Seroprevalence of brucellosis in humans, knowledge and practices among patients and medical practitioners in Wakiso district, Uganda

Alice Joy Namuwonge
Makerere University
Patrick Vudriko
Makerere University
Michel Dione
International Livestock Research Institute
Matthias Afayoa
Makerere University
Gordon Kibirige
Zia Angelina Health Centre
Denis Rwabiita Mugizi
Makerere University
Joseph M Kungu (kungu@live.com)
Makerere University

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Abstract

Background

In Uganda, brucellosis remains an endemic public health concern that requires adequate knowledge among the public and medical practitioners to reduce risk of transmission, correctly diagnose and manage infected humans. This study investigated the seroprevalence of human brucellosis, assessed knowledge of patients and medical practitioners about human brucellosis, and evaluated factors that influence good self-reported practices of medical practitioners towards the disease.

Methods

A cross-sectional study was conducted using a questionnaire and key informant guide among 300 patients and 30 medical practitioners respectively from May to July 2019 at Zia Angelina Health Centre, Wakiso district. Serum samples were tested for *Brucella* antibodies using Rose Bengal Plate Test. Cross tabulation between the five categories of professionals (nurses, laboratory personnel, medical doctors, clinicians, and pharmacists) and their responses to knowledge and practices was performed using Chi-square test. Logistic regression analysis was performed to measure the strength of association between overall knowledge and practice scores and demographic characteristics of study participants using odds ratios at 95% confidence intervals. Variables with p-value < 0.05 were considered as predictors of outcome.

Results

Human brucellosis seroprevalence was 0.3% (n = 1, CI: 0.0-2.4). Only 6.3% (n = 19, CI: 4.1–9.7) of patients were knowledgeable about human brucellosis, and having secondary education [AOR = 0.06, 95% CI: 0.01–0.47, p = 0.007] was significantly associated with good knowledge. Overall, 26.7%, (n = 8, p = 0.414) of medical practitioners were considered to have good knowledge of human brucellosis, however, no predictor to good knowledge was found. About a third (33.3%, n = 10, p = 0.047) of respondents had an overall good self-reported practice score towards human brucellosis. Being at a certificate education level [AOR = 0.04, 95% CI: 0.00-0.78, p = 0.033], and level of knowledge about brucellosis [AOR = 0.03, 95% CI: 0.00-0.59, p = 0.020] were identified as predictors of good practices.

Conclusions

The prevalence of human brucellosis was very low among patients who participated in the study, with participants having poor overall knowledge and practices towards the disease. These findings suggest a need for sensitization programs to improve human brucellosis awareness, and to enhance management of the disease in the health facilities.

Background

Brucellosis is an endemic bacterial zoonotic disease of public health and veterinary importance in most developing countries [1]. Brucellosis has been eradicated in developed countries but remains prevalent in Latin America, Mediterranean countries, Asia and Africa causing over half a million new cases worldwide annually regardless of misdiagnosis and underreporting of cases [2]. Previous hospital based studies conducted in Kenya, Sudan, Ethiopia and Malaysia reported seroprevalences ranging from 3.6–23.3% among patients [3–6]. In Uganda, similar studies indicated prevalences of 18.7%, 7.5% & 14.9% among febrile patients in the various parts of the country [7–9] highlighting brucellosis as an important cause of fever. Keeping livestock and consumption of raw animal products were the most commonly reported risk factors associated with *Brucella* seropositivity [7–12].

The World Health Organization (WHO) in 1986 recommended the use of doxycycline combined with either rifampicin or streptomycin as therapeutic regimen for uncomplicated human brucellosis [13]. After performing clinical trials to evaluate the efficacy of the two WHO recommended regimens, the use of doxycycline-streptomycin regimen was more effective than the doxycycline-rifampicin regimen [14–16]. In Uganda, the ministry of health published national clinical guidelines recommending; doxycycline, 100mg every 12 hours for 6 weeks plus either gentamicin, 5-7mg/kg IV daily for 2 weeks or ciprofloxacin, 500mg twice daily for 2 weeks for adults and children aged above 8 years with brucellosis [17]. Whereas cotrimoxazole, 24mg/kg every 12 hours for 6 weeks combined with gentamicin 5-7mg/kg IV in single or divided doses for 2 weeks was suggested for children below 8 years of age [17]. Practices such as adherence to the recommended clinical practice guidelines assist medical workers in providing quality health care to patients. The practice of medical practitioners, driven by their knowledge about the disease, is relevant particularly in management and control of diseases such as brucellosis which remains endemic in Uganda [18–20] with high reported seroprevalences of human brucellosis [7–9].

Despite the significance of public knowledge on brucellosis in reducing the risk of contracting the disease especially in endemic countries [21], reports indicated that people's awareness of brucellosis was inadequate in communities worldwide [18]. For instance, some studies revealed low-to-moderate knowledge levels of community participants about brucellosis in Uganda and Saudi Arabia [20–23]. Although knowledge of community participants about brucellosis is a significant determinant of its sero-prevalence, few studies have been done to validate it in different community settings in Uganda.

Therefore, the objectives of this study were to: (a) determine the seroprevalence of human brucellosis among patients; (b) assess factors associated with knowledge of patients and medical practitioners about human brucellosis; (c) evaluate factors that influence good self-reported practices of medical practitioners towards the diagnosis and management of human brucellosis at Zia Angelina H/C, Wakiso district, central Uganda. The findings of this study may guide in the setting up of appropriate strategies for disease management and control in communities and health facilities.

