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Review

A Review of the Literature on the Environmental and Health Impact of Plastic Waste Pollutants in Sub-Saharan Africa

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Abstract: The discovery of plastic by humankind is fast becoming a challenge as the end-of-life disposal of plastic continues to be a discourse on the global platform. This discussion results from several findings that the additives in plastic distress both land and marine life by contributing to organic pollutants when the plastic waste is disposed of improperly. With a growing population in sub-Saharan Africa, managing waste generally, and plastic waste, in particular, represents a continuous challenge. With only between 15–25% of its plastic waste recycled, the larger proportion of waste is either burnt openly or disposed of in open spaces or landfills, where the additives pollute the environment. Moreover, some of the waste finds its way into waterways through estuaries into global water networks and continues to cause harm to man through the food chain. This article examines the literature to highlight the environmental and health impact of plastic waste pollution in sub-Saharan Africa, and it proposes mitigation strategies to reduce the critical consequences of plastic waste pollution.

Keywords: plastic waste; pollution; environment and health; sub-Saharan Africa

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1. Background

The phrase plastic is derived from the Greek term *plastikos*, which indicates a material or element that can keep its form in a variety of applications [1]. Plastic, an extract and byproduct of coal, petroleum, and natural gas, is made up of long-chain polymer molecules, and no less than 43% of their end-of-life either gets burnt openly or ends up in landfills or the oceans [2]. Researchers, such as [3–5] and others, have indicated that plastic may take up to 500 years to degrade due to its lethal additives. Despite this challenge, plastic consumption continues to increase annually by at least 5%, with an annual global production hitting 150 million tons [6]. Moreover, the additive in plastic affects the ecosystem and humans when end-of-life plastics are contaminated and disposed of, thereby contributing persistently to organic pollutants [7]. Furthermore, because many of these additives are hydrophobic, they can contaminate marine life when they find their way into them [8].

Africa is home to several aquatic habitats, such as the Congo, Niger, Nile rivers, the Great Lakes, and Lake Chad, with estuaries into international water networks [9]. Meanwhile, the region is regarded as a leading contributor to the largescale plastic pollution of marine systems, with Egypt, Algeria, Nigeria, South Africa, and Algeria ranking seventh, ninth, eleventh, and thirteenth in a global ranking of 192 countries in plastic waste generation, respectively [10]. Adam [11] contends that the African state may continue to worsen global plastic pollution, as most regions appear to lack major institutionalized plastic methods and techniques. Figure 1 presents an overview of the plastic waste emitted into the oceans via rivers [12].

Although plastics have substantial benefits over other materials in terms of durability, weight, and low-cost manufacturing [13], the additive it contains comprises numerous

toxic chemicals that can dissipate in the form of microplastic pollutants, which can cause severe respiratory ailments and other health and environmental issues [14]. The presence of microplastics in the ecosystem is an indication of the rapid and continuous increase in the production of plastic and the mishandling of plastic waste, while several processes, including domestic waste disposal, maritime activities, drainage, agricultural runoff, etc., contribute to its pollution of the environment [15]. Furthermore, humans are constantly exposed to microplastics through inhalation, ingestion, and skin contact, and the toxic substance of the microplastic can cause oxidative stress and inflammation, which can lead to immune function disruption, neoplasia, increased particle translocation, and neurotoxicity [16]. Dioxins, for example, are fatal organic pollutants produced by plastic polymers that impair the development of the reproductive system, induce neurological damage, and cause cancer [17]. However, reference [18] posited that definitive evidence linking microplastic consumption to human health is currently lacking, and further research and more rigorous clinical studies are required to explore the potential implications of the microplastic contaminant in our health and environment.

