

Are biosecurity measures effective in diseases control in livestock farms in Africa? A systematic review and meta-analysis

Authors and their affiliations

Ronald Vougat Ngom^{1*}, Adonis M. M. Akoussa¹, Gaspard J. Ayissi¹

¹School of Veterinary Medicine and Sciences, University of Ngaoundéré, Ngaoundéré, Cameroon

Corresponding author

Ronald Vougat Ngom, romsonbey@yahoo.fr

Author contributions

Ronald Vougat Ngom drafted the protocol and all authors provided their input.

Registration

This amendment protocol is published online with Systematic Reviews for Animals and Food (SYREAF) available at: <http://www.syreaf.org/>. This protocol is reported using the items (headings) recommended in the PRISMA-P guidelines (Moher et al., 2015).

Support

This project has not be funded.

1. Introduction

1.1. Rationale

Livestock production plays a crucial role in most African countries (Chisoro et al., 2023). However animal diseases, which can cause serious production losses, and economic costs, is one of the main problem in this sector (Kerfua et al., 2023). To overcome this problem, the majority of livestock farmers used antimicrobials (Mshana et al., 2021; Alhaji et al., 2023). The extensive and sometime irresponsible use of antimicrobial in animals in Africa has caused antibiotic residues in foods of animal origin (Vougat et al., 2017; Vougat Ngom et al., 2017) and have been associated with the emergence of antimicrobial resistance (AMR) (Mshana et al., 2021), known as a global health problem with the highest burden reported in Africa (Murray et al., 2023).

Following the above consideration, news strategies to prevent diseases in livestock farms and therefore reduce antimicrobial usage is highly needed. Many studies presented biosecurity as the key strategy that can contribute to reduce disease transmission and AMU (Filippitzi et al., 2018; Dhaka et al., 2023). Biosecurity is a set of management and physical measures designed to reduce the risk of introduction, establishment and spread of animal diseases, infections or infestations to, from and within an animal population (WOAH, 2023). This systematic review and meta-analysis was conducted with the aim to determine the evidence of biosecurity measures for controlling animal diseases in livestock farms in the Africa context.

1.2. Objectives

The objective of this protocol is to describe the methods to answer to the question: Is there any evidence of the efficacious of biosecurity measures for controlling diseases in livestock farms in Africa?. The PICO elements are:

1. **Population:** livestock (retricted to poultry, pig, cattle, sheep and goat) in farm in Africa
2. **Intervention:** biosecurity measures
3. **Comparator:** no biosecurity measures
4. **Outcome:** disease prevalence/occurrence

2. Methods

2.1 Eligibility criteria

1. Criteria related with the elements of the PICO question.
2. Language: Publications in English and French.
3. Publication types: Journal articles that provides results of original research, fulfills the study design eligibility criteria.
4. Publication date: No limits.
5. Geographical location of studies: African countries
6. All study design will be included

2.2. Information sources

To identify relevant documents, the search will be conducted in five databases: CAB Abstract (Ovid interface), Agricola, Web of Science, Scopus and PubMed available via the University of Bern (Switzerland).

2.3. Search strategy

The search strategy will involve a multi-stranded approach that uses a series of searches, with different combinations of concepts to gather all possibly related research and thus achieve high sensitivity (Higgins et al., 2021). The search terms will be the same for all databases, but the formatting of the terms will vary due to different architectures of the databases. If few papers (<10) are found to be relevant to the review, in addition to the databases, citations will be extracted from included papers and important reviews. In the event of using search reviews, Scopus will be used for backward searching.

The concept of the search strategy will be the following:

[Biosecurity] AND [Farm] AND [cattle or poultry or pigs or sheep or goat] AND [African countries].

The general search strategy to identify studies relevant to this review will be the following as suggested by Ngom et al. (2023):

#1 ("biosecurity" or "farm biosecurity" or "animal biosecurity" or "preventive veterinary medicine" or "herd health management")

#2 (Farmer or farm* or "farm-level" or "farm-level*")

#3 (pig* or swine* or pig* or weaner or fatterer or sow or piglet* or boar or boars or "*Sus domesticus*" or chick* or poultry* or broiler* or layer* or turkey* or duck* or geese or goose or fowl* or avian* or bird* or hen or hens or "gallus gallus" or flock* or cattle or beef or cow* or calf or calves or "Bos indicus" or heifer* or bull* or bovine or dairy or zebu or sheep* or caprine or goat* or ovine or ewe, or "small ruminant" or "food-producing animal*" or "food animal*" or " animal husbandry" or "animal farming" or "domestic animal*" or livestock)

