Prevalence and predictors of risk factors for Brucellosis transmission by meat handlers and traditional healers' risk practices in Ibadan, Nigeria

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Brucellosis • Public health • Risk factors

Introduction. Brucellosis is endemic in Nigeria and risk factors enhancing its transmission are prevalent.

Methods. Following serological evidence of brucellosis and isolation of B. abortus from slaughtered cattle in Ibadan, Nigeria, we administered a semi-structured questionnaire to determine the prevalence and predictors of eating and selling bovine gravid uterus among 350 meat handlers from five major meat processing facilities. We conducted key informant interview for five leading traditional healers to document its use. Data were analyzed using Stata 12.

Results. The prevalence of eating and selling gravid uterus were 29.7% and 40.3% respectively. Being meat/offal processor (OR=1.9, 95%CI: 1.11-3.3, P = 0.008) and not knowing that eating undercooked contaminated gravid uterus could expose humans to brucellosis (OR=19.5; 95%CI: 5.73-66.03; P = 0.000) were strong predictors of eating gravid uterus. Similarly, being adult (OR = 1.7, 95%CI: 1.08-2.57, P = 0.02) and inadequate knowledge of brucellosis as a preventable disease (OR = 0.03; 95%CI: 0.004-0.27, P = 0.001) predicted selling gravid uterus. Qualitative data from the traditional healers revealed using gravid uterus as special medicinal preparations to hasten parturition in overdue pregnancies, treat infertility and old age diseases in humans.

Conclusions. We demonstrated a high prevalence of risk factors for brucellosis transmission, and some meat handlers' socio-demographic characteristics and brucellosis knowledge-based markers as predictors of these factors. The traditional healers' practices portend a challenge to the current brucellosis control strategy. These findings provide insights into designing all-inclusive health programmes aimed at controlling brucellosis spread in Nigeria and other similar settings in developing countries.
practice of eating and selling gravid uterus is common among meat handlers. In addition, traditional healers reportedly make use of gravid uterus locally called *abodi alaka* for some concoctions; whereas, a gravid uterus sustains the growth of *Brucella* organism [21, 22]. The risk is potentiated by the habit of eating uncooked or undercooked meat as well as poor handling during food preparation [11, 23]. This study was aimed at determining the prevalence and predictors of the risk behaviours of eating and selling gravid uterus by meat handlers and also documenting usage of this organ by leading traditionalists in Ibadan, Nigeria.

**Materials and methods**

**STUDY DESIGN, SITE AND POPULATION**

This cross-sectional study was conducted in Ibadan, Nigeria. Nigeria is the most populous country in Africa (over 170 million in 2012; [http://esa.un.org/wpp/ASCII-Data/DISK_NAVIGATION.ASCII.htm](http://esa.un.org/wpp/ASCII-Data/DISK_NAVIGATION.ASCII.htm)) with an estimated livestock population of 20.49 million cattle, 23.07 million sheep, 28.07 million goats, 6.54 million pigs ([http://www.fao.org/ag/againfo/resources/en/glw/GLW dens.html](http://www.fao.org/ag/againfo/resources/en/glw/GLW dens.html)), 18,200-90,000 camels, and 210,000 horses ([http://faostat.fao.org/site/573/default.aspx#ancor](http://faostat.fao.org/site/573/default.aspx#ancor)) [24]. It ranks second of the four countries (Nigeria, India, Ethiopia, and Bangladesh) that account for 44% of poor livestock keepers globally [25]. Ibadan is located in South-Western Nigeria and lies between latitude 7°32′N and longitude 3°54′E. It is the third largest metropolitan area, by population, as well as the largest metropolitan geographical area in the country. Previous and on-going reports showing serological evidence of brucellosis [17-20] as well as isolation of *B. abortus* (unpublished data) in slaughtered cattle in this study area abound. The study was carried out using the five major government-owned meat processing facilities which supply meat to the teeming population of over 2,893,137 people [26] in the area, including its surrounding environments. These meat processing facilities were chosen on the basis of the populations of their workers (Oyo State Department of Agriculture and Rural Development, personal communication) while the food animals slaughtered represent more than 65% of the slaughtered animals in the area.

