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Population awareness and attitudes toward waste-related health risks in Accra, Ghana

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ABSTRACT

Despite significant knowledge about the potential health hazards of waste, there are few studies in African cities that investigate awareness of health issues related to waste management, although such research is needed to lower population exposure. This paper examines the case study of Accra in Ghana, a city dealing with serious health and pollution problems. Three focus groups and 157 households in Accra were surveyed on household waste disposal and awareness of waste-related health hazards. Surveyed households had limited knowledge of waste-related health hazards in their neighbourhoods. Although the households reported diseases that could be associated with environmental factors linked to waste management, 87% of all surveyed households did not think that someone in their household could have fallen ill of a disease that can be related to waste. In middle- and high-income neighbourhoods, waste burning increases substantially when waste is not collected.

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Household attitude; health; waste collection; waste burning; waste dumping

Introduction

For most of the global population, cities provide the chance of a life of employment, far from war or other miserable living conditions (Satterthwaite 2005). However, the speed and scale of urban growth increases the challenges for city planning and management. In particular, the rapid urbanization of the developing world has exceeded the capability of most cities to provide a sufficient level of services to their citizens, leading to daunting sustainability challenges (Cohen 2006; Fobil et al. 2008; Ezeah and Roberts 2012; Almazán-Casali et al. 2019). The main aim of many developing countries is the basic provision of food, shelter, security and livelihoods (Konteh 2009). Therefore, in most cities of the developing world, municipal solid waste management is a neglected area, with no formally organised waste collection and/or insufficient waste management and recycling policies and practices (Seo et al. 2004; Al-Khatib et al. 2010; Hoornweg and Bhada-Tata 2012; Marshall and Farahbakhsh 2013). When solid waste management is given importance in developing countries, it is often driven by the issue of public health (Wilson 2007; Coffey and Coad 2010). The everyday nature of household waste generation and waste collection leads to an underestimation with regard to the adoption of long-term and sustainable waste management strategies (Petts 2000). Africa is a continent where the challenges associated with waste management are

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The data that support the findings of this study are available from the corresponding author, GK, upon request.

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already high and expected to worsen significantly, due to its large population growth and the health hazards associated with inadequate waste collection and treatment (Guerrero et al. 2013).

Studies on the connection between inadequate waste management and health have found that contamination due to improper waste collection can affect soil and water, exacerbating the diffusion of microbial agents, cholera and malaria (Abul 2010; Dzotsi et al. 2016; Songsore 2017) and other vector transmitted diseases (Fobil et al. 2010; Dhar-Chowdhury et al. 2015). Additionally, it is associated with limited evidence of congenital anomalies, low birth weight, respiratory diseases and increased risk of cancer (Porta et al. 2009; Amegah et al. 2012; Mattiello et al. 2013). The practice of burning domestic waste is associated with pollution by particulate matter (Dionisio et al. 2010; Arku et al. 2011), acidic gases and aerosols, as well as metals and organic compounds (Rushton 2003).

To help counteract the expected negative trend, this paper presents a case study of Accra in Ghana, a city dealing with serious health challenges, the most notable being two recent cholera epidemics (Dzotsi et al. 2016), and pollution problems also related to the ineffective management of the large amounts of solid waste and e-waste generated (Oteng-Ababio 2010, 2011; Agyei-Mensah and Oteng-Ababio 2012; Oteng-Ababio et al. 2013; Anaman and Nyadzi 2014; Wittsiepe et al. 2015; Oteng-Ababio and Grant 2019). Data from the Ghana Health Service 2010 states that 60% of the most frequent diseases in the country were related to insufficient environmental sanitation. Several studies demonstrate waste collection services to be a limiting factor of population health in Ghana (Boadi and Kuitunen 2005; Oteng-Ababio 2011; Owusu-Sekyere 2014; Miezah et al. 2015; Oteng-Ababio et al. 2017). Depending on the source of literature, it is estimated that only 33% to 55% of the waste produced in Accra is collected (National Climate Change Committee (NCCC) of Ghana 2015; Miezah et al. 2015). Low-income settlements are usually the last to be sufficiently serviced or are neglected altogether (Coffey and Coad 2010). While this paper focuses on impacts to human health, the potential medical expenses and loss of income due to ill health often lead to economic impact on households (McIntyre et al. 2006). In a country such as Ghana, where about 50% of the urban population is estimated to live below the poverty line of one US dollar a day (UN-Habitat. 2015. UN-Habitat Global Activities Report 2015), the loss of income is especially debilitating.

Unlike other studies done in Accra, the aim of this study is to provide insights into possibilities to protect human health by analysing how citizens in Accra deal with their household waste and by connecting this with the theoretical background of environmental health literacy. Environmental health literacy is a protective factor against environmental hazards as it helps households address exposure (Finn and O'Fallon 2015). Studies have examined health literacy for medical waste in Ghana (Sasu et al. 2011). Nevertheless, studies on household health literacy and household waste management are scarce, and this research, therefore, aims to provide an original contribution to the understanding of waste management perception; a detailed analysis of areas covered by previous studies; and insights into health literacy and household waste, as understanding household awareness forms the basis for developing measures to reduce household exposure, thereby addressing several Sustainable Development Goals (SDGs), namely 1 (no poverty), 3 (good health and well-being), 6 (clean water and sanitation) and 11 (sustainable cities and communities).

