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Cross sectional study on seroprevalence of Coxiellosis (Q-Fever) in sheep, goat and man in Diyala Governorate

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Abstract

***Coxiella burnetii* (*C. burnetii*)** is a major cause for global outbreaks of infectious abortion in animals, in addition to its zoonotic importance. This study aimed to determine the seroprevalence of *C. burnetii* antibodies in sheep, goats and humans in certain districts of Diyala Governorate. Blood samples were collected from, 284 animals including 143 sheep and 141 goats of both sexes from flocks with history of reproductive problems. Blood samples were also collected from (90) human patients (26 males and 64 females) that attending Baqubah general and private hospitals and showing clinical signs of flu with fever and history of miscarriage in women. Serum samples were tested using Indirect Enzyme Linked Immunosorbent Assays (i-ELISAs). In animals, overall seroprevalence for *C. burnetii* was 37.68%; represented by 33.57% and 41.84%) in sheep and in goats respectively. According to sex, positive results were significantly higher in rams 47.37% than ewes 31.45%. However, does gave significantly higher seroprevalence 44.44% than bucks 20%. The aborted ewes showed significant higher seroprevalence 40.54% than random ewes 27.59%, while aborted does yielded significantly 73.33% higher seropositivity than random ones 41.28%. In humans, overall seroprevalence for *C. burnetii* was 18.9%, moreover, gender wise significant difference was not detected between men (15.4%) and women (20.3%). In addition, significant difference was not detected between seroprevalence to *C. burnetii* in aborted 15.6% and none aborted women 25%. In conclusion, this study approved the seroprevalence of *C. burnetii* in sheep and goat and humans with variations in its prevalence according to sexes and reproductive status. The authors recommended more future studies in another Iraq governorates to determine prevalence map of this disease in Iraq.

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Introduction

Q fever (in man) or coxiellosis (in animals) is an important zoonotic disease caused by the Gram negative obligatory intracellular bacteria *Coxiella burnetii*. It is increasingly reported globally as an important cause of abortion in goats, with occasional outbreaks in sheep; it has long been identified as a zoonotic disease with socio-economic impact in various countries worldwide (Can *et al.,* 2015).

Infection of animals with *C. burnetii* is mostly asymptomatic, but infertility, abortions, stillbirths, and early neonatal deaths are prominent sequel of infection in domesticated ruminants (Marrie, 2007). Mastitis is a more common symptom in dairy cattle where abortion is rarely detected (To *et al.,* 1998). On the contrary, in man, Q-fever is associated with different signs; the acute form is associated with pyrexia, myalgia, generalized weakness, lethargy with signs of pneumonia and hepatitis (Angelakis and Raoult, 2010; Porter *et al.,* 2011). Severe placentitis is characteristic for Coxiellosis in small ruminants with excretion of extreme numbers of *C. burnetii* in aborting materials, vaginal mucous and feces. Cattle are less important as shedders for this microorganism, while small ruminants are more important as a reservoir and shedder for *C. burnetii*. Infected small ruminants can shed bacteria through feces, urine, milk, semen and vaginal discharge of affected females (Van Moll *et al.,* 1993; Rodolakis *et al.,* 2007; Angelakis and Raoult, 2010).

Not much is known about the effect of Q fever on infected pregnant women. Anyhow, *Coxiellla burnetii* infection in pregnant women may lead to spontaneous abortion, intrauterine fetal death premature delivery or intrauterine growth retardation. It is also possible for a Q- fever infected woman to have normal birth outcome (Carcopino *et al.,* 2007). Determining infected animals by serology is the first step to be followed for initiation of control measures as in vitro culture is not an easy task. In Iraq, Many studies have been conducted regarding prevalence of infection with *C. burnetii* in humans (Gati *et al.,* 2010; Abed *et al.,* 2010; Abdallah *et al.,* 2015; Lafta and Muhsen, 2016). Many of these studies were carried by USA military offices regarding outbreaks of coxiellosis among soldiers serving in and returning from Iraq. For the authors' knowledge, no previous studies were conducted concerning prevalence of *Coxiella burnetii* infection in man and animals in Diyala Governorate. Consequently, this study aimed to detect the prevalence of *Coxiella burnetii* serologically in small ruminant and humans referring to governmental and private medical centers with clinical signs of flue like symptoms, including a number of aborting women to evaluate zoonotic importance of this disease in this province.

