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Bushmeat Consumption in Africa: A One Health Perspective on Public Health Risks and Stakeholder Insights

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Abstract

The consumption of bushmeat, which includes wild animals hunted for food, is a widespread practice in Africa, driven by cultural traditions, dietary preferences, and economic factors. While it serves as a crucial source of protein and livelihoods for many rural and peri-urban communities, the bushmeat trade presents significant public health challenges, particularly from a One Health perspective. This interdisciplinary framework emphasizes the interconnectedness of human, animal, and environmental health, providing a holistic approach to addressing the risks associated with bushmeat consumption.

Key public health implications include the emergence and transmission of zoonotic diseases, such as Ebola Virus Disease, HIV, and monkeypox, which can jump from wildlife to humans through direct contact during hunting, butchering, and consumption of infected animals. Additionally, the bushmeat trade threatens biodiversity, alters ecosystems, and increases the likelihood of novel pathogens emerging due to human encroachment into wildlife habitats. Poor sanitary practices in bushmeat handling and the lack of regulatory frameworks exacerbate these risks, especially in resource-limited settings.

This abstract explores the drivers and consequences of bushmeat consumption, emphasizing the importance of adopting the One Health approach to mitigate risks. Strategies such as strengthening surveillance systems for zoonotic diseases, promoting alternative protein sources, enforcing wildlife conservation policies, and raising public awareness about the health risks are critical. Furthermore, cross-sectoral collaboration among public health officials, veterinarians, ecologists, and policymakers is essential to achieve sustainable solutions that balance human nutrition, wildlife conservation, and disease prevention. The findings underscore the urgency of integrating One Health principles into public health interventions to address the complex challenges posed by bushmeat consumption in Africa.

Keywords: Bushmeat Consumption, Zoonotic Diseases, One Health, Wildlife Conservation and Ecosystem Health

Introduction

The consumption of bushmeat, defined as the meat of wild animals hunted for food, is a longstanding practice in many African communities, deeply rooted in cultural traditions, economic necessity, and dietary preferences. It provides a critical source of protein and income, particularly in rural and peri-urban areas where access to alternative protein sources may be limited. However, the practice is increasingly recognized as a significant public health concern, primarily due to its role in the transmission of zoonotic diseases and its impact on biodiversity and ecosystem stability [1,2].

The close interaction between humans and wildlife during hunting, handling, and consumption of bushmeat creates opportunities for the spillover of pathogens from animals to humans. This has been linked to the emergence of several high-profile zoonotic diseases, including Ebola Virus Disease, HIV, and monkeypox, which have caused widespread morbidity and mortality in Africa and beyond [3,4]. Additionally, inadequate sanitary practices and the absence of regulatory frameworks for the bushmeat trade further exacerbate the public health risks associated with its consumption.

From a One Health perspective, the bushmeat trade illustrates the intricate interplay between human, animal, and environmental health. Human encroachment into wildlife habitats, driven by deforestation, agricultural expansion, and urbanization, has not only increased human-wildlife interactions but also disrupted ecosystems, heightening the risk of pathogen emergence [5]. Addressing these challenges requires a holistic approach that integrates expertise across disciplines, including public health, veterinary medicine, ecology, and socioeconomics.

This paper explores the public health implications of bushmeat consumption in Africa, with a focus on zoonotic disease risks and the broader ecological and socio-economic impacts. It emphasizes the importance of adopting a One Health framework to design effective interventions that balance human nutrition, wildlife conservation, and disease prevention. By strengthening surveillance, promoting alternative protein sources, and fostering cross-sectoral collaboration, sustainable solutions to mitigate the risks of bushmeat consumption can be achieved.

Methodology

This research employs a mixed-methods approach to investigate the consumption of bushmeat in various African countries, focusing on its public health implications, zoonotic disease risks, and ecological impacts. The methodology is structured into the following key components:

Study Design

A cross-sectional, multi-country study was conducted to examine the diverse practices and perceptions surrounding bushmeat consumption across regions in Africa known for significant reliance on bushmeat as a source of protein and livelihood. This comprehensive study focused on Central, West, East, and Southern Africa, encompassing countries such as the Democratic Republic of Congo (DRC), Nigeria, Ghana, Kenya, and South Africa. These countries were selected based on their ecological diversity, cultural traditions, and varying socioeconomic factors influencing bushmeat utilization.

Key Highlights of the Study: Regional Practices and Trends In Central Africa

Represented by the DRC, bushmeat consumption is deeply ingrained in the local culture and economy. Dense tropical rainforests provide a habitat for diverse wildlife species, making bushmeat a readily available protein source for rural communities. The region also faces challenges with illegal wildlife trade, which complicates sustainable management practices.

West Africa

Including Nigeria and Ghana, is marked by both urban and rural demand for bushmeat. In Nigeria, bushmeat markets serve as a primary source of income for hunters, traders, and vendors. Ghana showcases a similar dynamic, with bushmeat considered a delicacy and a symbol of cultural heritage in many communities.

East Africa

Represented by Kenya, contrasts with Central and West Africa, as bushmeat consumption is more restricted due to stronger wildlife conservation laws. Nevertheless, illegal hunting persists, driven by poverty and a lack of alternative livelihoods.

In Southern Africa

South Africa presents a unique scenario where bushmeat consumption is less widespread in urban centres but remains prevalent in rural areas. The country's dual approach to wildlife management, combining conservation with regulated game hunting, influences local practices.

Perceptions and Motivations

Across all regions, perceptions of bushmeat vary significantly. In rural areas, bushmeat is often seen as an affordable and accessible protein source. Conversely, in urban areas, it is increasingly regarded as a luxury or exotic food item. Economic drivers, such as high costs of alternative proteins and unemployment, further reinforce bushmeat reliance. Conservation attitudes also differ. In Ghana and Kenya, for example, community awareness campaigns have highlighted the ecological impacts of unsustainable hunting. However, enforcement challenges persist, particularly in regions like the DRC, where governance structures are weaker.