Methods

Study area

The study was conducted from 1st May, 2019 to 31st July, 2019 at Zia Angelina Health Centre (H/C) III located along Namugongo road in Kira Municipality, Wakiso District, Central Uganda. Wakiso district is the most populated district in Uganda having nearly two million individuals [24]. Kira municipality is one of the three most populous urban centres in Wakiso district with a population of 317,428 (15.9%) persons [24].

Zia Angelina H/C is located approximately 16 kilometres north-east of Uganda's Capital Kampala. The H/C was established in November 2000 as a private not for profit (PNFP) under the umbrella body known as Namugongo Social Services Organisation with several departments including; laboratory, maternity and antenatal care, anti-retroviral therapy clinic, dental and out-patient department (OPD). Being a PNFP, it serves approximately 2,000 patients on a monthly basis from neighbouring and distant villages such as Namugongo, Mbalwa, Kyaliwajjala, Bulooli, Kira, Kiwatule, Gayaza, and Seeta located in the Kampala metropolitan area [25], The study area was selected purposively basing on capacity to test for brucellosis and willingness to participate in the study.

Study Population

Inclusion criteria

The study enrolled patients aged ten years and above presenting with symptoms of brucellosis such as fever, headache, myalgia, backache, fatigue, loss of appetite, joint pain, or sweating during the study period but without severe conditions and mental problem, with willingness to participate. For eligible children below the age of 15 years, consent was sought and obtained from the parent or care taker who were also interviewed on the child's behalf.

The study population also included medical practitioners including laboratory personnel, clinicians, medical doctors, nurses and pharmacists who were on duty during the study period regardless of their working experience, but only those who consented to participate were interviewed. These professions were selected because of their involvement in the diagnosis and treatment of human brucellosis such as laboratory investigations, clinical diagnosis, dispensing drugs and treatment administration.

Sample Size Determination For Patients

The patients' sample size was determined basing on the 14.9% seroprevalence of brucellosis among febrile patients in south western Uganda [7]. Using Dohoo et al. formula [26] at a 95% confidence interval and a 5% desired level of precision, the calculated sample size was approximately 195 patients.

Sampling Strategy

Patients were selected by purposive sampling but only eligible patients with willingness to participate were included in the study. All medical practitioners were purposively selected due to their limited number but only those who consented to participate were interviewed.

Data Collection

Blood sample collection and serology

Upon obtaining an informed consent, approximately 3 mls of the venous blood were collected from each patient into a well-labelled sterile plain vacutainer tube following the sample collection standard operating procedure. The sample was then left to clot for 30 minutes at room temperature followed by centrifugation at 3000 rpm for 5 minutes to obtain clear serum. The serum obtained was screened for *Brucella* antibodies using commercial test kits of RBPT standard antigen according to the manufacturer's protocol (Veterinary Laboratory Agency, Weybridge, United Kingdom).

Briefly, RBPT reagent and controls were removed from the refrigerator and allowed to thaw for about 30 minutes to attain room temperature then mixed thoroughly but gently prior to use so as to resuspend any bacterial sediment. Upto 30µl of serum was dispensed onto the test card beside an equal volume of *Brucella abortus* antigen suspension and mixed thoroughly using an applicator stick then gently rocked on a mechanical rotator at 80-1000rpm for 8 minutes to allow incomplete antibodies if present to develop bacterial clumps before examination. No agglutination indicated absence of specific anti-Brucella antibodies in human serum against *Brucella* antigens hence considered negative.

Serial dilutions from 1/80 to 1/320 were performed on all positive to improve specificity of the test [27]. The results were read at the highest dilution (titration) still showing agglutination. Any serum sample that showed agglutination at a titration of 1/80 or above was considered to be positive [28].

Questionnaire

A structured questionnaire was used to obtain data on patients' socio-demographic characteristics and knowledge about brucellosis. The questionnaire was structured in English and translated to Luganda (the commonest local language used in the central region of Uganda). Prior to the beginning of data collection, the questionnaire was pretested on a random sample of ten patients (were excluded from the study) at the study site to assess its clarity and later modified basing on the pre-test findings. Each participant was first briefed on the purpose of study and reported that the information given together with their test result would be confidential and only used for research purposes and that participation was on voluntary basis. After signing an informed consent form, the questionnaire was administered to participants by a trained research assistant (fluent in Luganda and English).

Interview guide for medical practitioners

Medical practitioners were interviewed to assess their knowledge and self-reported practices towards human brucellosis using a prepared key informant checklist.

Data analysis

The collected (questionnaire and key informant interview) data were coded and entered in the EpiData software version 4.4, then exported to STATA version 14 software for statistical analysis. For descriptive statistics, categorical variables were reported in tables with numbers, percentages and their 95% confidence intervals. Pearson's chi-square test was used to determine any association between the five categories of professionals (nurses, laboratory personnel, medical doctors, clinicians, and pharmacists) and their responses to knowledge and practice questions related to human brucellosis, assessed statistical significance at $p < 0.05$. A bivariate logistic regression model was first fitted to evaluate the associations between each participants' independent variable and outcome variables (overall good knowledge and practice). Variables with a p value ≤ 0.2 were entered into multivariate logistic regression model through backward stepwise elimination method to obtain the final model of predictors of the outcome. Adjusted odds ratio with 95% confidence interval were calculated to measure the strength of association between the dependent and independent variables. Differences with a p-value < 0.05 were considered statistically significant.

