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Assessing Health Risks to Residents Living in Close Proximity to the Retirement Landfill, Montego Bay Jamaica

Sabrena K. Graham-Stewart[1], Denise R. Robertson[2], Trevina O. Grant[3], Joeneil R. Rowe[4]

[1] *Applied Research Methodology, The University of the Commonwealth Caribbean*
Email: sabrena.grahamstewart@gmail.com

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Abstract

The inhalation of landfill smoke and odour poses a health hazard to humans. This knowledge intensifies recognition of the public health risks these landfills pose to residents living around them. Though the effects of landfills on residential communities are well-known in literature, there are inconclusive findings in developing countries on the effects on living close by them. This study sought to address this knowledge gap by testing our main hypothesis that the Retirement Landfill in Montego Bay, St. James has an impact on the health of individuals living closer to it. The research questions looked at how health effects vary amongst residents exposed to landfill smoke and odour within 1-3km and 3-5km of the Retirement Landfill. Data were collected using a cross sectional study design with non-probability sampling applied. Interviewer administered questionnaires concerning demographics, medical diagnosis of ill health and general perception of the Retirement landfill were issued to a total of 384 household residents, with an equal split between residents residing within (1–3km) and (3-5km) of the Retirement Landfill. The results showed that over 70 % of respondents displayed at least one health symptoms when exposed to landfill smoke while over 56% reported health symptom when exposed to landfill odour. Residents closer to the Retirement Landfill were three times more likely to experience respiratory symptoms and four times more likely to experience gastrointestinal health symptoms, as a result of the smoke and odour from the landfill. These findings strengthen our call for better solid waste management policies aimed at increasing operational and infrastructural efficiencies at the Retirement Landfill, through recycling initiatives and implementation of a sanitary landfill.

Keywords: Landfill, Smoke, Odour, Health

Chapter 1. Introduction

Proper Solid waste management practices are fundamental in ensuring a strong and functional public health structure in human settlements. As our global population grows, many countries are struggling to provide adequate facilities and systems to effectively dispose of their waste. The rates at which waste is generated worldwide are rising. Globally there is a continuous increase in the amount of waste generated with 2.01 billion tonnes produced across cities worldwide in the year 2016.These rates translate to 0.74 kg of waste generated per person and with rapid increase in our population size coupled with increased citification of our habitat it is expected that there will be a 70% increase in waste generation to 3.40 billion tons in 2050, (World Bank, 2019).

According to the World Bank, (2012, p. 25) "Latin America and the Caribbean has the most comprehensive and consistent data (e.g. Pan American Health Organization's (PAHO). The total amount of waste generated per year in this region is 160 million tons, with per capita values ranging

from 0.1 to 14 kg/capita/day, and an average of 1.1 kg/capita/day. In the case of Jamaica urban households generate 18.29 kg of waste every 3.5 days on average, this translates to 1kg of waste per person daily. This waste profile is comprised mostly of organic waste which fell by over 14 % from 2006 to 2015 (Mckenzie, 2016).

Globally, approximately 37 percent of waste is processed via a landfill facility. Of these landfills 8 percent are sanitary landfills with infrastructure in place to monitor and dispose of landfill gasses (World Bank, 2018). Globally one will more likely find more robust and advanced waste disposal facilities with some level of monitoring and restrictions in median to higher income countries (World Bank, 2018). In the Caribbean, landfills are acknowledged to be the most widely used municipal waste-disposal method - their high scale efficiency allows them to be used for the diverse range of population sizes typical to the Caribbean (Phillips & Thorpe, 2013).

In Jamaica though majority of waste generated is taken to municipal landfills, the growing increase in maintaining these sites in optimal conditions coupled with the increase in waste generation has led to concerns over land availability (Ministry of Energy and Mining, 2010). This is brought into sharp review with all municipal landfill sites across the island including Retirement and Riverton having poor waste separation infrastructure and no control mechanism in place to manage gas emissions such as methane as well as leachate (Jamaica Observer, 2018).

Background of the Study: The Retirement Landfill, Retirement, St James

The Retirement Landfill is Jamaica's second largest landfill site and is four times smaller than the Riverton Landfill. The landfill is in Retirement, St James and receives the majority of waste from Western Jamaica serving the parishes of St James, Hanover, Trelawny and Westmoreland (Smith, 2003). The landfill collects approximately 69% of waste generated from approximately 115,815 tons of waste per year (Smith, 2003). The inability to secure funding to acquire necessary machinery to effectively cover the landfill and secure the facility as resulted in frequent arson attacks. (Inter-American Development Bank, 2015). Landfill fires at the facility persist for a few days creating smoke that covers a wide area, affecting residents and workers alike in Montego Bay. These fires and resulting increases the health risk of persons developing respiratory illnesses and are controlled only by utilizing all resources available (Inter-American Development Bank, 2015)

In July 2018, the Montego Bay business community as well as residents, were exposed to smoke coming from the Retirement disposal site. Montego Freeport, Granville, Camrose, Bogue Village and Retirement were among the affected communities, even persons in Sandy Bay, Hanover were impacted (Hines, 2018). In May 2019 fire broke out once again at the Retirement landfill, despite promises made by government officials to better manage the landfill site (particularly in managing fires). This event left business leaders expressing uncertainty that the relevant authorities could effectively manage the situation and create solution to prevent landfill fires (Frater, 2019). The smoke from these fires covered various areas of St. James and Hanover, significantly affecting the health of residents who reported a range a symptom including asthma related illnesses, swollen eyes, a strange taste in their mouth and overall general discomfort (Frater, 2019).

Public Health Implication of Living in Close Proximity to Landfills

The impact that landfills have on public health is far reaching, and many studies have found a direct risk to the public health of humans living near landfills. On the continent of Asia, a study conducted in four sites around Kammiampet open dumping ground and a control site in Cuddalore, India, showed that air quality testing at sites closer (0.3-3km) to the landfill had increased amounts of air pollutants arising from the smoke emanating from the landfill, as opposed to the control site located 10 km away (Lingan et al., 2014).

The accumulation of these pollutants in the body of residents around the dump through inhalation of air can produce a spectrum of chronic respiratory illnesses and lung damage (Lingan et al., 2014). Communities exposed to landfill gas emissions though often below toxic levels often report a range of health symptoms from smelling these gases ranging from headaches, feeling of vomiting, tiredness and a rage of respiratory illnesses (International Solid Waste Association, 2019).

In an urban area in Egypt, a significant amount of residents (89%) living downwind from a landfill site reported being affected by respiratory illness as a result of a landfill fire at the facility (The United Nations Human Settlements Programme 2010)

In another country on the African continent, landfill smoke blanketed parts of the Gambian City of Banjul, as a result of a landfill fire that occurred at a municipal landfill. The smoke created a significant public health risk, with tourist and residents alike expressing discomfort and overall poor quality of life (Ferronato &Torretta, 2019).

On the European continent Oxford University Press (2016) evaluated the impact hydrogen sulphide emitted from nine landfills in Lazio, Italy and hospitalizations for respiratory illnesses and deaths from lung cancer and found a significant association between the two variables. In the Americas a survey conducted in United States of America at St Louis, Missouri discovered a positive relationship between residents living in close proximity to the Bridgeton landfill and diagnosis of respiratory illnesses such as asthma, chronic obstructive pulmonary disease (COPD). The relationship although existed was too small to be considered statistically significant.

Though the St Louis Study showed no significant association between respiratory illness and living in proximity to landfills, the direct effects landfills play on the quality of life of humans and potential in lowering public health is clearly displayed in West Jefferson, Alabama. In a local town approximately 420 people were reeling from the odour emanating from the Big Sky Environmental Waste Disposal Site. Residents describe odour akin to rotting corpses, or carcasses and the smell of death. Persons have even reported headaches, and the inability to breathe (Milman, 2019). Residents in other communities such as in Waterloo, New York, describe the odour from the Seneca Meadows Landfill as sickly sweet, acrid, benzene-like in smell and stomach churning (Murphy, 2019). These strong orders can trigger Asthma related illnesses impact sleep quality causing headaches and nausea (Center for Health, Environment & Justice, 2016). Supporting finding of Heaney et al. (2011) confirmed a positive association between exposure to landfill odours twice daily, and physical symptoms such as mood states and acute irritant.

Proximity to landfills does increase the public health risks, but to date studies are unable to conclude just how significant is the impact between proximity to landfills and the resulting impact on communities. Landfills serve around 3.5 - 4 billion people and are attributed to general ill health and disruption to the quality of life amongst persons who live in proximity to them. Consistent increase in population size and with it increased waste generation in the next 15-20 years, means more waste will be disposed of in landfill sites. Our country's landfill sites are already ill equipped and in need of significant resources to remain sustainable and practical. This predicted overcapacity of landfills will directly increase the occurrence of landfill smoke and odour and therefore affect more and more people, as such immediate waste management solutions to protect and maintain stronger public health is needed.

Statement of the Problem

The World is grappling with increased waste generation and in Jamaica residential waste produced annually is approximately 800,000 tonnes and increasing at a rapid rate (Caribbean Policy Research Policy, 2015). Open air landfills are the most frequently used means of waste disposal amongst developing countries. In the region only a small proportion of countries have the proper infrastructure to effectively manage waste in the form of investing in and operating sanitary landfills (Riquelme et al., 2016).

In Jamaica, all eight of our landfills are inadequately managed with poor infrastructure, gross security breaches and overall poor mismanagement. The breakout of fires at our landfills is widespread and the resulting landfill smoke, threatens the quality of air inhaled and eventually affects the public's respiratory health (Jamaica Civil Society Coalition, 2012). Unfortunately, despite the known public health risk posed by landfills, management of solid waste and subsequent disposal takes the least precedence to other social issues such as providing water, electricity, transportation and housing to its citizens. Failing to address waste management processes will have deleterious effects on the quality of human health and environment (United Nations Human Settlements Programme, 2010).

To date no comprehensive studies have been undertaken to better understand the health effects of landfill smoke and odour in Jamaica. This study addresses this knowledge gap by exploring the public health effects on residents living in close proximity of Landfills, using the landfill in Retirement, St. James.

Purpose of the Study

The purpose of this study was to analyze the potential health risks associated with the proximity of residential areas to the Landfill in Retirement, St. James. The study considers health impacts such as respiratory illness and other ill health arising from the smoke and odour emanating from the disposal site, using a cross sectional study design.

Research Questions and Hypothesis

The following research questions and hypothesis guided the quantitative study in assessing the health risks of residents living in close proximity to the Retirement Landfill in St. James, Jamaica:

Question 1. How do health effects vary amongst residents exposed to landfill smoke and odour within 1-3km and 3-5km of the Retirement Landfill?

H0: There are no variations in health effects of residents living within 5km of the Retirement Landfill. It is expected that persons living within 1-3 km of the Retirement Landfill will not experience worse health symptoms as there is no greater exposure to elements or vectors around the landfill. The exposure rate is not expected to decrease as one moves away from the landfill (3-5km).
Ha: There are variations in health effects of residents living within 5km of the Retirement Landfill. It is expected that persons living within 1-3 km of the Retirement Landfill will experience worse health symptoms as there is greater exposure to elements or vectors around the landfill. This exposure rate is expected to decrease as one moves away from the landfill (3-5km).

Question 2. What are the health effects of inhaling landfill smoke arising from the Retirement landfill?
Question 3. What health effects does landfill odour emanating from the Retirement Landfill have when inhaled by residents?

Rationale of the Study

Academic studies into the health effects of landfill smoke and odour in Jamaica have never been done, as such our hypothesis is new and needed to bridge the gap in academic literature as such representing the first study of its kind to assess health risk of landfill smoke and odour in Jamaica. It will be the We as Jamaicans are faced with the all too familiar cry of residents and businesses of the devastating effects landfill smoke and odour have on the livelihood and work environment of persons in close proximity to the Riverton Landfill on Spanish Town Road. We felt it was our responsibility as citizens and researchers to explore this topic out of a need to strengthen the call for better management of our landfills and promote the productivity and health of this nation's most important resource-our people.

Significance of the Study

This study will contribute substantial information on the impact of landfills on public health. With the data to be acquired, it is expected that the urgency in addressing improvements to waste management policies and procedures of the National Solid Waste Management Authority(NSWMA) and other regulators of the system will be paramount, due to the significant contribution of the city of Montego Bay in driving the nation's commerce and tourism sector.

The research will provide a voice of the people to the Jamaican Government primarily the Ministry of Health and Wellness, and Ministry of Local Government and Community Development, who will be able to relay to the Cabinet the urgency of implementing zoning laws that will address and control proposed housing developments within a recommended distance from

future landfill sites. In addition, the move towards upgrading current landfills to sanitary ones, in an effort to improve public health and safety of residents and commuters within the city of Montego Bay, may achieve greater focus.

The public health implication of landfill sites, particularly that of the Retirement Dump, and the risk to the quality of life of residents in the study area can contribute significantly to the decision-making of stakeholders in public health such as the Epidemiology Unit at the Ministry of Health, the National Environment Planning Agency (NEPA), Jamaica Environment Trust as well as local donors interested in the sustainable growth and development of the Jamaican people.

Limitations

There are some common limitations that confronts academic research of this nature, with the most common being time and resource constraints. Given the stipulated period of time in which we were given to complete the thesis, the scope of the study was adjusted to accommodate this. Financial constraints presented limitations of the study as we were not able to support hiring and training of research assistants to cover a wider area of study and increase our sample size to further strengthen the impact of our findings.

The applied methodology was highly dependent on collecting information of self-reported symptoms based on said exposure to landfill smoke and odour and not diagnosed illnesses made by a medical practitioner. In this manner self-reported data is sometimes prejudiced because it is dependent on a someone's ability to remember as well as their personal view on perceived symptoms. We initially wanted to address this concern by cross referencing medical data for our community groups with health outcome data from the local health facilities however this information was not compiled by the Ministry of Health and Wellness and therefore not available for review. Additionally, we wanted to look at exploratory data such as updated air quality data, incidence of landfill fires and zoning laws for the Retirement Landfill. However, this was not forthcoming despite completing the access to information authorization forms mandated by the Government of Jamaica under the Access to Information Act. We were also unable to wait for the 30-days stipulated timeline before we could escalate our request to the above data that would have been fulfilled from government stakeholders such as the National Solid Waste Management Authority, Ministry of Health and Wellness, Jamaica Fire Brigade, National Environmental Planning Agency, as well as the St James Municipality. This greatly impacted the resulting exclusion of such data from the Background to the study.

