis* were 7.3% & 8.3% and 21.3% & 52.4%, respectively.

As regard results of SAT test using *Br. abortus* and *melitensis* Ags among the studied sample (Table 2), for *Br. abortus* Ag there were 7.0% of the tested subjects had positive titer at 1/20, 17.5% at 1/40, 21.1% at 1/80, 17.5% at 1/160, 21.1% at 1/320 and 15.8% at 1/640. On applying SAT test using *Br. melitensis* Ag, 2.1% of the tested subjects had positive titer at 1/20, 6.4% at 1/40, 25.5% at 1/80, 19.2% at 1/160, 27.6% at 1/320 and 19.2% at 1/640. All differences are statistically insignificant. The low titers (1/20 and 1/40) may be low dose of infection and became immune, previously infected and the titer decreased or early phase of infection. While, positive reactors with a titer of 1/80 and over were clear cases of brucellosis. Mahgoub [34] found 39.8% and 13.6% of his cases had titer <1/60 and ≥ 1/60, respectively for *Br. abortus*. Meanwhile, 42.2% and 13.2% of the cases had titer <1/60 and ≥ 1/60, respectively for *Br. melitnesis*. Also, Refaat et al. [35] showed 21.1% and 7.3% of their cases had titer <1/60 and ≥ 1/60, respectively for *Br. abortus*. Simultaneously, 24.2% and 8.3% of the cases had titer <1/60 and ≥ 1/60, respectively for *Br. melitnesis*. Collectively, Nassif et al. [37] reported 35.0%, 42.2%, 19.8%, and 2.8% of their cases had titer 1/80, 1/160, 1/320, and 1/640.

As respect infection rates (IRs) among the studied sample according to personal characteristics, we found 37.9% of the workers in 40-49 years age group were infected and 31.4% of the males were infected (Table 3). Wilson and Smith [38] cleared IR of brucellosis in males was higher than females. Regarding to occupation, total IR among workers was 33.1% and the highest IR was found among veterinary workers, 37.0%. Ghobshi et al. [33] reported IR was 15.2% among workers in slaughterhouses. They stated; working in slaughterhouses has been associated with the highest IR possibly due to easy contact with animals' blood and/or internal organs. Also, we reported the highest IR as regard duration of exposure was found among workers exposed ≥ 20 years. This is expected and accepted as more exposure time could increase infection rate.

As regard distribution of positive and negative serology groups according to personal risk factors (Table 4), we showed most (42.4%) of the seropositive subjects were in 40-49 years age group; this age group represented an insignificant risk factor (OR=1.59). On the contrary, the least (1.5%) of the seropositive subjects were in <20 years age group with insignificant protection (OR=0.30). These results are expected and accepted as workers in high age group may have long exposure period. Hashima et al. [17] and Gorbach et al. [39] cleared middle age is more susceptible to *Brucella* infection. Also, El-Kady et al. [14] found the highest prevalence (6.18%) of brucellosis was found among workers aged 30-39 years. Further, Kumar et al. [40] reported majority of cases with brucellosis in the US were found among young men between 20-40 years, this was related to the greater occupational hazards among them. Also, Refaat et al. [35] reported the highest proportion of brucellosis was found among the age group 20-40 years, while the lowest one was among

Table 2: Results of standard agglutination test (SAT) among positive serology group according to the titer.

SAT Titer	Positive serology				Yates χ^2 FE*	P-Value
	Abortus (n=57=86.4%)		*Melitensis* (n=47=71.2%)			
	No.	%	No.	%		
1/20	4	7.0	1	2.1	FE	0.37
1/40	10	17.5	3	6.4	2.0	0.15
1/80	12	21.1	12	25.5	0.09	0.75
1/160	10	17.5	9	19.2	0.0	0.96
1/320	12	21.1	13	27.6	0.31	0.57
1/640	9	15.8	9	19.2	0.04	0.84
*FE= Fisher exact						

Table 3: Infection rates (IRs) among the studied sample according to personal characteristics.

Variables	IR %	Variables	IR%
Age group (year):		**Duration of exposure (year):**	
<20	12.5	<5	17.0
20–29	22.2	5-9	29.3
30–39	31.3	10-14	31.4
40–49	37.9	15-19	32.8
≥ 50	31.1	≥ 20	41.9
Gender:		**Workers in SHs:**	
Male	31.4	Rural	38.8
Female	29.4	Urban	24.8
Occupation:		**Slaughterhouse site's:**	
Total:	33.1	El-Menia	18.9
Veterinary doctors	26.1	Abu-Qurkas	40.4
Administrators	18.5	Mallawy	27.9
Veterinary workers	37.0	Der-Mwas	37.5
Peelers	33.0	Matti	19.2
		Bany-Mazar	41.2

Table 4: Distribution of positive and negative *Brucella* serology groups according to personal risk factors.