Key questions assessing level of knowledge included, knowledge on etiology, zoonotic nature, transmission modes, symptoms, diagnosis, treatment, risk factors and prevention of human brucellosis. The correct response was scored one point and the wrong or do not know response scored zero, knowledge scores ranged from 0–12 and 0–20 points among patients and medical practitioners respectively. Participants who scored $\geq 50\%$ (≥ 6 points for patients and ≥ 10 points for medical practitioners) had an overall good knowledge score.

Key questions assessing level of practice related to diagnosis, sensitization, adherence to clinical guidelines, and management of human brucellosis. Responses to the 8 practice questions were assessed using frequencies: "always", "sometimes" and "never" responses which were awarded two, one, and zero respectively. Practice scores ranged from 0–8 and a respondent who scored $\geq 50\%$ (≥ 4 points) had an overall good practice score.

Results

Socio-demographic characteristics of the study participants

A total of 300 patients participated in the study, most of them being females (62%, n = 186). Majority of the respondents (46.3%, n = 139) were in the age group between 21 and 40 years old. More than half of the respondents were single (58.7%, n = 176) and had attained at least secondary education (69.4%, n = 208). Approximately 57% (n = 171) of the respondents were employed while a larger number of the respondents were Christians (96%, n = 288), Table 1.

Table 1
Socio-demographic characteristics of the patients (N = 300)

Characteristics	Number	Percent	95% CI
Sex			
Female	186.0	62.0	[56.3–67.3]
Male	114.0	38.0	[32.7–43.7]
Age (years)			
≥10–20	98.0	32.7	[27.6–38.2]
>20–40	139.0	46.3	[40.7–52.0]
>40–60	47.0	15.7	[11.9–20.3]
>60	16.0	5.3	[3.3–8.5]
Marital status			
Single	176.0	58.7	[52.9–64.1]
Married	124.0	41.3	[35.9–47.0]
Religion			
Christian	288.0	96.0	[93.1–97.7]
Muslim	12.0	4.0	[2.3–6.9]
Education level			
Tertiary	104.0	34.7	[29.5–40.3]
Secondary	104.0	34.7	[29.5–40.3]
Primary	86.0	28.7	[23.8–34.1]
No formal education	6.0	2.0	[0.9–4.4]
Occupation			
Employed	171.0	57.0	[51.3–62.5]
Unemployed*	104.0	34.7	[29.5–40.3]
Livestock keeper	25.0	8.3	[5.7–12.1]

self-employed, private and government employee, *students, house wives, and others

A total of 30 medical practitioners were interviewed during the study period, of whom 66.7% (n = 20) were females. Majority of respondents were nurses (40%, n = 12), certificate holders (53.3%, n = 16), and

between ages 31 to 40 years old (63.3%, n = 19), Table 2.

Table 2
Socio-demographic characteristics of the medical practitioners (N = 30)

Characteristics	Number	Percent	95% CI
Sex			
Female	20.0	66.7	[47.2–81.7]
Male	10.0	33.3	[18.3–52.8]
Age (years)			
21–30	9	30.0	[15.8–49.5]
>30–40	19	63.3	[43.9–79.2]
>40–50	2	6.7	[1.5–24.7]
Education level			
Certificate	16	53.3	[34.8–70.9]
Diploma	10	33.3	[18.3–52.8]
Bachelor	4	13.3	[4.8–31.9]
Profession			
Clinician	6	20.0	[8.8–39.2]
Medical doctor	2	6.7	[1.5–24.7]
Laboratory personnel	7	23.3	[11.0-42.8]
Pharmacist	3	10.0	[3.0-28.3]
Nurse	12	40.0	[23.5–59.1]

Seroprevalence of human brucellosis among patients

Of the 300 human sera samples taken for brucellosis testing using RBPT, only 0.3% (n = 1, CI: 0.0-2.4) serum sample was found positive. The positive sample was from a female married Christian aged between 21–40 years old, had attained secondary education level, and was employed.

Knowledge of the study participants about human brucellosis

Regarding patients' knowledge (Table 3), a majority (61.3%, n = 184) of the participants had heard of brucellosis disease, while 46.3% (n = 139) of respondents recognized brucellosis as a zoonotic disease.

The respondents mentioned consumption of raw milk (27.0%, n = 81), eating raw or half-cooked meat from an infected animal (21.3%, n = 64), and direct contact with infected animal tissues (1.3%, n = 4) as the modes of brucellosis transmission from animals to humans. Headache (14.3%, n = 43), fever (12.3%, n = 37), and joint pain (10.3%, n = 31) were mentioned as the common symptoms of brucellosis in humans. Although a majority (85.3%, n = 256) of the respondents did not know the preventive measures of human brucellosis, a large proportion of those who were aware mentioned at least one correct preventive measure, most commonly pasteurizing or boiling dairy products (13.0%, n = 39) and proper cooking of meat (10.3%, n = 31) (Table 3).

