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**Perceived environmental risks and hazards in urban poor communities and associated health outcomes; An Ecohealth study of the Odawna community in Accra, Ghana**

**Abstract**

**Background**: Environmental risks and hazards are a major contributor to the disease burden in Africa and globally. This is particularly a growing concern in urban poor communities of the global south due to rapid urbanization. Studies have shown that environmental risks and hazards threaten human health and wellbeing. The urgent need to understand the immense interdependencies that exist between humans and both biotic and abiotic environments and, consequent impact on human and planetary health has led to new approaches such as One Health and Ecohealth. Few studies have also been done to investigate the relationship between lay people's perception of environmental risks and experienced health outcomes.

**Objectives:** The study aimed to (1) describe household perception of environmental risks and experienced health outcomes, (2) examine the association between perceived environmental risks and health outcomes and (3) investigate the relationship between household characteristics, perceived environmental risks and experienced health outcomes.

**Methods:** A cross-sectional study of 152 households in the Odawna community using the Ecohealth approach developed and promoted by the International Development Research Centre (IDRC). The second and third objectives were analyzed using Chi-square correlation and binary regression respectively.

**Results:** Households perceived floods, air pollution, water pollution and waste accumulation as the main environmental risks facing the community. At the same time, most of the households had experienced sanitation-related illnesses while a smaller proportion had experienced airway illnesses and waterborne diseases. The results also indicate that perceived floods, air pollution and, sex of the household head were significant predictors of household experience of sanitation-related illnesses.

**Conclusion:** we recommend inclusive approaches such as Ecohealth to addressing health and environment issues in urban poor communities and, the need to examine risk perception at the local level among vulnerable communities.

**Keywords:** Environmental risks; urban poor; informal settlements; Ecohealth; risk perception

## Introduction

The United Nations estimates that an additional 2.5billion people will reside in urban areas by the year 2050, 90% of this change occurring in Africa and South-East Asia (UN-Habitat, 2020). These changes are mainly driven by migration (rural-urban and international migration), natural increase (more births than deaths) and reclassification of former rural areas into urban areas. The rapid urban growth experienced in the SSA has also affected the social, economic and environmental dimensions of sustainable development (Cobbinah et al., 2015; UNDESA, 2018). Wang (2005) identified three main characteristics of 21st century urban settings; the rapid rate in urban growth, increase in urban poverty and the rise of slums and informal settlements. Megacities of the global South are a product of underdevelopment facing a wide range of health challenges including poverty, diseases and environmental toxicity (Roy, 2011; Wang, 2005).

The rapid rate of urbanization and population growth is driving the rapid decline in environmental health (Ameen & Mourshed, 2017; Krefis et al., 2018). Low-income urban communities which are settlements to more than half of urban dwellers (UN-Habitat, 2020), are more exposed and vulnerable. These settlements are characterized by informality, high population density, poor housing structures, and lack basic services and infrastructure (Kayaga et al., 2020). The populations in these communities are also disadvantaged as they have limited financial, social and physical resources to cope with the risks and hazards (Kobina & Christian, 2016; Wang, 2005). With limited adaptive capacity, urbanization will exacerbate the environmental hazards facing the urban poor and the health burden due to morbidity and mortality.

In Ghana, localities with a population of 5,000 are considered urban areas. Ghana's census data shows steady growth in urban population from 23% in 1960 to 51% in 2010. This trend is projected to reach 75% by the year 2060 (World Bank, 2020). However, this urban growth has also been accompanied by increase in urban slums. Slums and informal settlements are a significant feature of the urban landscape in SSA. Urban slums are unplanned and spontaneous low class settlements associated with increased rural-urban migration into cities (Ghana Statistical Service, 2010). This is particularly a challenge in the major towns of Accra, Kumasi and Takoradi where open spaces have been converted into informal settlements (Puplampu & Boafo, 2021). Obeng-Odoom (2007) found a close association between urban growth rate and slum growth rate in Ghana noting that the two were simultaneously increasing almost at the same rate. This is also supported by Debroy (2018) who attributed the development of slums and informal settlements in Ghana to the mismatch between rapid urbanization and increasing demand for basic goods and services such as water, food, housing, and healthcare by the growing population.

Poor environmental conditions present significant health risks and burden on public health. According to the World Health Organization (WHO), ~ 23% of global diseases are associated with poor living and environmental conditions. Air and water pollution represent the significant risk factors for environmental diseases, including ischemic heart disease and typhoid, respectively. A seminar example is Cholera: a bacteria disease characterized by severe diarrhea and dehydration, which can be fatal. The 2019 cholera outbreak in Yemen resulted in ~3886 cholera-associated deaths from drinking fecal contaminated water (World Health Organization, 2019). Climate change has also been implicated as a promoter of disease in the environment. Hancock et al. (2015) demonstrated that changes in climate conditions alter infection patterns and the burden of vector-borne diseases like Malaria and dengue fever (Hancock et al., 2015). In urban settings where the population is driven by industrialization and large markets, overpopulation, and the need to settle in slums is inevitable. These are densely populated, usually urban areas characterized by poverty, overcrowding, absence of proper sanitation facility, and social disorganization.

Despite the health threat associated with living in slum areas, the population experiences an upward trend partly because of rural-urban migration and lack of knowledge on the risk involved. Research probing into the knowledge on the risk of living in slums environment within urban areas and health outcomes is presently limited in Ghana, where many people in urban environments live in slums. A notable exception is the work of Abu and Codjoe (2018) who investigated experienced and future perceived risk to floods and link to diarrheal diseases in urban poor communities of Accra (Abu & Codjoe, 2018). However, the study did not include other environmental risks that urban poor communities are exposed to including air pollution and waste pollution and the wide range of health outcomes as a result. Owusu and colleagues studied gendered perceptions and vulnerability to climate change in urban slums of Ghana (Owusu et al., 2019). However, their study was limited as it only focused on climate change leaving other environmental changes facing poor urban communities. It also failed to link climatic changes to perceived health outcomes and to account for differentials in households and other demographic characteristics such as migration status. The data analysis for this study was also descriptive did not look at how intersectionality of socio-demographic and other variables impacted vulnerability to environmental risk.

Ghana: a country in West Africa has about 31M population with a majority living in urban settings of Accra and Kumasi. These urbanized cities are known to have many slums, which serve as a dwelling environment for a considerable number of people. Though the government of Ghana and development partners have made an effort to address this issue icluding slum upgrading projects, decentralization of governance (Debroy, 2018), this issue still remains to be a challenge in Ghana (UN-Habitat, 2009). The world bank report on environmental risk placed air pollution as the top environmental risk in Ghana leading to 16,000 premature deaths annually (World Bank, 2020). However, the current data will remain incomplete in the absence of localized investigations to determine the true health burden of living in poor urban environments. Understanding people's perception of their environment in relation to their health can also be useful in determining the kind of interventions needed in urban planning and policy formulation. However, policymakers and authorities have ignored this vital aspect as they seek to address health and environmental issues within vulnerable urban communities (Charron et al., 2012). Odawna, an informal settlement and migrant community within Accra, is among the urban poor areas in Ghana that have been largely ignored. Investigating the perception and risk of disease among residents in Odawna will inform public awareness of the health implications of environmental degradation and promote pro-environmental behavior.