Materials and Methods

Area of the study

This cross-sectional study was conducted on sheep, goats and humans resident in different districts of Diyala Governorate in the period from the first of September /2016 to March / 2017. The geographical areas were chosen according to previous and recent information of reproductive problems such as late abortion, stillbirth and infertility in sheep and goats. Humans, samples were collected from persons referring

to governmental and private health centers in Baquba city; all were showing flu like clinical signs and some woman with history of reproductive problems.

Collection of blood samples

Ten milliliter of peripheral blood samples were drawn from jugular vein of sheep and goats using disposable syringes and kept into clot activator disposable tubes. The samples were kept cool and immediately transferred to the laboratory. Later on, samples were centrifuged at 3000 rpm for 5 minute using bench centrifuge (Gemmy industrial corp. ®) and serum was collected using 200 µl micro pipette (Labtech. ®) Each sample was dispensed into 5 separated Bendoff tubes (Cetotest ®) with 2.5 ml capacity. The samples were kept frozen at -20°C till used for serology.

Serology

All tests were performed at laboratories of the College of Veterinary Medicine / University of Diyala. Animal sera were tested by Commercial multi species i-ELISA IgG (Innovative Diagnostic (ID.vet®, Grabels-France). Human sera were tested by commercial i-ELISA IgG (Vircell Microbiologists®). All tests were run according to the manufacturer's instructions.

Statistics analysis

All results were put into possibility tables. A Statistical Set for Social Science (SPSS), version 22.0 (SPSS Chicago Inc.) was used to determine Chi-square test and P- value.

Results

A. Indirect ELISA for animal samples

Animals included in this study were divided into four groups according to the districts involved in the survey. The highest percentage of positive results for *C. burnetii* was noticed in Baqubah city (48.14%) followed by Kifri (38.37%), AL Meqdadiya (28.9%) and then Al Khalis (20%) (Table- 1; Figure.1). Significant differences were detected statistically between districts.

Table.1: Shows the positive results of i-ELISA for *C. burntii* according to district.

Animal group according to district	No. of animal sera	i-ELISA positive results *C. burnetii*
GII. Baqubah	108	52 (48.14%) B
GI. Kifri	86	33 (38.37%) B
GIII. Al Miqdadiyah	45	13 (28.9%) A
GIV. Al Khalis	45	9 (20%) A
Total	284	107 (37.67%)

Capital letters mean comparison between groups at P < 0.05.

A total of 284 animal serum samples were tested using i-ELISA (141 goat and 143 sheep); 48/ 284 (33.57%) and 59/141 (41.84%) were positive for *C. burnetii* in sheep and goats respectively. The doubtful results were detected in 9/143 (6.29%) and 10/141 (7.1%) of sheep and goat respectively (Table-2). Statistically significant differences were not detected between ovine and caprine percentage of positivity for *C. burnetii*.

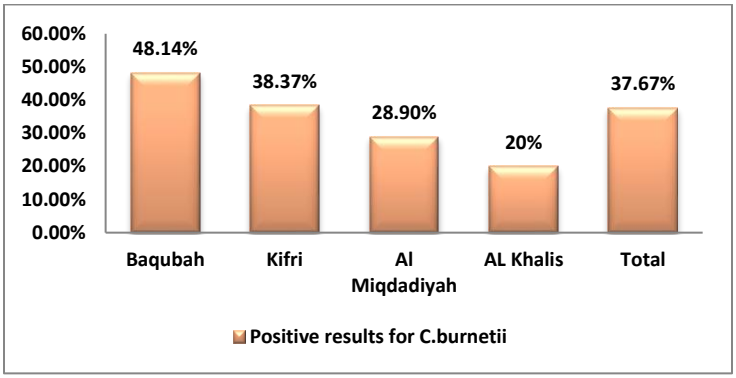

Figure.1: Shows the percentages of positive samples for *C. burntii* using i-ELISA according to district.

