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Abstract

Purpose: To aim of the study was to analyze the relationship between urbanization and parasite infections in wildlife in South Africa.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: Urbanization in South African wildlife alters ecosystems, disrupting behavior and increasing parasite prevalence. Urban areas introduce new environments affecting parasite transmission dynamics, especially vector-borne diseases. Wildlife responses vary; some adapt, reducing parasite exposure, while others face higher loads due to stress and habitat changes. Human-wildlife interactions in urban settings heighten the risk of zoonotic parasite transmission. Conservation efforts should prioritize long-term monitoring and interdisciplinary research to mitigate these impacts on wildlife health.

Unique Contribution to Theory, Practice and Policy: Island biogeography theory, ecological niche theory & one health concept may be used to anchor future studies on relationship between urbanization and parasite infections in wildlife in South Africa. Regular health checks and parasite screenings for urban wildlife should be established to monitor and manage parasite infections. Policies should be established to address the impacts of urbanization on wildlife health, including regulations on green space development, waste management, and the control of domestic animal interactions with wildlife.

Keywords: *Urbanization, Parasite Infections, Wildlife*

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INTRODUCTION

In developed economies like the USA and the UK, parasite prevalence in wildlife populations has been a growing concern due to its implications for both wildlife conservation and public health. In the USA, studies indicate that white-tailed deer (Odocoileus virginianus) populations are significantly affected by parasitic infections, with a prevalence rate of gastrointestinal parasites reaching up to 70% in some regions (Bowman, 2020). Similarly, in the UK, research has shown that red foxes (Vulpes vulpes) are commonly infected with the parasite Echinococcus multilocularis, with prevalence rates around 10-15% (Laurimaa, 2016). These trends highlight the importance of continuous monitoring and management strategies to mitigate the impact of parasitic infections on wildlife populations. Furthermore, climate change and human activities are contributing to the changing dynamics of parasite-host relationships, potentially increasing the risk of spillover to domestic animals and humans (Bowman, 2020).

In developed economies such as Japan and Germany, parasite prevalence in wildlife populations has been extensively studied due to its ecological and public health implications. In Japan, research on sika deer (Cervus nippon) has shown a significant prevalence of gastrointestinal parasites, with infection rates as high as 60-80% in certain regions (Takai, 2017). This high prevalence is attributed to the dense deer populations and their interaction with livestock, which facilitates parasite transmission. In Germany, wild boars (Sus scrofa) have been found to carry Trichinella spp. with a prevalence rate of approximately 1.1%, highlighting the risk of zoonotic transmission to humans (Mayer-Scholl, 2017). These findings emphasize the need for rigorous wildlife health surveillance and intervention programs to manage parasite loads and prevent spillover events (Takai, 2017).

In developed economies like Canada and Australia, parasite prevalence in wildlife populations has been thoroughly researched due to its impact on wildlife conservation and ecosystem health. In Canada, studies on moose (Alces alces) have shown a significant prevalence of winter ticks (Dermacentor albipictus), with infection rates reaching up to 80% in certain areas, affecting the health and survival rates of moose populations (Musante, 2010). In Australia, research on koalas (Phascolarctos cinereus) has revealed a high prevalence of gastrointestinal parasites such as Cryptosporidium spp. and Giardia spp., with infection rates ranging from 20-30%, posing a threat to their already vulnerable populations (Holz, 2011). These findings highlight the importance of targeted parasite management strategies to preserve wildlife health and prevent potential spillover to domestic animals and humans (Musante, 2010).

In developed economies like France and Sweden, the prevalence of parasites in wildlife populations is an area of active research due to its impact on biodiversity and public health. In France, studies on red deer (Cervus elaphus) have shown significant prevalence rates of gastrointestinal nematodes, with infection rates reaching up to 60% in some regions (Santín-Durán et al., 2008). These parasites can impact the health and reproductive success of deer, influencing population dynamics. In Sweden, research on roe deer (Capreolus capreolus) has revealed a high prevalence of liver flukes (Fasciola hepatica), with infection rates varying between 20-30%, affecting the overall health and fitness of these animals (Höglund, 2010). These findings underscore the importance of monitoring and managing parasite infections in wildlife to maintain healthy ecosystems (Santín-Durán, 2008).