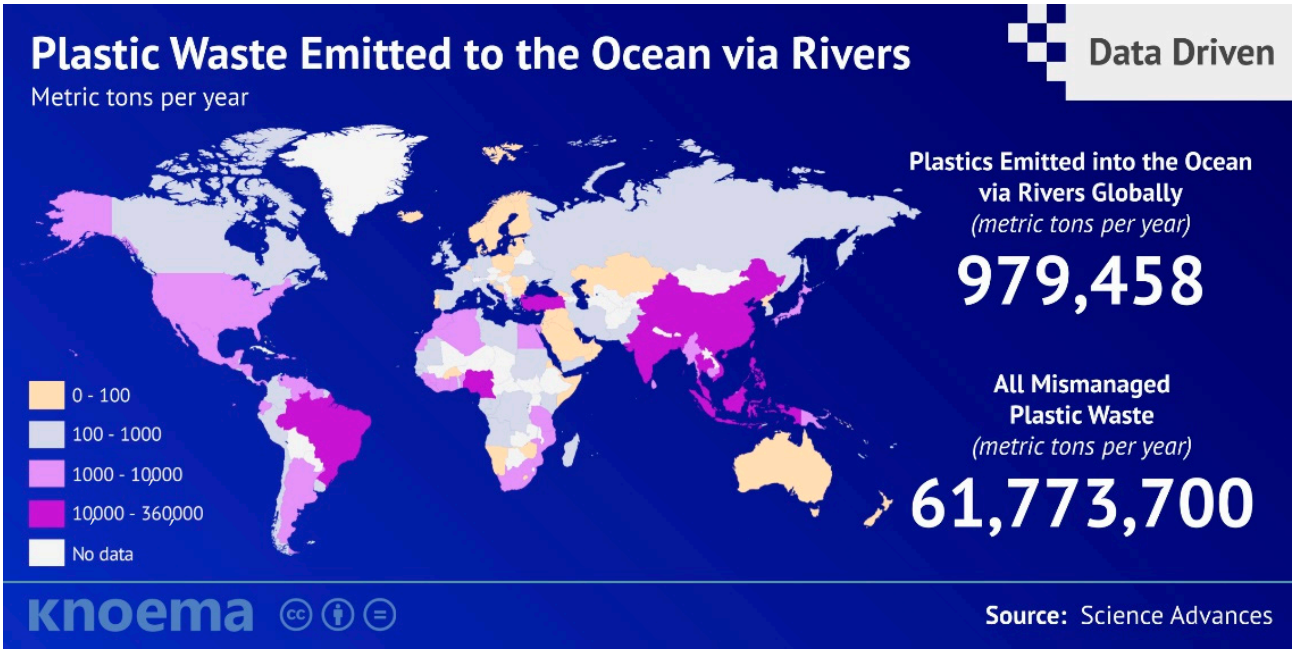

Figure 1. Plastic waste emitted into the oceans via rivers in tons per annum [12].

While African states also manufacture plastic polymers for a variety of human uses, Europe, China, and North America are the primary donors to the surge in global plastic production [19]. Babayemi [20] listed various applications, including water bottles, containers, trash cans, washing basins, plastic cutlery, plates, kitchen utensils, baskets, furniture, toys, clothes, flip flops, and medical devices. Cotta [21] further indicated that many African states are the target for most manufactured plastic products from industrialized countries via finished goods importation.

The different types, properties, common uses, and impact of plastics are presented in Table 1. With rapid economic growth and global technological advancement, plastic production continues unabated and, subsequently, the growth in accrual pollutants [22].

Table 1. Types, properties, and common uses of plastic and the impact of its pollutants.