Personal risk factors	*Brucella* serology				OR# (95%CI)* OR (95%ECL)**
	Positive (n=66)		Negative (n=145)		
	No.	%	No.	%	
Age group (years):					
<20	1	1.5	7	4.8	0.30 (0.01-2.45)**
20–29	8	12.1	28	19.3	0.58 (0.23-1.43)*
30–39	15	22.7	33	22.8	1.00 (0.47-2.10)*
40–49	28	42.4	46	31.7	1.59 (0.83-3.02)*
≥ 50	14	21.2	31	21.4	0.99 (0.46-2.13)*
Gender:					
Male	61	92.4	133	91.7	1.10 (0.34-4.17)**
Female	5	7.6	12	8.3	0.91 (0.24-2.29)**
Occupation:					
Veterinary doctors	6	9.1	17	11.7	1.16 (0.35-3.35)**
Administrators	5	7.6	22	15.2	0.46 (0.13-1.33)**
Veterinary workers	17	25.7	29	20.0	1.39 (0.66-2.90)*
Peelers	38	57.6	77	53.1	1.20 (0.64-2.25)*
Duration of exposure at work:					
<5 years	8	12.1	29	20.0	0.55 (0.22-1.36)*
5-9 years	12	18.2	29	20.0	0.89 (0.39-1.98)*
10-14 years	11	16.7	24	16.6	1.01 (0.43-2.34)*
15-19 years	22	33.3	45	31.0	1.11 (0.57-2.16)*
≥ 20 years	13	19.7	18	12.4	1.73 (0.74-4.04)*
Workers in slaughterhouses:					
Rural slaughterhouse	38	57.6	60	41.4	1.92 (1.02-3.62)*
Urban slaughterhouse	28	42.4	85	58.6	0.52 (0.28-0.98)*
Slaughterhouse site's:					
El-Menia	7	10.6	30	20.7	0.45 (0.16-1.14)**
Abu-Qurkas	19	28.8	28	19.3	1.69 (0.82-3.49)*
Mallawy	12	18.2	31	21.4	0.82 (0.36-1.81)*
Der-Mwas	9	13.6	15	10.4	1.39 (0.53-3.64)*
Matti	5	7.6	21	14.5	0.48 (0.14-1.41)*
Bany-Mazar	14	21.2	20	13.8	1.68 (0.74-3.81)*
***Brucella* past history (suspicion):**					
Yes	7	10.6	16	11.0	0.96 (0.34-2.64)*
No	59	89.4	129	89.0	1.05 (0.38-2.98)*

#OR= Odds ratio, ***CI=** Confidence interval, ****ECL=** Exact confidence limits

those >40 years. We cleared male gender was an insignificant risk factor for brucellosis (OR=1.10). This was agreed with Young and Hall [41], who reported brucellosis is primarily a disease of adult males, reflecting their occupational exposure. On the contrary, Hashima et al. [17] reported prevalence of brucellosis among females was higher than among males. We reflect this result to the work demands at sites of their study. Our results indicate male gender as a risk factor and female as a protective factor are statistically insignificant because of the high risk in slaughterhouse occupations regardless the gender. This is expected and accepted, as brucellosis is an occupational related disease with high male predominance. Shortly, our results were in agreed with Gorbach et al. [39], who reported men are more susceptible to *Brucella* infection than women. Considering occupation, we found all jobs represent insignificant risk factors except administrators represents insignificant protection factor. Sharmeen et al. [13] cleared occupations with increased risk of exposure include slaughterhouse workers. Workers at greatest risk of exposure are those engaged in killing, as butchers. Also, our results goes with that reported by Wilson and Smith [38], who mentioned the occupational incidence of brucellosis was very striking and the majority of cases occur where there are intimate contact with animals, removing their wastes and attending them in parturition, thus constantly exposed to infection. Also, abraded skin, superficial cuts or minor trauma, may help in introducing the organisms leading to systemic brucellosis. Veterinarians may contract brucellosis through inhalation of contaminated aerosols librated from animal excreta and aborted material [38,40,41]. Regarding duration of exposure at work place, workers with exposure groups <5 and 5-9 years represent insignificant protection; OR=0.55 and 0.89, respectively. While, workers with exposure groups 10-14, 15-19, and ≥ 20 years represent insignificant risk factors; OR=1.01, 1.11, and 1.73, respectively. However, there was a tendency towards an increase in the risk with an increase in period of exposure. Mahgoub [34] found 13.0% of the seropositive workers exposed to risk of *Brucella* infection for <5 years, 20.0% for 5-19 years and 18.9% of the infected subjects worked for ≥ 20 years. El-Kady et al. [14] showed the highest prevalence (5.54%) was found among workers with duration of exposure of 5-9 years. On the contrary, Refaat et al. [35] cleared there is no significant difference between veterinarians working more or less than 10 years, which may be due to presence of other contributing factors like nature and degree of exposure. As respect number of workers in rural/urban slaughterhouses, 57.6% of seropositive workers were found in rural slaughterhouses and representing significant risk (OR=1.92). Our result was agreed with Wassif et al. [42], who stated patients from rural areas were 90.9%. Regarding site of slaughterhouses, site with the highest risk was Abu-Qurkas district (OR=1.69) and the site with protection was El-Menia district (OR=0.45), with insignificant risk and protection, respectively. As regard past history of brucellosis by clinical suspicion, 10.6% of the current +ve serology suspected to have positive history compared to 11.0% among current –ve serology. This is an insignificant protective factor (OR=0.96). Mahgoub [34] reported past history of brucellosis was given by 9.6% of cases.