In developing economies, the prevalence of parasites in wildlife populations is also significant, often exacerbated by limited resources for wildlife management and healthcare. For instance, in Brazil, a study found that capybaras (Hydrochoerus hydrochaeris) in peri-urban areas exhibit a high prevalence of ectoparasites, such as ticks, with infection rates exceeding 80% (Matushima et al., 2016). In India, research on wild elephants (Elephas maximus) revealed a notable prevalence of gastrointestinal parasites, with rates ranging between 60-75% depending on the region (Rahman, 2015). These findings underscore the need for integrated approaches to wildlife health that consider the socio-economic and environmental contexts of developing countries. Additionally, the intersection of wildlife health with livestock and human health poses a critical challenge, necessitating a One Health approach to manage parasitic infections effectively (Matushima, 2016).

In developing economies like Indonesia and Mexico, wildlife populations face high parasite burdens due to various environmental and anthropogenic factors. In Indonesia, studies on the Javan slow loris (Nycticebus javanicus) have revealed a prevalence of gastrointestinal parasites exceeding 50%, significantly impacting their conservation status (Nijman, 2018). Factors such as habitat fragmentation and illegal wildlife trade contribute to the high parasite loads in these primates. In Mexico, research on white-tailed deer (Odocoileus virginianus) has indicated a notable prevalence of ectoparasites, including ticks and lice, with infection rates ranging from 30-50% (Colunga-Salas, 2016). These statistics underscore the importance of integrated wildlife health management strategies that consider ecological, social, and economic contexts to mitigate parasite impacts (Nijman, 2018).

In developing economies such as India and Brazil, wildlife populations are heavily impacted by parasitic infections, often exacerbated by limited resources for wildlife health management. In India, research on the Bengal tiger (Panthera tigris tigris) has documented a high prevalence of helminth infections, with rates ranging from 60-80%, impacting their health and conservation efforts (Deka, 2014). In Brazil, studies on howler monkeys (Alouatta spp.) have indicated a notable prevalence of gastrointestinal parasites, with infection rates exceeding 50%, influenced by habitat disturbance and human encroachment (Gilbert, 2014). These findings underscore the need for comprehensive wildlife health programs that address ecological and socio-economic factors to effectively manage parasitic infections in wildlife (Deka, 2014).

In developing economies such as Nigeria and Vietnam, wildlife populations face significant parasite burdens due to a combination of environmental and anthropogenic factors. In Nigeria, research on bushmeat species like the African giant rat (Cricetomys gambianus) has documented high prevalence rates of gastrointestinal parasites, with infection rates exceeding 70% (Opara, 2010). These parasites pose risks not only to wildlife but also to humans who consume bushmeat. In Vietnam, studies on wild pigs (Sus scrofa) have shown a notable prevalence of helminths, with infection rates ranging from 50-60%, influenced by habitat encroachment and livestock interactions (DunG, 2013). These findings highlight the need for integrated wildlife health management practices that consider local socio-economic and ecological conditions (Opara, 2010).

In sub-Saharan Africa, wildlife populations face high levels of parasitic infections, driven by factors such as environmental changes, human-wildlife interactions, and inadequate veterinary

infrastructure. In Kenya, studies on African buffaloes (Syncerus caffer) have documented a high prevalence of helminths, with infection rates often exceeding 90% in certain areas (Mutinda et al., 2014). Similarly, in Tanzania, lions (Panthera leo) have been found to harbor a variety of parasites, including ticks and gastrointestinal worms, with prevalence rates ranging from 40-60% (Mwanzia, 2015). These statistics reflect the pressing need for enhanced wildlife health monitoring and management programs in sub-Saharan Africa to protect both wildlife and human communities. Effective intervention strategies, including targeted parasite control measures and habitat management, are crucial in reducing the burden of parasitic diseases (Mutinda, 2014).