Participants' unwillingness to answer particular questions or unavailability to partake in the questionnaire survey impacted the collection of data. Given that researchers relied on residents reporting symptoms of Public Health effects through questionnaires, there was a possibility that higher recorded rates of symptoms in exposed areas could be attributed to reporting and/or recall biases. From a public health point of view, the findings of high reports of symptoms through self-reporting, may indicate the impact that factors such as stress, underlying health conditions, predisposed genetics or sensitivity to irritants, can have on ill health and/or perceived ill health.

As a result of these biases and small sample size, findings from the study did not provide a conclusive view of the public health effects of the Retirement Landfill on residents living within 5km of the landfill. Nonetheless, the findings provided valuable information on the difference in public health impacts with proximity to the landfill and serves as a guide in the continued improvement of the waste disposal and public health system.

Delimitations

We limited the study to observe the impact of landfill smoke and odour as these were some of the more common complaints of residents living near landfills. The sample size of individuals who formed part of the quantitative analysis was limited to 384 persons to allow for better managing of data collection and analysis, against the backdrop of the time constraint of the study. The study was also limited to data collection from residents within 5km of the Retirement Landfill and the

selection of the six communities chosen for our study made through judgement sampling techniques primarily due to our ability to target the required number of persons in our sample size.

We limited our study to observe the Retirement Landfill in St James primarily because majority of our research members reside in the parish and therefore ability to collect data would be easier. The research methods used in this study can be applied to assess other areas where landfills exist. Findings and recommendations however were limited to prevalence of various health implications to landfill smoke and odour arising from the Retirement Landfill based on the personal views of the respondents within the target area of study.

Operational Definition of Terms

It is important to define the technical terms used throughout the study in order to reduce misunderstandings, and thereby provide universal comprehension within the study. The operational terms are:

Landfill. Open uncontrolled non-engineered dump where municipal solid waste is disposed and has limited measures to control the operation and to protect the surrounding environment. These include but are not limited to management of leachate and separation of waste (World Health Organization, 1999)

Municipal Waste. Residential waste generated as a result of daily human activity (European Commission, 2017)

Public Health. The science of prolonging, promoting and protecting the health of communities by endorsing disease prevention, physical and mental health, sanitation, personal hygiene (Marks, Hunter & Alderslade, 2011)

Sanitary Landfill. Sanitary Landfill (SL) a technological advanced landfill built to provide better management of solid waste through leachate control, separation of waste, increased security and infrastructure to manage vectors, landfill gases etc. to promote public health and process waste more effectively (European Environment Agency, n.d.)

Organization of the Study

This paper consists of five chapters. Chapter One introduced the study and outlined its focus. The statement of the problem was highlighted, as well as, the background and purpose of the study. Three research questions were developed in order to provide the focus for the study, these are: How do health effects vary amongst residents exposed to landfill smoke and odour within 1-3km and 3-5km of the Retirement Landfill? What are the health effects of inhaling the landfill smoke arising from the Retirement landfill? What health effects does landfill odour emanating from the Retirement Landfill has, when inhaled by residents? The rationale, limitations, delimitations and significance of the study was outlined, and the technical terms used in the study were defined.

Chapter One provides an overview to the research study on the assessment of public health risks associated with living near to the Retirement Landfill. The chapter details the problem statement, rationale and purpose of study and presents the research questions and hypothesis tested. The significance that the study will have on key industry players such as government and community groups was established, and key operational terms outlined. Finally, limitations and delimitations of the study will be presented.

Chapter Two reviews the literature on academic work done previously on the topic and emphasizes the research questions that this study will seek to answer. Apart from addressing the research questions that were developed, the literature review is divided into two sections: respiratory health implications and health implications of odour. This division provides a better focus for the chapter, in achieving the study objectives and analyzing studies that are centered around the topic. Furthermore, this chapter provides an argument for the need to perform the study.

Chapter Three focuses on research methodology. It outlines the research design to be used along with sample size, population and study area. This chapter also outlines varying methods to be utilized in collecting, recording and analyzing findings. Additionally, chapter three addresses the

ethical concerns, as well as reliability and validity of the research study, budget and the timeline for completion of the study.

Chapter Four presents summarized data collected from administered questionnaires and the statistical treatment, and/or mechanics, of analysis and presents these using tables and figures. The chapter provides a concise report of the findings, as guided by our research questions, in addition to providing the demographics of our sample population.

Chapter Five concludes the research study and offers an interpretation of the research findings. It also provides concluding statements, offers recommendations to stakeholders, as well as examine areas for future research.

Chapter 2. Literature Review

In our rapidly growing world population, the matter of the impact of waste management practices in particular the disposal of these waste to landfills have increased the concern of how landfill sites impact the public health of communities in close proximity to these sites. In this chapter, literature will be examined and presented to reinforce our current understanding of the health implications of landfill sites and discuss the need for present research in addressing the research questions: How does health effects vary amongst residents living within 5km to the Retirement Landfill?; What are the respiratory effects of inhaling the smoke arising from fires at the Retirement Landfill on residents living within 5km of the landfill?; What health effects does landfill odour emanating from the Retirement Landfill have, when inhaled by residents?

Health Implications of Landfill Smoke

Several different studies have investigated the impact of landfill smoke on health, particularly respiratory health. Correa et al. (2011) found in a Brazil study, that persons who resided near landfill sites showed a range of respiratory illnesses particularly in children up to 13years of age. In the USA, Berger et al. (2000) and Chowti et al. (2018) discovered that there is a strong association between living closer to landfills and acute respiratory symptoms amongst residents. In Finland, it was found that there were cases of asthma and cancer among residents of houses built in a region that had a landfill (Pukkala & Pönkä, 2001).

Despite the findings of the above-mentioned studies there exists a general problem in epidemiologic studies of public health implications of landfill sites. These challenges were the same whether one looks at specific landfill site or more than one site at a time. There is a lack of knowledge as to if and how substance from landfill sites enter human population and affects health. Porta et al. (2009) used a peer review protocol to summaries findings of major studies on the health implication of landfills from the year 1983 to 2008. They discovered that majority of the studies provided inadequate evidence that directly established a direct link between landfill sites and reported health symptoms. This lack of evidence is partly due to lack of resources to extensively carry out exposure measurements or modeling.

Much of the respiratory health implications of landfills, centers around the release of smoke from landfill sites such as the Soluos landfill located at the far east-westerly area of metropolitan Lagos, which is often characterized by surface fires that release a thick white smoke and consist of by-products of partial combustion (Aderemi & Otitoloju, 2012). The smoke includes aggravating agents including organic compound with acidic properties and other compounds. When materials such as tires or plastics burn in high temperature surface fires, they release toxic compounds and in turn produces dense black smoke surface fires burn materials such as tires or plastics, (Aderemi & Otitoloju, 2012). In this smoke microscopic materials called Particulate Matter (PM) are released and when inhaled enters deep into the lungs where it remains up years and in turn puts persons at higher risk of developing infections of the respiratory tract. These particulates exacerbate asthma attacks and triggers a myriad of respiratory symptoms such as coughing and wheezing and aggravate underlying chest and pulmonary conditions (Aderemi & Otitoloju, 2012).

Several epidemiological studies have shown that the extent of increased respiratory and cardiovascular illnesses is dependent on the size of PM. The negative health implications of low and high PM exposure have been extensively studied in the field (Osornio-Vargas et al., 2003; Pražnikar & Pražnikar, 2012). Landfill sites play a huge role in the emission of these particulate

matter - affecting communities exposed to such particulates from outdoor sources which penetrate to the indoor environment and may cause respiratory harm (Meng et al, 2009; Zhu et al., 2010). A comparison between measurement for particulate matter near landfills and control sites showed elevated levels closer to landfills, thus prompting the need to better control landfill operations to minimize the risk posed to communities around them. To be taken into consideration are the elevated temperature and wind speed values in and around landfills contributing to higher recorded particulate matter concentrations (Chalvatzaki et al., 2010).

Morales et al. (2017) measured exposure to particulate matter arising from a landfill fire that broke out at the Santa Marta landfill in the urban area of Santiago (SMA), Chile, and found that PM values far exceeded the recommended levels set by the World Health Organization, and an urgent need to evacuate people living in close proximity to the landfill particularly those individuals who are most sensitive to pollution such as children, the elderly and pregnant women, as well as people with underlying chronic respiratory diseases. A strong relation between the acute and chronic respiratory conditions such as wheezing, shortness of breath, bronchitis, asthma and lung cancer and relations to particulate matter exposure is well documented in epidemiological literature (Li et al., 2018; Mészáros et al., 2015; Nastos et al., 2010).

Across the continent of Africa, a number of studies in Ghana, Swaziland, Sierra Leone, Nigeria and South Africa identifies significant respiratory health impact arising from landfill operations. It could be comparatively seen that even for the causes of the diseases, the households who were near the dumpsites were more exposed to higher concentrations of landfill smoke, and therefore more vulnerable to respiratory related illnesses. The strongest reported correlation between respiratory health and landfill sites was found in the Mangwaneni landfill in Manzini, Swaziland, where 82% of nearby residents and 58% of faraway residents' health was affected by the location of the dumpsite (Salam, 2010). At the Thohoyandou Landfill, Limpopo Province, South Africa 78% of participants living closer to the landfill site indicated a high level of poor air quality that resulted in them having a range of breathing disorders (Njoku et al., 2019).

In Ghana, studies on three landfills in the Kumasi Metropolitan Area reported lower number of residents indicating respiratory illnesses arising from the landfill site with 8.6% of residents (5.1% near dumpsites and 3.5% far from dumpsites) confirming their illnesses were as a result of breathing in landfill smoke, and dust particles along with offensive landfill odour from waste disposal site (Addo et al., 2015). The comparison of all three studies showed that irrespective of distance residents were affected by presence of dumpsites in close proximity to their communities. However, as one moves away from the dumpsite health implications became less severe opposed to increased symptoms present amongst persons who lived closer to the dumpsite.

Sankoh et al. (2013) in their study, showed that residents living less than 50 meters from the Granville Brook Dumpsite in Sierra Leone reported that the site was too close to their homes causing them a lot of sickness. While Addo et al. (2015); Njoku et al. (2019); Salam (2010) showed a large percentage of residents living in proximity to landfills reported a general concern on landfill operations and their respiratory health. Comparative studies at the Olusosun Dumpsite in Lagos State, showed that a large proportion of residents (45.9%) did not observe any significant impact on their health, living in close proximity to the landfill site (Babs-Shomoye & Kabir, 2016).

In other parts of the world the impact of landfill sites on respiratory health is well documented. In Staten Island, USA, 46% of residents from the landfill community were diagnosed with asthma, while chronic bronchitis was reported by approximately 30% of respondents (Berger et al., 2000). In Italy, pollutants co-emitted from the several landfills in Lazio were found to impact mortality, with lung cancer and respiratory illnesses (especially in children) being predominant reported illnesses requiring hospital care. At increased levels, these illnesses were linked to inhalation exposure to endotoxin, microorganisms, and aerosols from waste collection and land filling (Mataloni et al., 2016). In Tijuana, Mexico a study on the landfill in Los Laureles, Canyon

showed that residents reported more perceived toxicant exposure symptoms including nose and throat irritations, however, it could not be verified that proximity to the landfill site was the cause of health symptoms amongst residents of this specific community (Al-Delaimy et al., 2014).

Studies pointed out above have provided evidence of an association between residents living near landfills and ill health. Such association is related to the type and effectiveness of exposure assessment methodology. A common factor in majority of these academic studies, is looking at distance lived from landfill sites as measure of exposure. Though useful in giving voice to the concern of the impact of landfill sites on the respiratory health of residents, none of the studies provided conclusive evidence of the direct link between smoke emission and reported incidence of respiratory illnesses. More studies are needed to further assess toxicity and type of substances that residents living near landfill sites are exposed and resulting health implications.

Health Implications of Odour

Many researchers have found that landfill odour is considered a form of air pollution and indicate the level of negative effects this has on human population. Odours are often considered a common concern of landfill operations. Landfill odour results primarily from the anaerobic breakdown of biodegradable waste (Talaiekhozan & Rezania, 2018). Residents living near landfill sites often complain about a range of health symptoms. These symptoms range of from nausea, headaches, drowsiness, fatigue and an array of respiratory illnesses (Baah & Kharlamova, 2018).

Odours in landfill gas are caused primarily by hydrogen sulphide (H2S) and ammonia (NH3), released in the natural degradation of organic waste. Hydrogen Sulphide has the distinctive foul smell of rotten eggs, ammonia however has a strong suffocating odour. Humans are able to perceive hydrogen sulphide and ammonia at levels below what would cause damage to health. (Chen et al., 2003; Guarrieloo, 2009; Ko et al., 2015; Staszewska & Pawlowska, 2011). Literature has shown evidence of the positive role of hydrogen sulphide as one of the more recently recognized gaseous transmitters, involved in a large range of cellular functions including the regulation of blood pressure, transmission of neuron impulses, anti-inflammatory action, the digestive process along with a range of other cellular activities (Jin et al., 2015; Nicholls et al., 2013; Szabo et al., 2014).