Marshall and Farahbakhsh (2013) developed a systems model for waste management in developing countries with four main drivers: *rapid urbanization, the cultural and socio-economic context, the political context and international influences*. We took this model into account during data collection and also when discussing suggestions on how to reduce the health hazards posed by improper waste collection and management.

We made two hypotheses: 1. that formal collection capacity in high-density low-income neighbourhoods is lowest, leading to indiscriminate dumping and waste burning at the household level, while the reverse holds true in low-density high-income areas; 2. that awareness of health hazards related to waste management is highest in high-income low-density settlements.

Indiscriminate dumping of waste and waste burning have been associated with significant health hazards (Rushton 2003; Dionisio et al. 2010; Fobil et al. 2010; Modak 2011); therefore, we use these

two variables, income and density, as proxies for related health hazards. In conclusion, we expect health hazards to be highest in high-density low-income neighbourhoods, while awareness of health risks is lowest.

There are several definitions and conceptualizations of waste management, emphasizing economic, hygienic, anthropological, and environmental aspects, or framing waste from hazard or resource perspectives (Basel Convention 1989; Moore 2012). Due to the focus on health hazards, for this paper, we have adopted the following waste management definition '*the control of waste related activities, with the ultimate aim of resource conservation and protection of human health and the environment.*' (Pongrácz et al. 2004).

Methods

Study design

The general methodological approach was a case study of Accra, Ghana, which employed both qualitative and quantitative methods of data collection. Quantitative data were obtained with a survey of 157 households, while qualitative data were collected through three focus group discussions. All participants gave informed consent.

Case study area description

Ghana is a country in West Africa with a population of 24,658,823 and an annual growth rate of 2.5% (Ghana Statistical Service 2012). Accra, the country's capital city, has more than 2 million inhabitants. According to the latest estimates published by the Ghana Statistical Service for 2018, there are almost 5 million inhabitants in the greater Accra region. Various major ethnic groups have settled in Accra. The population consists of 47.5% Akan, 16.6% Mole-Dagbani, 13.9% Ewe, 7.4% Ga-Dangme, 5.7% Gurma, 3.7% Guan, 2.5% Grusi, 1.1% Mande and 1.4% others (Ghana Statistical Service 2012).

The current state of Accra's waste management system was greatly affected by the political turmoil and coups in the 1980s, amongst other things, leading to increased deficiencies in waste management. In 1985 the waste management department of the Accra Metropolitan Area (AMA) was established to ensure the collection and treatment of waste in Accra (Oteng-Ababio 2010). The Canadian company 'City and Country Waste' was given a monopoly on the waste sector in 1999 after the decision was taken to privatize the sector. When the company failed to deliver the expected results, the contract was cancelled. In its wake, private waste service providers emerged which currently provide 80% of waste-related services in Accra. Informally organized waste collection, e.g. through tricycles, is a response to the perceived inefficiencies in privatized waste management (Oteng-Ababio 2011; Asibey et al. 2019), which cannot provide collection services for all parts of the city (Anaman and Nyadzi 2014).

Within the city, four neighbourhoods were identified for the survey. These represent three relevant socioeconomic levels (high-income low-density, middle- and low-income high-density areas), which is particularly relevant as it was hypothesized that both the ability to pay for waste collection services and environmental health literacy regarding waste, differ by socioeconomic level. The neighbourhoods of James Town (JT) and Nima (NM) represent low-income high-density settlements; Asylum Down (AD) middle-income and East Legon (EL) high-income, low-density settlements. These four neighbourhoods lie in a line from the coast to Accra's northern boundaries. The neighbourhoods have also been selected in other studies related to either waste or air pollution, which provided additional information (Rooney et al. 2012; Zhou et al. 2013; Arku et al. 2014). Furthermore, the neighbourhoods consist of various ethnic groups, which can be an influential factor in the municipality's capacity to successfully implement solid waste management strategies, as public awareness and attitude lead to differences in household waste storage and separation,

interest in waste reduction, recycling, demand for collection services and willingness to pay for services, waste disposal through indiscriminate dumping or opposition to proposed locations of waste facilities (Marshall and Farahbakhsh 2013).

Focus groups

The purpose of conducting the focus groups in Accra was 1. to provide insights on relevant waste-related topics and 2. to clarify the use of terms for the household survey.

Three different target groups were defined: (a) students, and middle-aged mothers from (b) low- and (c) middle-income areas. The first target group included university students from different parts of the AMA. This target group was selected in order to gain an overview of waste management practices in different neighbourhoods and to observe potential differences in health awareness between participants with advanced education levels and the participants of other focus groups with on average lower education levels. Middle-aged mothers were selected for two focus groups as it was hypothesized that older female household members coordinate household waste management. For these two focus groups, the differentiation between middle and low-income was made, because it was hypothesized that waste management and health knowledge could differ based on income and education level. Additionally, differences in vocabulary used by members of different income groups were of interest.

The participants were selected to be homogenous (Krueger 1988). In the student focus group, homogeneity was based on occupation, educational level and age. In the other two focus groups, the criteria for selection were social group, age, residential area and family characteristics. The participants in the student focus group were selected from students living in one dormitory of the University of Ghana campus with a focus placed on each student growing up in a different area of Accra. The low-income focus group was organized via the headmaster of a school located in the same district. The middle-income focus group was organized via a large Presbyterian church. In all focus groups, the value was placed on ensuring that the participants were not familiar with one another, in order to reduce bias in answers. Participants in the focus groups numbered 8, 9 and 11. Each focus group was interviewed in the language of preference of the participants; English, Ga or Twi, by schooled interviewers. Each interview was recorded and then transcribed for analysis. A pragmatical content analysis was done to draw conclusions.