Table 3
Detailed responses of patients about human brucellosis knowledge (N = 300)

Knowledge questions	Number	Percent	95% CI*
Have you heard about brucellosis disease?			
Yes	184	61.3	[55.7–66.7]
No	116	38.7	[33.3–44.3]
Can brucellosis disease be transmitted from infected animals to healthy humans?			
Yes	139	46.3	[40.7–52.0]
No	38	12.7	[9.3–16.9]
Don't know	123	41.0	[35.5–46.7]
Mode of human brucellosis transmission			
Consumption of raw milk	81	27.0	[22.3–32.3]
Eating raw/ half-cooked meat from an infected animal	64	21.3	[17.0-26.4]
Direct contact with infected animal tissues	4	1.3	[0.5–3.5]
Don't know	200	66.7	[61.1–71.8]
Symptoms of human brucellosis can include;			
Fever	37	12.3	[9.1–16.6]
General body weakness	24	8.0	[5.4–11.7]
Headache	43	14.3	[10.8–18.8]
Back pain	3	1.0	[0.3–3.1]
Joint pain	31	10.3	[7.3–14.3]
Sweats	5	1.7	[0.7–3.9]
Loss of appetite	13	4.3	[2.5–7.3]
Don't know	235	78.3	[73.3–82.7]
Some effective measures to help prevent human brucellosis include;			
Pasteurizing/boiling dairy products	39	13.0	[9.6–17.3]
Proper cooking of meat	31	10.3	[7.3–14.3]
Covering body cuts when handling animal tissues	2	0.7	[0.2–2.6]
Don't know	256	85.3	[80.8–88.9]
Overall human brucellosis knowledge			

Knowledge questions	Number	Percent	95% CI*
Have you heard about brucellosis disease?			
Poor	281	93.7	[90.3–95.9]
Good	19	6.3	[4.1–9.7]
**CI* Confidence Interval, Percentages sum up to > 100% because some respondents mentioned more than one response			

The highest fraction of all medical practitioners knew the etiology of brucellosis (Table 4). Consumption of raw milk (93.3%, n = 28) followed by eating raw or half-cooked meat from an infected animal (33.3%, n = 10) were mentioned most often as modes of human brucellosis transmission. The symptoms of brucellosis among infected humans mentioned by the highest fraction of medical practitioners were joint pain (100%, n = 30), fever (76.7%, n = 23), general body weakness (63.3%, n = 19), and headache (50%, n = 15) and these responses did not differ by profession. Two-thirds of all respondents correctly mentioned the various methods for diagnosing human brucellosis and significantly, and as expected, laboratory personnel were significantly more knowledgeable about the diagnostic methods than the other four professionals. Clinicians and medical doctors had significantly more knowledge than nurses, laboratory personnel, and pharmacists about the standard treatment to prescribe for patients diagnosed with brucellosis. When medical practitioners were asked the risk factors for human brucellosis, consumption of livestock products (56.7%, n = 17) was the most mentioned followed by keeping livestock (46.7%, n = 14). Less than a quarter of all participants of which they were laboratory personnel had no knowledge about the preventive measures human brucellosis and this was significantly different (p = 0.027), Table 4.

Table 4
Knowledge about human brucellosis stratified by medical practitioner's profession (N = 30)

Variables	Medical practitioner					Total	P
	C, N = 6 (20%)	M, N = 2 (6.7%)	LP, N = 7 (23.3%)	P, N = 3 (10%)	N, N = 12 (40%)	N = 30 (100%)	value
Etiology of brucellosis							
Bacterial	6(100)	2(100)	5(71.4)	2(66.7)	7(58.3)	22(73.3)	0.358
Don't know	0(0)	0(0)	2(28.6)	1(33.3)	5(41.7)	8(26.7)	0.358
Mode of human brucellosis transmission							
Consumption of raw milk	6(100)	2(100)	5(71.4)	3(100)	12(100)	28(93.3)	0.134
Eating raw or half-cooked meat from an infected animal	3(50.0)	1(50.0)	3(42.9)	1(33.3)	2(16.7)	10(33.3)	0.594
Inhalation of infectious aerosols	1(16.7)	1(50.0)	0(0)	0(0)	1(8.3)	3(10.0)	0.287
Direct contact with infected animal tissues	3(50.0)	0(0)	2(28.6)	0(0)	1(8.3)	6(20.0)	0.202
Don't know	0(0)	0(0)	2(28.6)	0(0)	0(0)	2(6.7)	0.134
Symptoms of human brucellosis can include;							
Fever	6(100)	2(100)	4(57.1)	2(66.7)	9(75.0)	23(76.7)	0.391
General body weakness	5(83.3)	1(50.0)	6(85.7)	2(66.7)	5(41.7)	19(63.3)	0.274
Headache	4(66.7)	1(50.0)	4(57.1)	1(33.3)	5(41.7)	15(50.0)	0.831
Back pain	4(66.7)	1(50.0)	1(14.3)	1(33.3)	3(25.0)	10(33.3)	0.312
Joint pain	6(100)	2(100)	7(100)	3(100)	12(100)	30(100)	-
Sweats	3(50.0)	1(50.0)	1(14.3)	0(0)	0(0)	5(16.7)	0.051
Loss of appetite	0(0)	0(0)	1(14.3)	0(0)	3(25.0)	4(13.3)	0.539
Tests that can be used to diagnose whether or not a person is infected with brucellosis							
Blood culture	2(33.3)	1(50.0)	5(71.4)	0(0)	3(25.0)	11(36.7)	0.180
Polymerase chain reaction	2(33.3)	1(50.0)	5(71.4)	0(0)	1(8.3)	9(30.0)	**0.039**
Rose Bengal plate test	1(16.7)	0(0)	1(14.3)	0(0)	0(0)	2(6.7)	0.586
ELISA	0(0)	1(50.0)	2(28.6)	0(0)	0(0)	3(10.0)	0.073