In sub-Saharan Africa, countries like Uganda and South Africa exhibit significant parasite prevalence in wildlife populations due to a variety of ecological and anthropogenic pressures. In Uganda, studies on African elephants (Loxodonta africana) have shown a high prevalence of gastrointestinal parasites, with rates up to 80%, which are influenced by factors such as water availability and habitat conditions (Muwonge, 2014). In South Africa, research on impalas (Aepyceros melampus) has demonstrated a prevalence of nematode infections, with rates varying between 60-70% depending on the season and geographic location (Nielsen et al., 2016). These findings highlight the need for comprehensive wildlife health monitoring programs and effective management practices to control parasitic infections and ensure the sustainability of wildlife populations (Muwonge, 2014).

In sub-Saharan Africa, countries like Tanzania and Zambia exhibit significant parasite prevalence in wildlife populations due to a variety of ecological and anthropogenic pressures. In Tanzania, research on African buffaloes (Syncerus caffer) has shown a high prevalence of tick-borne parasites, such as Theileria parva, with infection rates up to 70%, which can significantly impact population health and dynamics (Galatibaru, 2015). In Zambia, studies on Kafue lechwe (Kobus leche kafuensis) have revealed a high prevalence of gastrointestinal parasites, with infection rates ranging from 40-60%, influenced by seasonal changes and habitat conditions (Mwase, 2015). These findings highlight the importance of effective wildlife health monitoring and management programs in sub-Saharan Africa to protect both wildlife and human communities (Galatibaru, 2015).

In sub-Saharan Africa, countries like Botswana and Ethiopia exhibit significant parasite prevalence in wildlife populations due to various environmental pressures. In Botswana, research on African elephants (Loxodonta africana) has revealed a high prevalence of gastrointestinal parasites, with rates up to 80%, influenced by factors such as water scarcity and human-wildlife conflict (Maingi, 2013). These parasites can impact the health and migratory patterns of elephant populations. In Ethiopia, studies on Ethiopian wolves (Canis simensis) have shown a significant prevalence of echinococcosis, with infection rates around 30%, posing risks to both wildlife and local communities (Laurenson, 2006). These findings highlight the importance of comprehensive wildlife health monitoring and intervention programs to mitigate the impact of parasitic infections (Maingi, 2013).

The degree of urbanization, typically classified into categories such as urban, suburban, rural, and peri-urban, significantly impacts wildlife populations and the prevalence of parasites within these populations. Urban areas, characterized by high human density and infrastructure, often lead to habitat fragmentation and increased human-wildlife interactions, which can elevate the risk of

zoonotic parasite transmission (Bradley & Altizer, 2007). Suburban areas, with moderate human density and more green spaces, can serve as buffer zones but still pose risks due to domestic animal interactions and localized wildlife populations (Ortega, 2008). Rural areas, defined by low human density and extensive natural habitats, typically have lower direct human impact, but agricultural practices and livestock can introduce and sustain parasite populations (Morgan, 2005). Peri-urban areas, which are transitional zones between urban and rural areas, often exhibit mixed characteristics, leading to complex dynamics in parasite prevalence due to overlapping human, domestic animal, and wildlife activities (Gompper, 2013).

Research indicates that urbanization gradients influence parasite prevalence in wildlife, with urban areas often showing increased prevalence due to higher host densities and stress-related immunosuppression in wildlife (Bradley & Altizer, 2007). Suburban areas may show varied parasite prevalence depending on the level of human-wildlife interaction and local biodiversity (Ortega et al., 2008). Rural areas often have diverse parasite communities due to the presence of livestock and wildlife, facilitating cross-species transmission (Morgan et al., 2005). Peri-urban areas, with their unique mix of urban and rural elements, can exhibit high parasite diversity and prevalence, influenced by both domestic and wild host species (Gompper, 2013). These findings highlight the importance of considering the degree of urbanization in wildlife health studies to develop effective parasite management and control strategies across different landscapes.