Household survey

The sample size, of 162 households, was calculated based on the United Nations guideline for household surveys, which provides concepts and procedures for designing samples for household surveys (UN, Department of Economic and Social Affairs 2005). The total number of households in the four neighbourhoods from the last census was considered as the population to be surveyed. Epi_Info 7 was used to calculate a random sampling size with four clusters and 5% error. Forty surveys were to be completed in each of the four neighbourhoods. The data collection was distributed throughout each neighbourhood. The results of five interviews were unfortunately lost and it was not possible to repeat them, and eventually, 157 household surveys were collected over a period of 4 weeks in April 2017. The number of non-respondents was extremely low and equal to 7 cases. The survey target population were adult mothers living in Accra in 2017, due to the focus group results indicating that middle-aged female members of households are responsible for household waste management. Additionally, various studies of risk perceptions have demonstrated that in general women are more concerned about environmental hazards than men (Flynn et al. 1994; Greenberg and Schneider 1995).

The survey consisted of 35 questions and was designed to take a maximum of 20 min to complete. The mode of data collection of the cross-sectional survey was a face-to-face interview in which the survey participant was asked the questions by the interviewer. This mode was selected because 26% of the Ghanaian population over the age of 11 are illiterate (Ghana Statistical Service

2012). Additionally, as within a single neighbourhood various languages are spoken by the inhabitants, interviewers were able to translate questions into the respondent's preferred language. Due to the different linguistic, ethnic and religious backgrounds in each neighbourhood, 13 interviewers were schooled on survey data collection. The interviewer selection was aimed to decrease the household non-response rate. Survey participants were recruited in randomly selected areas of each neighbourhood. As the residents' GPS locations were collected in the survey, it was mandatory that participants live at the location of survey participation.

The data from the household survey were analysed with Epi_Info 7 and SPSS, with the analysis based on descriptive statistics. Statistical association's measures were analysed with chi-square tests. It is supposed that the results obtained in this research are relevant for the whole city of Accra, as the neighbourhoods are representative of different social conditions in Accra with sufficiently defined boundaries to create identifiable areas for urban health research (Engstrom et al. 2013).

Results

Focus groups results

The focus group results are depicted in the following order: students, low-income high-density mothers and thereafter the middle-income mothers. All nine participants of the student focus group were from different areas of Accra and were aged 20–23. Regarding waste collection, five of the nine participants had a door-to-door collection, while two had a roadside collection, one had communal collection facilities, and the final participant stated that they disposed of the household waste themselves. All participants declared that there was no separate collection of waste by type in their neighbourhood.

Some participants detailed that their waste was collected by a formal provider, e.g. Zoomlion, while others explained that informal collectors, e.g. tricycles, came to pick up the waste. When waste was not collected it was disposed of through waste burning, indiscriminate dumping, e.g. in gutters during the rainy season or on open plots of land during the dry season, or through the collection by the informal sector. When asked about possible health effects of waste management in their neighbourhood, participant responses included respiratory disorders, eye and throat irritations due to waste burning at refuse dumps, malaria through mosquito breeding, cholera and diarrhea transmission due to flies.

The high-density low-income focus group was conducted in La Abormli and consisted of eight participants, all mothers and the wives of household heads. In all households, adults were responsible for waste disposal. In this neighbourhood, waste was disposed of at a communal collection site or was picked up by informal waste collectors. One participant stated that when waste was not collected, paper and plastic are separated and burned with kerosene, while the rest of the waste was taken to a nearby collection site. Another participant detailed that the household waited for the waste collectors to come or that they took their waste to the collection site. Additionally, a participant complained about waste and faeces being dumped in the gutter behind her house. When asked about possible health effects related to waste management, the following were mentioned: respiratory problems, transmission of airborne diseases from incorrectly dumped waste, and cholera. Additionally, malaria, diarrhea, dracunculiasis, and tuberculosis were named. Waste burning was a topic that the focus group strongly identified with: three participants stated that they would either put out a neighbour's fire or tell a neighbour to stop burning waste. Waste management, and not water, air dust, or other environmental or social topics, was identified by the participants as a priority for the improvement of the neighbourhood.

The middle-income focus group in Haatso consisted of 11 participants, all mothers and the wives of household heads. The participants of this focus group prioritized improving both water and waste management for their neighbourhood. Waste collection was mainly formal in this

neighbourhood. Under normal circumstances, the trucks came to pick up the waste twice a week. Participants mentioned that household waste management, when the service provider fails to pick up the waste, is by burning parts of their waste, letting waste accumulate as it will be picked up eventually or taking the waste to a collection site. This focus group again reinforced the fact that while any member of a household could dispose of the household waste, it is commonly seen as the responsibility of the women in the house. Diseases mentioned in association with poor waste management were cholera, diarrhea and malaria. One participant said that as almost all households burned waste when the formal collection was not done on time, neighbours do not tell each other to stop burning waste. When asked how and whether the participants prevent exposure to smoke, one participant stated that smoke enters the house even through closed windows. Differing from the other two focus groups, the middle-income focus group placed the responsibility for improving waste management with the government, while the other two focus groups saw it as a shared responsibility.