The study spanned a period of two months. The population at the meat processing facilities from which the respondents were selected consisted of meat butchers, meat/offal processors, meat buyers and children. The inclusion criteria for selection of potential participants were being meat handlers actively participating in meat processing operations and being at least 18 years of age. A meeting was held with all the potential participants on the objectives and benefits of the study and were informed that they could choose either to participate or not in the study. They were then grouped based on the slaughter halls where each of them worked. A pretest was conducted among ten randomly selected meat handlers, after which some of the questions were modified to improve clarity. Thereafter, visits were made based on the groupings and all consenting participants who met the inclusion criteria, excluding those who participated in the pretest, were interviewed. Each of them was allotted a code on the questionnaire. The researchers made provisions for interpreters for those who did not understand English, but only their local language. In all, only 17 people among those who met the inclusion criteria and were asked to be interviewed declined participation. In addition, the researchers identified a key leader who was knowledgeable about the traditional settings in each of the areas where the meat processing facilities used were located. These key leaders assisted the researchers in identifying the leading traditional healers in the areas for interview.

**DATA COLLECTION AND ANALYSIS**

Data for this study on the participating meat handlers were collected using a semi-structured interviewer-administered questionnaire by well-trained personnel. The questionnaire included three parts. In the first part, we attempted to determine the socio-demographic profiles of the respondents including the age groups (18–40 years as young adult and >40 years as adult), sex, highest education received, nature of occupation and length of years already spent as workers in meat processing. The second part had five questions to determine their knowledge on bovine brucellosis as it relates to its transmission to humans with response options of ‘yes’, ‘no’ or ‘I don’t know’. The third part contained five questions inquiring about their risk behaviours including whether or not they eat, or sell gravid uterus with response options of either ‘yes’ or ‘no’. Using a key informant interview, the identified leading traditional healers were asked questions on their uses of gravid uterus as well as on issues related to their awareness and knowledge of brucellosis transmission with respect to their practices. Their responses were documented, collated and summarized.

The central study outcome variables from the questionnaires on the meat handlers were whether the respondents did or did not eat or sell gravid uterus and those who indicated eating or selling it were classified as high risk and those who did not as low risk. The independent variables were demographic variables and knowledge-based markers related to brucellosis. Data were analyzed using Stata 12.0 (StataCorp LP, Texas, USA) and were tabulated based on the risk category. The values in each category were presented together with their respective percentages. Univariate analysis was first done on all variables using chi-squared statistic with Fisher’s exact test when necessary to determine potential variables for the logistic regression model. A multivariate unconditional logistic regression analysis was done using the variables that were statistically significant at 10% level. Backwards stepwise regression was used with the least significant variable removed at each stage until the model contained only those factors which were significant at the 5% level. All tests were two-tailed and p-values of less than or equal to 5% were considered significant.
The odds ratios were reported with their 95% confidence intervals (CI).

**Results**

A total of 350 meat handlers and five leading traditional healers participated in this study. Out of these meat handlers, 104 (29.7%) and 141 (40.3%), respectively affirmed eating and selling gravid uterus, thereby constituting the high risk groups (Tab. I). Based on socio-demographic characteristics, 50.9% were young adults, 62.9% were male respondents, 52.3% had primary education, 57.1% were meat/offal processors and 64.0% had been in meat processing facilities as workers for more than ten years (Tab. II).