Table. 2: Result of i-ELISA for *C. burnetii* in animals.

Animal species	No. of sera	Positive result *C. burnetii*
Sheep	143	48 (33.57%)A
Goats	141	59 (41.84%)A
Total	284	107 (37.68%)

Capital letters mean comparison between groups at P < 0.05.

According to sex, positive results for *C. burnetii* were detected in 9/19 (47.37%) and 39/124 (31.45%) of the rams and ewes respectively. (Table.3). Statistical higher significant positivity difference ($p<0.05$) was seen in rams in compare to ewes.

Table.3: Results of i- ELISA for *C. burnetii* in sheep according to sex.

Sheep sex	No. of sera	Positive result *C. burnetii*
Rams	19	9 (47.37%)B
Ewes	124	39 (31.45%)A
Total	143	48 (33.57%)

Capital letters mean comparison between groups at P < 0.05.

Out of 37 samples collected from aborted ewes, 15/37 (40.54%) were positive for *C. burnetii*, while 24/87 (27.59%) of random ewes showed positive result. Statistical difference was detected between the two groups at ($P < 0.05$) (Table-4).

Table. 4: Results of i-ELISA for *C. burnetii* in aborted and random ewes.

Ewes	No. of sera	Positive result *C. burnetii*
Aborted ewes	37	15 (40.54%)B
Random ewes	87	24 (27.59%)A
Total	124	39 (31.45%)

Capital letters mean comparison between groups at P < 0.05.

Sex wise results in caprine showed that 3/15 (20%) of bucks gave positive result and 1/15 (6.67%) gave doubtful reaction, while in does; 56/126 (44.44%) of samples were positive and 9/126 (7.14%) gave doubtful results (Table-5). Does gave significantly (p<0. 05) higher positivity than bucks.

Table. 5: Result of i-ELISA in goats according to sex.

Goats sex	No. of sera	Positive result *C. burnetii*
Bucks	15	3 (20%)A
Does	126	56 (44.44%)B
Total	141	59 (41.84%)

Capital letters mean comparison between groups at P < 0.05.

In aborted does, 11/17 (73.33%) of samples gave positive results for *C. burnetii* while 45/109 (41.28%) of random does showed positive results and 9/109 (8.26%) of the same group yielded doubtful results (Table-6). Aborted does yielded significantly (p<0.05) higher seropositivity than random does.

Table. 6: Result of i-ELISA in aborted and random does for *C. burnetii.*

Does	No. of sera	Positive result *C. burnetii*
Aborted does	17	11 (73.33%)B
Random does	109	45 (41.28%)A
Total	126	59 (46.82%)

Capital letters mean comparison between groups at P < 0.05.

B. Indirect ELISA for *C. burnetii* in humans.

A total of 90 human serum samples (26 men and 64 women) were tested using i-ELISA; 17/90 (18.9%) of samples gave positive result for *C. burnetii*. In men, 4/64 (15.4%) of samples were positive while in women 13/64 (20.3%) reacted positively; doubtful result was detected in one sample (1.6%) of a woman. Gender wise significant difference was not detected (Table.7).

Table.7: Result of i-ELISA for *C. burnetii* in humans.

Patient	No. of sera	Positive result
Men	26	4 (15.4%)A
Women	64	13 (20.3%)A
Total	90	17 (18.9%)

Capital letters mean comparison between groups at P < 0.05.

Out of 32 samples collected from aborted women, 5/32 (15.6%) were positive for *C. burnetii*, while 8/32 (25%) of none aborted women showed positive result. Statistical difference was not detected between the two groups (Table.8).

Table. 8: Result of i-ELISA for *C. burnetii* in women.

Women Patient	No. of sera	Positive result
Aborted	32	5(15.6%)A

Non aborted	32	8(25%)A
Total	64	13 (20.3%)

Capital letters mean comparison between groups at P < 0.05.