Variables	Medical practitioner					Total	P
	C, N = 6 (20%)	M, N = 2 (6.7%)	LP, N = 7 (23.3%)	P, N = 3 (10%)	N, N = 12 (40%)	N = 30 (100%)	value
Etiology of brucellosis							
Serum agglutination test	5(83.3)	2(100)	7(100)	1(33.3)	4(33.3)	19(63.3)	**0.017**
Don't know	1(16.7)	0(0)	0(0)	2(66.7)	7(58.3)	10(33.3)	**0.038**
Standard treatment options for patients with brucellosis							
Doxycycline plus gentamicin or ciprofloxacin	6(100)	2(100)	1(14.3)	2(66.7)	10(83.3)	21(70.0)	**0.005**
Don't know	0(0)	0(0)	6(85.7)	1(33.3)	2(16.7)	9(30.0)	**0.005**
Risk factors for human brucellosis							
Consumption of livestock products	3(50.0)	2(100)	4(57.1)	1(33.3)	7(58.3)	17(56.7)	0.678
Keeping livestock	5(83.3)	1(50.0)	2(28.6)	2(66.7)	4(33.3)	14(46.7)	0.239
Occupational exposure	3(50.0)	1(50.0)	0(0)	0(0)	2(16.7)	6(20.0)	0.132
Don't know	1(16.7)	0(0)	3(42.9)	0(0)	3(25.0)	7(23.3)	0.528
Some effective measures to help prevent human brucellosis include;							
Pasteurizing or boiling dairy products	5(83.3)	2(100)	4(57.1)	3(100)	12(100)	26(86.7)	0.093
Proper cooking of meat	4(66.7)	1(50.0)	3(42.9)	2(66.7)	5(41.7)	15(50.0)	0.831
Covering body cuts when handling animal tissues	1(16.7)	0(0)	1(14.3)	0(0)	1(8.3)	3(10.0)	0.905
Testing animals before slaughter	1(16.7)	0(0)	0(0)	0(0)	1(8.3)	2(6.7)	0.759
Vaccinating animals against brucellosis	2(33.3)	1(50.0)	0(0)	0(0)	1(8.3)	4(13.3)	0.185
Don't know	0(0)	0(0)	3(42.9)	0(0)	0(0)	3(10.0)	**0.027**
Overall human brucellosis knowledge							
Poor	3(50.0)	1(50.0)	5(71.4)	3(100)	10(83.3)	22(73.3)	0.414
Good	3(50.0)	1(50.0)	2(28.6)	0(00	2(16.7)	8(26.7)	0.414

Variables	Medical practitioner					Total	P
	C, N = 6 (20%)	M, N = 2 (6.7%)	LP, N = 7 (23.3%)	P, N = 3 (10%)	N, N = 12 (40%)	N = 30 (100%)	value
Etiology of brucellosis							

C Clinicians, *M* Medical Doctors, *LP* Laboratory personnel, *P* Pharmacists, *N* Nurses, *ELISA* Enzyme Linked Immuno-sorbent Assay, *Pearson Chi-square test p-value < 0.05 was statistically significant.

Overall knowledge

The overall score for good knowledge about human brucellosis among patients was 6.3% (n = 19), Table 3. On the other hand, about a quarter (26.7%, n = 8) of all medical practitioners had a good knowledge score about human brucellosis, however, there was no significant difference in the level of knowledge among all the five categories of professionals (Table 4).

Relationship of socio-demographic characteristics of the study participants with their knowledge about human brucellosis

The number of patients with overall good knowledge about brucellosis were higher among; female patients (5.9%, n = 11), those aged between 21 and 40 years (10.8%, n = 15), married (11.3%, n = 14), Christians (6.6%, n = 19), the employed (9.4%, n = 16), and those who attained tertiary education level (16.4%, n = 17), Table 5. The multivariate logistic regression model showed that participants who had attained secondary education level were 94% less likely to have a good knowledge score [AOR = 0.06, 95% CI: 0.01–0.47, p = 0.007] as compared to those who had attended technical institute or university, Table 5. There was no significant difference in knowledge of brucellosis between married and single participants.