Types and Properties	Common Uses	Health Impact	Environmental Impact
1 PETE Polyethylene terephthalates Clear, tough, solvent tolerant, an obstruction to moisture and gas softens at 80 °C	Water and soft drinks bottles, salad dressing and domes, containers, and biscuit trays	Causes carcinogens, vomiting, and diarrhea [23]	It may act as the conduit of bioavailable metals, including Zn, in the soil ecosystem [24,25]. Not recyclable [26] blocks the soil from breathing, thus disrupting food chain production [27,28]. Exposed microorganisms can potentially keep and transfer to other organisms in the soil ecosystem through the food chain and could be conveyed to deeper soil layers and leached to groundwater [29]. It takes a millennium to degrade [30]
2 HDPE High-density polyethylene (HDPE) Hard to semi-flexible, resilient to chemicals and humidity, opaque, waxy surface, softens at 75 °C, easily colored, processed and formed	Freezer and shopping bags, buckets, shampoo, milk and ice cream containers, chemical and detergent bottles, juice bottles, crates, and rigid agricultural pipe	Stomach ulcers [31], Oxidative stress, neurotoxicity, metabolism disruption [32], toxicity, inflammation [33]	
3 V Polyvinyl chloride (PVC) or Plasticized polyvinylchloride PVC-P Flexible, clear, elastic, strong, tough, softens at 80 °C and can be solvent soldered	Plumbing pipes and fittings, cosmetic containers, electrical conduit, wall cladding, blister packs, roof sheeting, bottles, shoe soles, garden hose, cable sheathing, and tubing and blood bags	Interferes with hormonal development [34], Asthma, extrinsic allergic alveolitis, chronic pneumonia, chronic bronchitis [35], Mood changes, impaired thinking, judgement, coordination, etc. [36]	
4 LDPE Low-density polyethylene (LDPE) Soft, elastic, bendable surface, luminous, scratches easily and softens at 70 °C	Refuse and garbage bags, irrigation tubing, squeeze bottles, straw film, and wrap	Oxidative stress affects cell viability, and Cytotoxicity [37,38]	
5 PP Polypropylene (PP) Translucent, hard, and softens at 140 °C, tolerates solvents, versatile	Garden furniture, Lunch boxes, kettles, microwave dishes, bottles and ice cream tubs, packaging tape, and straws	Cytotoxicity, secretion of cytokines and histamines, Stimulates the immune system, enhances potential hypersensitivity, Cytotoxicity and hemolysis [39], Colon cancer, Low sperm count and male infertility [40,41]	
6 PS Polystyrene (PS) or Expanded Polystyrene (PS) Semi-strong, glassy inflexible clear or opaque substance, softens at 95 °C, affected by fat, acids and solvents, but resistant to salt solutions and alkalis, low water absorption; when not pigmented, it is clear, odor- and taste-free	CD cases, plastic cutlery, imitation glassware, low-cost inelastic toys, video cases, cups, protective packaging, and building and food insulation	Secretion and activation of venous blood [42], Cytotoxicity, chemotaxis, cytokine secretion, phagocytosis, oxidative burst, nitric oxide production, myeloperoxidase [43]; Increase acute inflammation of immune cells, ROS production, cell death of fibroblasts [44], Colon cancer [45] Affects cell viability, uptake, and endocytosis [46]	
7 OTHER Polycarbonate and others: Include all multi-materials and resins properties reliant on plastic or its combination	Appliance and automotive modules, computers, electronics, packaging, etc.	Obesity, cancer, and endocrine problems in fetuses and children [47]	

However, research continues to develop biodegradable plastics that can decompose due to the movement of microbes such as algae and bacteria, and some of these eco-friendly plastics may disintegrate to the point where microbes can completely metabolize them into water and carbon [48]. Meanwhile, traditional plastics are frequently blended with organic elements, making recycling complicated without recourse to costly methods [49].

Serge Kubanza [50] observed that the management of waste is an age-old area of concern; governments in emerging economies are finding it more difficult than ever to achieve real growth in most urban settings. According to Nyathi [51], Rwanda and Tanzania prohibited the importing and use of plastic bags in 2005 and 2006, respectively, while according to [52], Uganda and Kenya passed legislation in 2007 to tax and prohibit thicker and thin bags, respectively. Other sub-Saharan African countries considering legislation prohibiting the use of plastics include Ethiopia, Ghana, and Lesotho, among others [53]. The most widely used compliance tool is the complete and partial prohibition of single-use plastic products, implemented in 34 African countries [54].

Despite the several policies and programs implemented by sub-Saharan African states, insufficient plastic waste disposal practices lead to issues affecting flora and fauna and greatly threatening conservation [55]. The challenge is further worsened by the further disposal threat of the COVID-19 PPE across the African states [56]. Al Qahtani [57] observed that the COVID-19 pandemic brought about a huge surge in demand for plastic personal protective equipment to prevent its transmission and the disposal of this equipment became a key environmental issue due to the huge plastic footprints hampering the environment and public health (See Figure 2).

