

Systematic Review of Reproductive Disorders in Ruminants Linked to Bacteria *Coxiella burnetii* in Africa during the Last Ten Years (2014-2023)

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Abstract

Background: *C. burnetii* is a zoonotic bacterium responsible for Q fever, with domestic ruminants being the main reservoirs and source of transmission of the bacterium to humans. To date, there is very little data in Africa regarding the association of *C. burnetii* with reproductive disorders in ruminants. This systematic review highlights the data from Africa over the last ten years (2014-2023) of *C. burnetii* in association with reproductive disorders in domestic ruminants in order to guide researchers' efforts in future research in African countries in order to better understand the current situation and identify gaps in existing knowledge.

Methods: A literature review was conducted using PRISMA criteria in two search databases publish or perish, and researchrabbit and also with search engines, Cochrane, PubMed, Web of Science, Scopus, semantic scholar, google scholar, crossref as well as Medline to search for documents published in Africa between 2014-2023 on the association of *C. burnetii* with reproductive disorders in domestic ruminants. Different diagnostic methods (ELISA and PCR test) were used to identify *C. burnetii* in samples of aborted animals and other parturient products.

Results: For this systematic review, a total of 20 articles were eligible. These articles are distributed as follows: 10 articles were carried out in North Africa, 05 in East Africa, 04 in Southern Africa and 01 in West Africa. No data in Guinea concern the association of *C. burnetii* with reproductive disorders in domestic ruminants. Different prevalences of antibodies to *C. burnetii* were observed with an overall abortion percentage of 16.1%. *C. burnetii* DNA was identified in aborted animals and gave 20% in sheep and 22.56% in cattle. Stillbirths were 65% in sheep and 10% in goats. *C. burnetii* was observed in fourteen placental tissues (19.1%) in cattle.

Conclusion: In view of the research on the insufficiency of data in West Africa, particularly in Guinea, it would be wise to explore Q fever, a disease that is both abortive and zoonotic, in order to include it in the list of diseases requiring mandatory notification in order to improve epidemiological surveillance in public health.

Keywords: Reproductive Disorder; *C. burnetii*; Domestic Ruminants; Africa 2014-2023

Abbreviations

iELISA: Indirect Enzyme-Linked Immunosorbent Assay; PCR: Polymerase Chain Reaction

Introduction

C. burnetii, responsible for Q fever, is a bacterium identified as Gram-negative [1,2]. Its global distribution is vast, with the exception of New Zealand [3-5]. According to the European Food Safety Authority (EFSA), the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO), and the Center for Disease Control and Prevention (CDC), Q fever is an emerging infectious disease [6,7]. This disease often presents asymptotically, which can complicate diagnosis [8]. However, *C. burnetii* has been identified in fetal membranes, amniotic fluids, and vaginal mucus in several domestic mammals, causing enormous economic losses and posing risks to human health [4,5].

In North Africa, a study conducted in Egypt gave a positive result in placental tissue, i.e. a prevalence of 0.9% in sheep and 3.4% in goats [11]. In South Africa, a seropositivity of *C. burnetii* was observed in aborted samples of 0.9% (95% CI: 0.3-1.7), with sheep 1.9% (95% CI: 0.6-4.4) having the highest seropositivity, followed by cattle 0.7% (95% CI: 0.09-2.6), while all goats 0.0% (95% CI: 0.0-4.2) tested were negative [12]. In Ethiopia, a study found that 20% (95% CI 12.74, 27.26) of sheep had recently undergone abortion, lamb losses were 65% (95% CI 56.34, 73.65) and stillbirths were 10% (95% CI 4.55, 15.44) [13]. According to the same source, neonatal losses were higher in *C. burnetii* positive herds. and *Toxoplasma gondii*.

Data from West Africa, even less from Guinea, on the association of *C. burnetii* reproductive disorders over the past ten years are very inadequate. This review was conducted to shed light on this zoonotic disease and to highlight the inadequacies for research perspectives on *C. burnetii* infection with a view to better epidemiological management.