Public Health and Zoonotic Risks

The study also explored the public health implications of bushmeat consumption, especially concerning zoonotic disease transmission. Regions with high bushmeat consumption, such as the DRC and Nigeria, face heightened risks of diseases like Ebola and Lassa fever due to close human-animal interactions.

Research Implications

The findings underscore the need for tailored policies addressing the socio-economic realities of bushmeatdependent communities while promoting sustainable practices and biodiversity conservation. Effective strategies should integrate community engagement, alternative livelihood programs, and robust enforcement mechanisms.

Data Collection Selection of Study Sites

The selection of study sites for this research was based on a systematic approach to ensure a comprehensive representation of regions with high bushmeat consumption. The criteria for site selection included areas with documented high rates of bushmeat hunting and consumption, proximity to wildlife habitats, and a history of zoonotic disease outbreaks. To capture the full spectrum of socio-economic and geographical dynamics, the study incorporated rural, peri-urban, and urban areas across the target countries.

High Rates of Bushmeat Hunting and Consumption

Regions with significant reliance on bushmeat were prioritized based on existing literature and government reports. For instance, in the Democratic Republic of Congo (DRC), sites in the Congo Basin were chosen due to the area's dense forests, which serve as a critical source of bushmeat for subsistence and commercial purposes [6, 8]. Similarly, in Nigeria, regions such as Cross River State were included because of their vibrant bushmeat markets and the cultural importance attached to bushmeat consumption [7].

Proximity to Wildlife Habitats

The proximity of communities to natural wildlife habitats was another essential factor. Areas bordering national parks and wildlife reserves were targeted because of the higher likelihood of human-wildlife interactions. In Ghana, for example, communities near Kakum National Park were studied, while in Kenya, sites close to the Maasai Mara ecosystem were selected. These areas were significant due to their role in sustaining local livelihoods and the conservation challenges posed by illegal hunting [8].

Prevalence of Zoonotic Disease Outbreaks

Regions with a history of zoonotic disease outbreaks were included to examine the public health risks associated with bushmeat consumption. For instance, in the DRC, sites linked to Ebola virus outbreaks were prioritized, given the documented connection between human-bushmeat interactions and disease transmission [9]. Similarly, in Nigeria and Ghana, regions with outbreaks of Lassa fever were incorporated into the study to assess the potential role of bushmeat as a vector [10].

Rural, Peri-Urban, and Urban Coverage

To capture the geographical and socio-economic diversity of bushmeat practices, the study included rural areas where bushmeat serves as a primary protein source, periurban areas where demand intersects with conservation pressures, and urban centers where bushmeat is often considered a luxury. For instance:

• **Rural Areas:** Villages near forests in South Africa and the DRC were included to understand subsistence hunting practices [8].

• **Peri-Urban Areas:** Peripheries of cities like Nairobi, Kenya, and Accra, Ghana, were studied for their blend of

rural and urban dynamics in bushmeat supply chains [11]. • **Urban Centers:** Cities such as Lagos, Nigeria, and Johannesburg, South Africa, were included to explore consumer perceptions and the commercialization of bushmeat [8].

Rationale for Comprehensive Inclusion

The integration of these diverse site categories allowed for a holistic understanding of the bushmeat phenomenon. This approach facilitated an analysis of factors such as income disparity, cultural traditions, market accessibility, and public health risks. By considering rural to urban gradients, the study provided insights into how bushmeat consumption patterns evolve across different socioeconomic contexts.

Sampling of Bushmeat Types:

Bushmeat samples were collected from local markets, hunting sites, and community households. Species were identified through morphological examination and genetic barcoding, categorizing them into key groups such as:

- Primates (e.g., chimpanzees, gorillas)
- Ungulates (e.g., antelopes, duikers)
- Rodents (e.g., cane rats, porcupines)
- Bats (e.g., fruit bats)
- Carnivores (e.g., civets, genets)

Stakeholder Interviews

Semi-structured interviews were conducted with a diverse group of stakeholders, including hunters, traders, consumers, and policymakers, to gain in-depth insights into the motivations, practices, and perceptions surrounding bushmeat consumption. This approach facilitated a nuanced understanding of the socio-cultural and economic factors driving bushmeat use while addressing its public health and environmental implications.

Interview Groups and Rationale Hunters

Interviews with hunters focused on their motivations for hunting, the tools and techniques they employ, and the challenges they face. Discussions explored:

Preferred Species: Hunters identified commonly targeted species, such as duikers, primates, rodents, and pangolins, and explained the factors influencing their choices, including species availability, demand, and economic value [8].

Hunting Practices: Information was gathered on hunting methods, seasonal variations in hunting activity, and perceptions of wildlife regulations.

Economic Dependence: Hunters shared insights into the financial importance of bushmeat hunting and its role in sustaining their livelihoods.

Traders

Bushmeat traders were interviewed to understand the supply chain dynamics and market structures. Key topics included:

Market Demand: Traders provided information on the most sought-after bushmeat species and seasonal trends in demand.

Trade Networks: Interviews revealed details about sourcing regions, transportation methods, and cross-

border trade practices.

Economic Incentives: Traders discussed profit margins, competition, and the impact of law enforcement on their activities [8].

Consumers

Engaging with consumers offered valuable perspectives on cultural and personal motivations for bushmeat consumption. Key questions explored:

Preparation and Consumption Practices: Respondents described traditional methods of preparing bushmeat, such as smoking, roasting, and stewing, as well as social contexts in which bushmeat is consumed.

Perceived Benefits: Consumers highlighted the taste, nutritional value, and cultural significance of bushmeat.

Health Risk Awareness: Interviews assessed consumer awareness of zoonotic disease risks associated with bushmeat consumption and their willingness to adopt safer alternatives [10].

Policymakers

Policymakers and regulatory authorities were interviewed to understand the governance framework surrounding bushmeat. Key areas of focus included:

Regulation and Enforcement: Policymakers discussed existing laws, enforcement challenges, and strategies for curbing illegal hunting and trade.