Environmental research in Ghana has also focused on household and individual perception towards disasters, mainly floods in urban poor communities and the resulting impacts (Abu et al., 2018; Adger et al., 2021; Christian et al., 2021). This has put more focus and resources on major disasters such as flood events as they are perceived to have greater health risk compared to the constant daily threat to health and wellbeing posed by poor environmental conditions such as poor air and water quality. Little has been done to evaluate how households in informal settlements of Accra-Ghana perceive their day-to-day environment and how it relates to their health. This research, therefore, intends to address these gaps and contribute to Ecohealth research in Ghana.

**Ghana's context**

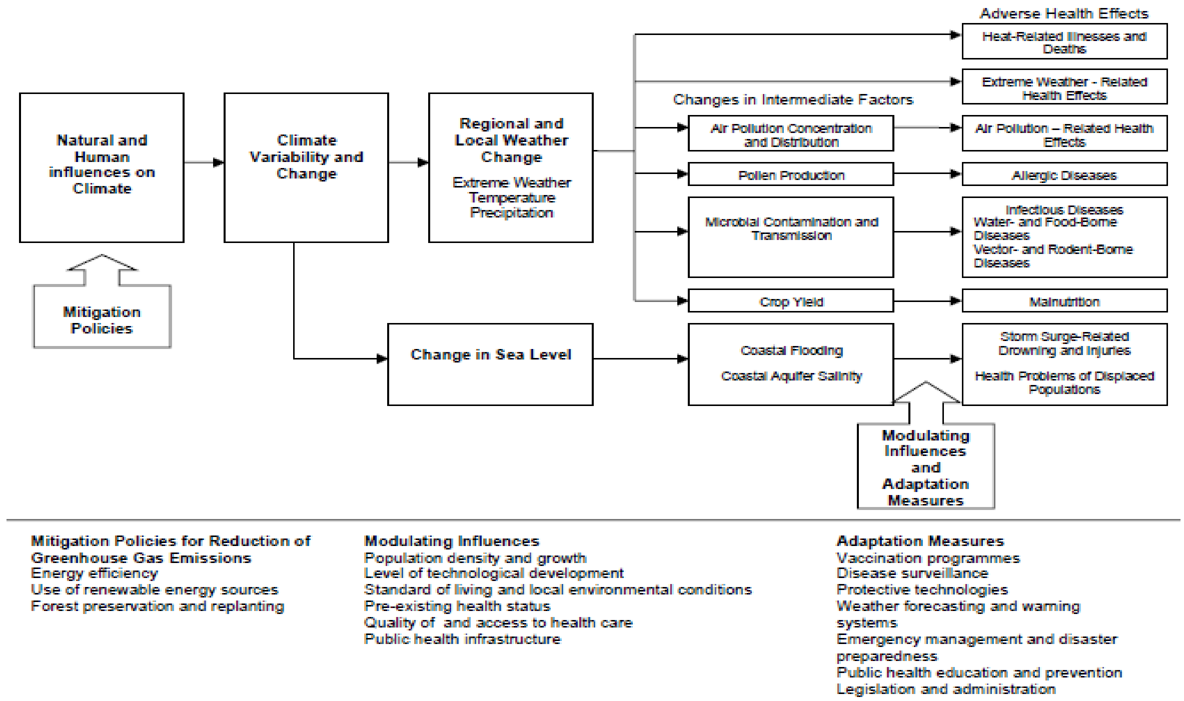
Ghana's population has grown from 6.7million in 1960 to over 30million in 2021 (GSS, 2021). During the period, it has experienced significant social, economic, and political progress including its 2011 classification as a Lower middle-income country (LMICs). Ghana's population is set to double by 2060 with more than 50% of its population residing in urban areas since 2009, a trend expected to rise to 75% within the next two decades (World Bank, 2020). Despite the progress, the country still faces multiple socioeconomic and environmental challenges that threaten its rapid growth and development. The 2020 Multidimensional Poverty Index (MPI) report by Ghana Statistical Services indicated that 45.6% of Ghana's population are multi-dimensionally poor. This index focused on the different forms of poverty that poor people encounter beyond income (<1$ a day) including malnutrition, lack of education, lack of access to clean water and poor housing (GSS, 2020).

By 2050, three million more people will reside in Ghana's coastal zones with a significant population in informal settlements where poverty and health burdens are prominent (World Bank, 2020). In 2017, the World Health Organization launched the Urban Health Initiative (UHI) in Ghana. This was in recognition of household and ambient air pollution as one of the leading environmental health risks in Ghana. The project aimed to combat and reduce air pollution which claimed an estimated 28,210 Ghanaians in 2016 (Climate & Clean Air Coalition, 2017). Children are facing increased pneumonia incidences due to exposure to wood fuel and other unclean sources of energy. Adults on the other hand, are facing a wide range of non-communicable diseases such as lung cancer and cardiovascular diseases because of ambient air pollution. Populations in poor urban settings especially in Accra also continue to suffer from water and sanitation related illnesses. The country has witnessed outbreaks of water-borne diseases (WBDs) such as cholera in the past while dealing with the persistent public health challenges such as malaria (Awuah et al., 2018; Ohene-Adjei et al., 2017).

**The concept of Ecohealth**

Ecohealth is an emerging and growing field of study which examines how changes in physical and socio-economic environments affect human health (Bergquist et al., 2017). This approach examines the ecological and socio-economic interactions and the impact on not only human health, but also ecosystems and provision of quality ecosystem services, and sustainability (Charron et al., 2012). Different perspectives exist on ecohealth research, but for this study, the perspective applied was developed and promoted by the International Development Research Centre (IDRC). Other scholars such as Lebel built upon this view. Lebel (2003) advanced an 'Ecosystem approach to health' to address the challenges of environment and health in developing countries. This approach linked better human health to sustainable environmental management practices. The conditions of an ecosystem such as the Odawna community, are often determined by the social and economic activities of the people who reside in and around the community leading to changes in the quality of the ecosystem services such as clean air and water. These changes ultimately affect human health in these communities.