Materials and Methods

Scientific research and selection criteria

A bibliographic search was carried out in two scientific databases (harzing's publish or perish and researchrabbit) with the search engines Cochrane, PubMed, Web of Science, Scopus and semantic scholar, as well as Medline and CrossRef. The terms used in the search bar were «Q fever», «Q fever», «Coxiellosis», «*C. burnetii*», «reproductive disorder», «abortion», «stillbirth», «stillbirth», «infertility», «metritis/endometritis», and «retained placenta». The target population was cattle, sheep and goats. This literature search was particularly interested in research carried out on reproductive disorders due to *C. burnetii* in domestic ruminants. For greater precision, the search was focused on studies carried out in Africa during the last ten years (2014-2023). Following these searches, relevant articles were selected and analyzed to extract information relating to the correlation of *C. burnetii* with reproductive disorders in domestic ruminants.

The articles selected for this systematic review were publications that met the following query: Africa in all its parts, the year of research, the nature of the samples, reproductive disorders, domestic ruminants. The bibliographic search obtained through the various databases provided 356 articles and theses related to Q fever. 68 articles were eliminated because they did not meet the search criteria. 288 articles remained, but after carefully examining the titles, abstracts, country and especially the year of publication, 258 of these articles were deemed inappropriate and were therefore omitted from the analysis.

Results and Discussion

From the bibliographic search, twenty (20) articles actually met the inclusion criteria and were therefore taken into account in this systematic review. The 20 articles admitted were distributed in the different regions of Africa.

Characteristics of the works included in the review

In this review, several serological tests (indirect, commercial and competitive enzyme-linked immunosorbent assay (ELISA)) and molecular tests (multiplex real-time polymerase chain reaction (RT -PCR)) were used to establish the etiology of outbreaks of abortion, stillbirth, stillbirth, infertility, metritis/endometritis and placental tissues to detect *C. burnetii* as a bacterium responsible for reproductive disorders in ruminants. The domestic ruminant species were cattle, sheep and goats. In these studies, the DNA of *C. burnetii* has been found in samples of aborted fetuses (livers, spleens,) ovarian tubes, vaginal and placental swabs, kidneys, lymph nodes, abdominal contents, whole blood and sera of cattle, sheep and goats.

Of the articles retained after review, 10 articles were conducted in North Africa, 05 in East Africa, 04 in Southern Africa and 01 in West Africa. From the analysis of table 1-4, we note a gap of information to be filled on the association of *C. burnetii* to reproductive disorders in domestic ruminants over the last ten (10) years, particularly in Guinea. Table 5 provides information on the distribution and immunity of *C. burnetii* in Guinea.

Authors	Title	Methods	Results	Contribution	Limit
[14]	Serosurvey of selected reproductive pathogens in domestic ruminants from Upper Egypt	Competition ELISA Tests	<i>C. burnetii</i> seropositivity was detected in 17.3% (68/392; 95% CI: 13.6-21.1%) of sampled ruminants, with seropositivity of 29.2% (38/130) in goats, 19.4% (25/129) in sheep, and 4.7% (5/106) in cattle.	This study highlights the importance of improving surveillance programs for the circulation of reproductive pathogens at the household-human interface and the role of implementing strict hygiene and biosecurity measures to control infection in Upper Egypt.	Further molecular and epidemiological studies on the large-scale circulation of these reproductive pathogens are needed to investigate both their economic and productive impact as well as the health implications for animal and human health in Egypt.
[15]	Seroprevalence and risk factors of the main abortive infectious agents of cattle in batna	ELISA and PCR test	The prevalence of antibodies against <i>Brucella</i> spp, <i>C. burnetii</i> and <i>Chlamydia abortus</i> were 28.6% (127/437; 95% CI, 24.2-34.6%), 13.3% (46/344; 95% CI, 9.8-17.8%), and 1.45% (4/344, 95% CI, 0.6-3.2), respectively. At the herd level, <i>C. burnetii</i> and <i>Chlamydia abortus</i> were observed in 11/22 (50.0%; 95% CI, 25.0-89.5%) and 4/22 (18.1%; 95% CI, 5.0-46.6%) respectively	NS	The lack of transboundary epidemiological and molecular studies on abortifacient pathogens in ruminants in North Africa is of concern for human and animal health as well as wildlife conservation and further research is warranted.