Conservation Efforts: Perspectives on balancing wildlife conservation with the socio-economic needs of local communities were gathered.

Public Health Interventions: Interviews explored ongoing initiatives to raise awareness about zoonotic diseases and promote alternative protein sources [11].

Broad Themes and Insights Cultural and Economic Drivers:

Across all stakeholder groups, bushmeat consumption was reported as deeply embedded in cultural traditions and as a critical economic activity, particularly in rural areas. Hunters and traders emphasized the absence of viable economic alternatives, while consumers highlighted the cultural symbolism of bushmeat in festivals and ceremonies [8].

Health and Safety Concerns:

Awareness of health risks varied widely. While some consumers and traders were aware of zoonotic diseases, many perceived the risks as negligible. Hunters expressed concerns about occupational hazards, including injuries and encounters with dangerous wildlife. Policymakers noted the need for more robust health education campaigns [10].

Challenges in Governance:

Policymakers and traders pointed to weak enforcement of wildlife laws as a significant challenge. Corruption, lack of resources, and limited community engagement were cited as barriers to effective regulation. Policymakers also emphasized the need for alternative livelihood programs to reduce dependence on bushmeat hunting and trade [8].

Epidemiological Surveys

To establish a link between bushmeat consumption and zoonotic disease prevalence, health records from local

clinics and hospitals in the study regions were systematically reviewed. These records were analyzed to identify reported cases of zoonotic diseases potentially associated with human interactions with bushmeat, including Ebola, Lassa fever, monkeypox, and anthrax.

Data Collection and Review Selection of Health Facilities:

Clinics and hospitals in proximity to identified bushmeat hotspots were selected. Facilities were chosen based on their historical data availability and accessibility to communities engaging in bushmeat hunting, trading, or consumption.

Focus on Zoonotic Diseases:

Health records were specifically reviewed for cases of zoonotic diseases with a known connection to bushmeat practices:

Viral Diseases: Ebola and monkeypox cases were prioritized due to their historical outbreaks in bushmeat-dependent regions, especially in Central and West Africa [9,12].

Bacterial Diseases: Anthrax outbreaks, often linked to improperly handled carcasses, were of particular interest [13].

Parasitic Diseases: Cases of trypanosomiasis were included, given its transmission through infected animal vectors frequently hunted for bushmeat.

Data Analysis:

Information on patients' occupations, dietary habits, and hunting or handling activities was assessed to trace possible connections between bushmeat exposure and disease incidence. This approach helped identify potential patterns and risk factors for zoonotic transmission.

Key Findings

Epidemiological data revealed correlations between bushmeat handling and disease prevalence, underscoring the need for targeted health education and preventive measures.

Laboratory Analysis

Bushmeat samples were subjected to comprehensive laboratory testing to identify zoonotic pathogens and assess public health risks. This analysis encompassed pathogen screening and toxicological testing to ensure a multi-faceted understanding of bushmeat's implications.

Pathogen Screening

Bushmeat samples collected from hunting and trading sites were screened for zoonotic pathogens using molecular and microbiological techniques, including Polymerase Chain Reaction (PCR), Enzyme-Linked Immunosorbent Assay (ELISA), and traditional culture methods. These methods allowed for the precise identification of pathogens across viral, bacterial, and parasitic categories.

Target Pathogens: Viruses:

Filoviruses: Bushmeat samples were tested for Ebola and Marburg viruses, given their association with wildlife reservoirs such as fruit bats and primates [9].

Coronaviruses: Samples were screened for zoonotic coronaviruses due to their potential for cross-species transmission and pandemic risk [14].

Lyssaviruses: Rabies virus testing focused on species commonly hunted in endemic regions.

Bacteria:

Bacillus anthracis (Anthrax): Testing was prioritized for samples from regions with a history of anthrax outbreaks [13].

Salmonella spp.: Samples were analysed for gastrointestinal pathogens linked to foodborne illnesses [15].

Mycobacterium tuberculosis Complex: Testing focused on species susceptible to zoonotic tuberculosis.

Parasites:

Trypanosoma spp.: Samples were screened for pathogens causing sleeping sickness, a significant public health concern in certain regions [16].

Toxoplasma gondii: Given its ability to infect a wide range of hosts, including humans, testing for T. gondii was a priority [17].

Toxicology Testing

In addition to pathogen screening, bushmeat samples were analysed for environmental contaminants, including pesticide residues, which present an underexplored but significant public health risk.

Methodology:

• **Chemical Analysis:** Samples were tested using gas chromatography-mass spectrometry (GC-MS) and high-performance liquid chromatography (HPLC) to detect organophosphates, organochlorines, and other pesticide residues.

• **Risk Assessment:** Contaminant levels were compared to established safety thresholds to evaluate potential health risks, particularly in communities relying heavily on bushmeat as a protein source [18].

• Public Health Implications:

The presence of contaminants highlighted additional risks

beyond zoonotic diseases, emphasizing the urgent need for food safety interventions.

Data Analysis

Quantitative Analysis:

Survey and laboratory data were statistically analysed to identify prevalence rates of pathogens, frequency of bushmeat consumption by species, and regional differences. Descriptive and inferential statistics were applied using SPSS and R software.

Qualitative Analysis:

Thematic analysis was performed on interview transcripts to explore cultural, economic, and awareness factors influencing bushmeat consumption.

Geographic Information System (GIS) Mapping:

GIS was used to map the spatial distribution of bushmeat trade routes, zoonotic disease hotspots, and wildlife habitat encroachment in study regions.

Ethical Considerations

Ethical approval was obtained from institutional review boards in each participating country. Informed consent was secured from all human participants, and wildlife sampling adhered to conservation guidelines to minimize ecological disturbance.

Validation and Triangulation

Findings from different methods were cross-validated to ensure consistency and reliability. For example, laboratory results were compared with health records, and stakeholder interviews were aligned with market observations.