Household survey results

The average survey respondent throughout all neighbourhoods was 46 years of age. The average time the survey respondent had been living at the same address was 32 years in JT, 25 in NM, 26 in AD and 12 in EL. The average income and income distribution of the target group were difficult to determine as most of the households in all neighbourhoods do not keep a budget. The survey respondents were mainly retired or working in sales and service jobs, with the majority being self-employed selling food. The respondents were representative of the target population of mothers and household head wives in the neighbourhoods.

Regarding respondent ethnicity, it is important to note that the number of Akans rose with income level. Ga-Dangme was the predominant ethnic group in JT and contributed to 50% of the survey respondents in AD (compare [Figure 1](#)).

Waste is collected differently in each of the four neighbourhoods. In the high-income, low-density parts of the neighbourhood EL, waste collection was provided almost exclusively by the formal sector via door-to-door collection. Waste collection in JT and AD, a low-income, high-density neighbourhood and the middle-income neighbourhood, respectively, was also mainly through door-to-door collection, but by both the formal and informal sector. In NM, a low-income, high-density neighbourhood, waste was mainly collected formally through communal collection. The frequency of door-to-door waste collection was mainly once a week in AD and EL while it was twice a week in JT. In NM, the households which had door-to-door collection had waste collected mainly once a week. Waste containers overflowed regularly in NM and the least in JT (compare [Figure 2](#)).

Of the 69 households that stated that their waste containers overflow, 44.9% exclusively waited for the collection service, while 24.6% of households directly called the informal collectors, 4.3% of households burned their waste, 4.3% of households brought it to a waste collection site, one household buried their waste and 2.9% dumped it indiscriminately while 8.7% households stated combinations of waste disposal, e.g. both burning waste and waiting for formal collection services (compare [Figure 3](#) for information by neighborhood). Therefore, 75% of the households with overflowing waste containers either waited for waste collection, thereby providing a breeding space for vectors and rodents, or organized informal collection. Nevertheless, households in which waste containers do not overflow also reported burning waste, in total 18.73% of the surveyed households burned waste.

Of the 28 households which burned waste, 90% were from either the middle-income neighbourhood AD or the high-income neighbourhood EL, where, respectively, 27% and 34% of the surveyed households burned some or all their waste (see [Figure 4](#)). In comparison, only one household (2.5%) in NM answered that they burn their waste. The main rationale stated for burning waste was to 'get rid of waste' (89% of respondents) or 'other' reasons (11%) such as costs or hygiene, e.g. the burning of toilet paper. When looking at the motives of households to burn waste,

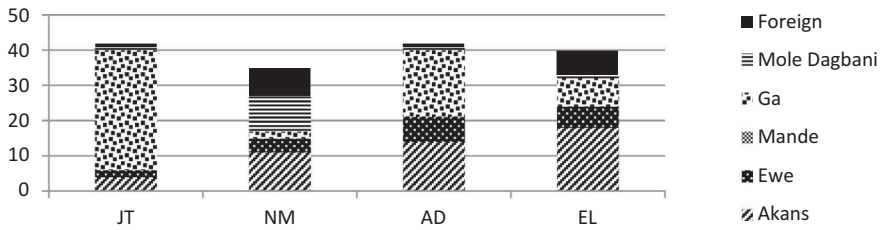


Figure 1. Survey respondent's ethnicity by neighbourhood.

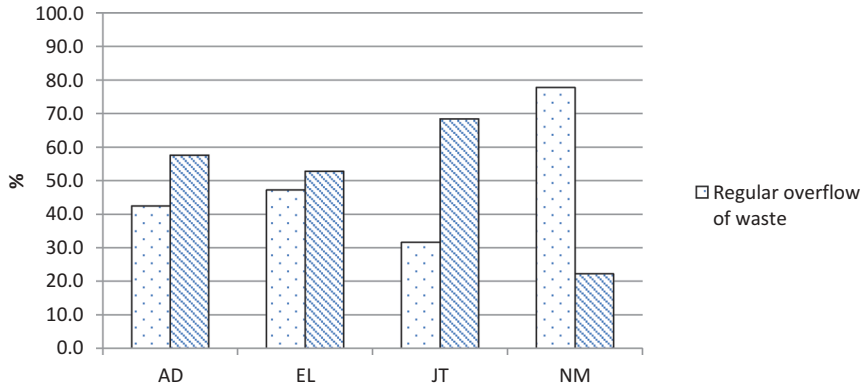


Figure 2. Percentage of household waste containers overflowing by neighbourhood.
 $X^2(3) = 10.7^*$, $p < 0.01$

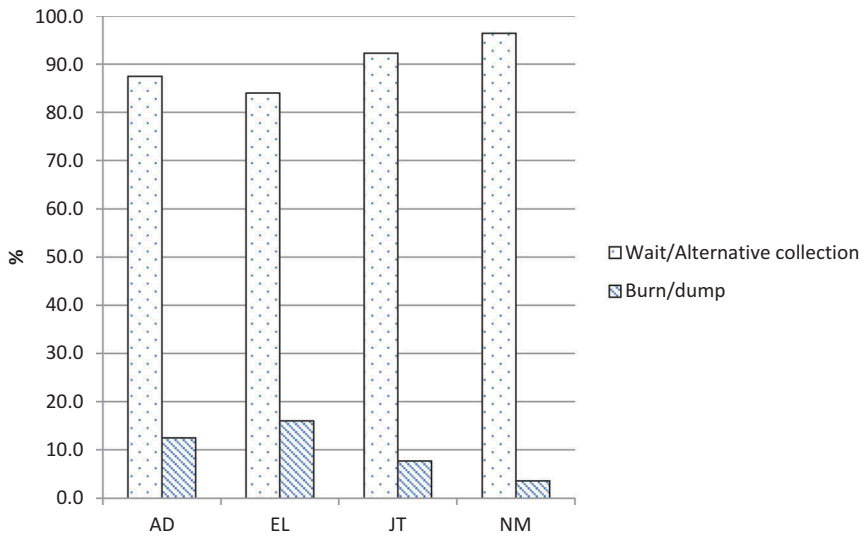


Figure 3. Household action when waste overflows.
 $X^2(3) = 4.05$, $p < 0.26$

75% of the households who burned waste wanted to get rid of their waste while 25% stated that they only burned waste when it was not collected.