[16]	Abortive diseases and their various associated risk factors in small ruminants in Algeria: a systematic review	Test methods for PPR: c-ELISA and RT-PCR	Prevalence of various abortive diseases in small ruminants in Algeria	Overview of the prevalence of causes of abortion in Algerian small ruminants.	Differences between sampling techniques Climate influence and diagnostic tests
[17]	Prevalence and factors associated with a higher or lower risk of exposure to <i>Coxiella burnetii</i> , <i>Chlamydia abortus</i> and <i>Toxoplasma gondii</i> in dairy cows that have aborted in Algeria	Elisa test	8.4% (31/368) for <i>C. burnetii</i> and 12.2% (45/368) for <i>C. abortus</i> and 13.8% (51/368) for <i>T. gondii</i>	This study made it possible to determine the serological prevalence (by the ELISA method) of Q fever, chlamydia abortion and toxoplasmosis, at the individual and herd level, in dairy farms in northern Algeria.	Follow up this epidemiological study on a larger scale, using PCR for more specific identification of the agents involved in abortion
[18]	Genotyping of <i>Coxiella burnetii</i> detected in placental tissues from aborted dairy cattle in the north of Algeria.	Real-time quantitative polymerase chain reaction (qPCR) targeting two different genes, IS1111 and IS30 A.	Fourteen placental tissues (19.1%) were positive for <i>C. burnetii</i>	NS	Human infection with Q fever is not a reportable disease.
[19]	Molecular and serological data supporting the role of Q fever in abortions of sheep and goats in northern Egypt	Indirect ELISA test and specific real-time PCR (Rt-PCR)	The ELISA study was not significant (P = 0.072), it was 22.7% and 12.5% in sheep and goats, On the other hand, for the Rt-PCR test it was significant (P = 0.01), it was 33.6% and 16.3% in sheep and goats,	Overview of the current cause of Q fever in domestic small ruminants in Egypt	Developing an epidemiological survey for Q fever in other governorates of Egypt
[11]	The burden of <i>Coxiella burnetii</i> among aborted dairy animals in Egypt and its public health implications	ELISA test and PCR test	Only one goat gave a positive result in both placental tissue and vaginal discharge, with an overall prevalence of 0.9%, while in goats it is 3.4%. In addition, the seroprevalence of <i>C. burnetii</i> IgG antibodies in the individuals examined was 19%.	<i>C. burnetii</i> may play a role in abortions in dairy goats rather than other dairy animals in Egypt, although its public health implications cannot be dismissed.	NS

[20]	A sero-survey of major infectious causes of abortion in small ruminants in Morocco	The Rose Bengal test and the indirect ELISA test	Ten herds (43%) were positive for brucellosis, 21 (91%) for chlamydia, 17 (74%) for toxoplasmosis, 13 (57%) for Q fever and 5 (22%) for leptospirosis	NS	Systematic use of a diagnostic laboratory for the search for abortive infections.
[21]	Abortions in Cattle on the Level of Tiaret Area (Algeria)	ELISA test	Q fever 23.91%, toxoplasmosis 15.21%, brucellosis 6.52%, neosporosis 2.17% and chlamydia 0%	NS	NS
[22]	Survey of Infectious Etiologies of Bovine Abortion during Mid - to Late Gestation in Dairy Herds	Real-time PCR	The DNA of <i>Campylobacter</i> spp. and <i>C. burnetii</i> were not present in the veterinary samples studied	This study highlighted the notion of co-infection, which underlines the great interest of a differential diagnosis of the different causes of abortion.	NS

Table 1: Work carried out on the association of the *Coxiella bacteria burnetii* to reproductive disorders in domestic ruminants in North Africa from 2014 to 2023.

Authors	Title	Methods	Results	Contribution	Limit
[23]	Q fever and toxoplasmosis in South African livestock and wildlife: a retrospective study on seropositivity, sporadic abortion, and stillbirth cases in livestock caused by <i>Coxiella burnetii</i>	ELISA test and polymerase chain reaction detection (PCR)	<i>C. burnetii</i> seropositivity was 0.9% (95% CI: 0.3-1.7), with sheep (1.9%; 95% CI: 0.6-4.4) having the highest seropositivity, followed by cattle (0.7%; 95% CI: 0.09-2.6), while all goats (0.0%; 95% CI: 0.0-4.2) and wildlife (0.0%; 95% CI: 0.0-2.5) tested were negative. Of 11 animals tested for <i>C. burnetii</i> , 10 (91.0%) were positive	The study demonstrated the presence of the causative agents of Q fever and toxoplasmosis in South Africa, laying the foundation for further studies on these zoonoses. Q fever and toxoplasmosis are important and should be monitored regularly	Only the DNA of the pathogen and not the disease was detected. However, the bacteria was confirmed by sequencing. Some of the tissues are those that have tested negative for other abortive pathogens such as brucellosis and chlamydia.