Outcomes and Reporting

The study aims to provide a comprehensive assessment of the public health risks and ecological impacts of bushmeat consumption across Africa. Findings will be disseminated through research publications, stakeholder workshops, and policy briefs to inform One Health interventions and conservation strategies.

Key Question	Response Category	Percentage (%)	Total Respondents (N)
Most in demand bushmeat species	Primates	40	150
	Duikers	30	
	Bats	20	
	Others	10	
Awareness of regulations in trade	Yes	70	150
	No	30	1
Educating customers on risk	Yes	20	150
	No	80	

Table 1: Type of Wildlife (Bushmeat) Trade

Analysis of Wildlife (Bushmeat) Trade Practices and Perceptions

Table 1 provides insights into the types of bushmeat traded, awareness of trade regulations, and the extent of customer education on associated risks. These findings highlight significant trends and gaps in the bushmeat trade that warrant attention for public health and wildlife

conservation initiatives.

Most in Demand Bushmeat Species

• Primates (40%):

Primates emerged as the most sought-after bushmeat species, comprising 40% of total preferences. This demand can be attributed to cultural beliefs, culinary preferences,

and the high perceived nutritional value of primate meat in many African communities [19]. However, hunting and consumption of primates significantly increase the risk of zoonotic disease transmission, particularly for viruses such as Ebola and HIV [9].

• Duikers (30%):

Duikers, small antelopes, ranked second in preference. Their high demand is likely due to their abundance in certain forest regions and the perception of their meat as a delicacy [8].

• Bats (20%):

Despite comprising only 20% of the demand, bats are a significant concern due to their role as reservoirs for zoonotic viruses like Ebola and Marburg. Cultural practices involving bat consumption, especially in regions with frequent zoonotic outbreaks, highlight the need for targeted public health interventions [20].

• Others (10%):

This category includes less commonly traded species, such as rodents and reptiles. Although these species are not as widely consumed, they still pose zoonotic risks and require monitoring.

Awareness of Regulations in Trade

• Yes (70%):

A significant majority (70%) of respondents were aware of regulations governing bushmeat trade. However, awareness does not necessarily translate into compliance, as weak enforcement and economic pressures often drive illegal hunting and trading practices [21].

• No (30%):

The remaining 30% indicated no awareness of existing regulations. This gap suggests the need for improved communication strategies to educate stakeholders about

the legal and health implications of unregulated bushmeat trade.

Educating Customers on Risk

• Yes (20%):

Only 20% of traders reported educating customers about the health risks associated with bushmeat consumption. This limited engagement could stem from a lack of knowledge among traders themselves or fear of discouraging buyers [22].

• No (80%):

The overwhelming majority (80%) of traders did not provide any risk education. This neglect leaves consumers unaware of the potential dangers, such as zoonotic diseases and exposure to contaminants, highlighting an urgent need for targeted educational campaigns.

Discussion

The findings underscore several critical issues in the bushmeat trade:

> **High Demand for High-Risk Species:** The preference for species like primates and bats amplifies the risk of zoonotic spillover events, which can have catastrophic public health consequences [9].

Regulatory Awareness and Compliance: While awareness of regulations is relatively high, practical barriers such as enforcement deficiencies and economic dependency on bushmeat trade hinder effective compliance [19].

Lack of Risk Education: The low rate of risk education among traders exacerbates public health vulnerabilities, emphasizing the need for capacity-building programs targeting bushmeat stakeholders.

Key Question	Response Category	Percentage (%)	Total Respondents (N)
Frequency of bushmeat consumption	Weekly	50	300
	Monthly	30	
	Rarely	20	
Awareness of health risks	Aware	65	300
	Not aware	35	
Willness to switch to alternative	Yes	60	300
protein sources	No	40	

Table 2: Response of respondent according to consumer choice

Analysis of Consumer Choices Regarding Bushmeat Consumption

Table 2 explores consumer preferences and attitudes toward bushmeat consumption, awareness of associated health risks, and willingness to switch to alternative protein sources. This analysis provides valuable insights into the behavioral and attitudinal factors driving bushmeat demand and informs interventions aimed at mitigating its associated risks.

Frequency of Bushmeat Consumption

• Weekly (50%):

Half of the respondents consume bushmeat weekly, indicating its significant role in their diet. Regular consumption is often driven by cultural traditions, perceived

taste preferences, and limited access to alternative protein sources, particularly in rural and low-income areas [19]. The high frequency of consumption poses substantial public health concerns due to the risk of zoonotic disease transmission, especially in regions with high wildlifehuman interaction [22].

• Monthly (30%):

Approximately 30% of respondents reported consuming bushmeat monthly, suggesting that for some, bushmeat may serve as a supplementary protein source rather than a staple. This group might represent urban dwellers or individuals with access to a more diverse diet [23].

• Rarely (20%):

The remaining 20% rarely consume bushmeat, possibly due to ethical concerns, health awareness, or preference

for alternative protein sources. This demographic could be targeted for advocacy and education campaigns promoting sustainable dietary choices.

Awareness of Health Risks

• Aware (65%):

A majority (65%) of respondents were aware of the health risks associated with bushmeat consumption. This awareness likely stems from ongoing public health campaigns, as well as community experiences with zoonotic disease outbreaks like Ebola and monkeypox [9]. However, awareness does not necessarily deter consumption, as economic and cultural factors often outweigh health concerns [20].

• Not Aware (35%):

A notable 35% of respondents lacked awareness of the health risks. This highlights the need for enhanced outreach and education initiatives, particularly in rural and marginalized communities where bushmeat consumption is highest [8].

Willingness to Switch to Alternative Protein Sources • Yes (60%):

A significant proportion (60%) of respondents expressed willingness to switch to alternative protein sources. This

suggests an opportunity to promote sustainable and safer protein options, such as poultry, fish, or plant-based proteins. Incentives, affordability, and cultural sensitivity are crucial to achieving this transition [21].

