Waste Management 105 (2020) 501–510

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Health effects associated with proximity to waste collection points in Beitbridge Municipality, Zimbabwe

Ofhani Munyai [a,b], Wilfred Njabulo Nunu [a,c,*]

[a] Department of Environmental Science and Health, Faculty of Applied Sciences, National University of Science and Technology, Ascot, Bulawayo, Zimbabwe
[b] Municipality of Beitbridge, 290 Justitia Road, P O Box 164, Beitbridge, Zimbabwe
[c] Scientific Agriculture and Environment Development Institute, Bulawayo, Zimbabwe

ARTICLE INFO

Article history:
Received 22 March 2019
Revised 24 February 2020
Accepted 26 February 2020
Available online 4 March 2020

Keywords:
Proximity
Waste
Waste collection points
Health effects
Beitbridge
Zimbabwe

ABSTRACT

Population growth, urbanisation and economic development have led to the increasing generation of municipal solid waste while environmentally sustainable management remains a challenge the world over. This study sought to investigate health effects associated with proximity to waste collection points in Beitbridge Municipality, Zimbabwe. A cross-sectional study was undertaken to compare the occurrence of disease among the residents living within different distances from the waste collection points (50 m, 100 m, 150 m, 200 m, 250 m, 300 m and above 300 m). A handheld GPS device was used to collect coordinates of the location for the purposes of mapping. The Fishers Exact test and the Multiple Logistic Regression model conducted (on STATA V 13 SE) to determine the association between different variables and the occurrence of health effects. Questionnaires were administered to 700 stratified randomly selected respondents. Five refuse collection points and spatial distribution of health conditions were mapped at Dulibadzimu high-density suburb. The overall response rate was 98% and females constituted the majority of respondents (58%). Most of these respondents were aged between 26 and 35 years of age and were involved in informal trading (35%). Reported health conditions were diarrhoea, dyspnoea, dry cough, eye irritation and asthma. Distance, waste collection point, level of education, nature of occupation and sex were significant contributors to the prevalence of health effects associated with exposure to waste. Exposure to waste is a serious health concern in Beitbridge. Local authority is encouraged to abolish these waste collection points and invest more on conventional waste management systems in partnership with different stakeholders.

1. Introduction

The changing patterns of resource consumption due to population growth, urbanisation and economic development have given rise to increasing volumes of municipal solid waste (MSW) (Hoornweg and Bhada-Tata, 2012). The existing waste management systems are overwhelmed with increasing quantities and composition of the waste (Mohanty et al., 2014). Municipal solid waste generation is expected to increase from 1.6 billion tonnes in 2016 to 3.4 billion tonnes in 2050 globally (Kaza et al., 2018). In 2050, Sub-Saharan Africa has been projected to more than triple from current levels, with South Asia also expected to more than double their waste streams (Kaza et al., 2018). It has been highlighted that local authorities in low-income countries are struggling to cope with the accelerated pace of waste generation such that level of collection is often lower than 70% and that over 50% of the waste collected getting disposed through uncontrolled landfilling (Haregu et al., 2017).

Most of the studies conducted around this subject have shown inter-linkages between poor MSW management and the manifestation of adverse health effects to the exposed human populations (Haregu et al., 2017; Al-Delaimy et al., 2014; Chokhandre et al., 2017; Ziraba et al., 2016; Thakur et al., 2018). Numerous factors such as the nature of waste, duration of exposure, population exposed and availability of prevention, mitigation and interventions that determines the severity of the impacts which range from the mild psychological, severe morbidity, disability or death (Ziraba et al., 2016). The organic waste provides a rich media for the growth of gastro-intestinal pathogens such as *Escherichia Coli*, *Vibrio Cholerae* and *Salmonella Typhi* when decomposing under suitable environment conditions of warmth and moisture (Achudume and Olawale, 2007). The failure of the solid waste

* Corresponding author at: Department of Environmental Science and Health, Faculty of Applied Sciences, National University of Science and Technology, P O Box Ac 939 Ascot, Corner Gwanda Road and Cecil Avenue, Bulawayo, Zimbabwe.
E-mail address: njabulow@gmail.com (W.N. Nunu).

https://doi.org/10.1016/j.wasman.2020.02.041
0956-053X/

collection systems has also contributed to the burning of waste at dumpsites (Cogut, 2016; Thakur et al., 2018; Sharma et al., 2018). Dumpsite waste fires are either started intentionally by people to reduce waste volumes or occur spontaneously releasing pollutants such as particulates, acidic gases and aerosols, metals and organic compounds (Cogut, 2016).