**Figure 1: Potential Health effects of environmental change from Haines et al., 2006**




## Traditional environmental health hazards facing urban poor communities

### Air Pollution

Air pollution is the biggest environmental health hazard against population health(World Health Organization, 2016). This is caused by the presence of particulate matter (PM) such as dirt, dust, soot, smoke and liquids in the atmosphere (National Centre for Environmental Health, 2016). Finer particulate matter referred to as $PM_{2.5}$ can penetrate directly into body organs including, the lungs and are of great concern to human health as they. Larger particles ($PM_{10}$) are common irritants on the nose, eyes, and throat. The rapid population growth and urbanization rate in developing economies has accelerated urban air pollution and the accompanying health impacts especially in lower and middle-income countries (Adon et al., 2016). Household air pollution and ambient air pollution co-exist and are composed of similar pollutants (Landrigan et al., 2018). Cohen et al.,

(2017) in estimating 25-year trend of global disease burden due to ambient $PM_{2.5}$ found that air pollution related deaths rose from 3.5 million in 1990 to 4.2 million in 2015. Lelieveld et al., (2019) also assessed the cardio-vascular disease burden because of ambient air pollution. The study concluded that annually, Europe experienced an excess mortality rate of 790,000 due to ambient air pollution, 48% of which were due to cardiovascular diseases (CVD's).

The 2019 World Air Quality Report by IQAir ranked Accra as the 9$^{th}$ most polluted regional city in Africa with $PM_{2.5}$ (IQAir, 2019). This is mainly attributed to accelerated urbanization and industrialization in high density urban areas. A study by Zhou et al., (2011) in Accra neighborhoods found a link between household and community use of biomass fuel and particulate matter pollution. The use of biomass fuel is particularly widespread within urban populations in Sub-Saharan Africa. The Ghana Statistical Service (2012) report indicated that 45% and 3% of households in Greater Accra use charcoal and wood respectively as their main source of energy for cooking. The high concentrations of $PM_{2.5}$ and $PM_{10}$ in Accra's neighborhoods are alarming as they are found to be 3-5times higher than the levels recommended by World Health Organization and Ghana's Environment Protection Agency (EPA) (Dionisio et al., 2010). The Air Quality Index Report by EPA Ghana also showed that majority of the population in Accra live and work in unhealthy conditions as a result of localized air pollution (EPA, 2018). This index was constructed by taking primary data on ambient air pollution across different settings such as roadside, residential, industrial, and commercial settings in Accra.

The state of air pollution in Accra is worsened by the dry season when the Harmattan wind blows from the Sahara Desert. Sahara desert is the main source of global dust (IQAir, 2019), and it is estimated that 60% of the dust matter moves southwards to the Gulf of Guinea where Accra and other major cities like Kano and Lagos are located (Afeti & Resch, 2000).

## Sanitation

The lack of properly managed sanitation and hygiene facilities is a public health concern in developing countries, particularly SSA where only 28% of the population have access to basic sanitation (WHO & UNICEF, 2017). WHO estimates that 4.5billion people still lack basic sanitation services globally with close to 900M people still practicing open defecation (World Health Organization, 2019). The inadequate facilities and services to dispose human excreta has exposed populations to pathogenic and parasitic infections. It has also led to fecal contamination of fresh water supplies leading to water-borne disease infections such as Cholera. This is far from the target 6.2 of the SDG's that seeks to ensure access to adequate sanitation and hygiene services to all and end open defecation by the year 2030 (Mara & Evans, 2018; UN, 2015).

Available data indicates that 22% of Ghana's population practice open defecation with more than half (56%) of the urban population having limited sanitation services (GSS, 2018). A negligible progress in improving sanitation services was also observed in 2019 driven by multiple factors (Appiah-Effah et al., 2019). The factors included; lack of public investments, poor implementation of water, sanitation and hygiene (WASH) strategies, poor public perceptions and attitudes, and widespread use of public toilets. Mariwah, Hampshire, & Owusu-Antwi, (2017) argued that improving public toilets in low-income, high density urban communities of Accra is the first step towards improving sanitation and ending open defecation. The study also showed that most residents sampled were dissatisfied with the sanitation conditions and were willing to pay more for better sanitation services.

## Waste accumulation

Solid waste refers to a range of garbage materials arising from both human and animal activities. The common sources include household, industrial, institutional, healthcare and construction work. In urban areas, solid waste generated from cities is generally referred to as municipal solid waste (MSW). The accelerated urbanization in developing countries has led to rapid growth of cities and metropolitan areas. This growth has also been accompanied by rapid solid waste generation in these areas. Poor urban planning, poverty and lack of proper institutions has made solid waste management (SWM) a major public health and environmental problem (Ferronato & Torretta, 2019).

The amount of solid waste generated in cities globally every year is expected to increase steadily from 1.3 billion tones in 2012 to a projected 2.2 billion tones by 2025 (Hoornweg & Bhada-Tata, 2012). World Bank estimates that an urban resident will generate an average of 1.42kg of solid waste per day by 2025. In SSA, the rapid increase in population will also increase solid waste generation from the current average of 62 million tones per year. Ziraba, Haregu, & Mberu, (2016) attributed different health outcomes to poor SWM. These outcomes range from psychological impacts to severe morbidity, mortality, and disability, with children being more vulnerable compared to other age groups. However, many studies have failed to establish a direct cause-effect relationship of specific waste to health outcomes making it hard to estimate the disease burden of solid waste. A systematic review of epidemiological studies on MSW by Aluko et al., (2021) and Ncube, Ncube, & Voyi, (2017) concluded that populations residing near landfills and incinerators experienced adverse health effects. Kimani (2007) found that exposure to waste and proximity to waste dumping sites in Dandora slum in Nairobi led to toxic lead concentration in children’s blood due to soil and water pollution.

The steady urban population growth experienced in Ghana over the last decade is set to further increase in real time. The growth will also lead to rapid solid waste generation making SWM a major threat to public health and environmental sanity. The major types and sources of solid waste in Accra include household, domestic, industrial, and commercial waste. Common household waste include food waste, plastic bags, and paper waste and electronic consumer products. Ruocheng & Badolo (2020) study found a strong positive correlation between poor SWM and negative health outcomes leading to diseases such as malaria, typhoid, and cholera in Accra Metropolitan Area. In addition, the endless utilization of inefficient waste disposal methods such as open dumpsites within urban cities by local authorities contributes markedly to environmental degradation and exposure of population to multiple health risks (Sankoh et al., 2013).

Poor waste handling is a major contributor of sanitation-related health problems including intestinal and blood infections. Evidence from Kretchy et al., (2021) inferred that waste handlers in poor peri-urban settlements in Southern Ghana were exposed to Soil Transmissible Helminthes (STH) Infection. The incidence of infection was much higher in comparison to the national average due to the occupational risk involved through fecal-contaminated solid waste.

**Modern Environmental Health Hazards (MEHH's) in urban poor communities**

Nweke & Sanders (2009) termed MEHH's as an increasing significant health concern in Africa. The rapid development coupled with poor safeguards on health and environment have led to emergence of MEHH’s (World Health Organization, 1997). Common MEHH’s include environmental degradation, climate change and emerging infectious diseases.