• No (40%):

Conversely, 40% of respondents were unwilling to switch, indicating a strong attachment to bushmeat consumption. This resistance could be rooted in cultural identity, lack of affordable alternatives, or distrust of new food sources [22]. Addressing these barriers is essential for reducing dependence on bushmeat.

Discussion

The data reveal critical aspects of bushmeat consumption patterns:

High Consumption Frequency: Regular bushmeat consumption underscores its role in local diets, but also highlights the associated zoonotic risks and ecological impacts.

> **Moderate Risk Awareness:** While a majority are aware of health risks, gaps in knowledge persist, particularly regarding specific zoonotic diseases [20].

> **Potential for Dietary Transition:** The significant willingness to adopt alternative protein sources provides a pathway for reducing bushmeat reliance.

Key Question	Response category	Percentage(%)	Total Respondents (N)
Perceived effectiveness of regulations	Effective	20	50
	Ineffective	80	
Public health campaigns for	Sufficient	25	50
education	Insufficient	75	

Table 3: Respondents Base on Policymakers

Analysis of Policymakers' Perspectives on Bushmeat Regulation and Public Health Campaigns

Table 3 provides insights into the opinions of policymakers regarding the effectiveness of current regulations on bushmeat trade and the adequacy of public health campaigns for educating the public. Policymakers play a crucial role in shaping interventions that balance the socioeconomic importance of bushmeat with its ecological and public health impacts.

Perceived Effectiveness of Regulations

• Effective (20%):

Only 20% of respondents considered existing regulations on bushmeat trade to be effective. These policymakers may believe that the current frameworks have successfully deterred illegal hunting and trade in specific areas, possibly due to localized enforcement or community engagement efforts. For instance, targeted measures such as antipoaching patrols and penalties for violations can show localized success [24].

• Ineffective (80%):

A vast majority (80%) viewed the regulations as ineffective, reflecting widespread challenges in implementation and enforcement. Issues such as lack of resources, corruption, weak legal frameworks, and the socio-cultural significance of bushmeat contribute to regulatory failures [25]. Additionally, informal and underground bushmeat markets often bypass official oversight, exacerbating the issue. This highlights the need for comprehensive policy reforms and enhanced enforcement mechanisms.

Public Health Campaigns for Education • Sufficient (25%):

About 25% of policymakers believed that public health campaigns were sufficient. This minority likely points to specific initiatives that have succeeded in raising awareness about zoonotic diseases and hygiene practices. For example, Ebola-related public health campaigns in West Africa were instrumental in educating communities about disease prevention [26].

• Insufficient (75%):

A significant 75% indicated that public health campaigns were insufficient. This underscores gaps in outreach, funding, and localized content. In many regions, limited access to mass media and literacy barriers hinder the effectiveness of traditional awareness methods. Furthermore, campaigns may lack cultural sensitivity, reducing their resonance with target audiences [9].

Discussion

The data reflect critical shortcomings in both regulation and public health education:

> Regulatory Challenges:

The perceived ineffectiveness of regulations points to systemic issues such as poor governance, lack of enforcement personnel, and the high demand for bushmeat as an affordable protein source. Addressing these challenges requires integrated approaches, such as engaging local communities in co-management of wildlife resources and providing economic alternatives [21].

> Educational Gaps:

The inadequacy of public health campaigns highlights the need for innovative strategies, such as utilizing local languages, incorporating traditional knowledge, and leveraging digital platforms for dissemination. Ensuring that health education aligns with cultural values is essential for its success [22].

Recommendations

• Strengthening Enforcement Mechanisms:

Governments should allocate more resources to wildlife

protection agencies, train enforcement personnel, and enhance monitoring systems. Community-based approaches can complement these efforts by involving locals in conservation and anti-poaching activities.

• Enhancing Public Health Campaigns:

Public health education must be context-specific, using relatable narratives to convey risks associated with bushmeat consumption. Collaborations with local leaders, NGOs, and media outlets can amplify these messages.

• Policy Reforms:

Policymakers should review existing legal frameworks, ensuring they are robust and adaptable. Incentives for sustainable practices, such as promoting alternative livelihoods, can reduce dependency on bushmeat.

Key Question	Response Category	Percentage (%)	Total Respondents (N)
Zoonotic disease case linked to bushmeat	Yes	70	100
	No	30	
Educating patients about risks	Yes	50	
	No	50	100
Pertnerships for zoonotics disease monitoring	Exist	40	
	Do not exist	60	100



Health Workers' Perspectives on Zoonotic Disease Management Linked to Bushmeat

Table 4 illustrates the perspectives of health workers regarding zoonotic diseases associated with bushmeat, patient education about associated risks, and partnerships for disease monitoring. Health workers play a pivotal role in addressing zoonotic diseases by identifying cases, educating patients, and collaborating in monitoring and response efforts.

Zoonotic Disease Cases Linked to Bushmeat

• Yes (70%):

Seventy percent of respondents reported encountering zoonotic disease cases linked to bushmeat consumption. Common zoonotic diseases associated with bushmeat include Ebola, Lassa fever, and monkeypox, which are prevalent in regions with high bushmeat hunting and consumption [9]. Health workers frequently observe symptoms related to these diseases in patients, particularly in areas near wildlife habitats where human-animal interactions are high.

• No (30%):

Thirty percent indicated they had not encountered such cases. This disparity may reflect geographical differences in disease prevalence, diagnostic capacity, or underreporting of zoonotic diseases in health facilities [27].

Educating Patients About Risks

• Yes (50%):

Half of the health workers reported actively educating patients about the risks associated with bushmeat consumption. Effective education involves raising awareness of zoonotic disease transmission and promoting safe handling and cooking practices. However, limited resources and time constraints often hinder such efforts. Campaigns targeting patients in clinical settings could reinforce this critical role.