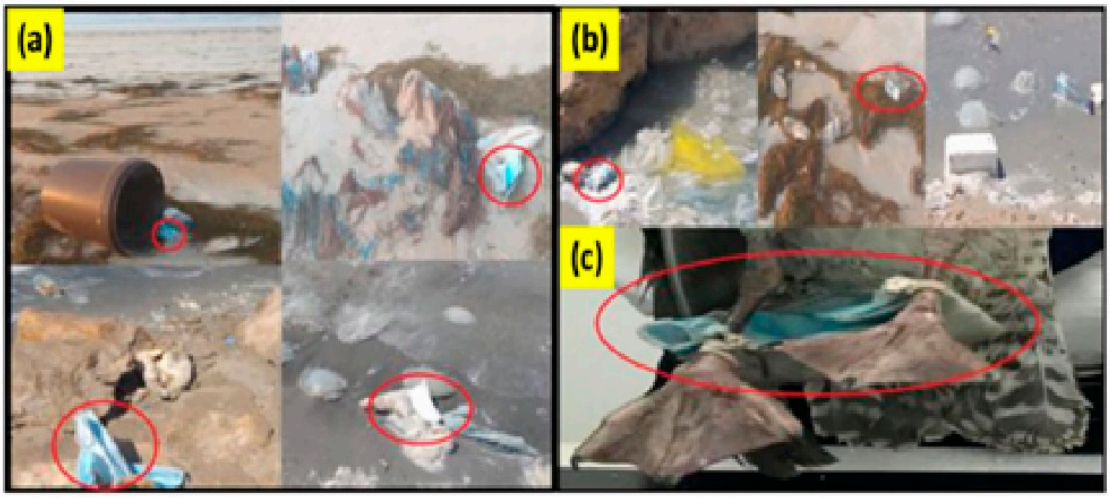

Figure 2. Adverse effects of COVID-19 PPE plastic pollution on marine and coastal ecosystems. (**a**) Face masks dotting a beach, (**b**) various plastic types found at a beach. (**c**) Seabirds' feet tangled in face mask cords [57].

Meanwhile, plastic waste makes up the bulk of municipal waste not only in Africa but globally, and it is recorded that approximately 300 million tons per annum are being generated worldwide [58]. Furthermore, it is recorded that the plastic waste generated between 1950 and 2018 equaled 6 billion tons, and less than 15% of this volume was recycled or incinerated [59]. This statistic implies that about 80% of plastic waste is disposed into landfills, which aligns with the position of AWARD [60] that over 90% of South African waste goes into landfills. Meanwhile, Mohale [61] reported on the scarcity of land for the development of landfill sites in many low-income cities and the resultant effect of this, according to [62], is the littering of the environment and the clogging of drainages whenever the wind blows them away from disposal sites.

Moreover, Ferronato [63] indicated that while some of the generated plastic waste is collected, some remains uncollected due to poor waste management infrastructure and irregular collections, which are prevalent in developing countries. Some of these uncollected wastes are sometimes incinerated or openly burnt. Incineration is a widely accepted combustion technique used for solid waste management, and it uses a lot of inert and organic materials, which are complex to degrade when burned [64]. When plastic wastes are burnt, they release noxious gases which contaminate the atmosphere [3], and the

stubborn feature of plastics generates a huge problem in the degradation procedure [65]. The plastic growth in Africa is responsible for this challenge, coupled with inefficient plastic waste management practice [66]. Shahul Hamid [67] argues that, despite these facts, there are suboptimal studies in Africa for global plastic dispersal and large quantities in the ecosystem. With this as a premise, this study seeks to increase awareness of plastic pollution and its impacts on the environment and the health of humans.

This article reviewed the literature on plastic waste pollution and its environmental and health impacts, specifically focusing on Africa. First, the article reviews the plastic pollution literature in Africa, underlining its sources, causes, and consequences before making recommendations, and emphasizes the need for further study.

2. Materials and Methods

The current study is a systematic review of the available literature to integrate any insights on the environmental and health impact of plastic pollutants in sub-Saharan Africa. The goal was accomplished by critically evaluating articles on plastic pollution from sub-Saharan Africa, and comprehensive secondary data were gathered by means of appropriate internet search engines such as PubMed, the Directory of Open Access Journals (DOAJ), Scopus, Cambridge Journal, Google Scholars, Web of Science, Springer Link, ScienceDirect, Policy, and government documents and articles for review. We were able to obtain the relevant information by using appropriate keywords and phrases (such as "plastic waste pollution", "environmental challenges associated with plastic waste pollution", "health issues associated with plastic waste pollution", and "plastic waste pollution") during the information search. Meanwhile, any article that included "plastic waste" or "recycled plastic" was deemed a relevant document, while other sections of the titles were excluded.