Discussion

Abortion in animals is a major cause of economic loss all over the world. A rapid and accurate laboratory diagnosis is crucial to start applying control measures for outbreaks of abortion in order to limit their spread and to occupying their zoonotic potential (Borel *et al.,* 2014).

In this study, Indirect ELISA test (i-ELISA) was applied for the diagnosis of animal Coxiellosis. The i-ELISA is preferable than IFA and CFT because it is applicable for large-scale screening tests usually used in veterinary medicine (Roest *et al.,* 2011). The Multi-species i-ELISA test used in this study that contain Phase I and II *C. burnetii* antigen of a strain isolated in France from an aborted bovine placenta (Rodolakis, 2006).

Through conducting this work, (37.68%) of the tested animals were positive for *C. burnetii* infection. This results are revealed higher seroprevalence percentages in compare with previous studies that done in another parts of Iraq such as AL-Qassim city, Thiqar Governorate, where a seroprevalence was (16%) in small ruminant and (5.8%) in sheep respectively (Kshash, 2012; Abed *et al.,* 2010). However, high seroprevalence percentages of this study is compatible with the results that reported in AL-Dewania city using molecular techniques (38.181%) in sheep (AL-Hamdawee *et al.,* 2016) and (41.84%) in sheep in Al-Basrah Governorate (Lafta and Muhsen, 2016). The results of this study are also compatible with previous studies reported in Iran with seroprevalence of (35.5%) in goats and cattle using ELISA (Khalili and Sakhaee, 2009), (33.6%) of sheep sera (Esmaeili *et al.,* 2014) and (26.4%) in small ruminants (Ezatkhah *et al.,* 2015) in South East Iran.

Meanwhile, low molecular prevalence (5.3%) was reported in caprine and negative result for all sheep samples in Saudi Arabia (KSA) (Mohammed *et al.,* 2014), however, another study revealed (12.38%) in sheep (Abdel Rahman, 2014). The results of the current study is also higher than the results of previous study in Egypt, where 39 /148 (26.35%) was recorded in small ruminants using i-ELISA (Abushahba, et al., 2017).

The reported serprevalence percentages are also disagreed with previous studies reported elsewhere in the world. In Turkey, the seroprevalence was (20%) and (10.5%) in sheep according to Kennerman *et al.,* (2010) and Kayedi *et al.,* (2017). The seroprevalence of *C. burnetii* was 4.75% in goats in China (Li *et al.,* 2018), 6 % in sheep in Hungary (Gyuranecz *et al.,* 2014). However, the percentage was 1% or less in another European countries (Agerholm, 2013) and 0.6% among sheep in Sweden (Ohlson *et al.,* 2014). Low prevalence percentage (1.85%) was also reported in India ((Stephen *et al.,* 2014), while in Japan the percentage of prevalence was (8.67%) in sheep (Giangaspero *et al.,* 2013).

Several factors have significant roles in raising the possibility of acquiring *Coxeilla* infection in Iraq. The traditional animal management and raising systems are allowed the animals to graze freely and wonder in pastures through the whole day that increase the *Coxeilla* infection through contaminated food, water or inhalation of aerosols.

Moreover, the climate in Iraq is hot, dry and windy in most seasons; this may greatly enhances aerosolization of bacteria, in addition, most animals in Diyala Governorate are infested with ticks. Poor sanitation and hygiene practice in most sheep and goat flocks such as neglecting the disposal of birth and abortion products as placentas, fetal fluids and aborted fetuses, is an important factor for increasing seropositivity for all diseases including coxiellosis. The remnant birth or abortion tissues are eaten by dogs and cats that may act as reservoirs for infection. Once a place is contaminated with *C. burnetii*, it is difficult to be decontaminated (Oyston and Davies, 2011). These findings highlight the hazard of environmental contamination by *C. burnetii* and declare the importance of sheep and goats in the epidemiology of Q fever in Iraq.