[24]	A novel multiplex qPCR -HRM assay for the simultaneous detection of four abortive zoonotic agents in cattle, sheep, and goats	real-time polymerase chain reaction (qPCR) based on high-resolution melting curve (HRM) analysis	<i>C. burnetii</i> (47.05% GC content, 121 bp), <i>Leptospira</i> spp. (43.22% GC content, 77 bp) and <i>L. monocytogenes</i> (42.86% GC content, 93 bp).	Detecting individual infections and co-infections with zoonotic abortifacients in ruminants.	NS
[25]	Investigation of the outbreaks of abortions and orchitis in livestock in Namibia during 2016-2018	PCR tests	The fetuses were all negative for <i>Brucella</i> spp., <i>C. burnetii</i> , <i>Chlamydia</i> spp., <i>Listeria monocytogenes</i> , <i>Salmonella</i> spp., <i>Campylobacter fetus</i> spp., pathogenic strains of <i>Leptospira</i> , bovine viral diarrhea virus, Rift Valley fever virus, <i>Anaplasma phagocytophilum</i> and bovine herpes virus 4 <i>Campylobacter fetus</i> spp. and <i>Trichomonas foetus</i> Spp	NS	NS
[26]	Sero-Epidemiological Study of Selected Zoonotic and Abortifacient Pathogens in Cattle at a Wildlife-Livestock Interface in South Africa	Immunosorbent Kits (ELISA) (IDEXX, Liebefeld-Bern, Switzerland)	The seroprevalence (and 95% CIs) of <i>C. burnetii</i> , <i>T. gondii</i> , <i>C. abortus</i> , <i>N. caninum</i> , and RVFV were 38.0% (31.0-45.5%), 33.2% (26.4-40.5%), 20.7% (15.0-27.2%), 1.6% (0.3-4.7%), and 0.5% (0.01-3.0%), respectively.	Pathogens, with the exception of RVF virus, are either documented for the first time in cattle in South Africa or at the wildlife-livestock interface for the first time in over 30 years	NS

Table 2: Work carried out on the association of the *Coxiella bacteria burnetii* to reproductive disorders in domestic ruminants in southern Africa from 2014 to 2023.

Authors	Title	Methods	Results	Contribution	Limit
[27]	Neglected zoonotic bacteria causes and associated risk factors of cattle abortion in different agro-ecological zones of southwest Ethiopia	Indirect ELISA test	The prevalence of abortion in cattle was found to be 22.56% (95% CI: 18.74-26.38) in the study areas. <i>Leptospira Hardjo</i> (OR = 1.8, 95% CI: 1.04-3.00), <i>C. burnetii</i> (OR = 2.7, 95% CI: 1.26 to 5.62) and <i>Brucella abortus</i> (OR = 9.8, 95% CI: 1.27 to 17.15) were all associated with the occurrence of abortions in cattle, as were their co-infections (OR = 8.1, 95% CI: 1.28 to 39.33).	This research demonstrated that there is a high prevalence of bovine abortion in the region, indicating that it is one of the major contributors to loss of cattle production.	NS
[28]	Apparent prevalence of brucellosis, Q-fever and toxoplasmosis in aborted goat's at North Shoa, Ethiopia	Rose Bengal precipitation test (RBPT) and indirect ELISA tests	64.7% and 8.6% of them were positive for Q-fever and toxoplasmosis, respectively, but none of them were positive for brucellosis	NS	More detailed studies using more sensitive diagnostic tests to examine the full extent of the problem in small ruminant populations
[29]	Prospective cohort study reveals unexpected aetiologies of livestock abortion in northern Tanzania	Indirect ELISA test and PCR, qPCR and RT-PCR test	<i>C. burnetii</i> , which was detected by qPCR with a cycle threshold (Ct) value < 40 in 16 (22.5%) of 71 cattle, 24 (24.5%) of 98 goats, and 12 (27.3%) of 44 sheep, but only six (11.5%) of these 52 animals met the study case definition (Ct ≤ 27) for <i>C. burnetii</i> as a presumed etiology of abortion	The results significantly add to current knowledge in sub-Saharan Africa, providing important evidence from which to prioritize disease interventions.	NS