Most significantly, the impact of plastic waste pollution in sub-Saharan Africa, the advantages of sustainable plastic waste management, the health and environmental-related challenges associated with plastic waste pollution, and all mitigation measures were thoroughly investigated. In addition, this study considered the relevant documents from 2011 to 2021, totaling over 180 articles, and only 36 published articles were analyzed without considering the other documents and citations. Therefore, this study summarizes the current information by evaluating 36 published articles (See Figure 3).

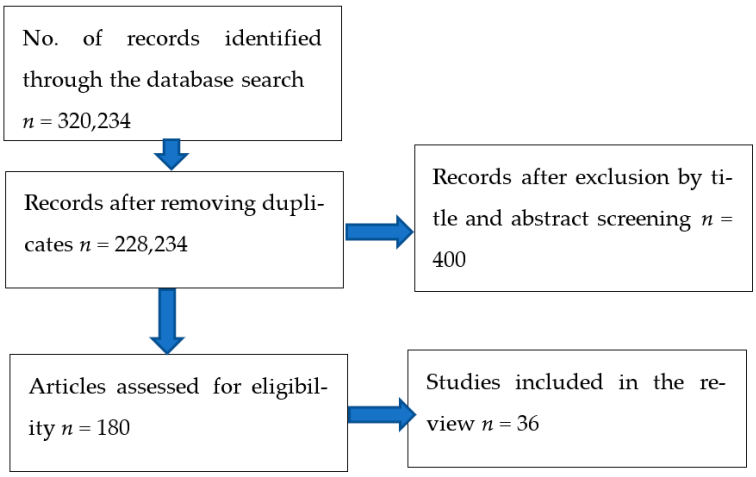

Figure 3. Flow chart of article collection and inclusion.

For the sake of conformity within the scope of a review and to avoid repetition, the identified papers were initially screened by study title for inclusion criteria. The source definition and publication status were then taken into account to exclude nonpeer-reviewed articles. Finally, only papers with full-text were accessed and included after an abstract and full-text screening to ascertain those studies based on plastic pollution in any of the countries in the sub-Saharan African region.

It must be noted that the literature review undertaken was comprehensive but not exhaustive and that while the authors used an extensive range of search engines, it does not mean that we captured every peer-reviewed publication. Thus, many considerable articles may have been omitted.

3. Description of the Study Area

With a population of over 1 billion and a projected population of over 2.2 billion by 2050, SSA comprises 48 countries (see Figure 4), with the fastest global urbanization rate [68]. According to Kaza [68], the volume of waste produced in SSA in 2018 was approximately 180 million metric tons, with a per capita of nearly 0.50 kg/capita/day. Meanwhile, the growth in population and urbanization are not without their challenges (threats to the biodiversity of the ecosystem) [69]. While most SSA countries have poor fiscal development, some researchers have linked this to one of the major contributors to significant waste generation [70]. Lindley [71] highlighted that, in terms of waste management, sub–Saharan Africa is confronted with an assorted set of challenges, which differ in terms of growth regionwide. Some challenges include a lack of a beneficial environment for governance and business, a dearth of skilled waste management personnel and infrastructure, and gender inequalities which all generally contribute to inefficient municipal solid waste management [72]. The slow economic development in the continent ultimately intensifies the poverty level, which is further aggravated by a growing population [73], which consequently affects waste management, as the stakeholders cannot afford strategies in light of dwindling Fiscus [74]. Regarding waste generation across different social income groups, Debrah [72] identified that lower-income earners produce more organics while higher-income earners produce more recyclables and inorganic waste.

Although city growth and waste generation go *pari passu*, the government's attention in developing nations is shifting towards the provision of other amenities which equally need attention [75]. Hence, waste management generally faces a major challenge, especially with the pace of urbanization, which is projected by 2050 to grow from 55% to 68%, more than twice the urban populace in sub-Saharan Africa and South Asia [76]. Despite this, the current quantity of waste produced is more than twice the populace, and the disposal and collection methodologies are suboptimal, leading to health, economic, and environmental concerns [77].

While the data are sparse, a recent study approximates that, apart from that on land, 12.7 million MTs of mishandled plastic waste has the potential to go into the ocean from each of Africa's island and coastal countries [78].