Some scientist considered serology is inefficient for early diagnosis of Q fever, because of the delay of 2 to 3 weeks between exposure and seroconversion (Wegdam-Blans *et al.,* 2012). Anyhow, antibodies to *C. burnetii* in ruminants and humans have been reported to remain in circulation for long periods, thus making serological diagnosis reliable for detecting previous exposure to the organism (Mulemea *et al* ., 2016). Consequently, the high seroprevalence percentages among small ruminants that reported in this study act as indicator to the presence of a current or previous infection with *C. burnetii*. Moreover, seropositivity for *C. burnetii* does not necessarily indicate infectivity status of the animal, and seronegative ruminants can shed *C. burnetii* (Pradeep *et al.,* 2017). Meanwhile, the molecular techniques such as PCR is the only test that may yield over interpreted results and misdiagnosis in cases of ovine and caprine abortion, as the presence of the agent (or its nucleic acids) does not necessarily mean presence of the disease; because endemic organisms like *C. burnetii* may be normal resident microflora (Hazlett *et al.,* 2013).

The results of this study revealed apparently higher positive reactions to *C. burnetii* in animal sera using i-ELISA in sheep than goats with no statistical significance. Nevertheless, it has been reported that infection with *Coxiella burnetii* accounted for about (23%) of all goat abortions (Moeller, 2001). Moreover, the frequency of goats coxiellosis occurrence is more important than in sheep with up to 90% of females being affected (Berri *et al.,* 2007).

Sex wise results obtained in the present study showed significant ($p<0.05$) higher seropositive results in rams (47.37%) than ewes (31.45%). This result partially agreed with that reported in AL- Basrah Governorate, where seroprevalence of *C. burnetii* in rams was none significantly higher than in ewes (rams 46.15%, ewes 41.5%) (Lafta and Muhsen, 2016). In addition, none significant higher prevalence was also reported in rams, (12.26% and 14.81%) in ewes and rams, respectively in KSA (Abdel Rahman, 2014). The none significant difference was also detected for seroprevalence of *C. burnetii* between rams and ewes in AL- Qasim city in Iraq (Kshash, 2012) and in Iran (Shokat *et al.,* 2015; Rad *et al.,* 2014; Ezatkhah *et al.,* 2015).

The results of the current study is disagreed with the previous report in Al-Diwaniyah city that showed significantly higher molecular prevalence in ewes than rams (AL-Hamdawee *et al.,* 2016), and also in Southeast Iran with (32.5%) in ewes and (16.4%) in rams (Ezatkhah *et al.,* 2015). Conversely, caprine showed significant ($P<0.05$) higher seroprevalence in does (44.44%) than in bucks (20%). This finding is in agreement with that observed in KSA that reported (36.08%) seropositivity in does and (16%) in buck (Abdel Rahman, 2014). While in Iran, higher seropositivity

was detected in bucks than does (28.2% does, 37.5% bucks) (Rad *et al.,* 2014). Other studies regarding sex wise revealed 52.1% and 100% in does and bucks respectively (Shokat *et al.,* 2015) in Iran , while in France the seropositivity were (80%) in does and (100%) in bucks. Meanwhile, other studies detect no significant difference concerning sex in caprine (Kshash, 2012; Ezatkhah *et al.,* 2015; Kayedi *et al.,* 2017; Li *et al.,* 2018). It has been suggested that hormones may play an important role in determining susceptibility to infection. Estrogen can enhances antibody production ,while androgen suppress both T-cell and B-cell immune responses, pregnancy can change hormonal profile of females leading to incompetence of immune system (Cantas *et al.,* 2011; Porter *et al.,* 2011). This may partially explain sex wise differences in various studies reviewed in this study.