Table 5
Bivariate and multivariate analysis of factors associated with patients' knowledge towards human brucellosis

Variable	Good knowledge, N (%)	Bivariate analysis		Multivariate analysis	
		Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Sex					
Female	11(5.9)	Reference			
Male	8(7.0)	1.20(0.47–3.08)	0.704		
Age group (years)					
≥10–20	0(0)	1 empty			
>20–40	15(10.8)	Reference			
>40–60	4(8.5)	0.77(0.24–2.44)	0.656		
>60	0(0)	1 empty			
Marital status					
Married	14(11.3)	Reference		Reference	
Single	5(2.8)	0.23(0.08–0.66)	**0.006***	0.50(0.17–1.52)	0.222
Religion			-		
Christian	19 (6.6)	Reference			
Muslim	0(0)	1 empty			
Education level					
Tertiary	17(16.4)	Reference		Reference	
Secondary	1(0.9)	0.05(0.01–0.38)	**0.004***	0.06(0.01–0.47)	**0.007****
Primary	0(0)	1 empty		1 empty	
No formal education	1(16.7)	1.02(0.11–9.32)	0.984	1.12(0.12–10.41)	0.921
Occupation					
Employed	16(9.4)	Reference			

Variable	Good knowledge, N (%)	Bivariate analysis		Multivariate analysis	
		Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Sex					
Unemployed	0	1 empty			
Livestock keeper	3(12.0)	1.32(0.36–4.90)	0.677		
OR: odds ratio; CI: confidence interval; * significant at 20%,** significant at 5%					

All pharmacists lacked good knowledge unlike other professionals (Table 6). Similarly, males (50%, n = 5), diploma holders (50%, n = 5), and medical practitioners aged between 31 and 40 years (31.6%, n = 6) had better knowledge about brucellosis, Table 6. In bivariate analysis, sex, education level, and profession were significantly associated with good knowledge score, while age was not (Table 6). However, no significant difference was found between the demographic variables and knowledge levels of medical practitioners in the multivariate analysis, Table 6.

Table 6
Socio-demographic characteristics associated with level of knowledge of medical practitioner about human brucellosis

Variable	Good knowledge, N (%)	Bivariate analysis		Multivariate analysis	
		Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Sex					
Female	3(15.0)	0.18(0.03–1.01)	**0.051***	0.14(0.01–2.75)	0.195
Male	5(50.0)	Reference		Reference	
Age group (years)					
21–30	2(22.2)	0.62(0.09–3.92)	0.610		
>30–40	6(31.6)	Reference			
>40–50	0(0)	1 empty			
Education level					
Certificate	1(6.3)	0.07(0.01–0.72)	**0.025***	0.08(0.00-1.65)	0.101
Bachelor	2(50.0)	1(0.09–10.17)	1.000	0.37(0.01–17.39)	0.615
Diploma	5(50.0)	Reference			
Profession					
Medical doctor	1(50.0)	1 (0.04–24.55)	1.000	2.68(0.03-225.23)	0.662
Laboratory personnel	2(28.6)	0.4 (0.04–3.96)	0.433	0.50(0.02–11.73)	0.668
Nurse	2(16.7)	0.2 (0.02–1.82)	**0.153***	3.42(0.09-136.17)	0.513
Clinician	3(50.0)	Reference		Reference	
Pharmacist	0(0)	1 empty		1 empty	
OR: odds ratio; CI: confidence interval; * significant at 20%					

Self-reported practices of medical practitioners towards human brucellosis

In Table 7, a third of the participants (33.3%) mentioned that they always advised febrile patients to test for brucellosis and this was significantly less in nurses compared to other professionals. Most respondents (56.7%, n = 17) declared that they educated patients about preventive measures for brucellosis. Clinicians (33.3%, n = 2) and medical doctors (50%, n = 1) always followed the national clinical guidelines when managing patients diagnosed with brucellosis, however, a large proportion (73.3%, n = 22) of respondents never practiced adherence and these differences were significant across professionals. Most of the laboratory personnel (85.7%, n = 6) and pharmacists (66.7%, n = 2) self-reported to have never followed-up patients on treatment as compared to other professionals and this was significantly different (Table 7).

Table 7
Responses of medical practitioners to practices related to diagnosis and management of human brucellosis

Variables	Medical practitioner					Total	P
	C, N = 6 (20%)	M, N = 2 (6.7%)	LP, N = 7 (23.3%)	P, N = 3 (10%)	N, N = 12 (40%)	N = 30 (100%)	value
Do you advice patients presenting with fever to test for brucellosis?							
Always	4(66.7)	2(100)	1(100)	1(66.7)	2(58.3)	10(33.3)	**0.047**
Sometimes	2(33.3)	0(0)	6(85.7)	1(33.3)	5(41.7)	14(46.7)	0.147
Never	0(0)	0(0)	0(0)	1(33.3)	5(41.7)	6(20.0)	0.107
Do you educate patients about preventive measures for brucellosis?							
Always	2(33.3)	1(50.0)	1(14.3)	0(0)	1(8.3)	5(16.7)	0.402
Sometimes	4(66.7)	0(0)	2(28.6)	2(33.3)	4(33.3)	12(40)	0.330
Never	0(0)	1(50.0)	4(57.1)	1(66.7)	7(58.3)	13(43.3)	0.172
Do you adhere to the national clinical guidelines when managing patients with brucellosis?							
Always	2(33.3)	1(50.0)	0(0)	0(0)	0(0)	3(10.0)	**0.047**
Sometimes	3(50.0)	0(0)	1(14.3)	1(33.3)	0(0)	5(16.7)	0.084
Never	1(16.7)	1(50.0)	6(85.7)	2(66.7)	12(100)	22(73.3)	**0.004**
Do you follow-up patients on brucellosis treatment?							
Always	0(0)	0(0)	0(0)	0(0)	2(16.7)	2(6.7)	0.523
Sometimes	5(83.3)	2(100)	1(14.3)	1(33.3)	6(50.0)	15(50.0)	0.073
Never	1(16.7)	0(0)	6(85.7)	2(66.7)	4(33.3)	13(43.3)	**0.049**
Overall practice							
Poor	1(16.7)	1(50.0)	6(85.7)	2(66.7)	10(83.3)	20(66.7)	**0.047**
Good	5(83.3)	1(50.0)	1(14.3)	1(33.3)	2(16.7)	10(33.3)	**0.047**

C Clinicians, *M* Medical Doctors, *LP* Laboratory personnel, *P* Pharmacists, *N* Nurses, *Pearson Chi-square test p-value < 0.05 was statistically significant.