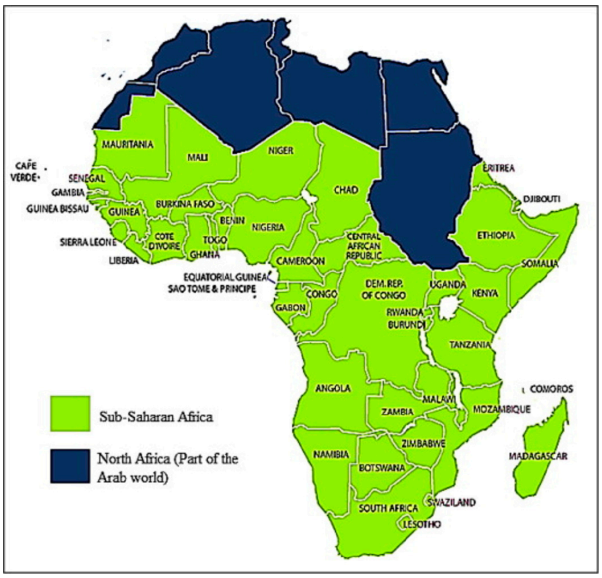

Figure 4. Map of Africa, demarcating Saharan and sub-Saharan Africa [79].

These data give an overview of the danger of plastic waste pollution in the region.

4. The Environmental and Health Impact of Plastic Waste Pollutants in Sub-Saharan Africa

This section discusses the environmental and health effect of plastic waste pollutants in sub-Saharan Africa (as collected from the published literature).

4.1. Environmental Impact of Plastic Waste Pollutants in Sub-Saharan Africa

Global population increase influences plastic waste dispersal, which can inevitably result in environmental contamination [79,80]. This is evidenced by a declining trend in the natural habitat, the morbidity of marine organisms, and the obstruction of drainage facilities, particularly in emerging economies, resulting in breeding places for disease-triggering pathogens, as well as bad smells, decreased water and oxygenation diffusion, and reduced agricultural productivity [81].

Poor waste management practices and obliviousness to the repercussions on human and environmental health are the leading causes of the high degree of plastic pollution in the sub-Saharan African ecosystem [82]. Many countries are experiencing economic hardship, with insufficient systems for solid waste management practices preventing inappropriate waste disposal [83]. In most African countries, illegal waste dumping along major roads, in open grounds, canals, storm drains, and river banks, as well as in unsanitary landfills, are the most prevalent techniques of solid waste management [82,84–88]. The percentage range of plastic materials deposited in most landfills in African states is between 4% and 15% [89].

Studies from several sub-Saharan African countries such as Kenya, Nigeria, Algeria, Mozambique, and Burkina Faso, among others, observed that waste is mostly disposed of in open dumpsites where they are left to aerobically and or anaerobically decompose, thereby emitting greenhouse gases (GHGs), and this is the primary source of anthropogenic releases [85,90–93].

Alemayehu [86] and Woldeyohans [87] observed that the Ethiopian aquifer and surface water pollution from landfill leachate frequently depends on biochemical concentration and composition in the leachate and is further and strongly influenced by waste typology, some of which are plastics. The studies posited that while some pollutants may be adsorbed, the conservative ingredients of the harmful chemicals persist in water and soil long after leachate exodus.

Generally, in South Africa, as soon as most consumer products, such as plastics, electronics, automobile interiors, cushioning foams for furniture, textiles, and other materials, have outlived their useful life, they are discarded into landfills [88]. These products contain polybrominated diphenyl ethers (PBDEs), a flame-retardant element, and studies in the recent past have shown a high rate of PBDEs in leachates from landfills, indicating the broad use and exposure of these composites materials [94].

In Nigerian-populated metropolitan areas, plastic waste materials are chock-full in drainage channels [95] (See Figure 5), thus impeding the free flow of rainwater, resulting in floods causing monumental losses, and potentially becoming a source of water-borne diseases [96,97]. Apart from littering the landscape in Egypt, the authors of [98] observed that 0.25 million tons of plastic waste were disposed into the Mediterranean in 2019, making it the largest contributor to plastic waste in this marine system.

Consequently, many water bodies and landscapes are littered with different sizes and shapes of plastic debris [48,99]. Furthermore, the lack of potable water in many African homes also generates plastic pollution, as residents resort to purchasing drinking water in packaged plastic containers [100].

Ayeleru [55] identified that the incineration and landfilling of plastic waste in sub–Saharan Africa contributes to global warming, the depletion of natural resources, and harm to ecosystems due to human actions.

Figure 5. Plastic waste blocking drains in Nigeria [95].