**Assessment of predictors of eating gravid uterus by meat handlers**

Of all the socio-demographic variables, only being meat/offal processors ($P = 0.008$) was the significant factor associated with eating gravid uterus. The meat/offal processors (OR: 1.9, 95% CI: 1.11-3.30) respondents were about two times more likely to eat gravid uterus than the butchers (Table II). Furthermore, the low risk group (those who did not eat gravid uterus) demonstrated significantly better knowledge than those who ate gravid uterus. For instance, 18.3% of the low risk group and only 1% of the high risk group knew that *Brucella*-contaminated gravid uterus could contaminate other raw meat or food materials by contact ($P = 0.000$). Again, 38.2% of the low risk group and only 2.9% of the high risk group knew that consumption of under-cooked or raw contaminated gravid uterus could expose humans to infection with brucellosis ($P = 0.000$). However, the two groups did not differ significantly (though the low risk group demonstrated higher knowledge level) in whether or not brucellosis was a preventable disease ($P = 0.322$) (Table III). Overall, not knowing that consumption of undercooked or raw contaminated gravid uterus could expose humans to brucellosis (OR = 19.5, 95% CI: 5.73-66.03, $P =0.000$) and that it could contaminate other food materials or raw meat (OR = 13.6, 2.05-118.92, $P =0.008$) were the strong predictors of eating gravid uterus by the meat handlers. Lower risks of eating gravid uterus were predicted by having heard of brucellosis and knowing brucellosis as a zoonosis (Tab. III).

**Assessment of predictors of selling gravid uterus by meat handlers**

Only being adult (OR: 1.7, 95% CI: 1.08-2.57, $P = 0.02$) of all the socio-demographic variables examined was the strong predictor of selling gravid uterus by meat handlers.

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**Tab. I.** Prevalence of risk factors for brucellosis transmission to humans among meat handlers in Ibadan, Nigeria (n = 350).

| Variable | N (%; 95% CI) |
|----------|---------------|
| Eat gravid uterus | 104 (29.7; CI: 24.9 - 34.5) |
| Sell gravid uterus to unsuspecting buyers as some other meat parts | 141 (40.3; CI: 35.2 - 45.4) |
| Do not wear protective coverings when handling gravid uterus | 289 (82.6; CI: 78.6 - 86.6) |
| Do not separate gravid uterus from other raw meat | 131 (37.4; CI: 32.3 - 42.5) |
| Do not wash hands after handling gravid uterus | 215 (61.4; CI: 56.3 - 66.5) |

**Tab. II.** Socio-demographic characteristics of meat handlers in relation to the risk factor of eating gravid uterus in Ibadan, Nigeria (n = 350).

| Variable | Category | Total n (%) | Do not eat gravid uterus (n = 246) % | Eat gravid uterus (n = 104) % | Univariate P-value | Logistic regression OR, 95% CI, P-value |
|----------|----------|-------------|------------------------------------|-----------------------------|-------------------|-------------------------------|
| Age      | Young adult | 178 (50.9) | 50.4 | 51.9 | 0.80 | NA* |
|          | Adult     | 172 (49.1) | 49.6 | 48.1 |       | NA* |
| Gender   | Male      | 220 (62.9) | 61.4 | 66.3 | 0.38 | NA* |
|          | Female    | 130 (37.1) | 38.6 | 33.7 |       | NA* |
| Education| None      | 60 (17.1)  | 15.4 | 21.2 | 0.39 | NA* |
|          | Primary   | 183 (52.3) | 54.1 | 48.1 |       |     |
|          | Post-primary | 107 (30.6) | 30.5 | 30.8 |       |     |
| Duration in meat processing facilities (in years) | ≤ 10 | 126 (36.0) | 35.4 | 37.5 | 0.70 | NA* |
|          | > 10      | 224 (64.0) | 64.6 | 62.5 |       |     |
| Occupation | Butchering | 150 (42.9) | 45.5 | 36.5 | 0.02 |     |
|          | Meat/offal processing | 200 (57.1) | 54.5 | 63.5 | 1.9, 1.11-3.30, 0.008 |     |

*NA: Variables not significant at univariate analysis and were not included for logistic regression.
with the adult respondents being almost two times more likely to sell gravid uterus than the young adult group (Tab. IV). With respect to knowledge-based markers for brucellosis transmission, the low risk group demonstrated significantly better knowledge than the high risk group, except on the questions that related to whether or not consumption of contaminated gravid uterus could expose humans to brucellosis infection (OR = 0.2, 95%CI: 0.13-0.44, \( P = 0.015 \)) and that brucellosis was a preventable disease (OR = 0.3, 95%CI: 0.004-0.27, \( P = 0.001 \)) (Tab. V).