### Climate change

Flooding represents the main environmental shock facing Accra city and threatens its long-term sustainable growth and resilience (RIPS, 2020). The impact of flooding varies based on the exposure, sensitivity, and adaptive capacity of the affected population. The Odawna community is a low-income community at risk of severe flooding with poor adaptive capacity. Thus, making the resident population vulnerable to extreme climatic events (Codjoe et al., 2020; Gough et al., 2019). The changes in frequencies and intensity of climatic events such as heat waves, droughts, and floods due to climate change consequently affects public health.

Faced with severe climate risks, Ghana has committed to decrease its GHG emissions by 15% by the year 2030 and to a further 45% based on external support through finances, technology transfer and capacity building (GH-INDC, 2015). This goal targets key sectors responsible for the bulk of emissions such as energy, transport, urban waste, industries, and forest resources.

### Environmental degradation

Donohoe (2003) while describing the causes and consequences of environmental degradation, noted that environmental degradation had the greatest impact on population health. The causes included rapid population growth, overconsumption of natural resources, air and water pollution while the consequences included chronic poverty, extreme weather patterns, biodiversity loss and, acute and chronic diseases (Donohoe, 2003). Briggs (2003) noted that environmental degradation and pollution presented a serious public health concern due to its impact on health outcomes. Studies by Suk et al., (2003) and Mathee et al., (2018) in South Africa also placed children under the age of 5 as the most vulnerable group to environmental burden of diseases particularly due to exposure to environmental toxins and climate change.

Ghana's coastal zones faces multiple environmental challenges. These include coastal erosion and pollution, floods, marine ecosystem degradation and land-use changes including urbanization(World Bank, 2020). The IPCC Special Report on climate change and land also warned that climate change will further exacerbate land degradation in low-lying coastal areas such as Accra, Ghana (IPCC, 2019). The 2020 Environmental Performance Index (EPI) ranking developed by Yale Centre for Environmental Law and Policy ranked Ghana in the bottom 15globally and bottom 10 in SSA. The index measured key indicators such as pollution emissions, climate change, waste management, sanitation, air and water quality, biodiversity, and ecosystem services across 180 countries.

As population increases, more people are relying on forest services for basic needs such as clean air, food and water. Brockerhoff et al., showed the interdependencies and how ecological processes, functions, services and goods contributed to human well-being through improved living conditions (Brockerhoff et al., 2017). Without these services, populations are vulnerable to environmental health hazards such as climate change and pollution of water, air, soil, and food.

Solarin et al., (2017) confirmed the Environmental Kuznets Curve (ECK) and the Pollution Haven hypothesis in Ghana. The Environmental Kuznets Curve shows the relationship between economic growth and environmental degradation. Early stages of economic development as is the current case of most developing countries such as Ghana, has led to massive degradation of the environment (Kearsley & Riddel, 2010). This is due to energy intensive industrialization, rapid urbanization, reliance on unclean sources of energy such as biomass fuel, limited tech-infrastructure and, weak and poorly enforced environmental regulations. In developed economies such as the OECD countries where peak economic growth has been attained, Maneejuk et al., (2020) confirmed the ECK which hypothesizes a decline in pollution and improved environmental quality.

The advantage of technology and strong environmental policy regulations in developed countries have made developing countries the New Haven for pollution. Heavy polluters have taken advantage of the weak environmental policies to establish industries in Ghana. Other key drivers of environmental degradation in Ghana include, energy consumption, Foreign Direct Investment (FDI) and institutional quality. Solarin et al., in confirming the pollution haven hypothesis in Ghana, also recommended for the amendment of the Environmental Protection Act (1994) to regulate emissions from foreign heavy-polluting industries operating in the country.

**Plastic waste and E-waste**

Plastics present a serious human health and environmental burden due to their resistance to degradation and the toxins contained in them such as bisphenol A (BPA), phthalates, poly-fluorine's, lead, cadmium, ethylene dichloride and antimony trioxide (Ologbonjaye et al., 2019).

In 2018, the world produced an estimated 380million tonnes of plastic (Ologbonjaye et al., 2019). In Ghana, plastic manufacturing industries are mostly concentrated in the large towns of Accra and Kumasi. Henríquez-Hernández et al., (2017) identified income, hygiene, and convenience as the key drivers of single-use plastics in Accra, particularly sachet and bottled water. According to Fobil & Hogarh (2009), weak waste management regulations in Ghana have also enabled the proliferation of plastic waste in urban areas leading to public health concerns. Scientifically proven health effects due to bio-accumulation of plastic compounds on humans include; cancers, blood and bone marrow infections, damage to the central nervous system (CNS), circulatory and respiratory systems, skin and eye irritation, and damage to the liver, spleens and other major organs of the body (Andra & Makris, 2012; Hagmar et al., 2001; Kim et al., 2011; Kim et al., 2009; Korobitsyn, 2011; Ologbonjaye et al., 2019).

The advancement in communication and information technology has accelerated the per capita consumption of electronic products globally (Oteng-Ababio, 2010). Items such as mobile phones, televisions, refrigerators, and computers have become common items in households across the sub-region. Global consulting firm, Deloitte, reports that developing economies are overtaking developed countries in ownership and usage of electronic gadgets such as mobile phones (Deloitte, 2021). The increasing demand for electronic devices has led to accelerated production while their short lifespan has led to generation of massive electronic waste (e-waste). These wastes have ended up as second hand goods in countries like Ghana, which lack regulatory policies on used electrical and electronic products (Adanu et al., 2020).

Electronic wastes such as batteries, computer and television monitors are sources of toxic chemicals including Mercury, Cadmium, Chromium, Lead and Beryllium. These compounds accumulate in human organs through direct consumption in food, water and breathing air with severe health implications such as poisoning, kidney failure, damage to the CNS and miscarriages (Henríquez-Hernández et al., 2017; Huang et al., 2014).

A study by Fujimori et al., in 2016 on an E-waste burning site in Agbogbloshie, Accra-Ghana found that the soil was polluted with heavy metals such as lead and Copper. Another study by Amankwaa, Adovor Tsikudo, & Bowman (2017), on the same site found that e-waste workers, traders and even residents had elevate blood lead levels due to exposure to the toxic elements at the site. E-waste dumpsite and recycling site at Agbogbloshie in Accra, Ghana has made it one of the most polluted slums globally and is responsible for the elevated Lead levels in the Odaw River (Caravanos et al., 2011; Daum et al., 2017).

**Ecosystems and infectious diseases**

The ability of an infectious pathogen to survive and spread in part depends on the natural environment. Environmental factors such as climate, sanitation and hygiene, and overcrowding are well known to influence the emergence and spread of infectious pathogens that can be contagious (Saker et al., 2004). In the past two decades, the World Health Organization (WHO), reported several outbreaks of infectious diseases mostly driven by environmental factors that increases contacts between humans and wildlife which mediates zoonotic transmissions.