There is however existing evidence of the negative effects of hydrogen sulphide on the physiological health (Guidotti, 2010; Jiang et al., 2016). Humans are highly sensitive to the smell of hydrogen sulphide and detect smells at 0.5 to 1 part per billion (ppb). At an exposure levels of 50 ppb, humans will find the smell displeasing (Rim-Rukeh, 2014). At severe toxicity levels (greater than 500 ppm) unconsciousness and eventual death will ensue immediately whilst in post-acute exposures (> 100 ppm) humans display symptoms such as breathing difficulties, non-cardiogenic pulmonary edema, cyanosis that leads to eventual coma and death (Rubright, 2016). The health implications of low-level or long-term exposure to hydrogen sulfide (< 1 ppm) are more difficult to estimate given poor knowledge of how these levels affect cellular function. It has been found however that hydrogen sulphide exposure at these levels could cause visual impairment, fatigue, nausea, respiratory illnesses and headaches due to the high level of sensitivity these internal processes are to H2S exposure (Rubright et al., 2017).

Landfill odour poses a risk to surrounding communities and concern over the health risk they pose is amongst the most common public complaints, (Brancher & Lisboa, 2014). In Africa, The Soluos landfills located in Lagos had an inadequate gas collection system and resulted in landfill gases freely disposed into the atmosphere, creating unpleasant odour around communities close to the landfill. While many residents found the odours unpleasant, and experienced symptoms such as nausea or headaches, no major medical attention was usually required (Aderemi & Falade, 2012). Increased prevalence of self-reported health symptoms of residents living near the Dompoase Landfill in the Kumasi, Ghana were consistent with symptoms resulting from odour exposure such as fatigue, sleepiness, and headaches among residents near the landfill site (Owusu-Sekyere et al.,2013).

Malaysian Studies at the Pajam and Ampar Tenang Landfill were consistent with studies in Africa with common ailments reported by residents exposed to odorous emissions being headache

and dizziness (Sakawi et al., 2010).The incidence of headache or dizziness occurred primarily when the intensity of odour generated from the landfill was high and persisted over a long period, in addition to reported cases of persistent cold, flu and loss of appetite (Rozaimi et al 2014). Weather was one of the significant factor which influenced how often landfill odour was detected and how strong this odour was perceived by residents in one study at the Ampar Tenang landfill in Malaysia, with wind direction and speed, temperature and humidity reported to affect the frequency and intensity of odour from the landfill site (Sakawi et al., 2011). The Caribbean Studies conducted at the Truitier's landfill in Haiti, concluded that concentration of hydrogen sulphide levels far surpassed the average level occupational exposure ratings and created a danger for the population requiring immediate attention (Pierre-Georges et al., 2017).

Odour impact and proximity to landfill site affected the range of health symptoms experienced by residents in Malaysia with almost 59 % of respondents indicating they experienced a strong intensity in landfill odour and (76 %) agreed that this odour released from landfill site negatively affected their health with residents displaying symptom such as: nausea, headache, loss of appetite, disturbed sleep pattern; emotional disturbance, mental instability, irritability, and interference with proper working(Sakawi et al.,2011). In Finland respondents living in close proximity to a waste facility reported increased measures of annoyance with odour and displayed more physical symptoms than others living further away. These symptoms include unusual shortness of breath, eye irritation, hoarseness or dry throat, toothache, unusual tiredness, fever or shivering, joint pain and muscular pain (Aatamila et al., 2010).

De Feo et al. (2013) in their study at a waste disposal site in Tufino, Italy also ascertained that respondents living closer to the landfill perceived odour as a health concern. However, there were proportions of respondents living closer to the waste facility who made no complaints on odour impact - it was later discovered residents received recompense that strongly affected their perception of the health effects of landfill odour.

Organic wastes are broken down by aerobic and anaerobic processes, creating the release of landfill gases of which hydrogen sulphide is the main component of odour emanating from landfill sites. Landfill odours cause negative health effect to human health and affect the wellbeing of life. Exposure to high concentrations can have deadly impact on residents living around them. Though the studies reviewed may not associate odour exposure from landfills with long-term adverse health effects or illness, it nevertheless causes disruption and stress of day-to-day life of residents, greatly impacting their quality of life and therefore necessitates further review.

Conceptual Framework

As outlined by the literature reviewed, there is sufficient evidence to suggest that a relationship exists between distance and health effects resulting from exposure to landfill smoke and odour. However, there might be indirect associations brought on by factors such as wind direction. As a result, this research paper presents a framework that will assist in understanding the associations between living in close proximity to the Retirement Landfill and health effects experienced and does not consider causation of such health events. It provides the rationale for bridging the gap in academic literature, to determine if distance lived from landfill has any relation to respiratory, gastrointestinal and neurological effects commonly experienced due to landfill smoke and odour exposure, especially since this is the first study of its kind to be conducted in Montego Bay, Jamaica.

This research project outlines the concepts related to landfill smoke and odour exposure and how such concepts individually and collectively affect human health. The concepts discussed are not novel but can be applied to a rural setting within a developing country, whereby the role of the relevant authorities in managing waste disposal sites is lacking. Finally, a discussion surrounding health effects due to landfill smoke and odour exposure, and the relationship between experiencing these effects and distance from the Retirement landfill is provided. In addition, the discussion includes the occurrence and frequency of contributing factors of landfill smoke and odour and the level of concern on health, expressed by respondents, being exposed to these factors. The literature supporting the framework was divided into two sections: health implications of landfill smoke and health implications of odour. The main elements of landfill smoke and odour - particulate matter

and hydrogen sulphide, respectively, were studied to gain a better understanding of their significance in producing the health effects experienced by study participants. Academic literature covering landfills in a number of countries, was examined to provide supporting evidence that persons living closer to the landfill within 1-3km will experience more health effects compared to those living further away between 3-5km.

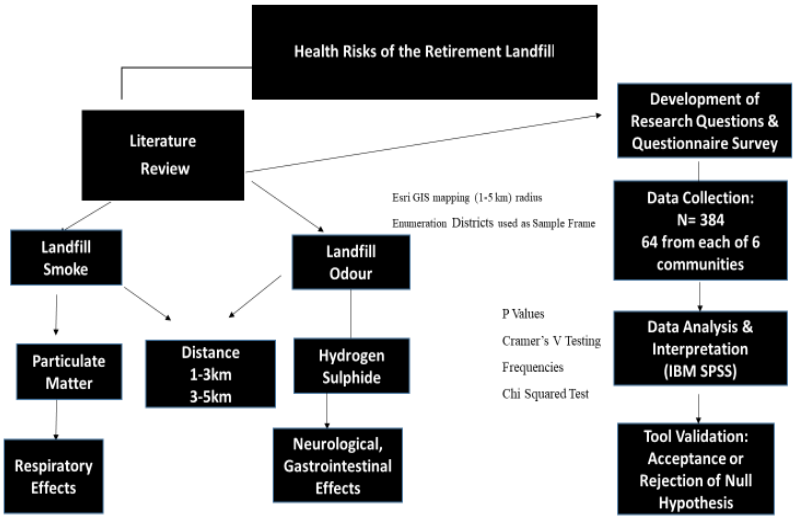

Figure 1: Conceptual Framework for Health Implications of Landfill Smoke and Odour

Chapter 3. Methodology

In the previous chapter, we reviewed literature centered on the health effects of smoke and odour on residents, emanating from landfills, as a result of living near these landfills. In this chapter, we will present the methods and procedures that were used in this study in answering the following research questions: How do health effects vary amongst residents exposed to landfill smoke and odour within 1-3 and 3-5km of the Retirement Landfill? What are the health effects of inhaling the landfill smoke arising from the Retirement landfill? What health effects does landfill odour emanating from the Retirement Landfill has, when inhaled by residents?

To achieve the research objectives, information was gathered from several community groups within 5km of the Retirement Landfill through quantitative research methods. Quantitative data was collected by way of a questionnaire survey, conducted on an individual level within the chosen study area. Description of the location and sample size used as a representative portion of the overall study area, the data collection methods, and the data processing and analysis methods which were employed are discussed below.

Research Design

This study utilized a quantitative design method. This decision was based on the conviction that for this study to yield meaningful conclusions, capturing measurable data that could be used in various formulations to give a deeper understanding of our findings. Out of the various types of quantitative research, it was agreed that a cross sectional study design would be best suited. This design assisted in assessing the health implications associated with exposure to the smoke and odour from the Retirement Landfill and allowed us to look at numerous variables at once such as: age, gender, tenure of residence and how these factors affected health implications of the landfill smoke and odour.

The use of a cross sectional research design enabled us to examine our subject matter within a specific geographical area accessing a specific number of individuals as the subjects of enquiry. In addition to being relatively fast to conduct, given the time limitation of the study, the chosen research design was better suited for us to make assumptions about possible relationships between variables and gather data that could be built on for future research and experimentation. This preliminary data would in turn through continued studies help provide improvements in

public health planning, monitoring, and evaluation. Whilst the selected research design provided many benefits, one major limitation in its application was that it measured a one-time only exposure to landfill smoke and odour and not a progressive measurement of health implications over time. We could not make inferences or measure incidence of the health implications observed and were therefore careful about using our findings to give direct cause and affect associations between variables studied.

Area of Study

The study was conducted in Jamaica in the Parish of St James. St James is located on the north-west end of Jamaica, bounded by Trelawny to the east, St. Elizabeth to the south and Hanover and Westmoreland to the west (Jamaica Information Service, 2019). The population size of the parish in 2018 was 185,697 (Statistical Institute of Jamaica, 2019). Montego Bay is the capital of St. James and is recognized as a vibrant coastal city, one of the tourist centrals of Jamaica and is saturated with hotels, restaurants, craft markets, and guest houses.
Our research study targeted six (6) communities in the parish of St James that are within 5km of the Retirement Landfill. See Table 1 below.

Participating Communities	Population	% Population	Sample	% Sample	Sample Percentage of Population
Bogue Village	7,830	37%	64	16.67%	1%
Granville	5,669	27%	64	16.67%	1%
Retirement	3,855	18%	64	16.67%	2%
Pitfour	1,428	7%	64	16.67%	4%
Westgate Hills	1,233	6%	64	16.67%	5%
Catherine Mount	1,160	5%	64	16.67%	6%
Total	21,175	100%	384	100%	2%

Table 1 : Number of Participants in Population and Sample (Statistical Institute of Jamaica, 2011)

Sampling Frame

Our study employed the recognized boundaries of Enumeration Districts (EDs) (See Table 2). In St James, Enumeration Districts are political divisions delineated for voting purposes, and are also recognized and utilized by the Statistical Institute of Jamaica in conducting the national census.

Sample

The sample size of the study was calculated using Cochran's Sample Size Formula. The Cochran formula is:

$$n_0 = \frac{Z^2pq}{e^2}$$

Where e is the desired level of precision (i.e. the margin of error),
Z is the standard deviation found in a z-table based on the confidence level,
p is the (estimated) proportion of the population which has the attribute in question,
q is 1 – p
In the absence of any information on the sample population to begin with, we assumed that 50% of the individuals to be studied would display health symptoms associated with inhalation of landfill smoke and odour, and this would represent our maximum variability. In the formula, "p" would therefore be 0.5 and with a 95% confidence level, and at least 5 percent - plus or minus -precision considered, our calculation resulted in a 384 representative sample population to be studied, that is,

$$n_0 = \frac{Z^2pq}{e^2}$$

$n_o = (1.96)^2\ (0.5)\ (0.5)/\ (0.05)^2$ Therefore, no = 384

Judgement Sampling techniques was used to select communities within the study area based on community size, years built and community layout and was mapped using Esri GIS Mapping Survey employed by the St. James Municipal Corporation. This allowed us to differentiate communities into two strata. Stratum 1 contained communities within a 1-3 km distance from the landfill site, while Stratum 2 represented communities 3-5 km from the Retirement Landfill.

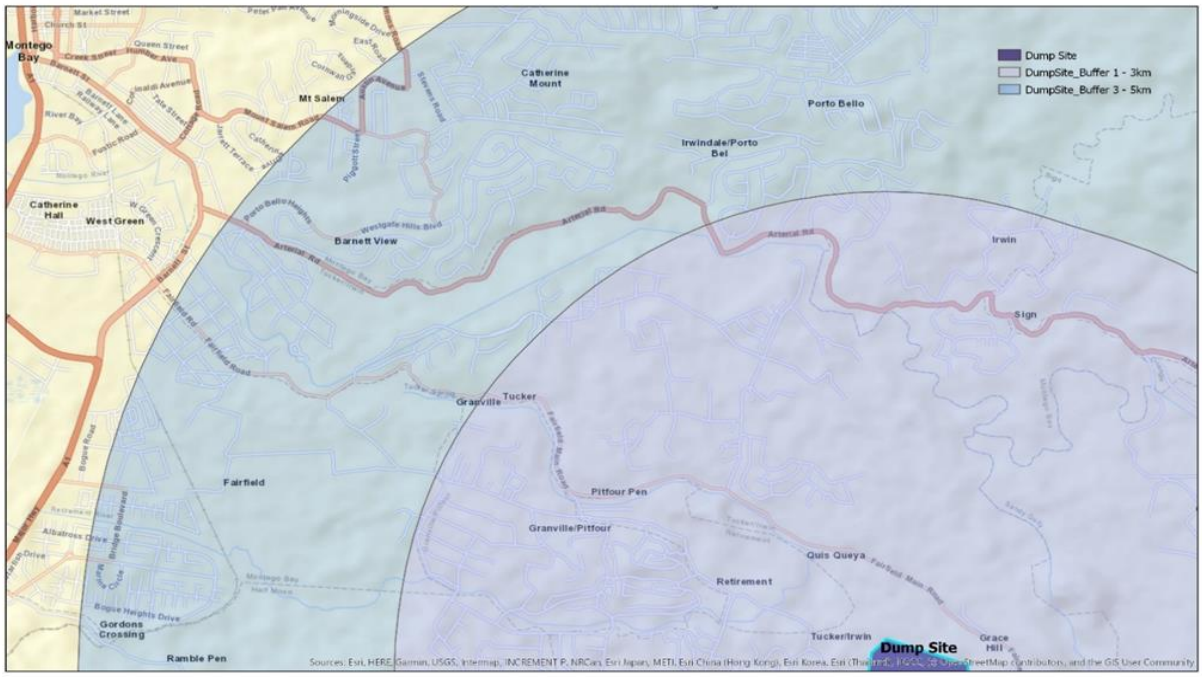

Figure 2: Esri Mapping of Sample Area

As Shown in Table 2 below each Stratum comprised of three communities each chosen at random. Houses in the communities visited were selected using systematic sampling with every 2nd home on either side of the street to be included until the sample size of 384 was achieved.