Cudjoe [101] presents the findings of an assessment of the dioxin emission latency of incineration initiatives in African urban spaces between 2012 and 2025 and reports that it was higher in Algeria, Egypt, Morocco, Nigeria, and South Africa than in other African nations due to a high concentration of plastics in their wastes. Meanwhile, the authors of [102] indicated that, from their life cycle assessment of waste-to-energy treatment plants for the generation of electricity in twelve designated cities of Nigeria, the presence of plastic was observed in the waste composition, which is the principal source of chlorinated materials and leads to high dioxin releases during waste combustion.

Adam [11] observed that land-based plastic waste is a major problem across the African region, arising from increased plastic production and its mismanaged disposal. Benson [103] also reiterated that the threat of plastic waste pollution in African states had increased drastically since the World Health Organization acknowledged the coronavirus infection as a pandemic, and plastic PPEs and single-use nose masks were mandatory for people leaving their homes. According to Benson [103], multiple factors are at the root of this rising threat, including the escalated public utilization of single-use plastics, a lack of sustainable plastic waste management infrastructure, and urbanization.

Akan [104] stated that increased plastic waste in the African ecosystem principally results from inefficient policies, futile regulatory monitoring and requirements, and the slow acceptance of advanced procedures. In addition, there are inadequate plastic waste recycling prospects in Africa, consequentially resulting in the incursion of plastic wastes in aquatic bodies, as substantiated by the fact that, in Ghana and Nigeria, less than 10% of plastic waste is being recycled [105,106]. Serge Kubanza [50] and O'Brien [107] also documented that the use of nonreusable plastic bags is still high, despite the South African government's introduction of high tax regulation.

The preceding reveals that the continuous presence of plastic waste has a severe short- and long-term environmental impact on the sub-Saharan African environment.

4.2. The Health Impact of Plastic Waste Pollutants in Sub-Saharan Africa

In a literature review conducted by the World Health Organization [108] (WHO, 2022), experts found inadequate proof of the harmful impacts of these elements on human health. Marsden [109] stated that because of the challenges of characterization and ecotoxicological evaluations, the WHO [108] has called for further investigations into the probable effects of micro- and nanoplastics on the environment and human health. However, plastic particulate research is uncommon, particularly in developing economies where plastic pollution is prevalent [110]. The lack of evidence and scientific uncertainty in the available data has proven to be a serious challenge for decision-makers [111]. Furthermore, plastic

elements in freshwater sources, such as wells and rivers, are becoming an increasing issue, necessitating comprehensive research to identify the various frameworks of permeation and the health hazard to humans [112].

Humans are exposed to plastic waste pollutants in the air through open burning, in soil via disposal in landfills and any other open space, and in water through food chain ingestion, inhalation, and dermal absorption, regarding direct exposure and dust [113]. Campanale [26] indicated that most of the additives found in plastics are endocrine and carcinogenic disruptors, and humans are exposed to them primarily through inhalation, skin contact, and ingestion.

Jiang [114] summarized the presence of plastic wastes in food and animals and articulated the pervasive biological exposure to micro- or nanoplastics, implying that acknowledging the health consequences is a pressing and unmet need. During this review, we saw a cow rummaging waste in one of the South African cities and churning away at plastic waste (See Figure 6).

Figure 6. A cow seen churning away at plastic waste in a South African city (picture taken by author).

Fish consumption in South Africa increased between 1994 and 2009 by more than 26%, thus posing a potential threat to human health because the consumption of aquatic species can transfer microplastics, associated chemicals, and microbes to humans [115].

Egbuna [116] inferred that the increasing cases of different diseases in Nigeria and elsewhere might not be unconnected with identifying some of the pollutants which are directly altering the genetic sequence of DNA. Meanwhile, those contaminants that have been shown to induce antagonistic health defects can, on their own, percolate into the environmental compartments from microplastics, bioaccumulate in aquatic bodies, and arguably be transmitted through the food chain, owing to their aquaphobic characteristic [18].

In a critical examination of the emerging pollutants in the Mid-Eastern and North African area, reference [117] identifies the majority of microplastics resulting from the degradation of larger plastic debris which finds its way into the water bodies and from which humans consume. In addition, the authors of [22] stated that microplastics advance critical environmental implications, such as the formation of metal toxicity in terrestrial and aquatic lifeforms, disruptions to the ecosystem food chain, and public health complications for individuals who consume seafood.