[30]	Causes and Flock Level Risk Factors of Sheep and Goat Abortion in Three Agroecology Zones in Ethiopia	Immunosorbent assays (ELISA)	76.23% of sheep and goat flocks tested positive for one or more abortion-causing agents, namely <i>C. burnetii</i> , <i>C. abortus</i> , <i>Brucella</i> spp. and <i>T. gondii</i> ; mixed infection was found in 44.39% of the 223 flocks tested. This study revealed an overall annual abortion rate of 16.1% in females and 12.5% in ewes.	This study provided important information on the occurrence, causes and risk factors of abortion in small ruminants in smallholder farming systems in Ethiopia.	NS
[13]	Risk factors for reproductive disorders and major infectious causes of abortion in sheep in the highlands of Ethiopia	Rose Bengal precipitation test (RBPT) and indirect ELISA tests	The study found that 20% [95% CI 12.74, 27.26] of flocks had recently experienced sheep abortion, lamb losses were 65% [95% CI 56.34, 73.65] and stillbirths at 10% [95% CI 4.55, 15.44]. Neonatal losses were higher in <i>C. burnetii</i> and <i>Toxoplasma gondii</i> positive herds,	The study demonstrated the importance of reproductive failures in sheep in different districts of Ethiopia and the probable contribution of different infectious agents to these reproductive disorders.	Further epidemiological field studies and targeted intervention are needed.

Table 3: Work carried out on the association of the *Coxiella bacteria burnetii* to reproductive disorders in domestic ruminants in East Africa from 2014 to 2023.

Authors	Title	Methods	Results	Contribution	Limit
[31]	Q fever in the peri-urban area of Ouagadougou in Burkina Faso: seroprevalence in dairy cows, knowledge and behaviors at risk of zoonotic transmission of this zoonosis in cattle herds	The indirect ELISA test	The apparent “animal” seroprevalence and the “herd” prevalence were 26.2% and 60% respectively.	NS	Disease detection in humans and an efficient control strategy are therefore necessary to improve public health. The implementation of an integrated “One Health” approach must be considered.

Table 4: Work carried out on the association of the *Coxiella bacteria burnetii* to reproductive disorders in domestic ruminants in West Africa from 2014 to 2023.

Authors	Title	Areas and year of study	Methodology			Results	Article Limit	Year of publication
			Number and nature of samples examined	Analysis technique	Target Species			
[32]	New data about immune level strats of the guinea population republic to the cause of CU fever	Republic of Guinea (Lower Guinea, Middle Guinea, Upper Guinea and Forest Guinea) 2015-2019	2346 serum samples distributed across the four regions of Guinea	Enzyme-Enriched Immunoassay (ELISA)	Primates (Men)	Nationwide, <i>C. burnetii</i> -specific immunoglobulins were recorded in 124 of 2346 sera, or 5.3%.	Study the share of Q fever in the total structure of fevers recorded in Guinean territory Assess the impact of the bacteria on the main sources of infection	2021
[33]	Epidemiology of Zoonotic <i>Coxiella burnetii</i> in The Republic of Guinea	Kindia Region/ Guinea 2019-2020	750 small mammals and 9,620 ticks	Real-time polymerase chain reaction (RT-PCR)	Ticks collected from small mammals and cattle	11 out of 750 small mammal samples (1.4%) and in 695 out of 750 tick samples (1.4%). 9,620 (7.2%). The high number of infected ticks (7.2%)	Understanding the role of ticks in the epidemiology of <i>C. burnetii</i> in Guinea.	2023
[34]	Seroprevalence of brucellosis, Q fever and Rift Valley fever in domestic ruminants in Guinea in 2017-2019	17 prefectures: Beyla; Boffa; Boke; Coyah; Dabola; Dalaba; Faranah; Forécariah; Gaoual; Gueckedou; Kindia; Koundara; Kouroussa; Macenta; Mamou; Mandiana and N'zérékoré. 2017-2019	1357 domestic ruminants	immunosorbent assay (ELISA)	Domestic ruminants	In all domestic ruminants the three pathologies, out of 1357 samples, 262 sera were positive distributed between domestic ruminants and the three diseases	Investigating the mechanisms of interference between infections by longitudinal monitoring of selected livestock in different ecological zones of Guinea	2022