### Discussion

The global burden of human brucellosis remains enormous [2, 4]. Though eradicated in many developed countries after years of effort, the disease is still a major neglected zoonosis of developing countries, including Nigeria [1]. The incidence is directly related to the prevalence of the disease in animals, eating habits, poor hygiene and practices that expose humans to infected animals or their products [9]. As such, livestock workers, including meat handlers, have been incriminated in the spread of human brucellosis in Nigeria [15, 27-28]. Poor hygiene and eating of raw or improperly cooked contaminated meat, the practices characteristic of meat handlers in Nigeria are known to favour the spread of brucellosis [11-12]. In order to reduce the spread of human brucellosis in the country, knowledge about the predictors of the risk factors of eating and selling gravid uterus known to sustain *Brucella* organisms is essentially required. This current study presents the socio-demo-

| Variable | Total n (%) | Do not eat gravid uterus (n = 246) | Eat gravid uterus (n = 104) | Univariate P-value | Logistic regression OR, 95% CI, P-value |
|----------|-------------|-----------------------------------|-----------------------------|-------------------|----------------------------------------|
| Have you heard of brucellosis? | | | | | |
| Yes | 14 (4.0) | 4.1 | 3.8 | 0.015 | 0.2, 0.04-0.71, 0.016 |
| No | 336 (96.0) | 95.9 | 96.2 | | |
| Does brucellosis spread from animals to man? | | | | | |
| Yes | 9 (2.6) | 3.7 | 0.0 | | 7.5; 0.89-60.42; 0.065 |
| No | 111 (31.7) | 25.2 | 51.9 | | 2.2; 0.27-18.19; 0.457 |
| I don’t know | 230 (65.7) | 73.1 | 48.1 | | |
| Does *Brucella*-contaminated gravid uterus contaminate other food material/raw meat by contact? | | | | | |
| Yes | 46 (13.1) | 18.3 | 1.0 | | |
| No | 101 (28.9) | 30.5 | 25.0 | | 15.6; 2.05-118.92; 0.008 |
| I don’t know | 203 (58.0) | 51.2 | 74.0 | | 27.5; 3.72-205-57; 0.001 |
| Does consumption of undercooked or raw contaminated gravid uterus expose humans to brucellosis infection? | | | | | |
| Yes | 97 (27.7) | 38.2 | 2.9 | | |
| No | 94 (26.8) | 25.6 | 54.6 | | 19.5; 5.73-66.03; 0.000 |
| I don’t know | 159 (45.4) | 35.2 | 62.5 | | 21.7; 6.38-71.38; 0.000 |
| Is brucellosis a preventable disease? | | | | | |
| Yes | 14 (4.0) | 4.9 | 1.9 | | |
| No | 76 (21.7) | 20.3 | 25.0 | | 0.322 NA* |
| I don’t know | 260 (74.3) | 73.8 | 73.1 | | |

*NA: Variables not significant at univariate analysis and were not included for logistic regression.*
graphic factors of meat handlers and brucellosis knowledge-based markers which influence the occurrence of the risky practices of eating and selling gravid uterus in Nigeria. It also reports the implications of traditional healers’ usage of gravid uterus on the epidemiology and control of human brucellosis in the country.

To our knowledge, this study appears to be the first to investigate the predictors of the risk factors of eating and selling gravid uterus by meat handlers in Nigeria as well as traditional healers’ practices in relation to brucellosis transmission. This study has established a high prevalence of risk factors for human brucellosis infection including the primary outcomes of interest, namely eating and sell-
The use of only government-owned meat processing facilities. Inclusion of private meat facilities could have

...and cleaning of slaughtered animal parts [46] and a 48% seroprevalence amongst abattoir workers, particularly those involved in the slaughtering and cleaning of slaughtered animal parts [46] and a 48% seroprevalence amongst families associated with livestock keeping [12]. Alavi et al. [47] also reported an association between work practices and infections amongst nomads in Khuzestan, Iran.