Study Areas	Enumeration District	Men	Women	Total
Strata 1 (1 - 3 Km)				
Retirement	West Central 36 - 38 and 41 - 43	1,888	1,967	3,855
Granville	West Central 31, 32 and 44-54	2,782	2,887	5,669
Pitfour	West Central 42 and 43	662	766	1,428
Strata 2 (3 - 5 Km)				
Westgate Hills	West Central 21, 26 and 27	583	650	1,233
Catherine Mount	West Central 24 and 25	524	636	1,160
Bogue Village	West Central 1, 56-67 and 69-72	3,791	4,039	7,830
Total		**10,230**	**10,945**	**21,175**

Table 2 : Enumeration Districts of the Sample Population.

(Statistical Institute of Jamaica, 2011)

Data Collection

Using a quantitative research design, structured closed-ended questionnaires were administered directly by the interviewer to residents living within 5km of the Retirement landfill site. The 4-page questionnaire collected data on demographics, location and range of symptoms indicative of increased exposure to smoke and odour from landfill sites. A team of two researchers were assigned a specific community in which to conduct the survey, and a starting point determined randomly by the selection of a numbered piece of paper, that represented the various housing units in the assigned community.

In the assigned communities' questionnaires were interviewer-administered to every second housing unit depending on the Enumeration District in which the interviewer conducted the

survey. Respondents comprised of any member of the household that was over the age of 18 years old and willing to participate in the study. The researchers explained the purpose of the study and asked for the required consent to administer the questionnaire. In the event that residents were unavailable at their place of residence, respondents in the next house on the same side of the street was sampled. After this, the original sampling interval of every two house resumed. Questionnaires were administered Mondays to Thursdays between 3-7pm and on Sundays between 10am-6pm with 1-hour lunch breaks and, three 15-minute rest breaks included.

Data Analysis

Administered questionnaires were processed and checked for completeness, accuracy and consistency of responses in order to identify and remove errors. The responses of the data gathered from the survey were inputted into IBM Statistical Package for Social Sciences (SPSS) software for analysis. The main analysis techniques used were descriptive in nature. The advantage of using this method is that tools such as tables, frequencies, and percentages was used to present descriptive analysis of the responses.

The use of inferential statistics through probability calculations and the resulting P-value that determined the acceptance or rejection of the null hypothesis outlined in our main Research Question 1 was utilized. Chi-square testing was used to assess goodness of fit between our observed results and those expected theoretically, this included Cramer's V testing.

The chi-square is calculated by the sum of the squared difference between observed (O) and the expected (E) data (or the deviation, d) divided by the expected data.

Reliability and Validity

In quantitative studies, creating a well thought out research plan detailing data collection and analysis assisted in reducing bias in our study. A 20-respondent pilot test was used to refine the research instrument and establish protocols and procedures. Participation selection and research bias represents critical areas of review to minimize errors in our research. To minimize participation selection bias, the use of mixed sampling technique utilizing stratified random sampling, as well as systematic sampling increases the possibility of including a representative portion of our sample population.

The decision to administer the survey to every second house reduces personal choice on the part of the researchers to only go to houses based on elements of perceived demographic profile, such as more attractive or larger house, thereby reducing elements of research bias. Incidents of research error were also reviewed and the use of in between rest breaks was therefore implemented to reduce the influence of fatigue in capturing data received from respondents.

In cases where respondents were inclined to answer closely linked questions the same way, researchers administering the questionnaires were guided to adjust the variation of asking question to minimize this. A preset question rewording template agreed upon by the researchers was designed. This template consisted of common synonyms for words used throughout the questionnaire that may not be readily understood by some respondents e.g. the word "odour" was interchanged with "bad smell" to streamline the way the researcher explained certain terms minimizing interviewer bias, thus increasing consistency in how information is solicited, recorded, or interpreted.

Leading questions and wording were also areas of concern that were addressed primarily through the closed ended and structured design of our questions, thereby minimizing the tendency to elaborate on participants' responses and infer researchers' personal assessment of responses. Questions were designed to remain direct and clear in order to avoid ambiguity.

Reliability and validity of the study were assessed through statistical tests such as the Cronbach Alpha using SPSS (Statistical Package for Social Sciences by IBM incorporated). For these tests to be done a pretest of the instrument using a sample of 20 participants outside of the study area was done, to establish any weaknesses relating to ambiguity of the questions, and the necessary adjustments were therefore made. The system generated the Cronbach's alpha value and

just like a correlation coefficient, the closer it is to one, the higher the reliability and validity of our instrument. The results of the test were 0.581 and Cronbach's Alpha Based on Standardized Items 0.597. There are varying views on the interpretation of Cronbach's Alpha value many of which provided different "acceptability" values that would indicate the reliability and validity of their test (Taber, 2017).The widely accepted idea of there being a marker of acceptability of alpha values and viewing lower values as an indication of an unsatisfactory instrument should be the case (Plummer & Tanis Ozcelik, 2015). Griethuijsen et al. (2014) in his study pointed out that acceptable values of Cronbach's alpha started at 0.6 a value and as such our Cronbach Alpha value of 0.581 was interpreted as an indication that our study adequately accounted for reliability and validity. We recommend using more Likert Sca1e questions for future studies in order to improve the strength of the data collection instrument.

Timeline and Budget

Refer to Appendix B for Table showing timeline for completion of study and Appendix C for table showing our research budget.

Ethical Considerations

The research proposal was presented to the Graduate Studies Department of the University of the Commonwealth Caribbean for evaluation and acceptance. Ethical consideration was given in adherence to informed consent; therefore, all the participants in our study were informed about the purpose of the research. It was made known to the respondents that the research is solely for academic purposes and therefore presented no known risks involved in one's participation.

Voluntary participation was another ethical issue that was adhered to by the researcher. Participants were not forced to participate in the research but were selected based on their willingness to participate in the study. Respondents were also informed about their freedom to withdraw from the study at any point in time where they believe that the questions were not applicable to them. Confidentiality was assured in that information retrieved will not be disclosed to anyone and for that matter their names and identities were not needed and will not be featured in the research. Disposal of information was also considered - the researchers assured the participants that all information relating to them will be destroyed after the work has been accepted by the Graduate School. With regards to referencing, all references and information sources were acknowledged in our work.

Chapter 4. Results

In Chapter 3 we discussed the research design and methodology which were implemented to address our research questions. This chapter presents analysis of our results achieved with applying methodologies outlined in the previous chapter. Data was analysed to identify, describe and explore the relationship between exposure of residents living 1-3km and 3-5km from the Retirement Landfill, to landfill smoke and odour and the health effects this may have on the residents. The section contains reports on research finding and an explanation of the data as appropriate. The chapter is organized under three main headings: response rate, demographic data and findings. The findings are presented under subheadings relating directly to the research questions. The chapter ends with a summary of the major findings.

Response Rate

Of the 384 participants targeted for this study, all respondents participated, resulting in a 100.0% response rate. Six communities were selected that were located with 5 km of the Retirement Landfill. Sixty-four (64) participants were selected from each community. Table 3 below shows the response rate for each community.

Communities	Distance (km)	Number Selected (n)	Actual Number Participating	Response Rate
Granville	1-3 km	64	64	100.00%
Retirement	1-3 km	64	64	100.00%
Pitfour	1-3 km	64	64	100.00%
Bogue Village	3-5 km	64	64	100.00%
Westgate Hills	3-5 km	64	64	100.00%
Catherine Mount	3-5 km	64	64	100.00%
Total		**384**	**384**	

Table 3 : Response Rate of Study Participants

Demographic Data

This section presents demographic variables such as age range, gender, education and employment profile, followed by years lived in the communities studied. The socio-demographic characteristics of household respondents as collected during our field survey are presented below.

Age and Sex

From our data collection across 384 respondents surveyed (26.6%) were between 44 years and 56 years. This was followed by those respondents (26.0%) who were between 18 and 30 years, while a quarter (25.3%) were between 31 and 43 years old. Those who were between 57 and 59 years old accounted for 15.1% while the smallest proportion of respondents (7.0%) were 70 years old and over. Respondents were predominantly males (56.3%) while (43.8%) were females. As seen in Table 4 below, younger respondents were predominantly females while older respondents were predominantly males. The data revealed that most respondents between 18 and 43 years old were female, (56%) while most respondents between 44 and 70 years and older were males (52.4%).

Age (Years)	Sex		Total
	Male	Female	
18 -30	24.50%	28.00%	26.00%
31 - 43	23.10%	28.00%	25.30%
44 - 56	27.80%	25.00%	26.60%
57 - 70	16.70%	13.10%	15.10%
70 and over	7.90%	6.00%	7.00%
Total	**56.30%**	**43.80%**	**100.00%**

Table 4 : Cross Tabulation of Gender and Age Range of Participant

Education Profile

The highest level of education attained by the majority of respondents (55.2%) was secondary education. As shown in Table 5 below this was followed by those who attained tertiary level education (28.4%) and (16.4%) who had attained primary level education.

Educational Level	Number of Participants	Percentage
Primary	63	16.4
Secondary	212	55.2
Tertiary	109	28.4
Total	384	100

Table 5 : Respondents' Educational Profile

Employment Profile

The majority of the residents were employed (78.4%). Of this category, most were employed by a company (41.7%) while 36.7% were self-employed. A little over one-tenth (11.2%) were retired, followed by (8.9%) who were unemployed. Students accounted for (1.6%) of residents interviewed. See Table 6 below.

Employment Category	Number of Participants	Percentage
Employed	160	41.7
Retired	43	11.2
Self-employed	141	36.7
Student	6	1.6
Unemployed	34	8.9
Total	**384**	**100**

Table 6 : Respondents' Employment Profile

Tenure of Residence

In Table 7 it is shown that the majority (73.2%) of residents lived in their respective communities for over ten years. This was followed by one-tenth of the residents (9.9% and 9.6%) who had lived in the community between 1-4 years and 5-9 years respectively; while (7.3%) lived in the community for less than one year.

Tenure of Residence	Number of Participants	Percentage
Less than 1 year	28	7.3
1-4 years	38	9.9
5-9 years	37	9.6
10 years & above	281	73.2
Total	**384**	**100**

Table 7 : Respondents' Tenure of Residence Profile

Exposure Profile to Environmental Pollutants

An initial breakdown of community distance and exposure environmental pollutants shows that regardless of distance (1-3 km or 3-5 km) most respondents (65.6% and 73.7% respectively), reported that they were not exposed to vapours, gas, dust, or fumes that caused them to experience any respiratory illnesses at work as shown in Table 8.

Do you or any member of your household work in a job that exposes you to vapours, gas, dust, or fumes that causes you to experience any respiratory illnesses?	Distance		
	3-5 km	1-3 km	Total
Yes	23.70%	32.30%	28.00%
No	73.70%	65.60%	69.60%
I don't know	2.60%	2.10%	2.40%
Total	49.70%	50.30%	100.00%
χ^2 (2, N = 382) = 3.539, p-value < 0.05			

Table 8 : Respondents' Exposure to Pollutants at Work Across Community Groups

As shown in Table 9 below, regardless of distance (3-5 km 31.9% vs. 1-3 km 28.1%) most respondents reported that they never experienced smoke and fumes coming from heavy vehicles (for example, trucks or buses) that drive past their home.

How often do you experience smoke and fumes coming from heavy vehicles (for example, trucks or buses) that drive past your home?	Distance		Total
	3-5 km	1-3 km	
Never	31.90%	28.10%	30.00%
Rarely	22.00%	27.10%	24.60%
Sometimes	20.90%	15.60%	18.30%
Often	9.40%	15.60%	12.50%
Always	15.70%	13.50%	14.60%
Total	49.90%	50.10%	100.00%
χ^2 (4, N = 383) = 6.202, p-value > 0.05			

Table 9: Respondents' Exposure to Pollutants at Home Across Community Strata

Occurrence of Landfill Smoke

Almost two-thirds (65.1%) of respondents experienced smoke coming from the Retirement Landfill. Thirty-five percent of residents, however, did not experience smoke from the landfill.

As seen in Table 10, the majority of respondents (92.2%) who experienced smoke from the landfill resided 1-3 km away from the landfill.

As shown in Table 10 below, this association was statistically significant (χ^2 (1, N = 384) = 123.980, p-value < 0.01) and moderately strong (Cramer's V = 0.568).

Do you experience smoke coming from the Retirement landfill in your community?	Distance		Total
	3-5 km	1-3 km	
Yes	38.00%	92.20%	65.10%
No	62.00%	7.80%	34.90%
Total	50.00%	50.00%	100.00%
χ^2 (1, N = 384) = 123.980, p-value < 0.01 and Cramer's V = 0.568			

Table 10 : Occurrence of Retirement Landfill Smoke Across Community Strata

Table 11 below, shows that of the respondents who indicated that they experienced smoke from the landfill, residents of Granville (95.3%) were more likely to indicate exposure compared to all other communities. On the other hand, residents of Westgate Hills (84.4%) were more likely to indicate that they did not experience any smoke. This association was statistically significant (χ^2 (5, N = 384) = 178.635, p-value < 0.01) and moderately strong (Cramer's V = 0.682).

Do you experience smoke coming from the Retirement landfill in your community	Community						Total
	Bogue Village	Catherine Mount	Granville	Pitfour	Retirement	Westgate Hills	
Yes	73.40%	25.00%	95.30%	0.906	90.60%	15.60%	65.10%
No	26.60%	75.00%	4.70%	0.094	9.40%	84.40%	34.90%
Total	16.70%	16.70%	16.70%	0.167	16.70%	16.70%	100.00%
χ^2 (5, N = 384) = 178.635, p-value < 0.01 and Cramer's V =0.682							

Table 11: Occurrence of Retirement Landfill Smoke per Community

Frequency of Landfill Smoke

Regarding the frequency of smelling landfill smoke, the largest proportion of respondents (37.6%) indicated that they sometimes smelt smoke arising from the landfill followed by 27.9% who never experienced smoke from the landfill. Just under one fifth (18.1%) rarely experienced smoke; 12.3% of residents often experienced smoke from the landfill while 4.2% indicated that they always smelled smoke arising from the landfill.