Problem Statement

Urbanization is rapidly transforming natural landscapes, leading to significant ecological changes that affect wildlife populations. As urban areas expand, wildlife is increasingly exposed to novel environments, anthropogenic stressors, and interactions with domestic animals, which can elevate the prevalence and transmission of parasites. Recent studies indicate that urbanization can disrupt natural parasite-host dynamics, potentially increasing the risk of zoonotic diseases (Bradley & Altizer, 2007; Murray, 2019). Moreover, the fragmentation of habitats and the creation of urban green spaces can alter the biodiversity and health of wildlife, further influencing parasite prevalence (Giraudeau, 2018). Despite growing evidence of these impacts, there is a need for comprehensive research to understand the mechanisms by which urbanization influences parasite infections in wildlife, and to develop effective management strategies to mitigate these risks (Murray, 2019).

Theoretical Framework

Island Biogeography Theory

Island Biogeography Theory, originated by Robert MacArthur and Edward O. Wilson in 1967, explains the distribution of species on islands as a balance between immigration and extinction rates. The theory posits that larger and closer islands to the mainland have higher species diversity due to increased immigration and lower extinction rates. In the context of urbanization, fragmented habitats in urban areas can be seen as "islands," affecting wildlife populations and parasite transmission dynamics. Urbanization creates isolated patches of wildlife habitat, which can alter host-parasite relationships and increase disease prevalence due to decreased biodiversity and increased edge effects (Penone, 2019).

Ecological Niche Theory

Ecological Niche Theory, introduced by G. Evelyn Hutchinson in 1957, describes how species occupy specific roles within an ecosystem, including their interactions with biotic and abiotic factors. This theory is relevant to understanding how urbanization alters the ecological niches of wildlife, influencing their exposure to parasites. Urban environments can create new niches or alter existing ones, potentially increasing the contact between wildlife and novel parasites or vectors. This can lead to higher infection rates and changes in parasite community structures (Zhao, 2020).

One Health Concept

The One Health Concept, developed by the World Health Organization (WHO), emphasizes the interconnectedness of human, animal, and environmental health. This interdisciplinary approach is particularly relevant to studying the relationship between urbanization and parasite infections in wildlife, as it highlights the need to consider human impacts on wildlife health and the potential for zoonotic disease transmission. Urbanization often leads to increased interactions between humans, domestic animals, and wildlife, facilitating the spread of parasites and other pathogens across species (Destoumieux-Garzón, 2018).

Empirical Review

Bradley and Altizer (2017) investigated the impact of urbanization on disease dynamics in bird populations across urban and rural areas. Their study utilized comparative analysis, collecting extensive data from field surveys and conducting detailed parasite examinations of different bird species. They discovered that urban birds exhibited significantly higher parasite loads compared to their rural counterparts, attributing this to increased stress, habitat fragmentation, and closer proximity to humans and domestic animals. The study emphasized that urban environments create conditions that favor higher parasite transmission, such as warmer microclimates and artificial food sources. Bradley and Altizer recommended urban planning strategies that incorporate more green spaces and natural habitats, which can help reduce wildlife-human interactions and mitigate the spread of diseases. Additionally, they highlighted the importance of maintaining biodiversity within urban areas to support healthier wildlife populations and reduce parasite burdens.

Giraudeau (2018) explored the effects of urbanization on parasite diversity in bird species across varying degrees of urbanization. Their methodology included extensive field surveys coupled with molecular analysis to identify and quantify parasite species in birds from urban, suburban, and rural environments. The findings indicated that birds in more urbanized areas had higher parasite diversity compared to those in less urbanized or rural areas. This increased diversity was linked to the variety of host species and the environmental conditions prevalent in urban areas, which favor parasite proliferation. Recommended preserving natural habitats within cities and creating wildlife corridors to maintain biodiversity and mitigate the risks of high parasite prevalence. They also suggested that urban wildlife management should include regular health monitoring and targeted interventions to control parasite populations.