In this study, statistically significant ($P < 0.05$) higher seroprevalence (40.54%) for *C. burnetii* was detected in aborted ewes than in random ewes (27.59%). This finding agreed with that reported in Thi- Qar province, where seroprevalence was 12/13 (92.3%) of aborted ewes and 1/13 (7.7%) of none aborted ones (Abed and Abd-UL-Husien, 2010), and in Iran with a prevalence of (50%) in aborted ewes and (26.9%) in random ewes (Shokat *et al.,* 2015). While, the results of this study is disagreed with that obtained in AL-Basrah Governorate who recorded (38.8%) seroprevalence in aborted ewes and (41.83%) in none aborted ones (Lafta and Muhsen, 2016). Anyhow, serological studies using different confirmed serological tests showed that about 24% of seronegative goats and sheep can shed bacteria actively in their excretions and secretions, as well as seropositive animals. This means that being seronegative does not indicate uninfected animal (Rousset *et al.,* 2009).

Aborted does included in the present study gave statistically significant ($p<0.05$) higher seropositivity (73.33%) than random does (41.28%). This was highly expected as pregnant ruminants are highly susceptible to *C. burnetii* infection (Berri *et al.,* 2007; Khalili and Sakhaee, 2009). For does to be seronegative does not necessarily means that they are not infected (Porter *et al.,* 2011). This finding is close to that detected in Iran and a seropositivity of (100% and 51.1%) being reported in aborted and random does, respectively (Shokat *et al.,* 2015).

In serological diagnosis of Q fever in humans, anti-phase II antibodies (IgG and IgM) are known to be found in high levels at acute stage of the disease, whereas anti-phase I antibodies (IgG and IgA) are found at high levels only during chronic infection (Setiyono *et al.,* 2005), antibodies against phase II antigen remained detectable after infection for years or for life (Anderson *et al.,* 2013). These facts support the use of *C. burnetii* i-ELISA IgG against phase II kits in the current study.

Serological examination of human samples for *C. burnetii* infection revealed (18.9%) positivity using *C. burnetii* i-ELISA IgG against phase II, this result indicated that Q fever is endemic in Diyala Governorate and it should be considered in the differential diagnosis of diseases associated with flue like symptoms and chronic vascular and heart diseases.

Higher seropositivity percentage (31.5%) for Q fever has been detected among people in AL-Nasiriya province (Gati *et al.,* 2010). Moreover, in Iran, 37/105 (35.2%) of febrile patients had a positive serological test for acute Q fever (Metanat *et al.,* 2014) , while in Kenya the percentage was (26.7%) (Nakeel, 2016). In China, seroprevalence in humans was (25%) (El-Mahallawy *et al.,* 2016). In Eastern Turkey

a prevalence of (32.4%) has been reported among farmers with clinical signs suggestive for Q fever (Senay *et al.,* 2006). In Australian abattoir workers the disease was reported with (29%) seropositivity to Q fever (Gilroy *et al.,* 2001). In Bulgaria high seroprevalence (34.61%) was reported among patients with vascular diseases (Martinov, 2007), moreover, seroprevalence percentages were (38.5%) and (30%) in Basque country and Sweden farmers respectively (Gati *et al.,* 2010). Meanwhile lower seroprevalence 6/190 (6.6%) has been reported among humans in Turkey using ELISA test (Arserim *et al.*, 2011). Conversely, there are reports close to that found in the current study; as in Greece (Shapiro *et al.,* 1990), Australia (Costa *et al*., 2006), Bulgaria in patients with pneumonia (Martinov, 2007), in Spain, Italy, republic of Czechoslovakia, Switzerland and Sweden (Gati *et al*., 2010).

The relatively high seroprevalence of *C. burnetii* in humans included in the current study and endemic nature of *C. burnetii* infections in Iraq is expected because the availability of natural reservoirs for the *Coxiella burnetii* such as birds, ticks and many species of the mammals as cats, dogs, rodents and ruminants, particularly sheep and goats the most important host. *Coxiella burnetii* can also be transmitted with wind causing infections at a distance far from the original source of bacteria. In addition to that, infection with *C. burnetii* is mostly latent and subclinical in animals in spite of persistent shedding of bacteria to the environment especially in females during parturition or abortion, where millions of bacteria being released per gram of placental fluids (Gati *et al.,* 2010), while only one is needed to cause infection. The other factor helps in the elevation of the *C .burnetii* prevalence, is the limited use of tetracycline in human patients in Iraq, which is the drug of choice in treating *C. burnetii* infection. Humans are usually infected by contaminated aerosols from domestic animals particularly after contact with parturient females and their birth products, as asymptomatic animals that can shed *C. burnetii* in large quantities when giving birth. Shedding can also occur in feces, milk and urine (Gati *et al.,* 2010), farmers are used to be close to their animals while giving birth. Also, the consumption of contaminated foods as unpasteurized milk and dairy products, although there is a controversy about the oral route to be a source of infection (Porter *et al.,* 2011). These risks are common in our society because of the rural nature of lifestyle and habits of farmers to live in direct contact with their animals (Gati *et al.,* 2010), in addition of low sanitary measures usually carried by uneducated people.