Respondents who resided 1-3 km away from the landfill were frequently exposed to smoke from the Retirement Landfill compared to those who were 3-5 km away, as seen in Table 12 below. This association observed was statistically significant (χ^2 (4, N = 359) = 99.931, p < 0.01) and moderately strong (Cramer's V = 0.528).

How often do you smell smoke arising from the landfill?	Distance		Total
	3-5 km	1-3 km	
Never	50.30%	8.30%	27.90%
Rarely	21.60%	15.10%	18.10%
Sometimes	22.20%	51.00%	37.60%
Often	5.40%	18.20%	12.30%
Always	0.60%	7.30%	4.20%
Total	46.50%	53.50%	100.00%
χ^2 (4, N = 359) = 99.931, p-value < 0.01 and Cramer's V = 0.528			

Table 12 : Frequency of Retirement Landfill Smoke across Community Strata

Respondents who resided in Westgate Hills were more likely to report that they never (76.5%) experienced smoke from the landfill. However, respondents who resided in Granville, as shown in Table 13 below, were more likely to indicate that they have been exposed to smoke sometimes (54.7%) and always (10.6%).

As shown in Table 13 below, this association observed was statistically significant (χ^2 (20, N = 359) = 155.592, p < 0.01) and moderately strong (Cramer's V = 0.329).

How often do you smell smoke arising from the landfill?	Community						Total
	Bogue Village	Catherine Mount	Granville	Pitfour	Retirement	Westgate Hills	
Never	20.00%	58.90%	6.30%	0.109	7.80%	76.50%	27.90%
Rarely	26.70%	21.40%	12.50%	0.141	18.80%	15.70%	18.10%
Sometimes	41.70%	14.30%	54.7%	0.547	43.80%	7.80%	37.60%
Often	10.00%	5.40%	15.60%	0.156	23.40%	0.00%	12.30%
Always	1.70%	0.00%	10.90%	0.047	6.30%	0.00%	4.20%
Total							**0.178**
χ^2 (20, N = 359) = 155.592, p-value < 0.01 and Cramer's V = 0.329							

Table 2 : Frequency of Retirement Landfill Smoke per Community

Community Concern about Landfill Smoke and Health Implications

The majority (60.1%) of residents expressed that they were extremely concerned about respiratory implications from the smoke from the landfill. This was followed by 15.4% who indicated they were not concerned at all and just over one-tenth (10.7%) who were moderately concerned about the respiratory health implications from the smoke from the landfill. A small proportion (8.7% and 5.1%) were slightly and somewhat concerned.

As shown in Table 14, respondents who resided 1-3 km away from the landfill (65.1%) were more likely to report that they were extremely concerned about how the smoke would affect their health as opposed to persons residing within 3-5 km. This association observed was statistically significant (χ^2 (4 N = 356) = 18.169, p < 0.05) but weak (Cramer's V = 0.182).

How concerned are you about respiratory health implications from this smoke?	Distance		Total
	3-5 km	1-3 km	
Not at all concerned	22.60%	9.40%	15.40%
Slightly concerned	8.50%	8.90%	8.70%
Somewhat concerned	4.90%	5.20%	5.10%
Moderately concerned	9.80%	11.50%	10.70%
Extremely concerned	54.30%	65.10%	60.10%
Total	46.10%	53.90%	100.00%
χ^2 (4, N = 356) = 18.169, p-value < 0.05 and Cramer's V = 0.182			

Table 14 : Level Of Concern Over Health Implications of Landfill Smoke

Medical Diagnosis of Illness Associated with Landfill Smoke Amongst Residents

When asked if they or any member of their household had been diagnosed by a doctor, nurse, or other health professional with a respiratory illness, more than three quarters of participants (77.6%) said no. One fifth (20.1%) of residents said they had been medically diagnosed with a respiratory illness, while 2.3% did not know if they or any household member had been diagnosed.

Of the 67 residents who indicated that they or any member of their household had been diagnosed by a doctor, nurse, or other health professional with a respiratory illness, the majority (74.6%) had been diagnosed since living in their community. One quarter (25.4%) of the residents were medically diagnosed with a respiratory illness prior to living in the community.

As seen in Table 15 below, respondents from both groups who resided 1-3 km (83.0%) and 3-5 km (55.0%) away from the landfill indicated that they were diagnosed with respiratory health issues since living in their community. However, respondents who resided 1-3 km away from the landfill were more likely to agree with this statement. This association observed was statistically significant (χ^2 (1, N = 67) = 5.800, p < 0.01) but weak (Cramer's V = 0.294).

Diagnosed with Respiratory Health issue since living in the community	Distance		Total
	3-5 km	1-3 km	
Yes	55.00%	83.00%	74.60%
No	45.00%	17.00%	25.40%
Total	29.90%	70.10%	100.00%
χ^2 (1, N = 67) = 5.800, p-value < 0.01 and Cramer's V = 0.294			

Table 15 : Diagnosis of Respiratory Illnesses across Community Strata

Range of Health Symptoms Experienced from Landfill Smoke

Coughing was the primary symptom experienced by a majority (77.7%) of residents due to smoke from the landfill in their community. This was followed by heaviness in breathing, which was experienced by 48.6% of residents, shortness of breath experienced by 36.5% of residents, and wheezing experienced by one third (33%) of residents.

The symptoms least experienced by residents were increased effort in breathing and gasping for air, which was experienced by 27% and 18.2% of residents respectively (See Figure 1 below).

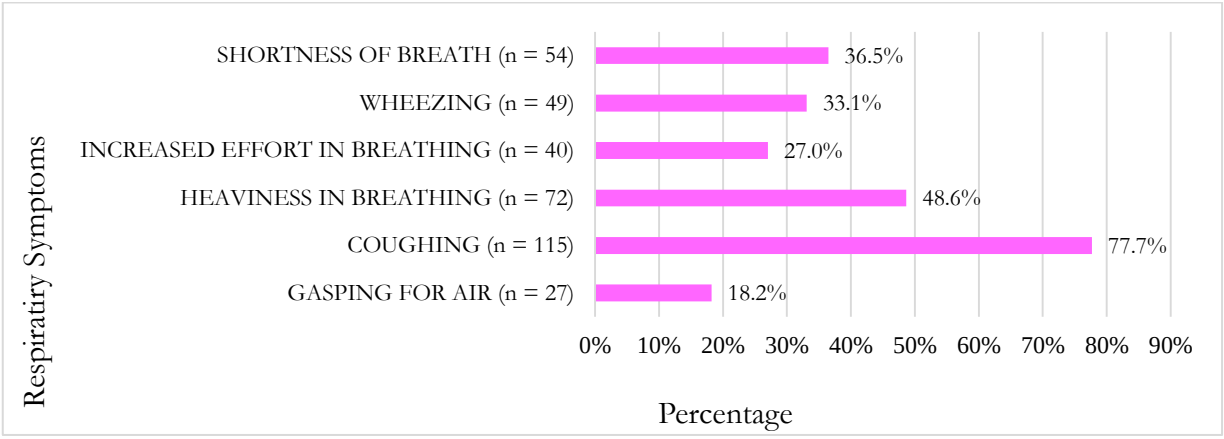

Figure 3: Respiratory Symptoms Reported from Exposure To Retirement Landfill Smoke (n=148)

Assessment of Health Symptoms From Landfill Smoke Correlated to Distance from The Landfill

Association between Distance and Shortness of Breath

The data showed that there was a statistically significant association (χ^2 (1, N = 226) = 14.295, p < 0.01) between distance and "shortness of breath". It was observed that respondents who lived within 1-3 km (33.9%) from the Retirement Landfill were more likely to indicate that they experience "shortness of breath" as a result of the smoke from the landfill. However, a weak association was reported (Cramer's V = 0.251). Refer to details in Table 16 below.

Shortness of Breath		Yes	No	Total
Distance	3-5 km	12.40%	87.60%	100.00%
	1-3 km	33.90%	66.10%	100.00%
Total		23.90%	76.10%	100.00%
χ^2 (1, N = 226) = 14.295, p-value < 0.01 and Cramer's V = 0.251				

Table 16 : Incidence of Shortness of Breath across Community Groups

Association between Distance and Wheezing

Similarly, Table 17 shows that there was a statistically significant difference (χ^2 (1, N = 221) = 16.792, p < 0.01) between respondents who lived 1-3 km and 3-5 km away from the landfill. It was observed that respondents who resided 1-3 km (32.8%) were more likely to report that they experience symptoms such as "wheezing" as a result of the smoke from the landfill. A weak association was however reported (Cramer's V = 0.276).

Wheezing		Yes	No	Total
Distance	3-5 km	9.80%	90.20%	100.00%
	1-3 km	32.80%	67.20%	100.00%
Total		22.20%	77.80%	100.00%
χ^2 (1, N = 221) = 16.792, p-value < 0.01 and Cramer's V = 0.276				

Table 17 : Incidence of Wheezing across Community Groups

Association Between Distance and Increased Effort in Breathing

Respondents who resided 1-3 km away from the landfill were more likely (27.3%) to indicate that they experienced "increased effort in breathing" when compared to those who lived 3-5 km away (9.8%). This difference was statistically significant (χ^2 (1, N = 212) = 10.550, p < 0.01), with a weak association (Cramer's V = 0.223). See table 18 below.

Increased Effect in Breathing		Yes	No	Total
Distance	3-5 km	9.80%	90.20%	100.00%
	1-3 km	27.30%	72.70%	100.00%
Total		18.90%	81.10%	100.00%
χ^2 (1, N = 212) = 10.550, p-value < 0.01 and Cramer's V = 0.223				

Table 18 : Incidence of Increased Effort in Breathing Across Community Groups

Association between Distance and Heaviness in Breathing

The data showed that there was a statistically significant association (χ^2 (1, N = 244) = 13.511, p < 0.01) between distance and respondents experiencing "heaviness in breathing" as a result of the smoke from the landfill.

As seen in Table 19, most respondents did not experience "heaviness in breathing", however, respondents who were located 1-3 km away (39.4%) from the landfill were more likely to experience heaviness in breathing compared to those who lived 3-5 km away (17.9%). This correlation was weak, recording a Cramer's V value of 0.235.

Heaviness in Breathing		Yes	No	Total
Distance	3-5 km	17.90%	82.10%	100.00%
	1-3 km	39.40%	60.60%	100.00%
Total		29.50%	70.50%	100.00%
χ^2 (1, N = 244) = 13.511, p-value < 0.01 and Cramer's V = 0.235				

Table 19 : Incidence of Heaviness in Breathing Across Community Groups

Association between Distance and Coughing

As shown in Table 20, there was a statistically significant association (χ^2 (1, N = 287) = 28.770, p < 0.01) between distance and respondents who experience "coughing". Most of the respondents (52.6%) who resided 1-3 km away from the Retirement Landfill reported that they experienced "coughing" as a result of the smoke from the Retirement Landfill. This association was moderate, recording a Cramer's V value of 0.317.

Coughing		Yes	No	Total
Distance	3-5 km	21.40%	78.60%	100.00%
	1-3 km	52.90%	47.10%	100.00%
Total		40.10%	59.90%	100.00%
χ^2 (1, N = 287) = 28.770, p-value < 0.01 and Cramer's V = 0.317				

Table 20: Incidence of Coughing across Community Groups

Association between Distance and Gasping for Air

Table 21 shows that the majority of respondents reported that they did not experience "gasping for air" as a result of the landfill smoke. However, respondents who resided 1-3 km (20.0%) away from the Retirement Landfill were more likely to report that they experience symptoms such as "gasping

for air" compared to those who resided 3-5 km away from the Retirement Landfill (7.1%). This association was statistically significant (χ^2 (1, N = 199) = 7.092, p < 0.01) recording a Cramer's V value of 0.189.

Gasping for Air		Yes	No	Total
Distance	3-5 km	7.10%	92.90%	100.00%
	1-3 km	20.00%	80.00%	100.00%
Total		13.60%	86.40%	100.00%
χ^2 (1, N = 199) = 7.092, p-value < 0.01 and Cramer's V = 0.189				

Table 21 : Incidence of Gasping for Air across Community Groups

Severity of Health Symptoms From Landfill Smoke

Except for coughing where the largest proportion (39.1%) experienced mild symptoms, most respondents, (between 32.2% and 42.6%) experienced all symptoms with some level of severity. The largest proportion (42.6%) of these residents experienced severe shortness of breath (See Figure 2 below). The majority (66.5%) of residents did not experience increased health symptoms from respiratory illnesses when landfill smoke was in the community while 33.5% experience elevated health symptoms.

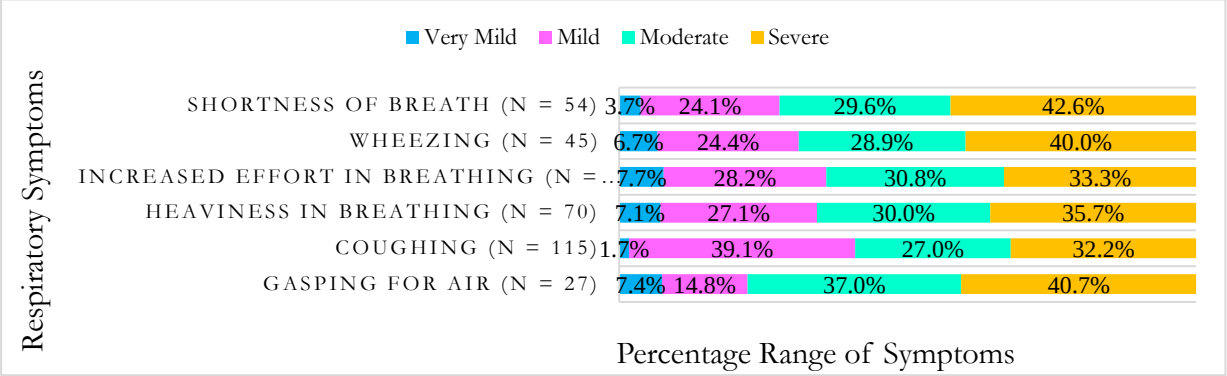

Figure 4: Severity of Respiratory Symptoms

Assessment of Severity of Symptoms From Landfill Smoke by Community Distance

The most severe symptoms of shortness of breath, gasping for air and wheezing were examined across Community groups and displayed in the Tables below.