Our findings notwithstanding; one limitation of this study is the use of only government-owned meat processing facilities. Inclusion of private meat facilities could have
given more comprehensive insights. However, the findings of this study are generalizable to meat handlers in Nigeria as the chosen facilities are typical of other meat processing facilities in terms of conditions of the facilities and the ways by which meat handlers are regulated. Despite this limitation, the study has demonstrated a high prevalence of risk factors for human brucellosis transmission as well as some socio-demographic characteristics of meat handlers and knowledge-based markers as predictors of risk factors of eating and selling gravid uterus in Ibadan, Nigeria. It has also reported risk practices by traditional healers that could serve as a limiting factor to brucellosis control in the area. The information provided are very important insights in understanding the epidemiology of human brucellosis in Nigeria and thus serve as critical baseline data for informed control and prevention of the disease in the country. Overall, we recommend the need for all-inclusive brucellosis control programmes, taking into consideration the roles of meat handlers and traditional lifestyles in the epidemiology of human brucellosis in Nigeria. Such risk factors might not be limited to Nigeria alone, but also common among other developing countries particularly in sub-Saharan Africa. As such, there is a need for both national and international relevant stakeholders to synergistically formulate policies towards raising awareness campaigns about zoonoses in general among the high risk occupational groups in developing nations of the world.

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The authors declare that there is no conflict of interest whatsoever.

Authors’ contributions

HKA initiated the concept and design of the study and wrote the manuscript; PIA did the statistical analysis and was involved in the writing of the manuscript; and MAO did the data collection and wrote the first draft of the manuscript. All authors read and approved the final version of the manuscript.