• No (50%):

The other 50% indicated they do not educate patients about the risks. This gap may stem from a lack of training on zoonotic diseases or inadequate materials for public health communication. Integrating zoonotic disease awareness into routine health services could address this shortfall [28].

Partnerships for Zoonotic Disease MonitoringExist (40%):

Only 40% of respondents acknowledged the existence of partnerships for zoonotic disease monitoring. Collaborative efforts, such as One Health initiatives, are essential for integrating human, animal, and environmental health data. Such partnerships can enable early detection and response to zoonotic disease outbreaks [29].

• Do Not Exist (60%):

A significant 60% stated that partnerships do not exist in their regions. This highlights gaps in multi-sectoral collaboration, often due to limited funding, unclear roles, or weak institutional frameworks. Strengthening partnerships among health sectors, veterinary services, and environmental agencies is critical to addressing this issue [27].

Discussion

The findings highlight several challenges in managing zoonotic diseases linked to bushmeat: > High Disease Prevalence:

High Disease Prevalence

The high proportion of zoonotic cases emphasizes the need for robust surveillance systems to identify and track outbreaks. Early detection can prevent the escalation of diseases into epidemics [9].

> Educational Deficit:

The equal split in patient education underscores inconsistent efforts to raise awareness. Training health workers on zoonotic disease risks and developing culturally appropriate educational materials are essential steps to bridge this gap.

> Weak Partnerships:

The lack of widespread partnerships points to systemic weaknesses in zoonotic disease monitoring. Investing in One Health programs and fostering cross-sectoral collaboration can enhance surveillance and response capacity [28].

Recommendations

• Strengthen Surveillance Systems:

Enhance diagnostic capacities at local health facilities and establish integrated reporting mechanisms to improve data collection on zoonotic diseases.

• Health Worker Training:

Incorporate zoonotic disease education into health worker training programs and provide continuous professional development opportunities.

• Foster Partnerships:

Promote partnerships between public health, veterinary, and environmental agencies through One Health frameworks to improve zoonotic disease monitoring and response.

Stakeholder Group	Key Question	Response Category	Percentage (%)	Total Respondents (N)
Hunters	Target animals for bushmeat	Antelopes and cane rats	45	200
		Primates	30	
		Bats	15	
		Others(Rodents, carnivores)	10	
	Hunting methodes used	Traps	50	200
		Guns	40	
S h o		Snare	10	
	Sign of illness in hunted animals observed	Yes	60	200
		No	40	

Table 5: Stakeholders Engagement (Bushmeat) Trade

Stakeholder Engagement in Bushmeat Trade: Hunters' Perspectives

Table 5 explores the role of hunters in the bushmeat trade, focusing on targeted animals, hunting methods, and observations of illness in hunted animals. Hunters are a critical stakeholder group, as their practices significantly influence the supply chain, zoonotic disease risks, and the sustainability of wildlife populations.

Target Animals for Bushmeat

• Antelopes and Cane Rats (45%):

Antelopes and cane rats were the most commonly targeted species, comprising 45% of responses. These species are often preferred for their perceived palatability, availability, and cultural significance in regions where bushmeat consumption is prevalent [30].

• Primates (30%):

Primates, targeted by 30% of hunters, are particularly concerning due to their close genetic similarity to humans, which increases the likelihood of zoonotic disease transmission [1]. Diseases like Ebola and monkeypox are closely linked to the handling and consumption of primates. • Bats (15%):

Bats, making up 15%, are another high-risk group, as they are known reservoirs for several zoonotic viruses, including

filoviruses and coronaviruses [31].

• Other Animals (10%):

The remaining 10% included rodents and small carnivores, which also pose public health risks due to their potential to harbor zoonotic pathogens like leptospirosis and hantaviruses [32].

Hunting Methods Used

• Traps (50%):

Traps are the most widely used hunting method, accounting for 50% of responses. Trapping is often considered cost-effective and requires minimal technical expertise. However, it may result in prolonged suffering and unintended capture of non-target species, raising ethical and biodiversity concerns [33].

• Guns (40%):

Guns, used by 40% of hunters, enable selective hunting but pose challenges such as overharvesting and the potential for unregulated firearm use [34].

• Snares (10%):

Snares, employed by 10%, are less prevalent but are associated with significant risks to biodiversity as they indiscriminately capture animals, including endangered species [24].

Observations of Illness in Hunted Animals • Yes (60%):

Sixty percent of hunters reported observing signs of illness in the animals they hunted. This is a critical public health concern, as handling or consuming sick animals increases the risk of zoonotic disease transmission. Hunters often lack training to recognize disease symptoms, which can lead to the spread of pathogens to humans through direct contact or foodborne routes [35].

• No (40%):

The remaining 40% did not observe signs of illness, either due to a lack of noticeable symptoms or limited understanding of what constitutes signs of disease. This highlights the need for education and training programs to improve disease recognition among hunters.

Discussion

The findings emphasize the complexity of hunting practices in the bushmeat trade and their implications for public health and conservation:

> Zoonotic Disease Risks:

Targeting high-risk species like primates and bats underlines the urgent need for awareness campaigns and regulation to reduce human exposure to zoonotic pathogens [1].

> Sustainable Practices:

The dominance of traps and guns in hunting methods raises concerns about sustainability and biodiversity conservation. Promoting alternative livelihoods could reduce hunting pressure on wildlife [24].

> Illness Recognition:

Training hunters to identify signs of illness in wildlife could serve as an early warning system for zoonotic disease outbreaks, integrating them into broader One Health surveillance systems [35,36].

Recommendations

• Training and Education:

Provide training for hunters on identifying signs of disease and safe handling practices to minimize zoonotic disease risks.

• Regulatory Frameworks:

Implement and enforce hunting regulations to limit the capture of high-risk species and ensure the sustainable use of wildlife resources.

• Alternative Livelihoods:

Develop community-based programs to offer alternative income-generating opportunities, reducing reliance on bushmeat hunting.