Severity of Shortness of Breath

Respondents who resided closer (1-3 km 48.8% vs 3 -5 km 23.1%) to the landfill were more likely to report that they experienced severe cases of "shortness of breath". This difference, however, was not statistically significant, as displayed in Table 22 (χ^2 (2, N = 54) = 3.164, p > 0.05).

Severity of Symptoms Shortness of breath	Distance		Total
	3-5 km	1-3 km	
Mild	30.80%	26.80%	27.80%
Moderate	46.20%	24.40%	29.60%
Severe	23.10%	48.80%	42.60%
Total	24.10%	75.90%	100.00%
χ^2 (2, N = 54) = 3.164, p-value > 0.05			

Table 22: Severity of Shortness of Breath across Community Strata

Severity of Gasping for Air

As presented in Table 23, respondents who resided 1-3 km away (45.0%) from the landfill were more likely to indicate that they experienced severe symptoms concerning gasping for air. This association was however not statistically significant (χ^2 (2, N = 27) = 0.601, p > 0.05).

Severity of Symptoms: Gasping for Air	Distance		Total
	3-5 km	1-3 km	
Mild	28.60%	20.00%	22.20%
Moderate	42.90%	35.00%	37.00%
Severe	28.60%	45.00%	40.70%
Total	25.90%	74.10%	100.00%
χ^2 (2, N = 27) = 0.601, p-value > 0.05			

Table 23 : Severity of Gasping for Air across Community Strata

Severity of Wheezing

As displayed in Table 24 below, respondents who resided 1-3 km away (41.7%) from the landfill were more likely to indicate that they experienced "wheezing" which was severe. This association was not statistically significant (χ^2 (2, N = 45) = 0.941, p > 0.05).

Severity of Symptoms Wheezing	Distance		Total
	3-5 km	1-3 km	
Mild	44.40%	27.80%	31.10%
Moderate	22.20%	30.60%	28.90%
Severe	33.30%	41.70%	40.00%
Total	20.00%	80.00%	100.00%
χ^2 (2, N = 45) = 0.941, p-value > 0.05			

Table 24 : Severity of Wheezing across Community Strata

Occurrence of Landfill Odour

More than half of the respondents (59.3%) indicated experiencing bad smells from the landfill while 40.7% did not. Respondents who resided 1-3 km away from the Retirement landfill were 85.9% more likely to indicate that they experience bad odour. This association was statistically significant (χ^2 (1, N = 371) = 116.999, p-value < 0.01) and moderately strong (Cramer's V = 0.562), as shown in Table 25 below.

Do you experience bad smells in your community arising from the Retirement Landfill?	Distance		Total
	3-5 km	1-3 km	
Yes	30.70%	85.90%	59.30%
No	69.30%	14.10%	40.70%
Total	48.20%	51.80%	100.00%
χ^2 (1, N = 371) = 116.999, p-value < 0.01 and Cramer's V = 0.562			

Table 25: Occurrence of Landfill Odour across Community Strata

As shown in Table 26, of those who experienced bad odour, respondents who resided in the community of Retirement were 90.6% more likely to report that they indeed experienced bad odour. This association was statistically significant (χ^2 (5, N = 371) = 137.509, p-value < 0.01) and moderately strong (Cramer's V = 0.609).

Do you experience bad smells in your community arising from the Retirement Landfill?	Community						Total
	Bogue Village	Catherine Mount	Granville	Pitfour	Retirement	Westgate Hills	
Yes	51.60%	20.60%	89.10%	78.10%	90.60%	17.30%	59.30%
No	48.40%	79.40%	10.90%	21.90%	9.40%	82.70%	40.70%
Total	17.30%	17.00%	17.30%	17.30%	17.30%	14.00%	100.00%
χ^2 (5, N = 371) = 137.509, p-value < 0.01 and Cramer's V = 0.609							

Table 26: Occurrence of Landfill Odour per Community

Frequency of Landfill Odour

A little over one third (35%) of residents indicated that within the last 12 months, they sometimes experienced bad smells coming from the landfill in their community, while one-third of residents (33.5%) reported that they never experienced bad smells from the landfill. Just under one fifth (19.2%) of residents rarely experienced bad smells from the landfill while almost one-tenth (9%) said they often experienced bad smells from the landfill. The smallest proportion (3.3%) reported that they always experienced bad smells coming from the landfill in their community.

Respondents who resided 1-3 km away from the landfill were frequently exposed to bad odour from the Retirement landfill compared to those who were 3-5 km away. This association observed was statistically significant (χ^2 (4, N = 334) = 85.831, p < 0.01) and moderately strong (Cramer's V = 0.507) see Table 27 below.

How often do you experience bad smells coming from the landfill in your community during the last 12 months?	Distance		Total
	3-5 km	1-3 km	
Never	60.40%	13.20%	33.50%
Rarely	15.30%	22.10%	19.20%
Sometimes	19.40%	46.80%	35.00%
Often	4.20%	12.60%	9.00%
Always	0.70%	5.30%	3.30%
Total	43.10%	56.90%	100.00%
χ^2 (4, N = 334) = 85.831, p-value < 0.01 and Cramer's V = 0.507			

Table 27 : Frequency of Landfill Odour across Community Strata

Respondents who resided in Westgate Hills (76.3%) were more likely to report that they never experienced bad odour from the landfill. However, respondents who resided in Granville were more likely to indicate that they have always (10.6%) experienced bad odour from the Retirement landfill. This association observed was statistically significant (χ^2 (20, N = 334) = 121.213, p < 0.01) and moderately strong (Cramer's V = 0.301). See details in Table 28 below.

How often do you experience bad smells coming from the landfill in your community during the last 12 months?	Community						Total
	Bogue Village	Catherine Mount	Granville	Pitfour	Retirement	Westgate Hills	
Never	42.40%	70.20%	10.90%	20.60%	7.90%	76.30%	33.50%
Rarely	13.60%	14.90%	23.40%	15.90%	27.00%	18.40%	19.20%
Sometimes	33.90%	12.80%	50.00%	50.80%	39.70%	5.30%	35.00%
Often	8.50%	2.10%	7.80%	12.70%	17.50%	0.00%	9.00%
Always	1.70%	0.00%	7.80%	0.00%	7.90%	0.00%	3.30%
Total	17.70%	14.10%	19.20%	18.90%	18.90%	11.40%	100.00%
χ^2 (20, N = 334) = 121.213, p-value < 0.01 and Cramer's V = 0.301							

Table 28 : Frequency of Landfill Odour per Community

Community Concern about Landfill Odour and Illnesses

The majority (80.7%) of the residents reported having some level of concern about the effects of the bad smells from the landfill on their health, while just under one fifth (19.3%) reported not being concerned at all. Among the concerned, more than half (57.1%) were extremely concerned followed by almost one-tenth (9.4%) who were moderately concerned; 7.9% were slightly concerned and 6.3% reported being somewhat concerned.

As shown in Table 29 below, respondents who resided 1-3 km away (64.6%) from the landfill were more likely to report that they were extremely concerned about how the bad odour

from the landfill will affect their health. This association observed was statistically significant (χ^2 (20, N = 331) = 29.204, p < 0.01) and weak correlation (Cramer's V = 0.287)

How concerned are you with the effects of this bad smell on your health?	Distance		Total
	3-5 km	1-3 km	
Not at all concerned	32.40%	9.90%	19.30%
Slightly Concerned	6.50%	8.90%	7.90%
Somewhat Concerned	7.90%	5.20%	6.30%
Moderately Concerned	6.50%	11.50%	9.40%
Extremely Concerned	46.80%	64.60%	57.10%
Total	42.00%	58.00%	100.00%
χ^2 (4, N = 331) = 29.204, p-value < 0.01 and Cramer's V = 0.287			

Table 29 : Level of Concern of Landfill Odour across Strata

Medical Diagnosis of Illnesses Associated with Landfill Odour Amongst Residents

While just under one-tenth (8.2%) of the residents reported having to visit a health professional for any illnesses arising from the bad smell at the landfill, the majority (91.8%) of residents reported not having to seek medical assistance for ill health caused by the bad smells from the landfill.

The majority (63.5%) of residents indicated that they had developed symptoms related to the bad smells emanating from the landfill since living in the community. Just under one third (31.7%) indicated that they had these symptoms prior to living in the community, while 4.8% did not know whether they had developed the symptoms prior to or since living in the community.

As presented in Table 30, respondents who resided 1-3 km away from the landfill made up a larger portion of respondents were more likely to agree that they developed symptoms associated with bad odour since living in the community (75.0%) vs respondents living further away. This association observed was statistically significant (χ^2 (2, N = 104) = 18.842, p-value < 0.001) and moderately strong (Cramer's V = 0.426). However, it should be noted that this association is not valid because more than 20% of cells had an expected value of less than 5.

Did you develop these symptoms since living in this community?	Distance		Total
	3-5 km	1-3 km	
Yes	32.10%	75.00%	63.50%
No	64.30%	19.70%	31.70%
I don't know	3.60%	5.30%	4.80%
Total	**26.90%**	**73.10%**	**100.00%**

Table 30 : Residency and Development of Health Symptoms from Landfill Odour

Overview of Health Symptoms Displayed From Exposure to Landfill Odour

More than half of the residents (56.3%) reported experiencing headaches as a result of the bad smells emanating from the landfill in their community. This was followed by 39.3% who reported experiencing nausea and just over one third (34.8%) of residents who reported having trouble sleeping.

The symptoms least experienced due to the bad smells from the landfill included fatigue, dizziness, loss of appetite and vomiting which was experienced by 28.6%, 23.2%, 19.6% and 11.6% of residents respectively (Refer to Figure 3 below).

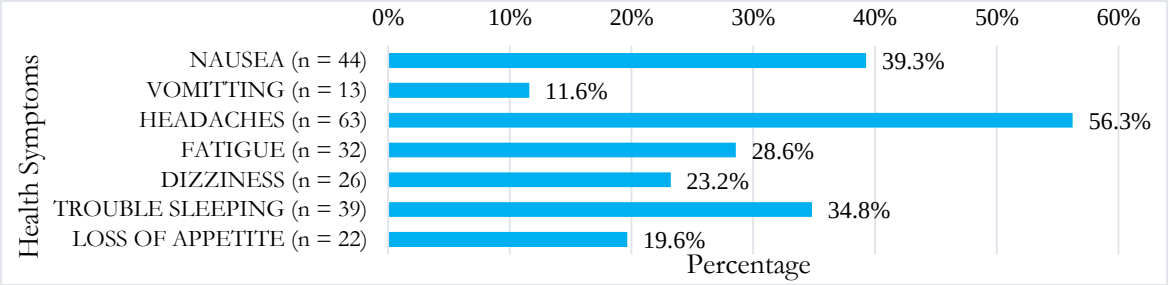

Figure 5: Health Symptoms Reported from Exposure to Retirement Landfill Odour (n=112)

Assessment of Health Symptoms From Landfill Odour Correlated Distance from The Landfill

Association Between Distance and Nausea

As presented in Table 31 below, there was no statistically significant association (χ^2 (1, N = 234) = 3.166, p > 0.05) between distance and respondents who experienced nausea.

It was observed however that respondents who resided closer (1-3 km 22.6% vs 3-5 km 13.4%) to the Retirement landfill were more likely to report that they experienced symptoms associated with nausea.

Nausea		Yes	No	Total
Distance	3-5 km	13.40%	86.60%	100.00%
	1-3 km	22.60%	77.40%	100.00%
Total		18.80%	81.20%	100.00%
χ^2 (1, N = 234) = 3.166, p > 0.05)				

Table 31 : Incidence of Nausea across Community Groups

Association Between Distance and Vomiting

Although most respondents (1-3km 91.4% vs 3-5 km 96.6%) reported that they did not experience vomiting; respondents who resided closer (1-3 km 8.6% vs 3-5 km 2.4%) to the landfill were more likely to indicate that they experienced vomiting, as shown in Table 32 below.

Vomiting		Yes	No	Total
Distance	3-5 km	3.40%	96.60%	100.00%
	1-3 km	8.60%	91.40%	100.00%
Total		6.40%	93.60%	100.00%
χ^2 (1, N = 203) = 2.219, p-value > 0.05				

Table 32 : Incidence of Vomiting across Community Groups

Association between Distance and Headaches

As seen in Table 33 below, respondents who resided 1-3 km away (31.2%) from the landfill were more likely to report that they experienced "headaches" than those who lived within 3-5 km of the landfill (15.2%). This difference was statistically significant (χ^2 (1, N = 253) = 8.267, p < 0.01). However, the correlation between distance and "headaches" was weak (Cramer's V = 0.181)

Headaches		Yes	No	Total
Distance	3-5 km	15.20%	84.80%	100.00%
	1-3 km	31.20%	68.80%	100.00%
Total		24.90%	75.10%	100.00%
χ^2 (1, N = 253) = 8.267, p-value < 0.01 and Cramer's V = 0.181				

Table 3 : Incidence of Headache across Community Groups

Association between Distance and Fatigue

Respondents who resided 1-3 km away from the Retirement Landfill were 20.3% more likely to indicate that they had experienced "fatigue (tiredness)". This difference was statistically significant (χ^2 (1, N = 222) = 9.318, p < 0.01). with a weak correlation recording a Cramer's V value of 0.205, see Table 34 below.