Respecting relation between symptoms and clinical examinations and serology results of the studied sample (Table 5); fever, back pain, myalgia, fatigue, and abdominal pain were found among 80.3%, 69.7%, 57.8%, 53.0%, and 24.2% of brucellosis cases, respectively with statistically significant differences with controls (P=0.00). Our results were agreed with El-Kady et al. [14], Refaat et al. [35], Nassif et al. [37], and El-Naggar et al. [43]. They reported the most prominent symptoms were fever, malaise, back pain, arthralgia, headache, and myalgia. El-Naggar et al. [43] noticed fever (90.6%) and arthritis (25.1%) were the most frequent clinical findings. Back pain is an early and constant symptom, spinal tenderness may be elicited clinically in about 50.0% of all patients and there is often muscle spasm limiting spinal movement [43]. As respect abdominal pain, our result was in accordance with Hoffman et al. [44]; they stated 20.0% of their patients complain of abdominal tenderness. On clinical examination, hepatomegaly was found significantly (P=0.001) among 21.2% of brucellosis cases. The major presenting signs were hepatosplenomegaly [34,35,43]. The results from fever hospital based studies are higher than our results, as our study was carried out among apparently healthy subjects during their work time. El-Naggar and El-Tahir [43] reported splenomegaly (14.5%), orchitis (7.5%), hepatomegaly (1.9%), and enlarged lymph node (1.9%) were found among brucellosis cases. Hepatomegaly showed much lower figure than ours. This may be due to presences of hepatomegaly among Egyptians for causes other than brucellosis as bilharziasis. Also, Hoffman et al. [44] showed hepatomegaly is less common than splenomegaly.

As regard relation between symptoms and clinical examination and serology results of brucellosis cases (Table 6), we cleared the only significant symptoms are fever and hearing loss. The fever was found among 94.7%, 100.0%, and 68.4% of *Br. abortus*, *melitensis*, and mixed infection; respectively (P=0.01). While, hearing loss was found among 0.0%, 11.1%, and 0.0% of the *Br. abortus*, *melitensis*, and mixed infection; respectively (P=0.04).

As respect relation between using personal protective equipments (PPEs) and workers with +ve and -ve serology results (Table 7), workers not wearing overall were 18.2% and 47.6% among workers with +ve and -ve serology, respectively with significant statistically difference (P=0.000). Meanwhile, 92.4% and 89.7% of +ve and -ve serology workers, respectively were not wearing protective gloves (P=0.7); 34.4% and 18.5% of +ve and -ve serology workers, respectively attributed this to gloves are not suitable at work (P=0.02). Simultaneously, workers not wearing protective boots were 15.2% and 40.7% among +ve and -ve serology workers with significant statistical difference (P=0.000). We cleared almost all the studied workers didn't use protective gloves and/or face mask, while most of them are using protective overall and/or boots. These could be explained; they using overalls and boots only to protect their casual clothes, but not for protecting themselves from catching infections. Most of the workers don't use standard PPEs during working at the slaughterhouses [12,45], so workers are at great risk of contracting brucellosis due to their practice and handling animal tissues without

Table 5: Distribution of positive and negative *Brucella* serology groups according to their symptoms and clinical examination results.