These included outbreaks caused by Ebola Virus, Middle East Respiratory Syndrome Coronavirus (MERS-CoV), Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV), Lassa fever, Yellow fever virus (Global Preparedness Monitoring Board, 2019) and most recently SARS-CoV-2; the etiologic agent for the ongoing COVID-19 pandemic. Africa is facing a blend of newly emerging diseases and re-emerging diseases such as Lassa fever, Rift Valley Fever, Ebola and cholera (Fichet-Calvet, 2009; Munster et al., 2018; Roess et al., 2016). Gwenzi & Sanganyado (2019) linked the recurrent outbreak of cholera and other water-borne diseases in SSA to environmental factors which are largely ignored in epidemiological studies. According to Rebaudet et al., (2013) overcrowded slums prone to floods faced risk of cholera outbreaks due to pollution of water and, poor sanitation and hygiene.

Infectious disease vulnerability index developed in 2016, ranked 22 countries in Africa in the top 25 most vulnerable countries to infectious diseases (Rulli et al., 2017). Weak healthcare systems and a population already compromised by diseases such as HIV, malaria and malnutrition among others indicated that a pandemic would severely affect SSA (Lone & Ahmad, 2020).

COVID-19 pandemic is already expected to leave a long-term impact on AMR as a majority of patients rely on antibiotics to manage Covid-19 symptoms (Getahun et al., 2020; Knight et al., 2021; Rawson et al., 2020). The increased challenge of AMR, difficulty of finding vaccines and the experiences of SARS-CoV infections, puts emphasis on the need for alternative methods of disease prevention and control such as improving the environmental conditions especially in vulnerable communities (Charron et al., 2012).

**Government efforts to protect Environment and Health in the Odawna community**

In 2019, the Government of Ghana and the World Bank launched the Greater Accra Resilient and Integrated Development Project (GARIDP). The project had two main development objectives, to improve; flood and solid waste managements, and access to basic infrastructural services to targeted communities living in the Odaw River basin such as the Odawna community. The GARIDP project has four major components; the first is to develop a resilient and sustainable structural and non-structural capacity for flood management such as flood warning systems. The second component is solid waste management aimed at reducing waste flow into waterways such as the Odaw River. Third component involves supporting vulnerable low-income communities to increase their resilience and improve their wellbeing. The last component involves strengthening the capacity of the Metropolis in terms of planning, monitoring and evaluation (Ministry of Works and Housing, 2018).

However, attempts to improve the environmental and human health and wellbeing in the Odaw River basin are faced with several obstacles that threaten the success of these efforts. The challenges include resident’s resistance to relocation efforts, mushrooming of structures such as temporary houses, shops, toilets and washrooms along the drains (Free Online Library, 2019). Other obstacles include active dumping even as de-silting and cleaning activities are ongoing in the Odaw and a lack of commitment by the municipal authority. WHO also launched the Urban Health Initiative (UHI) in 2016, with pilot projects in Accra, Ghana and Nepal. The Initiative was designed to reduce air pollution, promote sustainable urban planning and prevent the disease burden responsible for 28,210 premature deaths in Ghana caused by diseases such as stroke and lung cancer(World Health Organization, 2016)

**Methodology**

This study was conducted using secondary data obtained from the Eco-Health Survey of 2018. The survey was conducted by the Regional Institute for Population Studies (RIPS) with funding from the United Kingdom Global Research fund (GCRF). The Eco-Health Survey was conducted in the Odawna community in the Greater Accra Metropolitan Area (GAMA) in December 2018. This community was purposively selected because of its vulnerability to traditional and modern environmental hazards such as air pollution, floods, and waste pollution. These hazards have led to severe health outcomes especially the environmental burden of disease. A total of 152 households were sampled. The households sampled were selected randomly. The survey targeted household heads who were aged 17 years and above as they were affected or had experienced the hazards directly. Data collected from the survey was collected, summarized, and analyzed using Statistical Package for Social Sciences (SPSS) version 23. The Chi-square correlation was used to test the relationship between the independent variables and the outcome variable (p-value <0.05 was considered statistically significant). At the multivariate level, a binary regression was used to examine

**Profile of the Study community**

The Odawna community is in the Korle Klottey district of the Greater Accra region of Ghana. It is an informal settlement area within the commercial business district of Accra and is one of the communities along the Odaw River basin. The Odaw River is one of the largest open drain systems in Ghana and a natural waterway. Odawna is also a residential and commercial center due to the presence of the Odawna market. The community is also surrounded by several transport terminals such as bus stations, making it a major recipient of travelers, migrants into the city and traders due to the busy market. According to the 2021 GPHC, the population in the Odawna community stands at 4298 people with 2112 households in total.

## Socio-demographic characteristics of the respondents

Table 1 below shows the socio-demographic characteristics of the survey respondents. The age distribution indicate that the household heads were predominantly young, with 30.9% being below the age of 30 years. A lower proportion of the household heads were aged 30-49 (28.9%) while 40.1% were aged above 40 years. These results conformed to the 2021 Ghana Population and Housing Census report. The broad base and a narrow peak indicated a huge proportion of youths and children compared to smaller proportion of the elderly population. A high proportion (55.3%) of the household heads was males which is also consistent with the national statistics. Regarding the size of the household, a higher proportion (42.1%) of the household had 1 to 2 members and 3 to 4 members (40.1%) while only 17.8% of the households had five members or more.  Majority (77.6%) of the respondents in the study were migrants.

**Table 1: Socio-demographic characteristics of the respondents**

| Respondent's characteristics | Frequency | Percentage (%) |
|---|---|---|
| **Sex of the household head** | | |
| Male | 84 | 55.3 |
| Female | 68 | 44.7 |
| **Household size** | | |
| 1-2 | 64 | 42.1 |
| 3-4 | 61 | 40.1 |
| 5+ | 27 | 17.8 |

| | | |
|---|---|---|
| **Age of the household head** | | |
| Below 30 years | 47 | 30.9 |
| 30-39 years | 44 | 28.9 |
| 40 years and above | 61 | 40.1 |
| **Migration status** | | |
| Migrant | 118 | 77.6 |
| Non-migrant | 34 | 22.4 |
| Total | **152** | **100** |

*Source: The 2018 Eco-Health Survey Dataset*

**Results**

**The Odawna community is faced with a wide range of environmental risks and hazards**

On the respondent's satisfaction with the health and environment of their neighborhood; majority (75.7%) of the respondents were concerned about the waste-water disposal. In addition, about 85% of the respondents were concerned about the quality of air in the community. On the other hand, 71.1% of the respondents were satisfied with the drinking water in the community. A higher proportion (53.9%) of the respondents were satisfied with their health in the community. On adaptation capacity, both community and household level adaptation were included in the study. At the household level of adaptation, a higher proportion (63.2%) of the respondents had resources that would shield them from the effects of environmental problems. At the community level, majority (82.2%) of the respondents did not have adaptive resources to fight against the impacts of environmental changes. The resources included physical resources which are basic infrastructure and productive capital, financial resources and social resources which include formal and informal social relationships and institutions.