Sex wise results in human, detected statistically none significant higher seroprevalence to *C. burnetii* infection in women (20.3%) when compared to men (15.4%). This finding agreed with that reported in China, where no significant difference in seropositivity was detected between men (23.07%) and women (24.71%) (El-Mahallawy *et al.,* 2016). In Palestine; seroprevalence was significantly higher 17.14% (6 of 35) in females than males 8.57% (3 of 35) (Abushahba *et al.,* 2017). Alternatively, seroprevalence for *C. burnetii* infection was significantly higher in men (22.727 %) than women (10.714 %) in a study conducted in Al-Diwaniyah City using molecular techniques (AL-Hamdawee *et al.,* 2016). In South East Iran, the prevalence of acute in women and men was 17/37 (45.9%) and 20/37 (54%), respectively (Metanat *et al.,* 2014). A previous study was done in Northern Irish on Q fever seropositivity that found to be slightly, but significantly, higher in males than in females ($P< 0.05$) (McCaughey *et al.,* 2008). Another study concluded that adult males

are at greater risk of getting symptomatic form of Q fever (Raoult *et al.,* 2005). However, in Australia and France, the males are 5-fold and 2.5- fold more likely to get Q fever than females (Parker *et al.,* 2006). The exact reason for men to be more susceptible to Q fever in these studies is not known, but it has been assumed that female sex hormones as17 beta-oestradiol may play a protective role (Leon *et al.,* 2004; Raoult *et al.,* 2005; Parker *et al.,* 2006). There are few reports connecting between reservoir of *C. burnetii* close to human and sex susceptibility. Moreover, in countries where cats are the main reservoir of *Coxiella burnetii* no sex predisposition is reported, while those where cattle are considered the main reservoir, men between 30 and 70 years of age are the most frequently affected by clinical Q fever (Porter *et al.,* 2011). In rural areas of Diyala Governorate, women are keener to be associated with caring, raising and management of small ruminants and this may explain none significant higher seropositivity detected in women in the current study.

In the present study, 5/32 (15.6%) of samples collected from aborted women were positive for *C. burnetii*, while 8/32 (25%) of none aborted ones showed positive result, however, statistical difference was not detected between the two groups. For long; *C burnetii* infection is known to cause abortion in women developing Q fever (Raoult *et al.,* 2002). Anyhow in France, pregnant women were found to be significantly less frequently symptomatic than other women and other patients (Tissot-Dupont *et al.,* 2007). This finding disagreed with that reported by Porter and colleagues concerning hormonal changes during pregnancy that will lead to modulation of the immune system associated with activation of the latent bacteria and stimulates its increased multiplication in the placenta leading to abortion (Porter *et al.,* 2011). Higher seroprevalence 8 (20%) has been detected in a serological study carried on aborted women in one of Thi-Qar province's hospitals (Hindi *et al.,* 2015).

Finally, it can be realized that coxiellosis and Q fever are endemic in Diyala Governorate where a considerable seroprevalence has been detected among small ruminants and humans included in this study using i- ELISA. Coxiella infection should be included in the differential diagnosis of animal and human diseases with clinical signs suggestive for the disease. Preventative and control plans for *C. burnetii* infections in this governorate is necessary. Active surveillance and further research studies are recommended, to more clarify the epidemiology and importance of *C. burnetii* infections in animals and people in Iraq.

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