In an attempt to assess the individual exposure to substances originating from the main sources of burning aerosols in typical cities in West Africa, Xu [118] provided new insight into the health threats due to respiratory exposure. They discovered that phthalate

esters, which are generally used as plasticizers in goods, were found at high concentrations in the participants, and thus concluded that exposure could be strongly attributed to the environmental pollution sources, mostly from landfills and open burning.

In their investigation of the role of plastic debris as latent trajectories for morbific bacteria in Zanzibar, the authors of [119] confirmed that it serves as a novel transmitter for pathogenic bacteria that are multidrug-resistant in humans when amalgamated with poor waste management and sanitation, which may result in the spread of infectious diseases and antimicrobial resistance.

Olisah [120] discovered that PBDE levels regarding a noncarcinogenic health risk were high in the fish tested and that eating the fish poses no cancer health risk. They did, however, state that exposure in the long-term and organic contaminant bioaccumulation in various environments in other South African water bodies should be investigated.

The study of [121] investigated the attitudes and knowledge of youths towards single-use plastics in Nairobi and observed that, although they did not have the details, they comprehended single-use plastics as a grave health and environmental concern and recommended measures to reduce their use.

Be as it may, Adeniran [81] has identified that microplastics are hazardous vectors that could allow contaminant transmission in the related food types ingested; thus, chemical ingestion associated with microplastics, arising as a pollutant, might be a greater concern than plastic intake.

5. Recommendations

This review aimed to present evidence on the environmental and health matrices of plastic pollution in sub-Saharan Africa. Several works of literature have provided evidence of plastic pollution in sub-Saharan Africa. While it is evident that there is sub-optimal research on the health implications of plastic waste pollution in sub-Saharan Africa, it is necessary to act based on the obtainable pieces of global proof to mitigate this inherent challenge. Bezerra [54] reported that the implemented compliance tool in 34 African countries is the complete and partial prohibition of single-use plastic products. However, there is a critical need for education and advocacy among various stakeholders on the environmental implications of plastic pollution in SSA to ameliorate the growing threat of plastic pollution. Even though legislation and control have been cited as a major strategy for reducing plastic pollution in Africa, actions must also call for an indigenous and holistic methodology for the various frameworks of policy initiatives to ensure that the citizens own and protect the policies.

In addition, reuse and recycling must be promoted for waste management towards value addition and wealth creation to reduce plastic waste pollution and the subsequent health and environmental footprints. The primary motivation for this stems from the realization that the pollution management challenge results from diffusion and indirect causes. As a result, manufacturers should focus on substituting or replacing non-biodegradable polymers with biodegradable and recyclable polymers for plastic production. Furthermore, authors such as [122,123] emphasized that a strategy for sustainable plastic management must include key components, such as public awareness and participation, data management, collection-focused privatization, international collaboration, and waste-to-wealth energy. As a public policy strategy, the government should introduce "extended producer responsibility", wherein manufacturers are financially and legally saddled with mitigating their products' health and environmental impacts throughout their life cycle stages.

It is also recommended that sub–Saharan African governments have a regional tax policy to discourage the fabrication and importation of non-biodegradable single-use plastics, and this is expected to reduce, if not eliminate, the improper discharge of plastic waste. Furthermore, economic incentives can motivate citizens to recycle plastics and from source-separation for recycling. However, as this review demonstrates, no country in the study area is immune to plastic waste pollution; therefore, there is a need to advocate for policies that will ensure plastic reduction, reuse, and recycling. Additionally, such policies

must be implemented to reduce waste discharge into the environment, as implementation is a significant challenge in sub–Saharan Africa. If implemented, these recommendations will aid sub-Saharan African nations' efforts to eliminate plastic pollution, thereby contributing to sustainable development as well as net zero goals.

6. Conclusions

This review paper revealed evidence of the environmental and health impact of plastic pollution in various regions of sub-Saharan Africa. The available documents reveal that plastic pollution is a challenge in sub-Saharan Africa, and while there is much research on the environmental effect of plastic pollution, there is a research gap in the investigation of its health impact. We have made recommendations toward public awareness and enlightenment as well as policy formulation by governments, and this is expected to support the sustainable management of plastic waste and its pollution in sub-Saharan Africa.

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