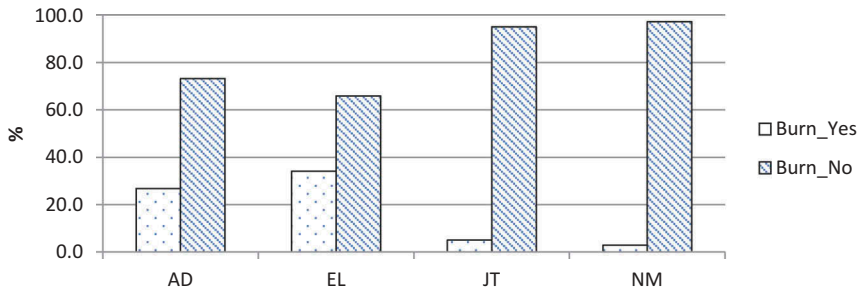


Figure 4. Households burning waste by neighbourhood.

$\chi^2(3) = 19.56^{**}$, $p < 0.001$

The majority of the waste burned by the surveyed households in EL was garden waste with a small quantity of plastic and paper. In AD, burned waste was mainly paper and some plastic and food waste. The 7% of households which burned waste when it was not collected were mainly from the high-income settlement EL and primarily burned garden waste. Participant responses to the question of whether waste was burned in the neighbourhood (JT 18%, NM 9%, AD 33%, EL 61%) suggest that the belief that neighbours burn waste is more prevalent in the high-income low-density neighbourhood and middle-income neighbourhoods than in the low-density low-income neighbourhoods.

Turning to household health awareness in relation to waste, households throughout all neighbourhoods stated that waste disposal is important due to a fear of illness, associated flies and the need for cleanliness.

In each neighbourhood, 90–98% of the surveyed households stated that no person within their household had suffered, during the past 12 months, from a disease or condition that could be linked to waste. The responses showed that individuals within 77% of the households suffered from malaria, 29% from stomach discomfort, 24% from skin infection, 20% from respiratory infections, 13% from diarrhea, 10% from typhoid fever and 8% from cholera (compare Figure 5), all of which can be linked to various environmental and hygiene factors including poor sanitation. Only 6% of the households surveyed stated that they had not had any of the above-mentioned diseases or conditions during the past 12 months. The number of different types of diseases per household during the past year was higher in the low-income high-density neighbourhoods. No statement can be made about the number of people affected per household or the severity of the health issue.

Respondents were asked to gauge the likelihood of falling ill with a specific disease due to the proximity to waste. Answers differed based on the household’s perception of the likelihood of falling ill

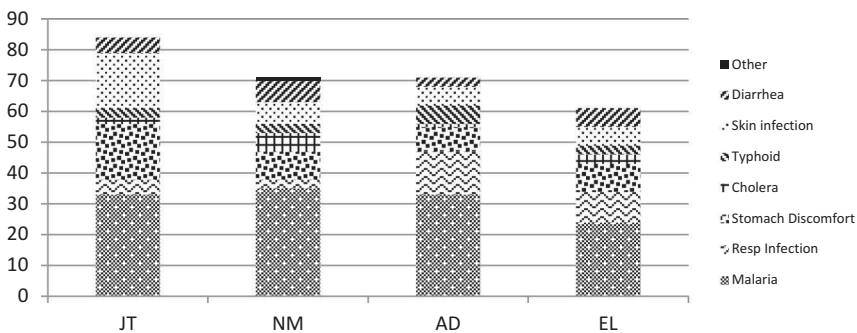


Figure 5. Household disease burden declared by respondents by neighbourhood.

by disease and neighbourhood (see Figure 6). Awareness of the interrelation of cholera and waste was high in all neighbourhoods. This is probably due to large-scale education measures after the recent cholera epidemics in Accra. In all neighbourhoods except for JT, residents had a high awareness that improper waste management can increase the risk of falling ill with malaria and diarrhea.

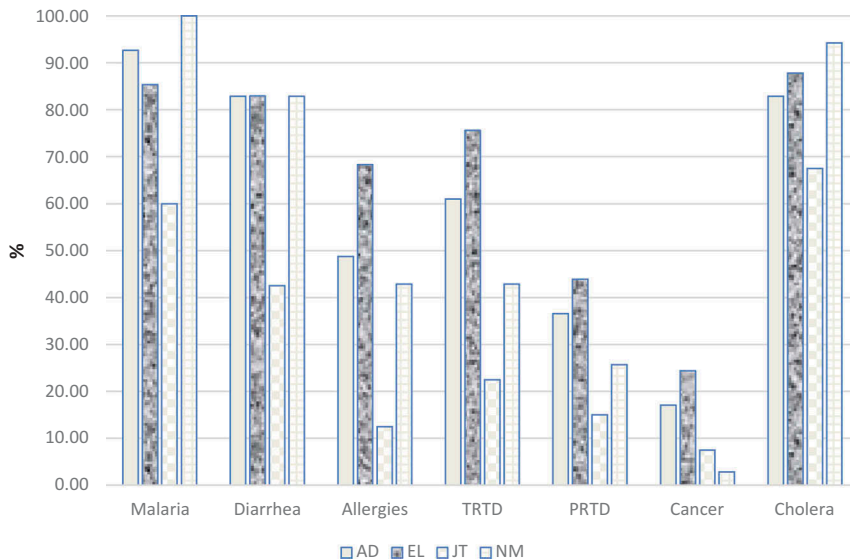


Figure 6. Household perception regarding the potential of becoming ill due to waste, by neighbourhood.