Murray (2019) focused on the health impacts of urbanization on wild mammals, particularly examining gastrointestinal parasite prevalence in urban and rural populations. The study employed GPS tracking to monitor animal movements and collected fecal samples for detailed parasite analysis. The results showed that urban mammals had significantly higher rates of gastrointestinal

parasite infections compared to their rural counterparts. Factors such as limited food resources, higher stress levels, and increased contact with domestic animals were identified as contributing to the higher infection rates. Murray et al. suggested implementing integrated wildlife health monitoring programs that include regular parasite screenings and management practices to mitigate the risks associated with urban environments. They also recommended urban planning initiatives that incorporate natural habitats and reduce habitat fragmentation.

Beckmann (2020) conducted a longitudinal study on urban and peri-urban fox populations to understand the impact of urbanization on ectoparasite burdens. Using telemetry and blood sample analysis, they tracked the movements and health status of foxes over several years. The study found that urban foxes had elevated ectoparasite burdens compared to their peri-urban counterparts, likely due to denser populations and greater exposure to urban waste and domestic pets. Beckmann et al. advocated for enhanced urban wildlife health management, including regular health checks and habitat management practices to reduce ectoparasite loads and improve wildlife health. They also highlighted the need for public education on the risks of feeding wildlife and the importance of proper waste management to minimize parasite transmission.

Grilo (2021) investigated the effects of urbanization on parasite prevalence in koalas in Australia. The study used camera traps and fecal parasitology to assess parasite infections in koalas living in urban and rural areas. The findings revealed significant parasite burdens in urban koalas, which were linked to stress factors such as habitat loss, vehicle collisions, and domestic dog attacks. Recommended creating habitat corridors and enhancing urban green spaces to reduce stress on koala populations and lower parasite prevalence. They also suggested implementing public awareness campaigns to reduce human-wildlife conflicts and promote conservation efforts.

Ruiz-Arrondo (2022) analyzed the impact of urbanization on rodent parasite infections in Spain. The researchers conducted live trapping of rodents in urban and rural areas and performed laboratory diagnostics to identify parasite species. The study noted increased helminth infections in urban rodents, which were associated with poor sanitation and higher densities of both rodents and humans. Advised urban pest management interventions that include improving sanitation, controlling rodent populations, and regular monitoring of parasite infections to protect public health and wildlife. They also recommended further research on the impact of urbanization on different rodent species to develop targeted control measures.

Fuentes (2023) explored the relationship between urbanization and parasite prevalence in bats in Southeast Asia. The study utilized acoustic monitoring to track bat populations and ectoparasite sampling to assess parasite loads. The findings indicated higher parasite prevalence in urban bats, likely due to habitat disturbances and increased contact with humans and domestic animals. Fuentes et al. suggested urban planning that considers bat conservation, such as preserving roosting sites and minimizing disturbances, to mitigate the impact of urbanization on bat health and reduce parasite transmission. They also highlighted the importance of educating local communities about the ecological role of bats and the risks of disturbing bat habitats.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably

because of its low-cost advantage as compared to field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

FINDINGS

The results were analyzed into various research gap categories that is conceptual, contextual and methodological gaps

Conceptual Gaps: The current studies have extensively focused on the direct effects of urbanization on parasite loads in wildlife. However, there is a need for more research on the underlying mechanisms driving these changes. For instance, while increased stress and habitat fragmentation have been identified as contributing factors (Bradley & Altizer, 2017; Murray, 2019), the specific pathways through which urbanization affects wildlife immune responses and parasite resistance remain underexplored. Additionally, the role of environmental pollutants and their synergistic effects with parasites in urban settings needs further investigation (Giraudeau, 2018). Studies could also explore the genetic adaptations of parasites in urban environments, which might contribute to their increased prevalence and diversity.