Overall practice

About a third (33.3%, n = 10) of all respondents had an overall good practice score towards human brucellosis and this practice was significantly showed mostly by clinicians (p = 0.047), Table 7.

Factors that influence good self-reported practices of the medical practitioner towards the diagnosis and management of human brucellosis

Results from the multivariate logistic regression analysis in Table 8 showed that medical practitioners at the certificate level of education were 96% less likely to have good practice towards human brucellosis than their counterparts who had attained higher education [AOR = 0.04, 95% CI: 0.00-0.78, p = 0.033]. Also medical practitioners with poor knowledge about human brucellosis were 97% less likely to have good practices than those with good knowledge [AOR = 0.03, 95% CI: 0.00-0.59, p = 0.020] (Table 8).

Table 8
Factors associated with good self-reported practices of medical practitioners towards human brucellosis

Variable	Good Practice, N (%)	Bivariate analysis		Multivariate analysis	
		Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Sex					
Male	5(50.0)	Reference			
Female	5(25.0)	0.33(0.07–1.65)	**0.178***		
Age group (years)					
21–30	3(33.3)	1.08(0.19–5.87)	0.926		
>30–40	6(31.6)	Reference			
>40–50	1(50.0)	2.17(0.12–40.81)	0.606		
Education level					
Diploma	7(70.0)	Reference		Reference	
Certificate	1(6.3)	0.03(0.00-0.33)	**0.004***	0.04(0.00-0.78)	**0.033****
Bachelor	2(50.0)	0.43(0.04–4.64)	0.486	0.23(0.01–6.55)	0.390
Profession					
Clinician	5(83.3)	Reference			
Medical doctor	1(50.0)	0.2(0.01–6.66)	0.368		
Laboratory personnel	1(14.3)	0.03(0.00-0.68)	**0.027***		
Pharmacist	1(33.3)	0.1(0.00-2.50)	**0.161***		
Nurse	2(16.7)	0.04(0.00-0.55)	**0.016***		
Knowledge of human brucellosis					
Good	7(87.5)	Reference		Reference	
Poor	3(13.6)	0.02(0.00-0.25)	**0.002***	0.03(0.00-0.59)	**0.020****
OR: odds ratio; CI: confidence interval; * significant at 20%,** significant at 5%					

Discussion

This study documented a very low seroprevalence of human brucellosis among patients by the RBPT method compared to the published seroprevalences of 7.5% and 14.9% in similar studies conducted in central [8] and south western Uganda [7] respectively. The high prevalence in south western Uganda could probably be due to the fact that it was conducted in a pastoral community where people were directly in close contact with livestock, enrolling a number of febrile patients with diverse exposures hence getting a higher prevalence.[7]

The current study was expected to have a relatively higher prevalence of brucellosis among patients as compared to the 7.5% reported prevalence among malaria-negative febrile patients in the Wakiso district [8] due to the generality of patients, increased sample size, and the use of only RBPT diagnostic method to detect the *Brucella* antibodies. However, the prevalence obtained in this study was much lower at the time of the study due to the fact that majority (84.2%) of the people sampled were urban residents [24] who were at low risk of exposure to livestock and its raw products. More so the high standard of living that comes with urban residence, and the tendency of them to consume pasteurized and formally marketed milk probably reduced the risk of infection with *Brucella* organisms. Therefore, this study finding suggests that brucellosis may not have been a common infection in the local population sampled in central Uganda during the time of the study. The brucellosis seroprevalence in this study was also much lower than that reported in other hospital based studies conducted in Kenya, Sudan, Ethiopia and Malaysia which ranged from 3.6–23.3% [3–6]. The difference in the findings could be attributed to the variations in sample sizes, population dynamics, and difference in the diagnostic tests used.

Despite majority (61.3%) of the patients had ever heard about brucellosis, only a few (6.3%) of the participants had good overall knowledge about the disease. Findings of this study could be attributed to laxity due to the reduced threat of brucellosis among low risk populations hence people were unbothered to know about the disease. The high awareness of brucellosis but with inadequate knowledge about the disease among participants in the current study concurs with other study findings [18] [20, 21]. Contrary to this, studies from north and western Uganda reported higher levels of knowledge about brucellosis of 91.3% and 53.1% among participants respectively [21, 22].

The only predictor for patient's knowledge was education level. Participants who had attained secondary education level were 94% less likely to have a good knowledge score as compared to those who had attended technical institute or university, this could be explained by the fact that at tertiary education level, students tend to be more exposed and have different sources of information to learn about infectious diseases. Education level was also found statistically significant among the participants in similar study in Uganda [20]. However, there was no association between patient's human brucellosis knowledge and age and gender as reported by other studies in Uganda and Saudi Arabia [20] [23]. Therefore, there is a need for health education on brucellosis targeting education level in communities to enhance people's knowledge about the disease.