The highest level of awareness of health hazards was among the Mole Dagbani and the lowest among the Ga-Dangme (compare Figure 7).

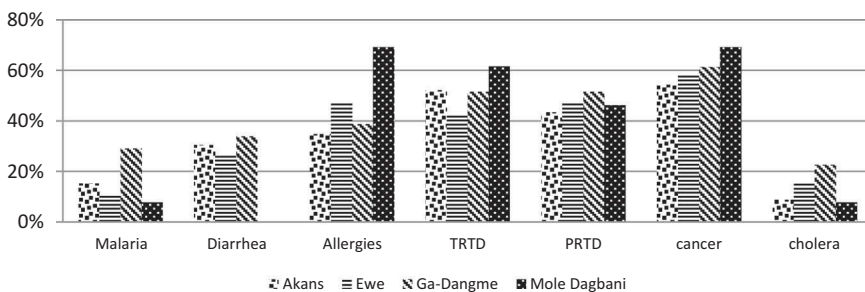


Figure 7. Ethnicity and health awareness.

Discussion

Focus group discussions

In each of the focus groups, the question order differed slightly. The order of questions could account for some differences in the answers provided by the participants. For example, in the second focus group the question 'What would you prioritize when improving the environment in your neighbourhood (e.g. waste, water, air pollution, dust, lack of green spaces, etc)?' was asked towards the end. In this group, all participants prioritized waste, which might be an influence of the focus group topic revolving around the

waste. In the third focus group, this question was asked before the topic of waste formally came up. In this group, both water and waste were strongly prioritized. Nevertheless, it can be assumed that waste is a topic of interest for the participants of all the focus groups.

Throughout all three focus groups, it emerged that formal waste collection service providers in Accra are not collecting waste in a reliable manner. This implies that the utilization of informal collection or household indiscriminate dumping and burning is common practice, which was also found by other studies in Accra (Fobil et al. 2008; Oteng-Ababio et al. 2013). Boadi and Kuitunen (2003) found that 14.3% of surveyed households in Accra burn a part of their waste. The 2010 census in Ghana states that in the Greater Accra Region about 11.2% of households burn their waste (Ghana Statistical Service. 2014). Results obtained from fieldwork in a low-income settlement published by Anaman and Nyadzi (2014) gave an approximate figure of 11% of respondents who burned all of their waste, with an additional 50% burning a part. Our study does not support this negative figure for the low-income areas, but does show a similar picture for the middle- and high-income areas. In all three focus groups, at least some of the participants in each group mentioned as waste-related health hazards; malaria, cholera and diarrhoea. Due to the cholera epidemic in 2014 and 2015 in Accra, which was linked in the media to the inadequate provision of liquid waste management, it was expected that participants of all focus groups would be aware of the connection between cholera, diarrhoea and waste management. Participant knowledge about the connection between improper waste collection and malaria was an unexpected finding. This connection was most clearly drawn in the first focus group with students, which might be ascribed to their higher educational level, age or on average higher-income families. The middle-income focus group named the least number of illnesses in relation to waste and was also the only group that did not mention respiratory disease. This is relevant as this is also the group where the largest percentage of participants stated that they burned waste. While the awareness of potential health-related effects due to poor waste management was comparatively low, the middle-income group strongly expressed dissatisfaction, ill-feeling and claimed a poor quality of life which aligns to the concept of well-being (Diener and Seligman 2004). Despite the large public awareness campaign after the cholera epidemic on the relevance of sanitation, it seems that faeces were indiscriminately dumped in some areas in Accra, suggesting the need for further education and an academic review of the challenges of the sanitation system. This is important, because where sanitation infrastructure is limited excreta is sometimes mixed with municipal solid waste, thereby increasing the potential hazardousness of the waste (UN-Habitat 2010). The provision of public toilets in low-income neighbourhoods could also lead to a decrease in open defecation and the indiscriminate dumping of faeces (Chalfin 2014), which reduces risk of exposure to waterborne diseases (Morua et al. 2011).

Elements of good governance, such as public participation, are needed to successfully implement changes in waste management. Various members of the middle-income focus group stated that the responsibility for the environment and waste management lies with the government. The participants showed a willingness to support initiatives such as the greening of former landfills and dumps if the government was seen to invest in the area, e.g. through the passing of regulations and lowering levels of corruption. Participants in all three focus groups showed a strong interest in environmental protection. In the student and middle-income focus groups, participants suggested decreasing their personal use of plastic bags and the wish for more formal recycling in Accra. Miezah et al. (2015) conducted a large-scale study on household waste, in which household willingness to participate in recycling activities was measured. The willingness shown in the earlier study aligns with the interest and suggestions received during this study. The willingness to actively participate could be used for innovation, as was done in Liberia with the bottle-house, which was a transdisciplinary project with a focus on the sustainability challenge of waste (Oyinlola et al. 2018).