Recommendations

• **Strengthen Enforcement Mechanisms:** Enhanced monitoring and enforcement of wildlife trade regulations can help curb illegal activities and reduce the risk of zoonotic disease transmission.

• **Community-Based Education Programs:** Tailored outreach programs focusing on the health risks of bushmeat consumption and sustainable alternatives can empower communities to make safer choices.

• **Policy Integration:** Coordinating public health, wildlife conservation, and law enforcement efforts under a unified policy framework can address the interconnected challenges of bushmeat trade.

Recommendations

• **Public Awareness Campaigns:** Strengthen educational efforts to raise awareness of the risks linked to bushmeat consumption, emphasizing personal and public health impacts.

• **Promotion of Alternatives:** Develop and subsidize accessible alternative protein sources to make them economically and culturally viable substitutes.

• **Community Engagement:** Collaborate with local leaders and stakeholders to address cultural preferences and ensure acceptance of new dietary practices.

Declaration

Declaration of Ethical Compliance:

All authors of this manuscript have thoroughly read, understood, and fully complied with the ethical guidelines outlined in the "Ethical Responsibilities of Authors" as presented in the Instructions for Authors. We affirm that the research and content of this paper adhere to the highest standards of integrity, ensuring that all applicable ethical principles are observed and upheld.

Ethics approval and consent to participate

The study received ethics approval (approval number MLF/2024/022) from the Committee on Animal Use and Care of the Ministry of Livestock and Fisheries in Niger State, Nigeria. Prior to sample collection, the researchers obtained informed consent from the farm managers overseeing the study site. The consent form clearly explained the study details and potential benefits. The farm managers voluntarily signed the form, agreeing to participate.

Not applicable

Availability of data and materials

All relevant data for the study is within the paper and also available as supporting information.

Competing interests

The authors have declared that there are no competing interests.

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The authors did not receive any specific funding for this research.

Authors' contributions

The research project was a collaborative effort involving several authors who made important contributions at different stages. Hussaini A. Makun and Hadiza M. Lami were responsible for the initial conception and design of the study. They played a key role in shaping the overall research approach and objectives. Adama Y. John, Micheal O. Mecheal, Evuti H. Aliyu, and Nma A. Bida served as the principal investigators. They designed the data collection tools, carried out the data gathering process, and conducted the analysis and interpretation of the results. Monday O. Micheal and Nma A. Bida provided oversight and supervision for the laboratory aspects of the research. Evuti H. Aliyu and Nma A. Bida took the lead in drafting the initial version of the manuscript. Hussaini A. Makun, Hadiza M. Lami, Adama Y. John, and Nma A. Bida then carefully reviewed and revised the article,

providing important intellectual input and suggestions to strengthen the final paper. All authors read and approved the completed manuscript prior to submission, ensuring consensus on the content and findings presented. This collaborative effort, with each author contributing their expertise at different stages, was crucial to the successful execution and reporting of this research project.

Consent to Publish

I, Dr Haruna Evuti Aliyu, the corresponding author of the manuscript titled "Bushmeat Consumption in Africa: A One Health Perspective on Public Health Risks and Stakeholder Insights," hereby grant permission to the Journal of Public Health and Epidemiology: Open Access to publish our research work. I confirm that: All authors have contributed to the research and manuscript preparation and have approved its submission for publication. The manuscript is original and has not been published elsewhere, nor is it under consideration by any other journal. We have disclosed any potential conflicts of interest and have adhered to ethical guidelines in conducting our research. We are aware that upon acceptance, our work may be published in any format deemed appropriate by the journal.

Thank you for considering our manuscript for publication. We look forward to your response.

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References

- 1. Wolfe, N. D., Daszak, P., Kilpatrick, A. M., & Burke, D. S. (2005). Bushmeat hunting, deforestation, and prediction of zoonotic disease. *Emerging infectious diseases*, *11*(12), 1822.
- Karesh, W. B., Dobson, A., Lloyd-Smith, J. O., Lubroth, J., Dixon, M. A., Bennett, M., ... & Heymann, D. L. (2012). Ecology of zoonoses: natural and unnatural histories. *The Lancet*, *380*(9857), 1936-1945.

- Leroy, E. M., Rouquet, P., Formenty, P., Souquiere, S., Kilbourne, A., Froment, J. M., ... & Rollin, P. E. (2004). Multiple Ebola virus transmission events and rapid decline of central African wildlife. *Science*, *303*(5656), 387-390.
- Jones, K. E., Patel, N. G., Levy, M. A., Storeygard, A., Balk, D., Gittleman, J. L., & Daszak, P. (2008). Global trends in emerging infectious diseases. *Nature*, 451(7181), 990-993.
- Daszak, P., Cunningham, A. A., & Hyatt, A. D. (2000). Emerging infectious diseases of wildlife--threats to biodiversity and human health. *science*, 287(5452), 443-449.
- Fa, J. E., Peres, C. A., & Meeuwig, J. (2002). Bushmeat exploitation in tropical forests: an intercontinental comparison. *Conservation biology*, *16*(1), 232-237.
- Okiwelu, S. N., Ewurum, N., & Noutcha, M. A. (2009). Wildlife harvest in Nigeria: socio-economic benefits of bushmeat in the Niger Delta. *Human Ecology*, *37*(5), 621–630.
- Lindsey, P. A., Balme, G., Becker, M., Begg, C., Bento, C., Bocchino, C., ... & Zisadza-Gandiwa, P. (2013). The bushmeat trade in African savannas: Impacts, drivers, and possible solutions. *Biological conservation*, *160*, 80-96.
- LeBreton, M., Prosser, A. T., Tamoufe, U., Sateren, W., Mpoudi-Ngole, E., Diffo, J. L. D., ... & Wolfe, N. D. (2006). Patterns of bushmeat hunting and perceptions of disease risk among central African communities. *Animal Conservation*, 9(4), 357-363.
- Bonwitt, J., Sáez, A. M., Lamin, J., Ansumana, R., Dawson, M., Buanie, J., ... & Brown, H. (2017). At home with Mastomys and Rattus: human-rodent interactions and potential for primary transmission of Lassa virus in domestic spaces. *The American journal of tropical medicine and hygiene*, 96(4), 935.
- 11. Coad, L., Fa, J. E., Abernethy, K., Van Vliet, N., Santamaria, C., Wilkie, D., ... & Nasi, R. (2019). *Towards a sustainable, participatory and inclusive wild meat sector*. CIFOR.
- Leroy, E. M., Epelboin, A., Mondonge, V., Pourrut, X., Gonzalez, J. P., Muyembe-Tamfum, J. J., & Formenty, P. (2009). Human Ebola outbreak resulting from direct exposure to fruit bats in Luebo, Democratic Republic of Congo, 2007. *Vector-borne and zoonotic diseases*, 9(6), 723-728.
- Turner, W. C., Kausrud, K. L., Krishnappa, Y. S., Cromsigt, J. P., Ganz, H. H., Mapaure, I., ... & Stenseth, N. C. (2014). Fatal attraction: vegetation responses to nutrient inputs attract herbivores to infectious anthrax carcass sites. *Proceedings of the Royal Society B: Biological Sciences, 281*(1795), 20141785.
- 14. Wang, L. F., & Anderson, D. E. (2019). Viruses in bats and potential spillover to animals and humans. *Current opinion in virology*, *34*, 79-89.
- Carrasco, E., Morales-Rueda, A., & García-Gimeno, R. M. (2012). Cross-contamination and recontamination by Salmonella in foods: A review. *Food Research International*, 45(2), 545-556.
- 16. Simarro, P. P., Franco, J. R., Cecchi, G., Paone, M., Diarra, A., Ruiz Postigo, J. A., & Jannin, J. G. (2012). Human African trypanosomiasis in non-endemic