References

[1] World Health Organization, Food and Agriculture Organization of the United Nations & World Organization for Animal Health. Report of the WHO/FAO/OIE joint consultation on emerging zoonotic diseases, World Health Organization, Geneva 2004.
[2] Pappas G, Papadimitriou P, Akritidis N, Christov L, Tsianos EV. The new global map of human brucellosis. Lancet Infect Dis 2006;6:91-9.
[3] Dean AS, Crump L, Greter H, Schelling E, Zinsstag J. Global burden of human brucellosis: a systematic review of disease frequency. PLoS Negl Trop Dis 2012;6:e1865.
[4] Minas M, Minas A, Gourgulianis K, Stournara A. Epidemiological and clinical aspects of human brucellosis in Central Greece. Jpn J Infect Dis 2007;60:362-6.
[5] Çiftçi E, Ince E, Doğru U. Pyrexia of unknown origin in children: a review of 102 patients from Turkey. Ann Trop Paediatr 2003;23:259-63.
[6] Pathak AD, Dubal ZB, Doijad S, Raorane A, Rodrigues S, Naik R, Naik-Gaonkar S, Kalorey DR, Kurkure NV, Naik R, Barbudhe SB. Human brucellosis among pyrexia of unknown origin cases and occupationally exposed individuals in Goa Region, India. Emerg Hlth Threts J 2014;7:238-46.
[7] Bax HL, Van Veelen ML, Gyssen IC. Brucellosis, an uncommon and frequently delayed diagnosis. Netherlands J Med 2007;2:352-5.
[8] Corbel MJ, Nicolletti PL, Young EJ. Brucellosis: epidemiology and prevalence worldwide. In: Young EJ, Corbel MJ, eds. Brucellosis: Clinical and laboratory aspects. Boca Raton: CRC Press 1989.
[9] Swai ES, Schoonman L. Human brucellosis: seroprevalence and risk factors related to high risk occupational groups in Tanga Municipality, Tanzania. Zoonoses Public Hlth 2009;56:183-2.
[10] Georgiou P, Nicholas A, Mile B, Epameinondas T. Brucellosis. New Eng J Med 2005;352:2325-36.
[11] John K, Fitzpatrick J, French N, Kazwala R, Kambarage D, Mfinanga GS, MacMillan A, Cleaveland S. Quantifying risk factors for human brucellosis in rural northern Tanzania. PLoS ONE 2010;5:e9968.
[12] Shirima GM, Fitzpatrick J, Kunda JS, Mfinanga GS, Kazwala RR, Kambarage DM, Cleaveland SC. The role of livestock keeping in human brucellosis trends in livestock keeping communities in Tanzania. J Hlth Res 2010;12:203-7.
[13] Baba MM, Sarkindared SE, Brisibe F. Serological evidence of brucellosis among predisposed patients with pyrexia of unknown origin in the north eastern Nigeria. Central European J Public Hlth 2001;3:158-61.
[14] Oukuwu AR, Yohanna CA, Abuh HA. Brucella infection among hospital patients in Makurdi, North central Nigeria. Niger J Parasitol 2006;16:73-78.
[15] Aworh MK, Okolocha E, Kwaga J, Fasina F, Lazarus D, Suleman I, Poggensee G, Nguku P, Nsugbe P. Human brucellosis: seroprevalence and associated exposure factors among abattoir workers in Abuja, Nigeria - 2011. Pan Afr Med J 2013;16:103.
[16] Alausa O, Awoseyi A. Brucellosis: the situation in Western Nigeria. Trop Geogr Med 1976;28:54-9.
[17] Ishola OO, Ogundipe GAT. Sero-prevalence of brucellosis in trade cattle slaughtered in Ibadan, Nigeria. Trop Vet 2001;19:17-20.
[18] Cadmus SIB, Ijagbone IF, Oputa HE, Adesokan HK, Stack JA. Serological survey of brucellosis in livestock animals and workers in Ibadan, Nigeria. Afr J Biomed Res 2006;9:163-8.
[19] Cadmus SIB, Osikoya IE, Adesokan HK. Brucellosis in trade cattle in Lagos State: an investigation of two Abattoirs. Niger J Vet J 2009;29:43-46.
[20] Bwala DG, McCrindle C, Fasina FO, Ijagbone I. Abattoir characteristics and seroprevalence of bovine brucellosis in cattle slaughtered at Bodija Municipal Abattoir, Ibadan, Nigeria. J Vet Med Animl Hlth 2015;7:164-8.
[21] Crawford RP, Huber JD, Adams LG. Epidemiology and surveillance. In: Nielsen K, Duncan BO, eds. Animal brucellosis. CRC Press 1990, pp. 131-151.
[22] McIntee M. The uterus: degenerative and inflammatory lesions. In: Reproductive pathology of domestic mammals. San Diego, California: Academic Press, Inc. 2012.
[23] Momoh HA, Ijale GO, Ajogi I, Okolocha EC. Risk factors and level of awareness of canine brucellosis in Jos, Plateau State, Nigeria. J Vet Med Animl Hlth 2015;7:39-44.
[24] Adamu NN, Ajogi I. Serological investigations of canes...
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(Camelus dromedarius) slaughtered at Kano municipal abattoir for evidence of brucellosis. Trop Vet 1999;18:45-8.

[25] International Livestock Research Institute. Mapping of poverty and likely zoonoses hotspots. Nairobi, Kenya: ILRI, 2012. http://cgspace.cgiar.org/handle/10568/21161. (Accessed June 24, 2014).

[26] Wahab B. Ibadan: a rapidly growing city in need of a master plan. Paper read at the Architects’Congress/Annual General Meeting organized by the Nigerian Institute of Architects, Oyo State Chapter, held at Penrose Event Centre, Obafemi Awolowo Avenue, Old Bodija Estate, Ibadan 2011. Available at: http://soesc.ui.edu.ng/WBWahab. (Accessed August 15, 2015).

[27] Adamu NB, Adeniyi SO, Adamu SG, Bale JOO, Okoh AEJ, Ocholi RA, Kwaga JKP, Ajogi I. Ali FHM, Mahdey EA. Adesokan HK, Raji AO. Bloomfield SF, Nath KJ. Hambolu D, Freeman J, Taddese HB. Adesokan HK, Alabi PI, Stack JA, Cadmus SIB. Knowledge and practices related to bovine brucellosis transmission amongst livestock workers in Yewa, south-western Nigeria. J South Afr Vet Asso 2013;84.