The results from the focus groups provided insights on how to modify the instrument for the household survey. All questions aligned to recycling and current separate collection of waste were removed from the survey, while options for household waste disposal in the case of delays in the formal collection were added.

Household survey

The difference in the frequency of waste collection between JT (2/week) and the other neighbourhoods (1/week) could be explained by the processing of fish in JT. It is expected that waste collection frequency is higher due to the smell and diseases associated with fish remains. Waste containers overflow more in neighbourhoods in which formal service providers are responsible for collection. Twenty percent of the households with overflowing waste containers then dispose of it in a manner that resulted in either health or environmental hazards, such as by dumping or burning it. About 90% of the households, which burned their waste, burned it for a different reason than out of necessity when their waste was not collected. Potential reasons for household-level waste burning could be financial or related to the effort connected with organizing collection or missing collection service provision for certain wastes, such as garden waste. This is aligned to the results of Anaman and Nyadzi (2014), who found a relationship between waste burning/indiscriminate dumping, and the distance to, and charges associated with, waste disposal sites. We found the number of households burning waste to be lower in low-income high-density neighbourhoods than middle- and high-income low-density neighbourhoods. In Nima, the only respondent whose household burned waste also said this was always done at night in secrecy. This suggests that social pressure to not burn waste was high in low-income high-density settlements. In Jamestown, two respondents stated that if one of their neighbours burnt waste, they would go and put out the fire, as there was a high risk of their house catching fire. This leads to the assumption that waste burning in neighbourhoods could be related to population density and proximity of neighbouring houses instead of education or income level.

Regarding health awareness, over 90% of respondents stated that no person in their household had suffered from a disease that could be linked to waste during the past year. Further in the survey, the respondents provided details of diseases that members of their household had had during the past year. The misalignment between these answers suggests that population health awareness was low throughout all neighbourhoods, even though household disease-burden potentially related to waste was highly affected, and that household health hazard was underestimated. These results align with other results from Ghana on the health awareness of informal sector workers in waste management (Asibey et al. 2019). Additionally, Grasmück and Scholz (2005) show that inhabitants with high exposure often underestimate their risk of falling ill through the exposed risk. As households throughout all neighbourhoods, besides Jamestown, stated that they are very likely to fall ill with malaria due to poor waste management, and individuals in 77% of households had malaria within the 12 months leading up to the survey, Fischhoff et al. (1997), explained that 'asking people about risks to other people like themselves is not the same as asking them about their personal risk' (p. 994). Therefore, household hazard perception appears to be distorted. The few respondents who recognized potential waste-related diseases in their household disease burden are mainly health professionals or employees of ministries connected to health; therefore, their health awareness is not deemed as representative of the average population in Accra. Neither the education level of the household head, nor the ethnicity, nor the assumed income due to residency in a neighbourhood, appeared to have an effect on the respondent's hazard perception of household waste.

Household risk perception needs to be addressed, as Vandermoere (2008) suggests that the awareness of a health hazard leads to a household's willingness to cleanse exposure-relevant contaminated sites, thereby leading to a reduction of health hazards.

Suggested measures for urban solid waste management in Accra

In order to increase the population's awareness of waste-related health hazards, measures to increase environmental health literacy regarding the connection of diseases and waste are needed, for example, on the link between waste dumping and malaria, as well as the diffusion of other vector-borne disease and the risks of exposure to mold (Abul 2010; Kretchy et al. 2015).

Additionally, measures to increase household participation in the waste collection are needed. Community-based waste management has shown the potential to increase household participation and environmental health literacy (Sekito et al. 2013; Sinthumule and Mkumbuzi 2019). Recommendations on how to increase the capacity of waste collection differ by income area and are provided in the following order: first low-income areas, followed by middle and then high-income areas.

Low-income areas

In Accra, collection capacity is currently being increased through the privatization policies initiated in the 1990s (World Bank 1996), but which have not lead to an efficient waste collection system in Accra (Fobil et al. 2008). While privatization can theoretically improve efficiency and lower operating costs, to date there is no evidence on differences in costs in public or private delivery of solid waste management. Privatization can lead to a displacement of the poor and thereby to significant social costs of greater inequality and more poverty in cities (Bel et al. 2010; Medina 2010). Hence, when increasing the collection capacity in Accra, it is important to consider informal sector integration into the waste collection system. Alfaro d'Alençon et al. (2018) provide a discourse on recognizing the informal sector. In some low-income areas of Accra, such as Nima, where waste is collected door-to-door, it is mainly collected on foot due to the narrow and uneven roads in the area. Thus, it is unlikely that formal sector collection can provide an adequate service in these areas. Additionally, results from the survey suggest that informal waste collection is more reliable and that payment schemes between informal workers and households appear to be functioning well, as households rarely stated that their waste containers overflowed in low-income high-density areas. Integrating the informal sector into collection services could be an option for increasing the reliability of waste collection and reducing environmental hazards related to informal collection. Modak (2011) suggests a process for informal sector integration, which could be applied to Accra in order to reduce the risk of indiscriminate dumping and burning of collected waste by the informal sector (Nyametso 2010). There are also some good case practices of scavengers organizing themselves into successful micro-enterprises, scavenger cooperatives or public-private partnerships in Africa (Rockson et al. 2013). More innovative approaches should integrate the informal sector and support recycling and re-use. All of these options require the public policy support that leads to sustainable grassroot development (Medina 2010) and consequently, should be supported when implementing Agenda 2030.