Fatigue (Tiredness)		Yes	No	Total
Distance	3-5 km	5.60%	94.40%	100.00%
	1-3 km	20.30%	79.70%	100.00%
Total		14.40%	85.60%	100.00%
χ^2 (1, N = 222) = 9.318, p-value < 0.01 and Cramer's V = 0.205				

Table 4: Incidence of Fatigue across Community Group

Association between Distance and Dizziness

The majority of respondents, regardless of distance, indicated that they did not experience dizziness. However, respondents who resided 1-3 km away (16.5%) from the landfill were more likely to report that they experience dizziness. This difference was statistically significant (χ^2 (1, N = 216) = 5.891, p < 0.05), recording a weak relationship/correlation (Cramer's V = 0.165) see Table 35 below.

Dizziness		Yes	No	Total
Distance	3-5 km	5.60%	94.40%	100.00%
	1-3 km	16.50%	83.50%	100.00%
Total		12.00%	88.00%	100.00%
χ^2 (1, N = 216) = 5.891, p-value < 0.05 and Cramer's V = 0.165				

Table 5: Incidence of Dizziness across Community Groups

Association between Distance and Trouble Sleeping

As seen in Table 36 below, there was a statistically significant relationship (χ^2 (1, N = 229) = 7.561, p < 0.01) between distance and respondents experiencing symptoms of "trouble sleeping". Again, the data revealed that respondents who resided 1-3 km away (22.6%) from the landfill were more likely to experience "trouble sleeping" compared to those who resided 3-5 km away (8.7%) from the landfill. This correlation was weak (Cramer's V = 0.182).

Trouble Sleeping		Yes	No	Total
Distance	3-5 km	8.70%	91.30%	100.00%
	1-3 km	22.60%	77.40%	100.00%
Total		17.00%	83.00%	100.00%
χ^2 (1, N = 229) = 7.561, p-value < 0.01 and Cramer's V = 0.182				

Table 36 : Incidence of Trouble Sleeping across Community Groups

Association between Distance and Loss of Appetite

The data revealed that there was a statistically significant difference (χ^2 (1, N = 212) = 7.617, p < 0.01) between respondents who lived 1-3 km and 3-5 km away from the Retirement Landfill. Respondents who resided 1-3 km (15.2%) away were more likely to indicate that they experienced a loss of appetite, as a result of the bad smells they encountered since living in the community. The association was weak (Cramer's V = 0.190) see Table 37 below.

Loss of Appetite		Yes	No	Total
Distance	3-5 km	3.40%	96.60%	100.00%
	1-3 km	15.20%	84.80%	100.00%
Total		10.40%	89.60%	100.00%
χ^2 (1, N = 212) = 7.617, p-value < 0.01 and Cramer's V = 0.190				

Table 37 : Incidence of Loss of Appetite across Community Groups

Overview of Severity of Health Symptoms from Landfill Odour

Among those who experienced a loss of appetite and trouble sleeping, the largest proportion (40%) reported that these symptoms were severe. For all other symptoms - fatigue, vomiting, dizziness, nausea and headaches, the largest proportion of residents (55.2%, 54.5%, 45.8%, 41.9% and 35.5% respectively) reported experiencing these symptoms mildly. It was noted that none of the residents experienced severe vomiting as a result of the bad smells from the landfill in their community (Refer to Figure 4 below).

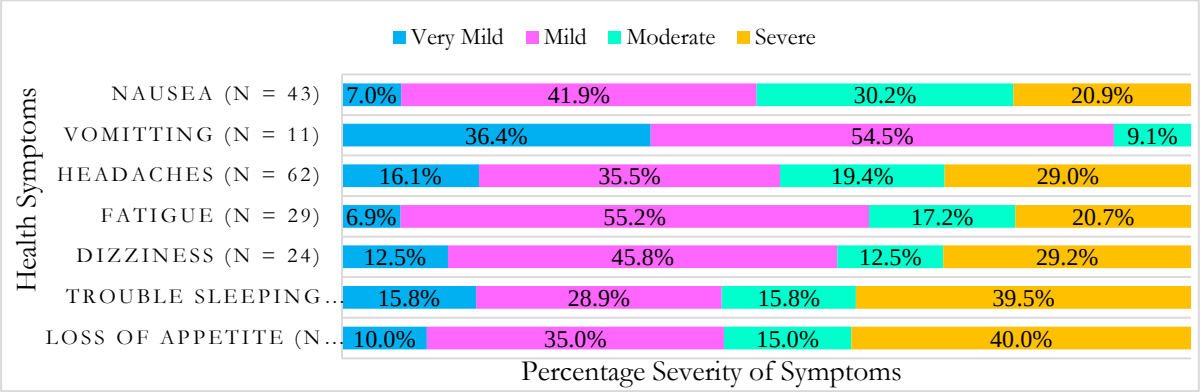

Figure 6: Severity of Symptoms from Retirement Landfill Odour

Assessment of Severity of Symptoms From Landfill Odour By Community Distance

Severity of Loss of Appetite

Interestingly, the data revealed that respondents who resided closer (1-3 km 44.4% vs 3-5 km 0.0%) to the landfill were more likely to indicate that they experienced severe loss of appetite. This association was not statistically significant (χ^2 (2, N = 20) = 2.716, p > 0.05). Details may be found in Table 38 below

Severity of Symptoms Loss of appetite	Distance		Total
	3-5 km	1-3 km	
Mild	50.00%	44.40%	45.00%
Moderate	50.00%	11.10%	15.00%
Severe	0.00%	44.40%	40.00%
Total	10.00%	90.00%	100.00%
χ^2 (2, N = 20) = 2.716, p-value > 0.05			

Table 38 : Severity of Loss of Appetite across Community Strata

Severity of Trouble Sleeping

As presented in Table 39 below, respondents who resided 3-5 km (42.9% vs 1-3 km 38.7%) were more likely to report that they experienced severe trouble sleeping. This association was not statistically significant (χ^2 (2, N = 38) = 0.044, p > 0.05).

Severity of Symptoms Trouble Sleeping	Distance		Total
	3-5 km	1-3 km	
Mild	42.90%	45.20%	44.70%
Moderate	14.30%	16.10%	15.80%
Severe	42.90%	38.70%	39.50%
Total	18.40%	81.60%	100.00%
χ^2 (2, N = 38) = 0.044, p-value > 0.05			

Table 39 : Severity of Trouble Sleeping across Community Strata

Severity of Dizziness

Respondents who resided 3-5 km away (40.0% vs 1-3 km 26.3%) from the landfill were more likely to report that they experienced severe dizziness. This association was also not statistically significant (χ^2 (2, N = 24) = 0.902, p > 0.05) see Table 40 below.

Severity of Symptoms Dizziness	Distance		Total
	3-5 km	1-3 km	
Mild	40.00%	63.20%	58.30%
Moderate	20.00%	10.50%	12.50%
Severe	40.00%	26.30%	29.20%
Total	20.80%	79.20%	100.00%
χ^2 (2, N = 24) = 0.902, p-value > 0.05			

Table 6 Severity of Loss of Dizziness across Community Strata

Chapter 5. Discussion

In Chapter Four we presented findings of our research examining the health effects of landfill smoke and odour on residents living within 1-3 and 3-5km of the Retirement Landfill. This chapter contains the discussion of the research findings outlined in Chapter 4, generalizations and other inferences which make up the conclusion, and the recommendations of the researchers to the beneficiaries of this study can also be identified in this chapter. Suggestions of further research areas ends the chapter and brings the research study to a close.

Discussion

In this study, we sought to evaluate the health impact of the Retirement landfill in St James on the household residents living within 5km of the landfill. The focus was on two factors - health and location. Therefore, it was necessary to have a comparison between the nearby households and the far away households. Most of the household respondents living near the dumpsite and farther away from the dumpsite perceived that the landfill had an impact on their health and the quality of their environment.

Occurrence and Frequency of Landfill Smoke and Odour

Our research study confirmed that 65% of respondents experienced smoke arising from the landfill and of that percentage respondents living within 1-3 k were more than two times likely to experience this landfill smoke. This association, being statistically significant, showed that a moderately strong relationship exists between living distance from the landfill and experiencing landfill smoke. Respondents within 1-3 km of the landfill were six times more likely to encounter landfill smoke on some level of frequency than communities in the 3-5 km range. Although communities in closer proximity to the landfill reported only smelling this landfill smoke sometimes, they were twelve times more likely to always smell landfill smoke than communities further away.

The number of persons who reported smelling landfill odour (stench) were fewer than those who reported smelling landfill smoke by almost 50%. Like landfill smoke residents living closer (1-3km) to the landfill were three times more likely to report smelling landfill odour than residents living further away (3-5 km). Interestingly, Bogue Village, a community within the 3-5 km distance from the landfill had significant rates of exposure to landfill odour (51.6%) leading one to question whether other factors could play a role in the occurrence of landfill odour in that community.

This observation was further explored when we analyzed data on the frequency of smelling landfill odour and found that although respondents living closer to the landfill were twice as likely to smell landfill odour more frequently, respondents in Bogue Village reported a significantly high frequency of smelling landfill odour (57.7%), although majority of respondents reported to smelling this odour sometimes. These results led to an examination into the findings of Sakawi et al. (2010)

who argued that a number of factors outside of proximity to landfill sites could increase the intensity and frequency of smelling landfill odour, and these factors include wind direction and rainfall.

Community Concern about Landfill Smoke and Odour On Health

Respondents reported some level of concern on how landfill smoke and odour could impact their health. Communities 1-3km away from the landfill reported higher percentages of being extremely concerned about landfill smoke affecting health than communities further away (65 % vs. 54%). In regards to landfill odour again we saw community groups closer to the landfill express that they were extremely concerned about the impact of landfill odour on their health (65% vs 47%) Other studies have also confirmed that there is a general concern amongst residents, living in close proximity to landfill operations, on being exposed to landfill smoke and odour, and the impact that this will have on their health (Addo et al., 2015; De Feo et al., 2013; Njoku et al., 2019 & Salam, 2010).

Though findings showed consistency in community groups closer to the landfill expressing extreme concern about the impact the landfill had on health, regardless of whether this was landfill smoke or odour community groups further away were more inclined (by 15%) to express a greater concern of landfill smoke than odour impacting health. Despite these findings when asked if they were willing to relocate the vast majority (over 70 %) from both community groups was unwilling to do so. This may be as a result of the overall cost associated in relocating as opposed to an acceptance of the residents being exposed to landfill odour and smoke.

Correlation between Health Effects of Landfill Smoke and Odour with Distance

The first research question sought to determine whether there were variations in the health implication to residents based on distance from the Retirement Landfill. For this research question, a series of chi-square tests were done to evaluate the following null and alternative hypotheses:

H0: There are no variations in health effects of residents living within 5km of the Retirement Landfill. It is expected that persons living within 1-3 km of the Retirement Landfill will not experience worse health symptoms as there is no greater exposure to landfill smoke and odour at this distance. The exposure rate is not expected to decrease as one moves away from the landfill (3-5km).

Our findings revealed that irrespective of distance from the Retirement landfill, communities showed a range of health symptoms resulting from their exposure to landfill smoke and odour emanating from the Retirement landfill. However, it was discovered that there was a statistically significant association between distance lived from the Retirement landfill and incidence of reported health symptoms - wherein communities closer to the landfill (1-3km) showed higher incidence of health symptoms compared to communities further away (3-5 km).

Residents living near the Retirement Landfill were three times more likely to experience respiratory symptoms including shortness of breath, wheezing, increased effort in breathing and gasping for air, and twice as likely to experience coughing and heaviness in breathing when compared to residents living 3-5 km away from the landfill. Increased incidence of respiratory symptoms with closer proximity to the Retirement landfill is consistent with other research conducted in the field (Addo et al., 2015; Correa et al., 2011; Njoku et al., 2019 & Salam, 2010).

Respondents closer to the landfill reported considerably more cases of health symptoms from inhaling landfill odour. They were four times more likely to experience loss of appetite and fatigue, three times more likely to develop vomiting, dizziness and trouble sleeping and twice as likely to experience nausea and headache, than respondents further away. The range of symptoms displayed by residents to landfill odour were not only consistent with findings of Rozaimi et al. (2014) and Sakawi et al. (2010), but was also consistent with the findings of Aatamila et al. (2010) and Owusu-Sekyere et al. (2013) which confirm a strong association between closer proximity to landfill sites and increased incidence of health symptoms caused by exposure to landfill odour.

In assessing the most severe respiratory health symptoms comprising of: shortness of breath, gasping for air and wheezing, in addition to the increased incidence of symptoms amongst resident living closer to the landfill, we found that these symptoms increased among residents living closer to the landfill with such residents being two times more likely to report severe cases of gasping for air and shortness of breath, with no significant change in reported cases of wheezing.

Severity of health symptoms displayed on exposure to landfill odour varied with persons living closer to the landfill reporting increased incidence of severe loss of appetite (44%) as opposed to no reported severe cases in residents living 3-5 km away from the landfill. The likelihood of developing severe cases of trouble sleeping was equal in both community groups. However, living further away from the landfill (3-5 km) had twice as many cases of severe symptoms of dizziness compared to persons closer to the landfill site reported cases Literature on the severity of health symptoms in correlation to proximity to landfill sites is not well defined and no comparative research could be found to establish the distribution of our findings.

In deciding which of the hypotheses to accept and reject, when measuring the range of symptoms correlated to the distance from the landfill, chi square test results showed a p value of <0.01 which is less than alpha (0.05) and as such the null hypothesis was rejected and the alternate hypothesis accepted. Based on our findings there are variations in health effects of residents living within 5km of the Retirement Landfill. Persons living within 1-3 km of the Retirement Landfill experience worse health symptoms as there is greater exposure to elements or vectors around the landfill. This exposure rate decreases as one moves away from the landfill (3-5km). Consequently, like Chalvatzaki et al. (2010) the increased concentration of hazardous toxicants from landfill smoke and odour is found closer to the source and therefore exposes residents living closer to significant health risks, and therefore speaks to the need for increased mitigation measures by the relevant stakeholders in waste management.