[35]	Contribution to the study of the biological diagnosis of Q fever in humans in the prefectures of Kindia, Kissidougou, Guéckédou and N'Zérékoré (Republic of Guinea)	4 prefectures of Guinea (Kindia, Kissidougou, Guéckédou and N'zérékoré 2017-2020	817 blood samples were taken from humans	Indirect ELISA technique was used for the detection of class G immunoglobulins (IgG) in the collected blood and direct ELISA technique was used for the search for <i>C. burnetii</i> antigen. And the PCR method	The Men	Examination of a total of 817 human blood samples yielded a total prevalence of 5.75%.	Investigating this zoonotic pathology is a necessity to reduce its prevalence. Further sero-epidemiological research on Q fever in cattle and ticks, which are risk factors for zoonotic transmission in rural communities.	2022
[36]	Detection <i>Coxiella burnetii</i> в клещах, собранных с крупного rogate skota, on territory nekotorykh Provincia Gvineisky Respirators	Republic of Guinea (Boké and Kindia 2018	204 tick samples collected from cattle	PCR (initial denaturation at 95°C for 5 minutes.)	Ticks	Genetic material of the causative agent of Q fever was not detected in more than 5% of the total number of samples studied	<i>Coxiella</i> infection outbreaks on farms in the country and the risk of infection by fever	2019
[37]	Demonstration of the circulation of <i>Coxiella burnetii</i> (q fever agent) in cattle in kindia and in guinea forester	Republic of Guinea (Kindia and Forest Guinea).	786 bovine blood samples	The indirect Enzyme Linked test Immunosorbent Assay (ELISAI) was used and PCR	Cattle	Analysis of 786 bovine blood samples detected 385 samples positive for <i>C. burnetii</i> , or 48.98%.	Conduct large-scale studies across the country	2022

[38]	Identification of the Farm Animals Immune to Pathogens of Zoonotic Infectious Diseases in the Republic of Guinea	Lower Guinea, Upper Guinea, Middle Guinea and Forest Guinea (2017-2020)	1,074 animal serum samples	Enzyme-linked immunosorbent assay (ELISA)	Cattle	Analysis of 1,074 animal serum samples yielded 172 positive cases, or 16.0%.	Continue to study the circulation of zoonotic and anthro-zoonotic pathogens in the territory of the Republic of Guinea and organize regular monitoring of the spread of zoonotic infectious diseases in collaboration with veterinary services	2022
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Table 5: Work on Q fever carried out in Guinea which only concerns the distribution and immunity of *Coxiella burnetii*.

Abortion

Abortion is defined as the interruption of gestation with expulsion of a non-viable fetus or a dead fetus (between the 42nd and 260th day of gestation in cows) [35,36]. These reproductive losses significantly impact not only the income of breeders, the cattle industry to maintain itself but also signal a possible health problem due to various zoonotic agents [41,42]. In an experimental research carried out in France, 11 heifers subjected to an intradermal experiment with doses of a suspension of *C. burnetii* (strain C9), 45% aborted and in the group of controls, only 19% aborted [43]. Analyses carried out by molecular methods on 50 samples of abomasal swabs from aborted fetuses of sheep and goats identified *C. burnetii* in 26% of the samples [10]. Another study carried out on 146 samples collected, 36 samples (24.7%) were positive for *C. burnetii* [44]. In cases of abortion by *C. burnetii*, while the expelled fetus has no specific macroscopic abnormalities, placental abnormalities range from mild to severe [45].

Intrauterine dynamics of *C. burnetii* infection

In vertebrates, the presence of *C. burnetii* leads to the recruitment of monocytes that cross the vascular endothelium and promotes the development of granulomas in affected organs [46]. Placentitis, an inflammatory reaction of the placenta, can be recognized visually by an increase in the thickness of the intercotyledonary areas accompanied by a distinct non-pigmented exudate [47]. However, it appears that these placental irregularities are less frequent in cases of abortions induced by *C. burnetii* in cattle than in small ruminants [48]. The histopathological features of placentas positive for *Coxiella* immunohistochemical tests showed infiltration of the chorionic stroma by mononuclear cells as well as necrosis of chorionic trophoblasts and focal exudation of fibrin [49].