Majority of the medical practitioners correctly recognized human brucellosis as a febrile disease. In this study, laboratory personnel and medical doctors were more knowledgeable about the diagnosis and

treatment of human brucellosis respectively than other cadres of medical practitioners. This can be explained by the fact that laboratory and medicine fields of study encompasses wider content on diagnosis and treatment of diseases respectively. Overall, about a quarter of the total medical practitioners interviewed had good knowledge about human brucellosis and this could increase the risk of misdiagnosis and underreporting of brucellosis. This finding is higher than the 15.3% reported by Nabirye et al in Uganda[20]. Contrary to our finding, similar studies conducted in South Arabia and Tanzania among primary health care physicians and medical workers respectively found majority well-informed about the transmission, clinical features, prevention, treatment, and diagnosis of brucellosis in humans. of brucellosis [29][30]. These differences may be due to variation in the number and content of the knowledge questions. Although a similar study conducted in northern Uganda found education level statistically associated with medics good knowledge about brucellosis [20], multivariate analysis of our study showed no significant differences between the demographic variables and knowledge levels of medical practitioners in the current study.

Regarding self-reported practices of medical practitioners on human brucellosis, majority of the medical practitioners acknowledged to have routinely tested febrile patients for brucellosis which minimizes misdiagnosis of the disease. Surprisingly, few of the medical practitioners mentioned adherence to the clinical guidelines when managing patients with brucellosis which could have led to mistreatments. A study among Dutch general practitioners demonstrated that lack of agreement with the guideline recommendations is the most common barrier to implementation [31]. More than half of the participants reported to have followed-up brucellosis cases on treatment which is crucial to ensuring that health workers receive important feedback regarding recovery, relapses, contraindications and any challenges of adherence to treatment. The self-reported practices of medical practitioners were found to be largely poor significantly across professionals, this is in agreement with another study done in Uganda, which indicates that 13.6% of medical workers had good practices regarding handling cases of brucellosis [20]. However, a study done in Saudi Arabia among primary health care physicians showed better (moderate mean score) practice [30], which is contrary to our finding. The current study found that medical practitioners at the certificate level of education were 96% less likely to have good practice towards human brucellosis than their counterparts who had attained higher education. Also medical practitioners with poor knowledge about human brucellosis were 97% less likely to have good self-reported practices than those with good knowledge. However, contrary to this study, no significant associations were found between practices of medical workers with their demographic characteristics in previous studies from Uganda and Saudi Arabia [20][30]. Basing on our study findings, interventions aimed at improving medical practitioners' knowledge about brucellosis at different education levels could enhance management and control of the disease.

This study had a few limitations. First, the very small number of sero-positives for human brucellosis could not permit statistical models for measure of associations between potential factors and *Brucella* seropositivity. The findings of this study may not be generalizable to the knowledge and practices of medical practitioners in other health facilities across the country as the study was restricted to responses of health workers in only one H/C in a district. The study excluded patients under the age of ten with fear

that care takers or parents would not accept, having this in mind, only patients aged ten years and above were studied. Lastly, medical practitioner's data about practices were collected through self-reports instead of observing practices implying a possibility of bias reporting.

Conclusions

The sero-prevalence of human brucellosis among patients at Zia Angelina H/C in Wakiso district was very low at the time of the study. This suggests that brucellosis may not have been a common infection in the local population during the study period. Majority of the patients were not knowledgeable about brucellosis which could increase the risk of contracting brucellosis in communities and possible future resurgence of the disease. Majority of medical practitioners were poorly knowledgeable about brucellosis, this could be one of the contributing factors to misdiagnosing the condition in Uganda. And majority of practitioners had poor practices towards the diagnosis and management of human brucellosis, this could increase the rates of therapeutic failure and relapse of brucellosis among treated patients.

Monthly surveillance for zoonoses should be continued at the various health facilities in Uganda coupled with health education on brucellosis in communities to enhance knowledge about the disease. There is a need for continuous health education among medical practitioners through refresher courses or mentorship programs to equip them with adequate knowledge about brucellosis, and build their capacity in brucellosis management emphasizing adherence to the recommended national clinical guidelines when managing human brucellosis. A new study which will involve sampling other high level health facilities, covering more districts, and including a qualitative study to assess knowledge should be done in future to validate the current study which involved a small study area and sample size. A similar study should be under taken to establish the prevalence of brucellosis in children under the age of ten because of the high consumption rate of milk products in this age group.

Abbreviations

CI: Confidence interval, H/C: Health Centre, OR: Odds Ratio, RBPT: Rose Bengal Plate Test, WHO: World Health Organization

Declarations

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Authors' contributions

AJN, PV and JMK developed the concept. AJN, PV, MD, MA, DRM and JMK were involved in data collection, data analysis, data interpretation, and manuscript writing. All authors read and approved the submitted version of the manuscript.

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Availability of data and materials

All relevant data has been included within the manuscript.

Ethics approval and consent to participate

This study obtained ethical approval from the research ethics committee of the school of Biosecurity, Biotechnical and Laboratory Sciences (SBLS) of College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University (SBLSREC:2209). Permission to conduct the study was also obtained from the administration of Zia Angelina H/C III.

An informed consent was obtained from both the adult participants and the parent(s)/guardian(s) of all participants under-16 years of age. Each participant was identified using a study number and confidentiality of data was ensured. All methods described here were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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