Middle-income areas

In middle-income areas of Accra, one of the challenges for formal waste collection is the mainly unpaved roads in these areas. Especially in the rainy season, road quality can decline dramatically, leading to irregular waste collection. In order to increase collection capacity in this area, it is vital that the road network is improved.

High-income areas

In high-income areas, the majority of waste burned by households is garden waste. One survey respondent stated that if he placed his garden waste in the rubbish bin for formal collection, there would be no room for other waste. Therefore, he and other neighbours choose to burn their garden waste. Decentralized composting could be an option to lower black carbon and CO₂ emissions in high-income areas. As many residents have household staff, which could either transport the waste or organize its collection, and sufficient financial means to pay for the additional service of decentralized composting, this option could be viable if residents are made aware of the health hazards of biomass burning.

Summary of suggested measures

The following table provides a summary of the identified challenges in the waste management sector, including suggestions for addressing them (see Table 1).

Table 1. Suggested measures for tackling problems in the waste sector in Accra.

Challenges identified	Suggested measures
Waste burning & indiscriminate dumping by households	<ul style="list-style-type: none"> ● Health education measures on health hazards of burning and dumping ● Better governance, including public participation – to understand the motivation or problem ● Decentralized organic waste treatment facilities, e.g. composting (high-income areas) ● Community-based waste management
Lack of public knowledge on health hazards from waste	<ul style="list-style-type: none"> ● Health awareness information campaign
Population lacks feeling of accountability, waste responsibility is solely attributed to the government	<ul style="list-style-type: none"> ● Address governance issues, including public participation: <ul style="list-style-type: none"> ○ define the role and involvement of citizens in waste management ○ promote waste separation measures for households ● Educational promotion for households on recycling/waste separation ● Publicize infrastructure investments made by the government.
Public dissatisfaction with the government's approach to waste management	<ul style="list-style-type: none"> ● Address governance issues, including public participation, to support: <ul style="list-style-type: none"> ○ transparency (financials, aims, priorities, challenges of solid waste management) ○ public education measures on health hazards of insufficient waste collection, to explain the focus on this instead of waste treatment ● Consider sustainable land-use for current land-fills
Unreliable and underdeveloped waste collection	<ul style="list-style-type: none"> ● Assess the development of the current situation ● Informal sector integration ● Road network improvements ● Consider alternative waste business models
Indiscriminate burning & dumping by informal collection providers	<ul style="list-style-type: none"> ● Informal sector integration ● Incentivize disposal at formal sites ● Create decentralized discharge points

Limitations

No focus group was conducted in a high-income, low-density neighbourhood such as EL. While this type of neighbourhood represents a minority of the population in Accra, it would have been helpful to pre-test the survey in this type of neighbourhood in order to check wording and relevance of questions for the target group. However, both the organization and the compensation of participants in these neighbourhoods were outside the time and financial restrictions of this research.

Limitations of the survey process that need to be considered are that while data in JT, NM and AD were collected on one weekday each, the data collection process in EL took 5 days, on both weekdays and weekends. The reason for this is that private household security is common in EL, leading to difficulty getting in contact with the actual residents of the house in order to collect data. Although the priority was to survey the household head's wife this restriction in EL led to a slight shift in the target group, as in EL either the household head or his wife were surveyed, depending on availability. Additionally, the participants in the other three neighbourhoods most likely did not commute to work, as they were available for surveys during the week and daytime, while the same cannot be said for participants from EL.

Unfortunately, the survey results do not allow any conclusions on whether there are households who instead of organizing waste collection, directly dump or bury parts or all of their waste. It can

be assumed that this applies to a number of households surveyed, as households also burn parts of their waste even when waste is collected on schedule. Regarding health literacy, the risk of over- or understating household health outcomes increases when respondents report on household members who are not present during the interview. Nonetheless, as the respondent is the household head or the household head's wife, knowledge about the health status of other household members can be expected.

Conclusion

The results show that population awareness and risk perception of waste-related health hazards are similarly low throughout all neighbourhoods disproving the second hypothesis that it would be lowest in low-income high-density areas. Regarding the connection between specific diseases and waste, awareness of the relationship between cholera and waste is the greatest. While households do appear to know that they can potentially fall ill due to poor waste management, they do not yet realize that this is likely already the case, or what measures can be taken to reduce exposure. While our results did show that formal waste collection capacity is lowest in low-density high-income areas, differing from our hypothesis, this does not seem to lead to increased indiscriminate dumping and waste burning at the household level as the informal waste management sector fills this gap. The opposite of our initial hypothesis held to be true, as there were indiscriminate dumping and waste burning at household level in middle and low-density high-income neighbourhoods where the formal collection is unreliable and this leads to higher health hazards related to waste.

Our findings add to the risk perception literature by demonstrating that in an area with high exposure to non-catastrophic risk, many households nevertheless do not perceive themselves to be at risk from waste management. The findings suggest that where diseases related to waste management with lower fatality rates are commonplace, people come to see them as a regular aspect of daily life.

In order to increase the waste collection capacity in Accra, further analysis is needed on informal sector integration and on alternative financing mechanisms or viable business models. Further discussions are needed to address the question of how to motivate households to dispose of their waste in a safer way and how to provide infrastructure for the safe disposal of household waste.

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Declaration of Interest

The authors report no conflict of interest.

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