countries (2000–2010). *Journal of Travel Medicine*, *19*(1), 44-53.

- 17. Dubey, J. P. (2016). *Toxoplasmosis of animals and humans*. CRC press.
- Carrizo, D., Bravi, M., et al. (2017). Pesticide residues in food and public health concerns. *Environmental Research and Public Health Journal*, 14(5), 487–499.
- 19. Wilkie, D. S., & Carpenter, J. F. (1999). Bushmeat hunting in the Congo Basin: an assessment of impacts and options for mitigation. *Biodiversity & Conservation*, *8*, 927-955.
- Hayman, D. T., Yu, M., Crameri, G., Wang, L. F., Suu-Ire, R., Wood, J. L., & Cunningham, A. A. (2012). Ebola virus antibodies in fruit bats, Ghana, West Africa. *Emerging infectious diseases*, 18(7), 1207.
- 21. Bowen-Jones, E., Brown, D., & Robinson, E. J. (2003). Economic commodity or environmental crisis? An interdisciplinary approach to analysing the bushmeat trade in central and west Africa. *Area*, *35*(4), 390-402.
- Brashares, J. S., Arcese, P., Sam, M. K., Coppolillo, P. B., Sinclair, A. R., & Balmford, A. (2004). Bushmeat hunting, wildlife declines, and fish supply in West Africa. *Science*, *306*(5699), 1180-1183.
- 23. Nasi, R., Taber, A., & Van Vliet, N. (2011). Empty forests, empty stomachs? Bushmeat and livelihoods in the Congo and Amazon Basins. *International Forestry Review*, *13*(3), 355-368.
- Lindsey, P. A., Balme, G., Becker, M., Begg, C., Bento, C., Bocchino, C., ... & Zisadza-Gandiwa, P. (2013). The bushmeat trade in African savannas: Impacts, drivers, and possible solutions. *Biological conservation*, *160*, 80-96.
- 25. Bennett, B. C. (2001). Hunting for Sustainability in Tropical Forests.
- 26. Gostin, L. O. (2015). World health organization reform:

lessons learned from the Ebola epidemic. *Hastings Center Report*, *45*(2), 6-7.

- 27. Grace, D., Mutua, F. K., Ochungo, P., Kruska, R. L., Jones, K., Brierley, L., ... & Ogutu, F. (2012). Mapping of poverty and likely zoonoses hotspots.
- 28. Zinsstag, J., Schelling, E., Crump, L., Whittaker, M., Tanner, M., & Stephen, C. (Eds.). (2021). *One Health: the theory and practice of integrated health approaches*. CABI.
- 29. World Health Organization. (2019). *Taking a multisectoral one health approach: a tripartite guide to addressing zoonotic diseases in countries*. Food & Agriculture Org.
- Fa, J. E., Peres, C. A., & Meeuwig, J. (2002). Bushmeat exploitation in tropical forests: an intercontinental comparison. *Conservation biology*, 16(1), 232-237.
- Hayman, D. T., Yu, M., Crameri, G., Wang, L. F., Suu-Ire, R., Wood, J. L., & Cunningham, A. A. (2012). Ebola virus antibodies in fruit bats, Ghana, West Africa. *Emerging infectious diseases*, 18(7), 1207.
- 32. Meerburg, B. G., Singleton, G. R., & Kijlstra, A. (2009). Rodent-borne diseases and their risks for public health. *Critical reviews in microbiology*, *35*(3), 221-270.
- Noss, A. J. (1998). The impacts of cable snare hunting on wildlife populations in the forests of the Central African Republic. *Conservation biology*, 12(2), 390-398.
- Robinson, J. G., & Bennett, E. L. (2004). Having Your Wildlife and Eating It Too: An Analysis of Hunting Sustainability Across Tropical Ecosystems. *Animal Conservation*, 7(4), 397–408.
- Karesh, W. B., Cook, R. A., Bennett, E. L., & Newcomb, J. (2005). Wildlife trade and global disease emergence. *Emerging infectious diseases*, 11(7), 1000.
- 36. World Health Organization. (2021). *Zoonotic Disease Awareness and Education Campaigns*.