Incidence and seroprevalence of rabies virus in humans, dogs and other animal species in Africa, a systematic review and meta-analysis

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This article reveals a **high burden** of rabies in Africa with an **incidence** of 83.4% in humans and 44.6% in dogs, and 41.7% in other animal species. Although rabies is near 100% fatality, this review also shows a **seroprevalence** as high as 33.2% in humans, 19.8% in dogs, and 3.6% in other animal species.

Abstract Reference PP20

BACKGROUND

Rabies virus (RABV) is the most common causative agent of rabies, distributed in almost all countries of the world and can infect a wide range of mammal species. Owned dogs are the principal hosts involved in the transmission of RABV to human in more than 99% of cases through bites. But rabies can also be transmitted by scratches, mucosal licking, and in rare cases by organ transplantation. Rabies is almost always fatal once clinical disease develops. Nevertheless, rabies is preventable through post-exposure prophylaxis (PEP), which has shown a good efficacy. However, this prophylaxis costs 40 United States Dollars, when the average daily allowance in Africa and Asia is 1–2 dollars per person, making it unaffordable for most population at risk. The persistence of rabies in Africa is mainly fuelled by the vicious cycle of the lack of accurate epidemiological data, the negligence of the populations and decision-makers, the lack of public information and sensitization on the risk of rabies, and the geographic and financial barriers to access rabies vaccines. WHO and partners launched a global plan to eliminate dog-mediated human rabies by 2030. It would be important to know the general epidemiological data on rabies in Africa in order to be able to put in place a global plan of elimination of rabies adapted to the African context. This study aims to contribute to ongoing efforts towards elimination of dog-mediated human rabies by providing an overview of the status and occurrence of rabies in Africa through a meta-analysis of rabies incidence and seroprevalence data in various categories of human, dog, and other animal species populations.

METHODS

We used the **CoCoPop (Condition, Context, and Population)** mnemonic approach recommended by the Joanna & Briggs Institute to define the inclusion criteria for this review. The **condition** was infection with the rabies virus (RABV). We classified RABV infections as past (antibody detection) and active (antigen, RNA, live virus and Negri bodies) infection. The **context** was the single-center or multi-center studies conducted in African countries. The **population** was humans and animals. We classified **human** subjects into suspected rabies cases and apparently healthy individuals. The animals were classified into **dogs**, which are the main vector of RABV transmission, and **other animal species**. Where possible, dogs were classified into owned dogs, stray dogs, wild dogs, rabies suspected case owned dogs, rabies suspected case stray dogs, and rabies suspected case wild dogs. Other animal species were classified according to their taxonomic order.

A comprehensive search of 5 databases including PubMed, Embase, Web of Science, African Journal Online and African Index Medicus was performed according to the guidelines of preferred items of systematic reviews and meta-analysis of observational studies, The search was performed from database inception through February 2020,

All references identified in the databases were exported to Endnote version X7 and the duplicates were eliminated. The titles and abstracts of the remaining references were selected in Rayyan Review by two investigators (JETB and SK). References included at this point were further explored from their full text. The eligibility of the selected articles was first checked before data extraction for the included articles using a Google questionnaire. Eligibility, data extraction, and review of risk of bias for each included article was performed by at least two investigators in this review. Disagreements between investigators were resolved by discussion and consensus or by arbitration by a third investigator if necessary. Risk of bias in included studies was assessed using a 10-item rating scale developed by Hoy and collaborators.

We considered past infections as seroprevalence data and current infections as incidence data. Calculations of incidence/seroprevalence, analysis of heterogeneity, publication bias and sensitivity were presented for humans, dogs and other animal species in the subcategories of active and current infections. A citation could contribute to several incidence/seroprevalence data, The incidence/seroprevalence of the rabies virus and subgroup analyses were obtained by a random effect model. The heterogeneity of the estimates was assessed by the Cochran test and the I2 and H statistics.