**Table 2: Climate risks faced by men and women in the Odawna community**

| Climate risk/hazard | Male | Female | Total |
|---|---|---|---|
| Floods | 52.0% | 42.1% | 94.1% |
| Air pollution | 51.3% | 37.5% | 88.8% |
| Waste pollution | 52.6% | 39.5% | 92.1% |
| Water pollution | 53.3% | 42.1% | 95.4% |

*Source: 2018 Eco-health survey dataset*

On the environmental risks facing the community, majority (94.1%) of the respondents perceived floods as a problem facing the community. Again, approximately 89% of the respondents perceived air pollution as an important problem facing the community. On the other hand, waste pollution was perceived as a challenge by 92.1% of the respondents. Approximately 95% of the respondents also perceived water pollutions as an important problem facing the community. The Odawna community is also located along the Odaw River which is also a main drain. The location of the households from the main drain is an important factor in determining household vulnerability to environmental hazards. In this study, 47% of the households were located within 80m of the Odaw stream.

**Health outcomes of environmental changes in the Odawna community**

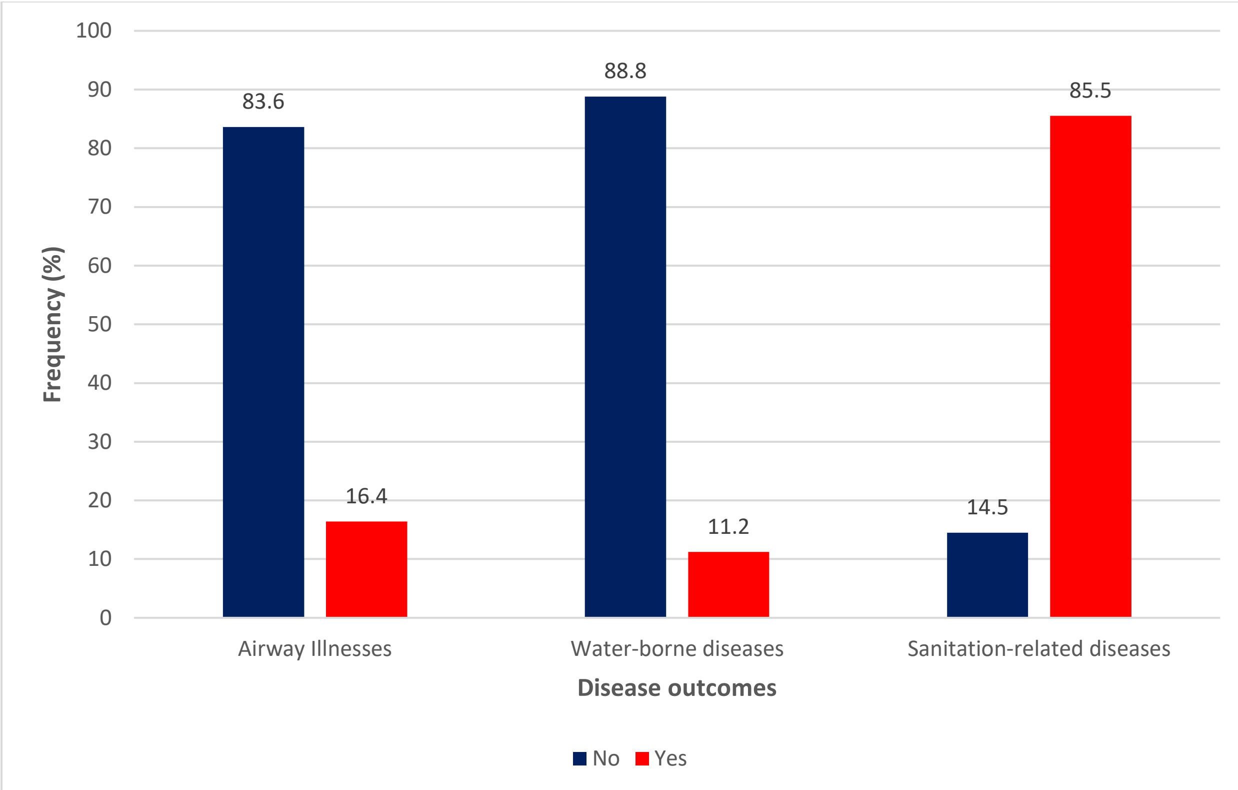
The main dependent variable (health outcome) represents the proportion of the household which experienced a broad range of diseases as a health outcome due to perceived environmental risks. The diseases were categorized into 3 broad groups: Airway illnesses, waterborne diseases, and sanitation-related illnesses.

**Table 3: Description of health outcomes**

| **Health outcome** | **Description** |
| --- | --- |
| Airway illnesses | Symptoms of airway illnesses described by the respondents include; difficulty in breathing, coughing, blood coughs, fever, rashes, insomnia, running nose and severe cold. |
| Sanitation-related illnesses | Symptoms of sanitation-related illnesses include; watery stool, diarrhea, catarrh, headache, weakness and loss of appetite. |
| Waterborne diseases | These include typhoid, cholera, bilharzia, bodily pains, blood in stool, vomiting and frequent urination. |

Of the 152 households, 16.4% had experienced airway illnesses because of the perceived environmental risks compared to 83.6% which experienced no air way illness. On the other hand, about 86% of the respondents reported a household member had experienced sanitation-related illnesses due to the perceived environmental risks. Only 11.2% of the households had members who had experienced water-borne diseases.

**Figure 2: Health outcomes experienced in the Odawna community**




*Source: Computed from the 2018 Eco-health survey dataset*

**Association between socio-demographic factors and health outcomes**

As seen in Table 4 below, there was no significant association between sex of the household head and airway illnesses with a p-value of 0.602 at 95% confidence level. There was also no significant association between sex of the household head and household experience of water-borne diseases with a p-value of 0.754.

**Table 4:Percentage distribution of Sex of the household head and health outcomes**

| **Sex** | **Diseases (Yes) (%)** | | | **Number** |
|---|---|---|---|---|
| | **Airway-illness** | **Sanitation-related illnesses** | **Waterborne diseases** | |
| Male | 17.9 | 91.7 | 11.9 | 84 |
| Female | 14.7 | 77.9 | 10.3 | 68 |
| **Total** | 16.4 | 85.5 | 11.2 | 152 |
| $\chi^2$ | **0.272** | **5.719** | **0.098** | **df=1** |
| P-Value | **0.602** | **0.017** | **0.754** | |

*Source: Health influences of global environmental changes (Ecohealth) 2018 dataset*

However, there was a significant association between sex of the household head and household experience of sanitation-related illnesses at a p-value of 0.017 at 95% confidence level. Approximately 92% of male-headed households experienced sanitation-related illnesses compared to about 78% of female-headed households.