[28] Hambolu D, Freeman J, Taddese HB. Predictors of Bovine TB risk behaviour amongst meat handlers in Nigeria: a cross-sectional study guided by the Health Belief Model. PLoS ONE 2013;8:e56091.

[29] Bloomfield SF, Nath KJ. Home Hygiene in Developing Countries: Prevention of infection in the home and the peri-domestic setting. Training resource for developing countries. International Scientific Forum on Hygiene 2013. Available at: http://www.ihf-homehygiene.org/training-best-practice/home-hygiene-developing-countries-prevention-infection-home-and-peri-domestic-4-175.htm

[30] Adesokan HK, Raji AO. Safe meat-handling knowledge, attitudes and practices of private and government meat processing plants’ workers: implications for future policy. J Prev Med Hyg 2014;54:10-6.

[31] Ali FH, Mahdey EA. Incidence of Brucella species in slaughtered food animals and its edible offal at Beni-suef. Egypt. Global Vet 2010;5:248-54.

[32] Ocholi RA, Kwaga JKP, Ajogi I. Phenotypic characterization of Brucella strains isolated from livestock in Nigeria. Vet Microbiol 2004;103:47-53.

[33] Adamu NB. Epidemiology of Brucella infection in ruminants and humans and its public health implications in Borno state, Northern Nigeria. J Public Hlth Epidemiol 2015;7:253-7.

[34] Alavi SM, Rafiei A, Nikkhooi A. Walshe MJ, Grindle J, Nell A, Bachmann M. Cadmus SIB, Alabi PI, Adesokan HK, Dale EJ, Stack JA. Mai H, Irons P, Thompson P. Altekruse SF, Street DA, Fein SB, Levy AS. McCarthy M, Brennan M, Kelly AL, Ritson C, de Boer M, European Commission. Incidence of Brucella species in slaughter plants’ workers: implications for future policy. J Prev Med Hyg 2014;54:10-6.

[35] Kumar P, Singh DK, Barbuddhe SB. Seroprevalence of brucellosis among abattoir personnel of Delhi. J Commun Dis 2002;35:131-7.

[36] Ramos TRR, Junior JWP, Sobrinho PAM, Santana VLA. Guerra NR, Melo LEH, Mota RA. Epidemiological aspects of an infection by Brucella abortus in risk occupational groups in the microregion of Araguaina, Tocantins. Braz J Infect Dis 2008;12:133-8.

[37] Mai H, Irons P, Thompson P. A large seroprevalence survey of brucellosis in cattle herds under diverse production systems in northern Nigeria. BMC Vet Res 2012;8:144.

[38] Cadmus SIB, Alabi PI, Adesokan HK, Dale EJ, Stack JA. Seudological investigation of bovine brucellosis in three cattle production systems in Yewa Division, south-western Nigeria. J South Afr Vet Asso 2013;84.

[39] Walshe MJ, Grindle J, Nell A, Bachmann M. Consumer knowledge and practices in the home in Turkey. Food Control 2007;18:45-51.

[40] Altekruse SF, Street DA, Fein SB, Levy AS. Consumer knowledge and practices of foodborne microbial hazards and food-handling practices. J Food Prot 1996;59:287-94.

[41] Akhvlediani T, Clark DV, Chubabria G, Zenaishvili O, Hepburn MJ. The changing pattern of human brucellosis: clinical manifestations, epidemiology, and treatment outcomes over three decades in Georgia. BMC Infect Dis 2010;10:346.

[42] Kumar P, Singh DK, Barbuddhe SB. Seroprevalence of brucellosis among abattoir personnel of Delhi. J Commun Dis 2002;35:131-7.

[43] Ramos TRR, Junior JWP, Sobrinho PAM, Santana VLA. Guerra NR, Melo LEH, Mota RA. Epidemiological aspects of an infection by Brucella abortus in risk occupational groups in the microregion of Araguaina, Tocantins. Braz J Infect Dis 2008;12:133-8.