RESULTS

Database searches yielded a total of 3,646 potentially relevant articles but a group of 73 articles corresponding to 142 incidence data was finally selected for this review. The studies were published between 1966 and 2019 and the participants were recruited between 1975 and 2018. Most of the studies had a moderate risk of bias (139/142; 97.9%). The majority of included studies were from East Africa (61/142; 43.0%) and West Africa (48/142; 33.8%). The included studies covered 21 African countries with the highest representativeness occupied by Nigeria (42/142; 29.6%) and Ethiopia (17/142; 12.0%). Dogs were the most recruited animal species (64/142; 45.1%) in the included studies, but RABV were also found in humans (7/142; 4.9%) and several other animal species (71/142; 50.0%). Apart from dogs, other animal species recruited belonged to 6 Orders including *Artiodactyla, Carnivora, Chiroptera, Perissodactyla, Primates,* and *Rodentia*. The included studies recruited 33,539 participants, including 642 humans, 19,177 dogs, and 13,720 other animal species.

The 5 included studies which enrolled humans suspected rabies cases with active infections (N = 222 participants) reported incidence ranging from 87.5 to 100% with a meta-incidence of 83.4% (CI 95%: 64.6–96.5) (Fig. 1). The studies in dogs were mainly carried out in Nigeria (31/64; 48.4%) (Supplementary Table 6). The 40 articles (42 incidence data) in dogs with active infection (N = 15,600 participants) reported incidence ranging from 0 to 100% with a meta-incidence of 44.1% (95% CI: 35.1–53.4). The studies in other animal species were mainly carried out in Namibia, Nigeria, and Ethiopia. The 24 articles (62 incidence data) in other animal species with active infection (N = 12,865 participants) reported incidence ranging from 0 to 100% with a meta-incidence of 41.4% (95% CI: 29.6–53.8).

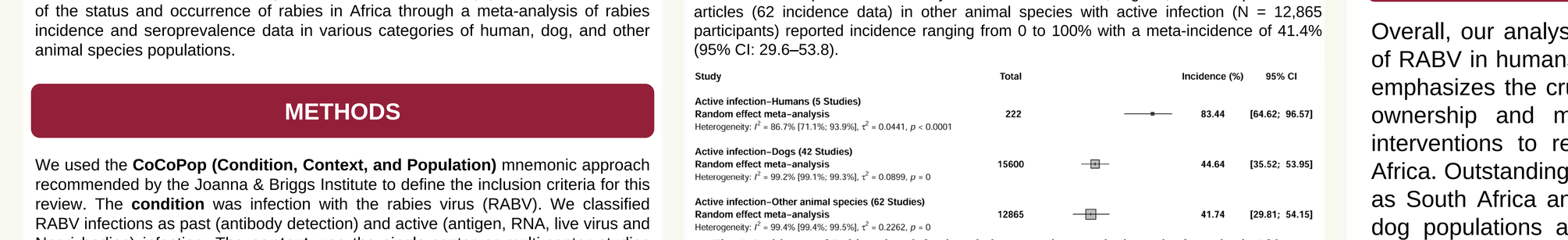

Fig. 1. Incidence of Rabies virus infections in humans, dogs, and other animal species in Africa.

The seroprevalence were 33.8% (CI 95%: 21.9–46.8) in 420 apparently healthy subjects with past RABV exposure (Fig. 2). The 15 articles (21 seroprevalence data) in dogs with past exposure (N = 3577 participants) reported seroprevalence ranging from 0 to 80% with a meta-seroprevalence of 19.8% (95% CI: 13.3–27.3). RABV meta-seroprevalence in dogs with evidence of past exposure ranged from 4.9% in wild dogs to 28.4% in unspecified dogs. The 9 articles (10 seroprevalence data) in other animal species with past exposure (N = 855 participants) reported incidence ranging from 0 to 40% with a meta-incidence of 3.6% (95% CI: 0.3–9.2). RABV meta-seroprevalence in other animal species with evidence of past exposure ranged from 0.4% in the Order Chiroptera to 7.8% in the Order Carnivora.