**Table 5: Percentage distribution of age of the household head and health outcomes**

The table 5 below shows that there was no significant association between age of the household-head and household experience of airway illnesses with a p-value of 0.778. There was also no significant association between age of the household head and sanitation-related illnesses with a p-value of 0.683.

| Age | Diseases (Yes) (%) | | | Number |
|---|---|---|---|---|
| | **Airway-illness** | **Sanitation-related illnesses** | **Waterborne diseases** | |
| <30years | 19.1 | 83.0 | 14.9 | 47 |
| 30-39 | 13.6 | 84.1 | 14.2 | 44 |
| 40+ years | 16.4 | 88.5 | 3.3 | 61 |
| **Total** | 16.4 | 85.5 | 11.2 | 152 |
| $\chi^2$ | **0.503** | **0.763** | **6.658** | **df=2** |
| P-Value | **0.778** | **0.683** | **0.036** | |

*Source: Health influences of global environmental changes (Ecohealth) 2018 dataset*

However, there was a significant association between age of the household head and household experience of water-borne diseases with a p-value of 0.036. Approximately 15% of the households with household heads who are below 30 years old experienced water-borne diseases compared to only 3.3% of households with household heads who were 40 years and above. Across the three age-groups, a lower proportion of the households had experienced water-borne diseases.

**Table 6: Percentage distribution of the size of the household and health outcomes**

| Household Size | Diseases (Yes) (%) | | | Number |
|---|---|---|---|---|
| | **Airway-illness** | **Sanitation-related illnesses** | **Waterborne diseases** | |
| 1-2 | 17.2 | 87.5 | 3.1 | 64 |
| 3-4 | 11.5 | 86.9 | 14.8 | 61 |
| 5+ | 25.9 | 87.8 | 22.2 | 27 |
| **Total** | 16.4 | 85.5 | 11.2 | 152 |
| $\chi^2$ | **2.888** | **1.602** | **8.279** | **df=2** |
| P-Value | **0.236** | **0.449** | **0.016** | |

*Source: Health influences of global environmental changes (Ecohealth) 2018 dataset*

There was a significant association between household size and experience of water-borne diseases with a p-value of 0.016. About 22% of households with more than 5members experienced cases of water-borne diseases compared to only 3% of households with 1-2members.

**Table 7: Percentage distributions of migration status and household health outcomes**

There were no significant associations between migration status and any of the three health outcomes as seen in the table below;

| **Migration status** | **Diseases (Yes) (%)** | | | **Number** |
|---|---|---|---|---|
| | **Airway-illness** | **Sanitation-related illnesses** | **Waterborne diseases** | |
| Migrants | 14.4 | 85.6 | 11.9 | 118 |
| Non-migrants | 23.5 | 85.3 | 8.8 | 34 |
| **Total** | 16.4 | 85.5 | 11.2 | 152 |
| $\chi^2$ | **1.598** | **0.002** | **0.246** | **df=1** |
| P-Value | **0.206** | **0.965** | **0.620** | |

*Source: Health influences of global environmental changes (Ecohealth) 2018 dataset*

**Association between environmental changes and health outcomes**

**Table 8: Percentage distribution of air pollution and health outcomes**

As shown in the table below, there is a significant association between air pollution and household experience of airway illnesses with a p-value of 0.026 at the 95% CL. About 14% of the respondents who were concerned about air pollution in the community experienced airway illnesses in their households.

| **Air pollution** | **Diseases (Yes) (%)** | | | **Number** |
|---|---|---|---|---|
| | **Airway-illness** | **Sanitation-related illnesses** | **Waterborne diseases** | |

| | | | | |
|---|---|---|---|---|
| Problem | 14.1 | 88.8 | 10.4 | 135 |
| Not a problem | 35.3 | 58.8 | 17.6 | 17 |
| **Total** | 16.4 | 85.5 | 11.2 | 152 |
| $\chi^2$ | **4.974** | **11.025** | **0.805** | **df=1** |
| P-Value | **0.026** | **0.001** | **0.370** | |

*Source: Health influences of global environmental changes (Ecohealth) 2018 dataset*

There was a significant association between air pollution and household experience of sanitation-related illnesses with a p-value of 0.001 at 95% CL. Approximately 89% of the respondents who were concerned about air pollution in their community had experienced sanitation-related illnesses in their households. There was no significant association between air pollution and household experience of waterborne diseases as seen above.

**Table 9: Percentage distribution of community adaptive capacity and health outcomes**

There was a significant association between community adaptive capacity and household experience of air way illnesses with a p-value of 0.009 at 95%CL. About 13% of the households without adaptation resources experienced airway illnesses.

| **Adaptive capacity** | **Diseases (Yes) (%)** | | | **Number** |
|---|---|---|---|---|
| | **Airway-illness** | **Sanitation-related illnesses** | **Waterborne diseases** | |
| Adaptation | 33.3 | 63.0 | 18.5 | 27 |
| No Adaptation | 12.8 | 90.4 | 9.6 | 125 |

| | | | | |
|---|---|---|---|---|
| **Total** | 16.4 | 85.5 | 11.2 | 152 |
| $\chi^2$ | **6.812** | **13.503** | **1.778** | **df=1** |
| P-Value | **0.009** | **0.001** | **0.182** | |

*Source: Health influences of global environmental changes (Ecohealth) 2018 dataset*

There was a significant association between community adaptive capacity and household experience of sanitation-related illnesses with a p-value of 0.001 at 95%CL. Approximately 90% of the households without adaptation resources experienced sanitation-related illnesses.

There was no significant association between community adaptive capacity and household experience of waterborne diseases.

**Table 10: A model estimation of perceived environmental risk and household experience of sanitation-related illnesses (Significant predictors only)**

| INDICATOR VARIABLE | SANITATION-RELATED ILLNESSES | |
|---|---|---|
| | **OR, 95% CI** | **P-Value** |
| **Floods** | | |
| Problem | 17.79 [1.55,203.15] | 0.02 |
| Not a Problem (R.C) | 1 | |
| **Air Pollution** | | |
| Problem | 4.82 [1.09,21.25] | 0.04 |
| Not a Problem (R.C) | 1 | |
| **Sex** | | |
| Female | 0.21 [0.06,0.77] | 0.02 |
| Male (R.C) | 1 | |

The results from the model above indicated that Floods, air pollution and sex of the household head were significant predictors of sanitation related illnesses. Perceived flood risk was a significant predictor of household experience of sanitation-related illnesses with a p-value of 0.02. The results indicate that households that perceived floods as an important environmental problem facing the community were 17.79 times as likely to experience sanitation-related illnesses compared to households that did not perceive floods as a problem facing the community.