Puerperal pathologies

Uterine function is often compromised in cattle by bacterial contamination of the uterine mucosa after parturition and the pathogens persist and often cause uterine inflammation, which is a major cause of infertility in cattle [50]. Several pathologies have been associated

with postpartum conditions such as metritis or endometritis, retained placentas and mastitis in domestic ruminants [51]. However, with regard to *C. burnetii* infection, there is no known evidence, according to Agerholm [48], no exact evidence describing an association between *C. burnetii* infection and postpartum illnesses.

Placental retention

Non-delivery refers to the retention of fetal envelopes in the uterine cavity after the expulsion of the fetus in cows within 24 hours of parturition. It can be total or partial. Non-delivery can be attributed either to the inertia of the uterine muscle, to pathological adhesion of the placenta, to a mechanical obstacle hindering the exit of the envelopes or to an excessive volume of the placenta [52]. A significant increase in the frequency of adnexal retention can be observed in domestic ruminants, more precisely in cows, which are not free from diseases. In addition, various pathogens related to uterine infections have been shown to correlate with increased rates of placental retention [53]. The precise mechanisms by which infectious agents trigger retained appendages remain largely unclear, which has led to the proposal of multiple hypotheses on this subject. One such hypothesis suggests that uterine infections may cause inflammation between the chorionic villi and uterine crypts, disrupt uterine involution and hormonal changes during the third parturition, and impact the endometrium and/or myometrium through bacterial toxins [54]. The consequences of non-delivery are both health and economic. Retained placenta is a significant risk factor for postpartum metritis in dairy cows, with a prevalence ranging from 92 to 100%. Cows with retained placentas often present with symptoms of acute endometritis [55]. In the chorionic stroma, mild to moderate infiltration of mononuclear cells, as well as necrosis of chorionic epithelial cells and villus tips, leading to neutrophil exudation have been observed [56]. In a fetal placenta histological study, out of 50 cotyledons tested by the molecular method, 10 (20%) were positive for *C. burnetii* DNA [57].

The assessment of the abortive capacity of *C. burnetii* is complex due to its detection in the placenta, postpartum products and vaginal mucus following spontaneous and induced abortions [51]. It is therefore imperative to establish a link between the observed lesions and the presence in the organism to validate *C. burnetii* as a potential cause of fetal pathology.

Metritis or endometritis

Endometritis refers to inflammation of the endometrial lining of the uterus in the absence of systemic manifestations. It is related to persistent uterine infection after parturition caused by pathogenic bacteria [58].

Uterine infections can be characterized based on various criteria, including histo-anatomical location, time of onset, presenting symptoms, and severity. Commonly referred to as endometritis or metritis in severe cases, this condition in dairy cows has a prevalence ranging from 2.5% to 36.5% [55]. Chronic metritis (endometritis) is a condition that negatively impacts reproductive efficiency, leading to decreased lactation and reduced lifespan, either through death of affected cows or premature culling [59]. The identification of *C. burnetii* in uterine secretions is not surprising, as the bacterium has been previously detected in the reproductive tract of asymptomatic animals [60]. Improved research methodologies and precise definitions are essential to combat an infection as widespread as Q fever.

Conclusion

The results of this systematic review allow us to define that *C. burnetii* is associated with reproductive disorders in domestic ruminants. Very little work has been done on this subject in the last ten years in Africa. Diagnostic methods (enzyme-linked immunosorbent assay (ELISA) and real-time polymerase chain reaction (RT-PCR)) have been used to detect *C. burnetii* in samples from aborted fetuses, ovarian tubes, vaginal and placental swabs of cattle, sheep and goats. Despite the importance of *C. burnetii* as a zoonotic disease and its economic impact, there is a significant gap in the scientific literature regarding its link with domestic ruminant reproduction. This systematic review, which highlights the lack of data in Africa as well as the absence of publications in this field in Guinea, suggests research perspectives in order to better understand this disease for better epidemiological surveillance.

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