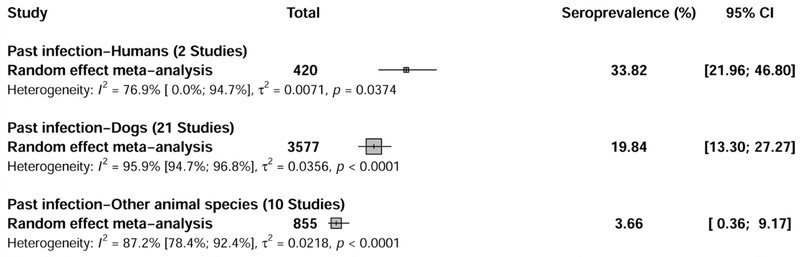

Fig. 2. Seroprevalence of Rabies virus infections in humans, dogs, and other animal species in Africa.

The RABV incidence was substantially heterogeneous with high rates recorded in active RABV infection, suspected rabies cases, suspected rabid owned and stray dogs, *Perissodactyla, Artiodactyla* and *Carnivora*. RABV incidence in humans was also higher in West and East Africa (Fig, 3). The highest incidence of RABV in owned dogs were in urbans setting and in Central and South Africa. The highest incidence in *Perissodactyla* was in urban settings.

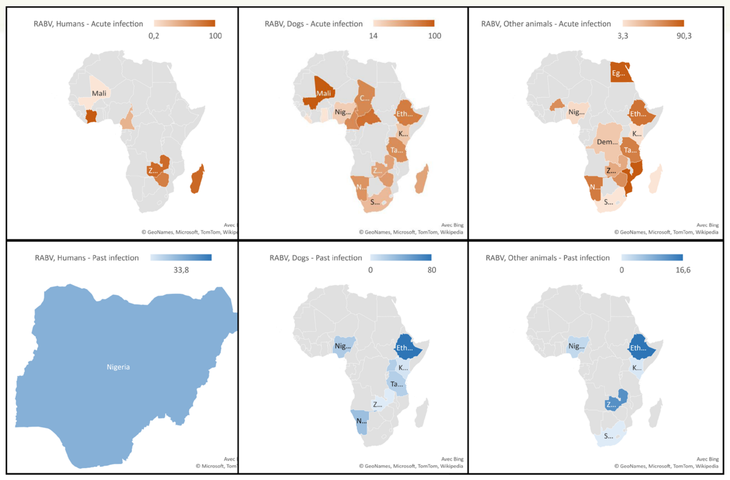

Fig. 3. Rabies virus incidence and seroprevalence in humans, dogs, and other animal species in Africa, 1966–2019.

CONCLUSIONS

Overall, our analyses revealed a high incidence in Africa of RABV in humans, dogs and other animal species. This emphasizes the crucial need to promote responsible dog ownership and mass vaccination campaigns as key interventions to reduce the risk of domestic rabies in Africa. Outstanding examples from African countries, such as South Africa and Malawi, where vaccine coverage of dog populations at ≥70% during several years of pilot programs have shown that the global elimination of dog mediated human rabies by 2030 is an achievable goal. All the tools are available and efficient and most African countries have already developed their strategic and/or operational plans for the national elimination of dog mediated human rabies by 2030.

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MORE INFORMATION / REFERENCES

For more information, this article was published in the journal "One Health" under the following reference: Wobessi, J.N.S., Kenmoe, S., Mahamat, G., Belobo, J.T.E., Emoh, C.P.D., Efietngab, A.N., Bebey, S.R.K., Ngongang, D.T., Tchatchouang, S., Nzukui, N.D., Modiyinji, A.F., Simo, R.E.G., Ka'e, A.C., Tazokong, H.R., Ngandji, A.B., Mbaga, D.S., Kengne-Nde, C., Sadeuh-Mba, S.A., Njouom, R., 2021. Incidence and seroprevalence of rabies virus in humans, dogs and other animal species in Africa, a systematic review and meta-analysis. One Health 13, 100285. https://doi.org/10.1016/j.onehlt.2021.100285

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