Household's perception of flood risk was associated with household experience of sanitation-related illnesses because flood incidents influence the health outcomes of populations as it exposes them to infections and diseases such as diarrhea, watery stool, fever, and catarrh.

Perceived air pollution was also a significant predictor of household experience of sanitation related illnesses with a p-value of 0.04. The results indicate that households that perceive air pollution as an important problem facing the community were 4.82 times as likely to experience sanitation-related illnesses compared to households that did not perceive air pollution as a problem. This association was also significant at the bivariate level with a p-value of 0.001 indicating that air pollution and household experience of sanitation-related illnesses were linked.

Additionally, sex of the household head was also a significant predictor of sanitation-related illnesses with a p-value of 0.02. Female-headed households were 0.21 times as likely to experience sanitation-related illnesses compared to male-headed households. Sex of the household and household experience of sanitation-relation illnesses was also significant at the bivariate level with a p-value of 0.02. The results indicate that the sex of the household head influence the health outcomes of the households and that gendered perceptions of environmental risk is a significant predictor of health outcomes.

Other socio-demographic characteristics such as size of the household, age of the household head and migration status were not significant predictors of sanitation-related illnesses.

**Discussion**

The first objective of the study sought to describe the household perception of their environment and their health in the study community. This objective was addressed by the univariate analysis which indicate that many of the households were dissatisfied with the quality of air (84.9%) and wastewater disposal (75.7%) in their neighborhood. This dissatisfaction may be due to poor environmental conditions in these communities as shown by Okurut et al., (2015) that a significant proportion of urban dwellers reside in informal settlements which lack basic sanitation and hygiene services. This has affected waste disposal and quality of air and water in urban communities like Odawna.

On environmental challenges, the respondents identified air pollution (88.8%), waste accumulation (92.1%), floods (94.1%) and water pollution (95.4%) as the main problem facing the community. Studies by Codjoe et al., (2020) and Kayaga et al., (2020) identified flooding as the main climate hazard facing the Odawna community and the results indicate that the weather event is a known risk to the population. Ofori (2007) also showed that low-income, low-rental, high density settlements such as the Odawna faced a wide range of environmental problems including poor waste management and water pollution.

Even though more than half (53.9%) of the households were satisfied with their health in the community, approximately 86% of the households had experienced sanitation-related illnesses compared to about 16% and 11% who experienced airway illnesses and waterborne diseases respectively. The high prevalence of sanitation-related illnesses is indicative of the poor state of sanitation and hygiene in the community exposing the population to a wide range of illnesses such as diarrheal diseases. Abu (2016) found increased reporting of diarrhea in flood prone urban poor communities of Accra.

The second objective sought to examine the relationship between perceived environmental risk and health outcomes in the Odawna community. At the bivariate level, the association between perceived flooding, waste accumulation and water pollution risk, and health outcomes were not significant. The perceived environmental risks could not be significantly associated with airway illnesses, sanitation-related illnesses, and waterborne diseases. Additionally, air pollution had a significant association with household experience of airway illnesses (p-value= 0.03) and sanitation-related illnesses (p-value=0.001) as shown in Table 8. However, air pollution was not significantly associated with household experience of waterborne diseases. Numerous literatures have shown the effect of air pollution on human health particularly respiratory illnesses (Anderson et al., 2012; Berglund et al., 1992; Lave & Seskin, 2013) which were conceptualized in this study as airway illnesses. However, people's perception of air pollution in the study community may be informed by the poor hygiene and sanitation conditions which may result to unpleasant odor or smell in the neighborhood. This might explain the significant association between air pollution and sanitation-related illnesses.

The final objective sought to investigate the relationship between household characteristics, perceived environmental risks and experienced health outcomes in the Odawna community. At the bivariate level, sex of the household head had a significant association with the household experience of sanitation-related illnesses (p=0.02 at 95% CL). It was however, not significantly associated with household experience of either airway illnesses or waterborne diseases. At the multivariate level, sex of the household head was also a significant predictor of household experience of sanitation-related illnesses with a p-value of 0.02 at 95% confidence level. These findings indicate that sex of the household head has an influence on the health outcomes of households. The results indicated that female-headed households were 0.21 times as likely to experience sanitation related illnesses compared to male-headed households. Literature has indicated that female-headed households are protected from diseases compared to male-headed (Yavinsky, 2012). This is because women are responsible for the care giving and health care needs of most households in SSA. However, according to Christian et al., (2021), female headed households were also likely to underestimate their vulnerability to floods and other associated risk including health. Indicating that female headed households are more vulnerable to environmental risks and the consequences. Owusu et al., (2019) in investigating gendered perception to climate change vulnerability in Accra slums also found that women were more vulnerable regardless of similar exposure to men. They attributed this to poor access to resources, lack of involvement in decision making and their inherent domestic role.

Other demographic characteristics: age of the household head, size of the household and migration status were not significant predictors of sanitation-related illnesses at the multivariate level. At the bivariate level, age of the household head was significantly associated with household experience of water-borne diseases with p=0.04 at 95% confidence interval (Table 4). The proportion of households experiencing waterborne diseases decreased with increase in the age of the household head with household heads who were 40 and above years reporting the least cases of waterborne diseases. Size of the households had a statistically significant association with household experience of waterborne diseases with a p-value of 0.02 at 95% confidence interval (Table 5). The percentage of the households who reported experiencing waterborne diseases increased with increase in the size of the household. Household disease incidences have previously been associated with composition of the household rather than age or size of the household (Ntshebe et al., 2019). Migration status of the households was not significantly associated with household health outcomes despite the study population having a migrant majority. Impoverished people often migrate for work and settle in areas exposed to pollution and other hazards including physical threats from floods making them more vulnerable to health hazards (Charron & Riojas-Rodríguez, 2012). Studies have also shown that migrants face more health inequalities including limited access to primary healthcare making them more vulnerable to diseases compared to non-migrants (Norredam, 2015).

**Conclusion**

The study revealed that the residents of Odawna perceived themselves to be at risk of a wide range of environmental risks such as floods, air pollution and waste-water pollution. The study found a link between these risks and experienced health outcomes particularly sanitation-related illnesses. Population characteristics, especially sex of the household head mediated the relationship between the perceived risk and the health outcomes experienced. The study highlights the health impacts of environmental challenges as perceived by urban poor communities. It also highlights the inextricable link between the environment and human health and the need for a common strategy to tackle the two challenges. Vulnerable populations, especially communities located along the Odaw River basin are facing multiple socio-economic and environmental inequalities that increase their exposure, sensitivity and weaken their adaptive capacity against such environmental risks. The results indicated that the resident's perception can provide evidence-based data which can inform interventions targeted towards urban poor communities and accelerate efforts towards achieving the goals set under SDG's 1, 3, 6, 11 and 13.

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