[44] Mai H, Irons P, Thompson P. A large seroprevalence survey of brucellosis in cattle herds under diverse production systems in northern Nigeria. BMC Vet Res 2012;8:144.

[45] Cadmus SIB, Alabi PI, Adesokan HK, Dale EJ, Stack JA. Seudological investigation of bovine brucellosis in three cattle production systems in Yewa Division, south-western Nigeria. J South Afr Vet Asso 2013;84.

[46] Walshe MJ, Grindle J, Nell A, Bachmann M. Dairy development in sub-Saharan Africa. World Bank Technical Paper 135, Africa Technical Department Series, 1991; World Bank, Washington DC.

[47] Alavi SM, Rafiei A, Nikkhooi A. The effect of lifestyle on brucellosis among abattoir workers: implications for future policy. J Prev Med Hyg 2014;54:10-6.

[48] Ali FH, Mahdey EA. Incidence of Brucella species in slaughtered food animals and its edible offal at Beni-suef. Egypt. Global Vet 2010;5:248-54.

[49] Ocholi RA, Kwaga JKP, Ajogi I. Phenotypic characterization of Brucella strains isolated from livestock in Nigeria. Vet Microbiol 2004;103:47-53.

[50] Adamu NB. Epidemiology of Brucella infection in ruminants and humans and its public health implications in Borno state, Northern Nigeria. PhD thesis. Ahmadu Bello University, Zaria, Nigeria: Veterinary Public Health and Preventive Medicine Department. 2009.

[51] Courtenay WH. Constructions of masculinity and their influence on men’s well-being: a theory of gender and health. Social Science Med 2000;50:1385-1401.

[52] Davidson KW, Trueck KE, van Roosmalen E, Stewart M, Kirkland S. Perspective: gender as a health determinant and implications for health education. Hlth Educ Behaviour 2006;33:731-743.

[53] European Commission. Risk issues. Special Eurobarometer 2006. Available at: http://ec.europa.eu/public_opinion/archives/ebi/ebi_238_en.pdf (Accessed September 04 2015). Nielsen K, Duncan B, Orlando, editors.

[54] McCarthy M, Brennan M, Kelly AL, Ritson C, de Boer M, Thompson P. Altekruse SF, Street DA, Fein SB, Levy AS. Consumer knowledge and practices of foodborne microbial hazards and food-handling practices. J Food Prot 1996;59:287-94.

[55] Akhvlediani T, Clark DV, Chubabria G, Zenaishvili O, Hepburn MJ. The changing pattern of human brucellosis: clinical manifestations, epidemiology, and treatment outcomes over three decades in Georgia. BMC Infect Dis 2010;10:346.

[56] Kumar P, Singh DK, Barbuddhe SB. Seroprevalence of brucellosis among abattoir personnel of Delhi. J Commun Dis 1997;29:131-7.

[57] Ramos TRR, Junior JWP, Sobrinho PAM, Santana VLA. Guerra NR, Melo LEH, Mota RA. Epidemiological aspects of an infection by Brucella abortus in risk occupational groups in the microregion of Araguaina, Tocantins. Braz J Infect Dis 2008;12:133-8.

[58] Mai H, Irons P, Thompson P. A large seroprevalence survey of brucellosis in cattle herds under diverse production systems in northern Nigeria. BMC Vet Res 2012;8:144.

[59] Cadmus SIB, Alabi PI, Adesokan HK, Dale EJ, Stack JA. Seudological investigation of bovine brucellosis in three cattle production systems in Yewa Division, south-western Nigeria. J South Afr Vet Asso 2013;84.

[60] Walshe MJ, Grindle J, Nell A, Bachmann M. Dairy development in sub-Saharan Africa. World Bank Technical Paper 135, Africa Technical Department Series, 1991; World Bank, Washington DC.

[61] Alavi SM, Rafiei A, Nikkhooi A. The effect of lifestyle on brucellosis among abattoir workers: implications for future policy. J Prev Med Hyg 2014;54:10-6.

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