Symptoms and clinical examination results	+ve serology (n=66)		-ve serology (n=145)		Yates χ^2 FE*	P-Value
	No.	%	No.	%		
Symptoms:						
Fever	53	80.3	6	4.1	126.87	0.00
Back pain	46	69.7	7	4.8	98.05	0.00
Fatigue	35	53.0	14	9.7	45.46	0.00
Myalgia	38	57.8	10	6.9	63.43	0.00
Abdominal pain	16	24.2	9	6.2	12.45	0.00
Arthralgia	5	7.6	8	5.5	FE	0.55
Anorexia	5	7.6	7	4.8	FE	0.52
Insomnia	3	4.5	4	2.8	FE	0.68
Loss of weight	3	4.5	4	2.8	FE	0.68
Hearing loss	1	1.5	2	1.4	FE	1.00
Clinical examinations:						
Lymph adenopathy	3	4.6	3	2.1	**FE**	0.37
Hepatomegaly	14	21.2	8	5.5	10.34	0.001
Splenomegaly	8	12.1	8	5.5	1.96	0.16

*FE= Fisher exact

Table 6: Distribution of positive *Brucella* serology group according to their symptoms and results of clinical examination.

Symptoms and clinical Examinations	Positive *Brucella* serology						Yates χ^2	P-Value
	Abortus (n=19)		Melitensis (n=9)		Mixed (n=38)			
	No.	%	No.	%	No.	%		
Symptoms:								
Fever	18	94.7	9	100.0	26	68.4	8.10	0.01
Back pain	15	79.0	7	77.8	24	63.2	1.81	0.40
Fatigue	10	52.6	3	33.3	22	57.9	1.76	0.41
Myalgia	11	57.9	6	66.7	21	55.3	0.39	0.82
Abdominal pain	3	15.8	3	33.3	10	26.3	1.23	0.53
Arthralgia	0	0.0	1	11.1	4	10.5	2.19	0.33
Anorexia	0	0.0	1	11.1	4	10.5	2.19	0.33
Insomnia	1	5.3	1	11.1	1	2.6	1.24	0.53
Loss of weight	0	0.0	0	0.0	3	7.9	2.32	0.31
Hearing loss	0	0.0	1	11.1	0	0.0	6.43	0.04
Clinical examinations:								
Lymphadenopathy	1	5.3	0	0.0	2	5.3	0.49	0.78
Hepatomegaly	3	15.8	3	33.3	8	21.1	1.13	0.56
Splenomegaly	2	10.5	1	11.1	5	13.2	0.09	0.95

Table 7: Distribution of positive and negative *Brucella* serology groups according to the barriers of using personal protective equipments (PPE) of brucellosis during work.

Barriers to use PPE at work	+ve serology (n=66)		-ve serology (n=145)		Yates χ^2 FE*	P-Value
	No.	%	No.	%		
Wear protective overall:						
Yes	54	81.8	76	52.4		
No:	12	18.2	69	47.6	15.36	0.000
Not the custom	3	25.0	14	20.3	FE	0.7
Not available	8	66.7	46	66.7	FE	1.00
Not suitable at work	1	8.3	9	13.0	FE	1.00
Wear protective gloves:						
Yes	5	7.6	15	10.3		
No:	61	92.4	130	89.7	0.15	0.7
Not the custom	21	34.4	52	40.0	0.34	0.56
Not available	19	31.1	54	41.5	1.48	0.22
Not suitable at work	21	34.4	24	18.5	5.02	0.02
Wear protective boots:						
Yes	56	84.8	86	59.3		
No:	10	15.2	59	40.7	12.31	0.000
Not the custom	3	30.0	12	20.3	FE	0.678
Not available	6	60.0	38	64.4	FE	1.00
Not suitable at work	1	10.0	9	15.3	FE	1.00
Wear protective face mask:						
Yes	4	6.1	16	11.0		
No:	62	93.9	129	89.0	0.79	0.373
Not the custom	32	51.6	48	37.2	3.0	0.08
Not available	26	41.9	60	46.5	0.35	0.55
Not suitable at work	4	6.5	21	16.3	0.19	0.66

*FE= Fisher exact

wearing PPEs. Further, the inappropriate and inadequate use of PPEs among these workers put them at great risk of exposure to *Brucella* infection and many other zoonotic diseases, especially as they engaged in unhygienic practices in a heavily contaminated setting [46].

Conclusion and Recommendation

Brucellosis is an important public health problem and has been recognized as a prevalent occupation-related disease, 31.1% among slaughterhouses workers in El-Menia governorate. The disease is preventable, so we must encourage implementation of infection control programs for workers at risk of infection with brucellosis. Prevention measures through health education, food hygiene, environmental protection, personal hygiene, and PPEs are urgently needed and an important complementary issue. Control measures through early detection and prompt treatment is must. Further studies should be done to understand the true prevalence and risk factors of this occupational disease in different areas, occupations, and populations in Egypt.

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