#4 (Africa or African or Comoros or Djibouti or Madagascar or Malawi or Seychelles or Cameroon or "Central African Republic" or Chad or Congo or "Equatorial Guinea" or "Atlantic Islands" or Gabon or Morocco or Sudan or Botswana or Lesotho or Swaziland or Benin or "Burkina Faso" or "Cape Verde" or Ghana or Guinea or Mauritania or Niger or Senegal or "Sierra Leone" or Togo or Burundi or Eritrea or Ethiopia or Kenya or Mozambique or Rwanda or Somalia or Tanzania or Uganda or Zambia or Zimbabwe or Angola or Algeria or Egypt or Tunisia or Namibia or "South Africa" or Gambia or Liberia or Mali or Nigeria or "Ivory Cost")

#1 AND #2 AND #3 AND #4

2.4. Study selection

Data management

All citations retrieved from the databases will be imported into Zotero software for deduplication. After duplicate removal, the file obtained will be uploaded in Rayyan online software for the screening process.

Selection process

The citations will be screened in two stages by two independent reviewers. Conflict will be resolved with a third reviewer if consensus between two reviewers cannot be reached. At the beginning of each screening stage, a pre-test will be conducted by reviewers to enable discussion and solve disagreement before carrying out the full selection process (Sanguinetti *et al.*, 2021). This test will consist of screening at least 5% of the total number of records found.

For the title and abstract screening, eligibility of studies will be assessed with the following questions :

1. Does the study concern livestock species? Yes [Include], No [Exclude], Unclear [Include]
2. Is the study original research? Yes [Include], No [Exclude], Unclear [Include]
3. Does the study take place in at least one African country? Yes [Include], No [Exclude], Unclear [Include]
4. Does the study concern biosecurity assessment? Yes [Include], No [Exclude], Unclear [Include]
5. Does the study concern a livestock diseases or pathogens in farms? Yes [Include], No [Exclude], Unclear [Include]

The full-text screening will include the following questions:

1. Is a full text available? Yes [Include], No [Exclude]
2. Is the full text available in English, or French? Yes [Include], No [Exclude]
3. Does the study concern biosecurity assessment at farm? Yes [Include], No [Exclude]
4. Does the paper concerned diseases/pathogens? Yes [Include], No [Exclude]
5. Does the study provided an evidence of presence of diseases/pathogens? Yes [Include], No [Exclude]
6. Does the association between biosecurity measures and the diseases/pathogens assessed? Yes [Include], No [Exclude]

2.5. Data extraction

A pair of independent reviewers will carry out this task using Excel software. Conflict will be resolved with a third reviewer if consensus between the two reviewers cannot be reached. Like in the screening phase, all the reviewers will first perform a calibration

exercise using at least 5% randomly selected papers. Data to be extracted from eligible studies will include the following items as:

General information

- First author name
- Year of publication
- Duration of study
- Country of study (where the sample was collected). If not stated, contact study authors or use NA if the authors do not reply
- Study design (cross-sectional, longitudinal study, etc.)

Population data

- Animal production type: level 1 (species), cattle, poultry, pigs, level 2, dairy cattle, calves, heifers, broilers, layer, turkeys, weaners, finishing pigs, etc.
- Number of farms
- Type of farm (conventional, commercial, etc.)

Intervention and outcomes

- Biosecurity measure assessed
- Diseases or pathogens studied
- Type of samples collected (faeces, water, organs, etc.)
- Total number of sample analysed
- Number of positive samples
- Factors calculated to study the association between biosecurity and the disease (Odds ratio or prevalence)

2.6. Quality of selected studies

The assessment of the quality of the included studies will be performed by using the recommendations of evaluation, development, and assessment (GRADE) system (Canfield et al., 2011).

2.7. Data synthesis and meta-analysis

The systematic review will be reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines (Page et al., 2020). The intention of this review is to conduct a quantitative synthesis of results via a meta-analysis if a consistent number of studies is finally selected. The synthesis will concern individual biosecurity measure. However, if a limited number studies is included, to avoid misclassification caused by unclear definitions of factors, biosecurity or management measures will be classified by group according to Biocheck.UGent™ (<https://biocheckgent.com/en/>), analysed and synthesised.

The summary will concern the biosecurity measures that reduce or increase the occurrence of a specific disease in a specific species. The OR and the corresponding 95% confidence interval (CI) will be used to assess the association between a group of biosecurity measure and a disease. The random-effects model will be applied. Cochran's

Q test and I² will be used to determine the heterogeneity of the studies, and the meta-regression test to evaluate the possible sources of heterogeneity if more than 10 studies are selected. When at least 10 studies are included for a meta-analysis, publication bias will be assessed by using funnel plot and Egger's weighted regression tests (Mavridis et al., 2013; Marvridis et al., 2014). A $P < 0.05$ will be considered statistically significant for all the tests.