Health Effects of Inhaling Landfill Smoke on Residents

The second research question sought to determine: What are the health effects of inhaling the landfill smoke arising from the Retirement landfill? To effectively assess the impact of exposure to landfill smoke and occurrence of respiratory illnesses we sought to factor in exposure to other pollutants that might result in similar respiratory-type symptoms we are trying to define with exposure to landfill smoke. In our findings, it was observed that regardless of distance lived from the landfill site, the majority of respondents reported that they were not exposed to vapours, gas, dust, or fumes that caused them to experience any respiratory illnesses while they were at work or home. We observed however, that a higher percentage of non-exposure to pollutants was recorded amongst communities further away from the landfill (3-5 km). Given the majority of our sample populations expressed not exposure to external pollutants at home or work, our reported cases of health symptoms displayed from respondents exposed to landfill smoke were assumed to be as a result of exposure to landfill smoke primarily.

Residents of both community groups were found to experience a range of respiratory symptoms. These symptoms include coughing, heaviness in breathing, shortness of breath, wheezing, increased effort in breathing and gasping for air. We discovered that of the symptoms displayed, the majority of residents (77.7%) experienced coughing as the primary symptom and the least displayed symptom was gasping for air (18.2%). As with studies conducted by Li et al. (2018), Mészáros et al. (2015) and Nastos et al. (2010), the symptoms displayed were indicative of acute and chronic respiratory illnesses.

Though both community groups displayed the above range of symptoms, there were key differences observed between communities closer to the landfill, where the likelihood of experiencing respiratory symptoms were greater. These findings resulted in a statistically significant association between distance lived from the landfill and displayed respiratory symptoms, with correlations between the two variables ranging from weak to moderate.

It was observed that respondents between 31 and 43 years old were more likely to indicate that they experienced shortness of breath as a result of the smoke rising from the landfill and women were twice as likely to report the symptom of gasping for air than men. Although a vast

majority of participants (77.6%) have reported no diagnosis of respiratory illnesses by a medical professional for themselves nor any household member, interestingly persons who reported to be medically-diagnosed with a respiratory illness resided closer to the landfill (83.0%) than persons further away (55.0%) and received this diagnosis since living in their community. This association observed between medical diagnosis of respiratory symptoms since living in the community and distance lived from the landfill was statistically significant and provide greater support for the findings of Njoku et al. (2019) that households who were near the dumpsites were more exposed to higher concentrations of landfill smoke, and were therefore more vulnerable to respiratory related illnesses.

Of the 384 sample population, 148 respondents reported having experienced respiratory type symptoms from inhaling landfill smoke, this represents 39% of our sample population causing us to associate that there are respiratory effects of inhaling smoke arising from fires at the Retirement Landfill. These effects varied amongst the symptoms themselves and community distance from the landfill - these include coughing, wheezing, shortness of breath, among others.

Health Effects of Landfill Odour on Residents

The third research question was geared at understanding the health effects of the stench or odour emanating from the Retirement Landfill. In answering this question, the research focused on the following areas: the occurrence and frequency of landfill odours, community concern, medical diagnosis associated with the odour, the health symptoms displayed by the community as a result of the landfill odours.

The results of the study revealed that there are health implications arising from the odour emanating from the Retirement Landfill. Headache, nausea and trouble sleeping were the main symptoms experienced by residents, followed by fatigue, dizziness and loss of appetite, as shown in Figure 3. This is consistent with a study conducted by Baah and Kharlamova (2018), where they also attributed these symptoms to odour exposure from landfills.

Though both community strata displayed the above range in symptoms, there were key differences observed between community distance and range of health symptoms displayed - with communities within 1-3 km of the landfill reporting on average a higher incidence (19.6%) of health symptoms compared to communities within 3-5km (7.9%). This association of increased incidence of health symptoms closer to the landfill site is consistent with findings of Aatamila et al. (2010).

In communities 1-3 and 3-5km away from the Retirement landfill neurological related symptoms such as headaches, dizziness, fatigue and trouble sleeping, were more predominant illnesses (31.4%) compared to gastrointestinal health symptoms such as nausea, vomiting and loss of appetite (18.9%). Owusu-Sekyere et al. (2013), Rozaimi et al. (2014), Sakami et al. (2010) all reported these symptoms were more common health symptoms displayed in their respective studies making our findings consistent with theirs.

While just under one-tenth (8.2%) of the residents reported having to visit a health professional for any illnesses arising from the bad smell at the landfill, the majority (91.8%) of residents reported not having to seek medical assistance for ill health caused by the bad smells from the landfill. We observed a similar case in the findings of Aderemi and Falade (2012) who found that while many residents found the odours unpleasant, and experienced symptoms such as nausea or headaches, no major medical attention was usually required. For residents that required medical attention more than 60% of them mainly from communities within 1-3 km of the landfill indicated that they had developed symptoms related to the bad smells emanating from the landfill since living in the community.

Of the 384-sample population, 112 respondents reported having experienced health symptoms from inhaling landfill odour, this represents 29% of our sample population causing us to strongly associate that there are health effects of inhaling odour arising from fires at the Retirement Landfill. These effects varied amongst the symptoms themselves and community distance from the landfill- these include headaches, dizziness, nausea, among others.

Conclusions

This study has evaluated the effect(s) of landfill smoke and odour arising from the Retirement Landfill on communities within 5km of the landfill site. In order to achieve this objective, it was necessary to share knowledge of the toxicological properties of the emitted compounds in addition to gathering information from residents through our interviewer-administered questionnaires. Our findings showed The Retirement landfill represent a threat to the surrounding residential housing with residents displaying a range of symptoms such as respiratory symptoms i.e. gasping for air, wheezing and shortness of breath - all indicative of various acute and chronic respiratory diseases. They also displayed neurological and gastrointestinal symptoms such as headaches, dizziness loss of appetite, nausea and vomiting.

The association between distance and health effects was significant, with increased health effects more likely to occur and more pronounced amongst communities in closer proximity to the landfill site. Residents in both community groups are seriously concerned about the health implications of the landfill yet despite this were unwilling to relocate from their communities. A deeper knowledge of the health risks associated with the Retirement landfill might be a starting point to build a more agile and more sustainable Municipal Solid Waste System including more controlled and sanitary landfills. It was necessary to identify the hazards they pose, assess the risks from exposure to them so stakeholders in solid waste management can effectively eliminate or reduce such risks to as low as possible. This study calls for the appropriate stakeholders in waste and environmental control to make advanced and sustainable changes in how landfills are managed that will ensure the reduction in risks posed to human health and environment.

Recommendations

The government at all levels must remain responsible for developing sustainable waste management policies which include governance waste disposal sites such as the Retirement Landfill. In light of our findings that there are associated health risks posed by landfill operations at the Retirement landfill, we strongly recommend that the Government of Jamaica provide strong infrastructural support in the design and advanced equipment needed to minimize residents' exposure to landfill smoke and odour.

More importantly, it is suggested that The Ministry of Health and Wellness invest in initiatives and research projects aimed at monitoring exposure rates to landfill smoke and odour. In addition, the Ministry can provide the appropriate response protocols where health educators and assessors are dispatched to communities in close proximity to formal and informal landfills to better understand the public health risk posed by the landfills.

The National Solid Waste Management Authority should be tasked with revolutionizing how solid waste is managed on a nationwide level by changing public orientation and awareness towards handling municipal waste (both solid and liquid) and disposal methods in a bid to separate waste and initiate recycling practices. The agency will require financing to implement an integrated sustainable waste management system, aimed not only at ensuring waste collection but the separation and sorting of waste at the disposal site and in the long implementation of a sanitary landfill. A properly operated sanitary landfill not only reduces objectionable landfill smoke and odours and health implications to communities but slows environmental degradation and supports improved air quality. Although implementing a sanitary landfill requires a significant investment, especially in the construction and design phase, as well as in the operational phase, we recommend small, incremental improvements to be made in the landfill design and operation over time to reduce the high overheads this engineering feat will attract. The initial investment will provide longer operating lifetimes (ten years or more) and if proper operational policies are implemented, the potential for increased job creation opportunities and renewable energy prospects could result.
The implementation of Active Control Systems that incorporates a blower (extraction fan) to create a vacuum within the landfill and withdraw the landfill gas (LFG) through a network of wells/trenches and pipework is another option to be explored. Proper regulation of LFG emissions usually contributes significantly to the effective control of odour. These collected LFG

emissions are usually treated either by combustion in a flare, or in LFG engines for energy production which can generate revenues.

Finally increasing security of the Retirement landfill and strictly enforcing employee training and conduct procedures will go a long way in minimizing unauthorized access and misuse of the landfill that may lead to fires at the site that often emit landfill smoke. Employees should be adequately trained in the safety aspects pertaining to the operational area and the implementation of the primary safety rules, which include but not limited to: prohibiting smoking, use of narcotics, alcohol during work and on property, setting up perimeter fencing and installation of top of the line security tracking systems. Coupled with these basic rules are creation of disciplinary action plans that hold accountable the solid waste management personnel in violation of the safety protocols where necessary to send a clear and decisive message that Landfill management is of primary importance in maintaining stronger healthier populations.

Suggestions for Further Research

Our study measured mere association between landfill smoke and odour exposure and the health effects. Our study also relied on self-reported symptoms, which may be subject to bias and therefore could not ascertain a cause-effect relationship. Based on these factors we suggest that future research on larger sample population that also include other municipal landfills that will have stronger statistical power in order to provide more substantiating evidence from which more generalized conclusions and assumptions can be made.

A cohort study monitoring the health status of residents over a duration of time will provide stronger epidemiological evidence of the adverse effects of landfill smoke and odour. Incorporating environmental monitoring and risk measurement using air quality data in future studies will supplement findings and provide the scientific basis of the health effects displayed. We suggest further exploratory research in the role of government in addressing the health risk posed to residents as this will provide a rounded or balanced view of the impact of landfill sites and will bolster the need to create and establish more robust key performance indicators (KPI's) for Landfill management.

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Appendices

Appendix A

Questionnaire Survey Sample

We are conducting a research study as part of our Master's Programme at the University of the Commonwealth Caribbean (UCC). This study aims to assess the public health risks of residents living in close proximity to the Retirement Landfill. We are kindly requesting your participation in our study by completing this questionnaire to gather information on current practices, concerns, and opinions on the health and respiratory effects of smoke and odour from the Retirement Dumpsite.

The questionnaire contains 21 questions and will take approximately 15 minutes to complete. Please note your responses will be held in the strictest confidence and will be solely and anonymously used for purposes of writing our research report. Thank you very much in advance for your time.

Age: (YEARS) □18 – 30 □31 – 43 □44 – 56 □57-69

□ 70 and over

Sex: □Male □Female

Highest level of Education Received: □Primary □Secondary □Tertiary

Employment Type: □Unemployed □Self-Employed □Employed □Retired □Student

Please read the below questions and tick the response that best applies

1. **How long have you lived in this community?**

□Less than 1 year □1 - 4 years □5 - 9 years □ 10 years and above

2. Do you or any member of your household work in a job that exposes you to vapours, gas, dust, or fumes that causes you to experience any respiratory illnesses?
□ Yes □ No □ I do not know

3. How often do you experience smoke and fumes coming from heavy vehicles (for example, trucks or buses) that drive past your home? □Never □Rarely □Sometimes □Often □Always

4. Do you experience smoke coming from the Retirement landfill in your community?
□Yes □No

5. How often do you smell smoke arising from the landfill?
□Never □Rarely □Sometimes □Often □Always

6. How concerned are you about respiratory health implications from this smoke?
□ Not at all concerned □Slightly Concerned □Somewhat concerned □ Moderately concerned □ Extremely concerned

7. Do you or any member of your household has been diagnosed by a doctor, nurse, or other health professional with a Respiratory Illness?
□Yes □No □ I do not know

8. If yes, was this diagnosis made since living in this community?
□ Yes □ No

9. Do you experience any of the below symptoms when there is landfill smoke in the community? (Check all that apply)

Symptoms	Yes	No
Gasping for Air		
Coughing		
Heaviness in Breathing		
Increased Effort In Breathing		
Wheezing		
Shortness of Breath		

10. If you tick yes to any symptom in question 9 above, how would you rate these symptoms?

Symptoms	Very Mild	Mild	Moderate	Severe
Gasping for Air				
Coughing				
Heaviness in Breathing				
Increased Effort In Breathing				
Wheezing				
Shortness of Breath				

11. Do you experience increased health symptoms from Respiratory illnesses when landfill smoke is in the community?

□ Yes □ No

12. Do you experience bad smells in your community arising from the Retirement Landfill?

□Yes □No

13. How often do you experience bad smells coming from the landfill in your community during the last 12 months?

□Never □Rarely □Sometimes □Often □Always

14. How concerned are you with the effects of this bad smell on your health?

□ Not at all concerned □Slightly Concerned □Somewhat concerned
□ Moderately concerned □ Extremely concerned

15. Have you experienced any of the following symptoms when you encounter this bad smell, in the community? (Check all that apply)

Symptoms	Yes	No
Nausea		
Vomiting		
Headaches		
Fatigue (tiredness)		
Dizziness		
Trouble sleeping		
Loss of Appetite (not eating)		

16. If you tick yes to any symptom in question 15 above, how often do you experience these symptoms?

Symptoms	Very Mild	Mild	Moderate	Severe
Nausea				
Vomiting				
Headaches				
Fatigue (tiredness)				
Dizziness				
Trouble sleeping				
Loss of appetite (not eating)				

17. Have you ever visited a health professional for any illnesses arising from the bad smell at the landfill?

□ Yes □ No

18. If yes, how often do you visit a health care professional for these illnesses?

□Never □Rarely □Sometimes □Often □Always

19. Did you develop these symptoms since living in this community?

□ Yes □ No □ I do not know

Please read the below statements and select to what extent you Agree or Disagree:

	Statement	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
20	**I am concerned for my health living within 5km of the Retirement Landfill**					
21	**I am willing to relocate from this community knowing that it is within 5km of the Retirement Landfill**					