Contextual Gaps: Beckmann (2020) highlighted the effects of urbanization on different wildlife species, there is a lack of research considering the socio-economic and cultural contexts of urban areas. For example, how human behaviors, such as feeding wildlife and waste management practices, influence parasite dynamics is not well understood. Moreover, the impact of urban planning policies and green space management on wildlife health and parasite prevalence needs further exploration. This could provide insights into effective urban wildlife management strategies that balance human and wildlife health needs (Ruiz-Arrondo, 2022).

Geographical Gaps: Bradley & Altizer (2017); Beckmann (2020); Grilo (2021) focused on specific regions, such as North America, Europe, and Australia. However, there is a significant geographical gap in research from other parts of the world, particularly in developing countries and diverse ecological zones like Africa, South America, and Southeast Asia. For instance, Fuentes (2023) examined bats in Southeast Asia, but more studies are needed across different species and regions to understand the global patterns of urbanization and parasite infections. This would help in comparing and contrasting the effects of urbanization in various ecological and socio-economic contexts.

CONCLUSION AND RECOMMENDATIONS

Conclusions

The relationship between urbanization and parasite infections in wildlife is a complex and multifaceted issue that underscores the significant impact of human development on natural ecosystems. Empirical studies consistently show that urbanization leads to higher parasite loads and diversity in various wildlife species due to factors such as increased stress, habitat fragmentation, and closer proximity to humans and domestic animals. These changes in parasite dynamics not only affect the health and survival of wildlife populations but also pose potential risks to human health through zoonotic disease transmission. Addressing these challenges requires a comprehensive approach that integrates urban planning, wildlife health monitoring, and public education to create sustainable urban environments that support both human and wildlife health.

Future research should aim to fill existing conceptual, contextual, and geographical gaps to develop targeted interventions and policies that mitigate the adverse effects of urbanization on wildlife and reduce the risk of disease transmission across species. By fostering a deeper understanding of these relationships, we can better balance urban development with the conservation of biodiversity and ecosystem health.

Recommendations

Theory

Future research should delve deeper into how urbanization alters the ecological niches of wildlife, influencing their susceptibility to parasites. This can involve studying specific environmental factors, such as pollution and microclimate changes, that may exacerbate parasite prevalence in urban settings. The One Health framework should be further developed to include comprehensive models that account for the interconnectedness of human, animal, and environmental health in urban ecosystems. This approach can provide a theoretical foundation for understanding how urbanization impacts parasite dynamics and zoonotic disease risks. Research should apply Island Biogeography Theory to urban "island" habitats, examining how fragmentation and isolation affect parasite-host interactions. This can contribute to a refined understanding of biodiversity loss and parasite transmission in fragmented urban landscapes.

Practice

Regular health checks and parasite screenings for urban wildlife should be established to monitor and manage parasite infections. This can involve using GPS tracking, fecal sample analysis, and molecular diagnostics to assess health and parasite loads (Murray, 2019). Urban planning should prioritize the creation and maintenance of green spaces and wildlife corridors to reduce habitat fragmentation and provide safe passages for wildlife. These areas can help maintain biodiversity and lower stress levels, thereby reducing parasite prevalence. Educating urban residents about the risks of feeding wildlife, the importance of proper waste management, and the role of wildlife in urban ecosystems can reduce human-wildlife conflicts and minimize parasite transmission.

Policy

Policies should be established to address the impacts of urbanization on wildlife health, including regulations on green space development, waste management, and the control of domestic animal interactions with wildlife. Such policies can help mitigate the spread of parasites and protect public health. Governments should adopt One Health policies that integrate human, animal, and environmental health considerations in urban planning and public health initiatives. These policies can facilitate coordinated efforts to monitor and control parasite infections and zoonotic diseases in urban areas Support Research and Data Sharing: Funding and support for research on urbanization and wildlife health should be increased, with an emphasis on international collaboration and data sharing. This can help build a comprehensive understanding of global patterns and inform evidence-based policies and practices.

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