Conclusions

This systematic review and meta-analysis will provide a synthesis of the current evidence regarding biosecurity implementation to prevent or control livestock diseases in Africa. If supported by data, results will be helpful for researchers and livestock farmers for a better understanding of the role of biosecurity as a key strategy for disease prevention in the context of increasing threats and decreasing financial resources in Africa. The results will also be helpful for identifying specific gaps in knowledge related to the topic. Moreover, the systematic review will suggest gaps in knowledge that require more research in the future.

References

- Alhaji, N. B., Odetokun, I. A., Adamu, A. M., Hassan, A., Lawan, M. K., & Fasina, F. O. (2023). Antimicrobial usage and associated residues and resistance emergence in smallholder beef cattle production systems in Nigeria: A One Health challenge. *Veterinary Research Communications*, 47(1), 233-245.
- Canfield S.E., P. Dahm, Rating the quality of evidence and the strength of recommendations using GRADE, *World J. Urol.* 29 (3) (2011) 311–317, <https://doi.org/10.1007/s00345-011-0667-2>
- Chisoro P, Jaja IF and Assan N (2023) Incorporation of local novel feed resources in livestock feed for sustainable food security and circular economy in Africa. *Front. Sustain.* 4:1251179. doi: 10.3389/frsus.2023.1251179
- Dhaka, P., Chantziaras, I., Vijay, D., Bedi, J. S., Makovska, I., Biebaut, E., & Dewulf, J. (2023). Can Improved Farm Biosecurity Reduce the Need for Antimicrobials in Food Animals? A Scoping Review. *Antibiotics*, 12(5), 893.
- Filippitzi, M. E., Brinch Kruse, A., Postma, M., Sarrazin, S., Maes, D., Alban, L., ... & Dewulf, J. (2018). Review of transmission routes of 24 infectious diseases preventable by biosecurity measures and comparison of the implementation of these measures in pig herds in six European countries. *Transboundary and emerging diseases*, 65(2), 381-398.
- Higgins, J.P.T., J. Thomas, J. Chandler, M. Cumpston, T. Li, M.J. Page, V.A. Welch (Eds). 2021. *Cochrane Handbook for Systematic Reviews of Interventions*, version 6.2 (updated February 2021). Available from www.training.cochrane.org/handbook.
- Kerfua, S. D., Railey, A. F., & Marsh, T. L. (2023). Household production and consumption impacts of foot and mouth disease at the Uganda-Tanzania border. *Frontiers in Veterinary Science*, 10, 1156458.
- Mavridis, D., A. Sutton, A. Cipriani, G. Salanti. 2013. A fully Bayesian application of the Copas selection model for publication bias extended to network meta-analysis. *Stat. Med.* 32: 51-66.
- Mavridis, D., N.J. Welton, A. Sutton, G. Salanti. 2014. A selection model for accounting for publication bias in a full network meta-analysis. *Stat. Med.* 33: 5399-5412.
- Moher, D., L. Shamseer, M. Clarke, D. Gherzi, A. Liberati, M. Petticrew, L.A. Stewart. 2015. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst. Rev.* 4: 1-9.
- Mshana, S.E.; Sindato, C.; Matee, M.I.; Mboera, L.E.G. Antimicrobial Use and Resistance in Agriculture and Food Production Systems in Africa: A Systematic Review. *Antibiotics* 2021, 10, 976. <https://doi.org/10.3390/antibiotics10080976>
- Murray, C. J., Ikuta, K. S., Sharara, F., Swetschinski, L., Aguilar, G. R., Gray, A., ... & Tasak, N. (2022). Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *The Lancet*, 399(10325), 629-655.
- Ngom, R. V., Mouiche, M. M., Ayissi, G. J., Dama, S. Z., Akoussa, A. M., Laconi, A., ... & Piccirillo, A. (2023). Protocol of the scoping review–Biosecurity measures assessment at animal farm level in Africa. <https://www.research.unipd.it/bitstream/11577/3495042/3/Scoping%20Revie>

w%20Protocol-Biosecurity%20measure%20assessment%20in%20animal%20in%20Africa final.pdf

Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021; 372: n71.

Sanguinetti, V. M., H. Ganshorn, S. Agbese, M.C. Windeyer. 2021. Protocol for a systematic review of disease control strategies used to prevent infectious mortality and morbidity in pre-weaned beef calves. PRISM Repository. Available from <https://prism.ucalgary.ca/handle/1880/113381>.

Vougat Ngom, R. R. B., Tomdieu, T., Ziébé, R., Foyet, H. S., Moritz, M., Vondou, L., ... & Garabed, R. B. (2017). Quality of veterinary pharmaceuticals and their use by pastoralists in the Far North Region of Cameroon. *Pastoralism*, 7(1), 1-14.

WOAH, 2023. *Terrestrial Animal Health Code*. <https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=glossaire.htm>. Acces on 02/16/2024