Burning of MSW can release hexachlorobenzene, formaldehyde, dioxins and other similar compounds to the environment which are highly persistent and degrade slowly in the air (Haregu et al., 2017; Cogut, 2016). Formaldehyde has especially been found to be associated with the occurrence of watery eyes, a burning sensation in the eyes and throat, nausea among other symptoms (Haregu et al., 2017). Several researchers have established that people residing near waste dumpsites were found to have experienced high incidences of diarrhoea and respiratory health effects such as dyspnoea, increased episodes of asthma, nose, throat and eye irritations as compared to their counterparts where there are no waste dumps (Haregu et al., 2017; Al-Delaimy et al., 2014; Chokhandre et al., 2017; Suleman and Agyemang-Duah, 2015).

The failure of waste collection systems in Zimbabwe has contributed to open solid waste dumps which are providing prime breeding sites for houseflies, rats and mosquitoes leading to a surge in communicable diseases such as fever, dysentery, diarrhoea, cholera and malaria in Chinhoyi, Mutare and Harare (Downmore et al., 2011; Tsiko and Togarepi, 2012).

Beitbridge Municipality has struggled to collect solid waste from the refuse collection points once per week as per international standards. The population for the border town has been doubling every 10 years which might be due to natural increase, urbanisation and in-migration from other cities (Chanza et al., 2017). The refuse collection fleet was reportedly obsolete and therefore could not cope with the amount of solid waste generated (Chanza et al., 2017). This has led to the establishment of temporal waste storage and collection points in suburbs. This has also contributed to the breeding of disease vectors and air pollution due to waste burning at these collection points (Chanza et al., 2017). Furthermore, a diarrhoea incidence of 58.4 per 1000 in 2014 was reported which was higher than the national rate of 57.3 for the under-fives. Beitbridge was ranked among the top 10 districts in the prevalence of respiratory conditions in Zimbabwe in 2014 (Chanza et al., 2017). This study, therefore, sought to investigate health effects associated with proximity to waste collection points in Beitbridge Municipality, Zimbabwe.

1.1. Specific objectives

This study sought to assess the health effects that are associated with proximity to municipal solid waste collection points through: mapping of all waste collection points in the Municipality of Beitbridge; determining the prevalence of health effects among the residents living within and outside 500-metre radius from the waste collection points and lastly by determining the relationship between disease prevalence within and outside 500 m from the waste collection points. Authors have cited that households that are less than 500 m from the dumpsite are deemed to be exposed to the health risks that the dumpsite might pose (Jerie and Zulu, 2017; Nwosu and Pepple, 2014).

2. Materials and methods

2.1. Study area

Beitbridge Municipality, situated in Matabeleland South Province, has a resident population of 42 218 (Chanza et al., 2017). It is the busiest in-land border post in Sub-Saharan Africa with approximately 170 000 people passing through the town every month (Chanza et al., 2017). Cross border activities generate most of the solid waste in terms of packaging material such as polythene, cans, bottles and cardboard boxes. The major formal commerce in the town includes banking, retailing and freight industry while the informal sector is primarily dominated by motor repair mechanics, vending of foodstuffs like cell phone accessories and clothing flea markets (Chanza et al., 2017). The area map is presented as Fig. 1.

2.2. Study design

A cross-sectional survey was conducted to examine and compare estimates of disease prevalence between the residents living within 50 m, 100 m, 150 m, 200 m, 250 m, 300 m and outside the 300 m of the five waste collection points in Beitbridge Municipality. This design was appropriate for this study as it enabled the determination of the relationships between exposure to the hazards from the waste collection points and the occurrence of diseases using different measures of association such as the Chi-squared test, odds ratios and confidence intervals (Hall, 2008; Nunu et al., 2020). This type of study provided an overall snapshot of the characteristics, frequency of occurrence of health effects (diarrhoea, dyspnoea, dry cough, asthma, and nose, throat and eye irritations) associated with exposure to waste collection points which in this context includes to enable generalisations to be made to the study population (Hall, 2008; Nunu et al., 2020). The buffers are shown in Fig. 1.

2.3. Study population and sampling

A sample size of 700 was determined using EPI INFO (Version 7.2) with a two-sided confidence interval of 96%, the width of confidence of 4% and a sampling power of 50% and this gave an estimated sample size of 656 which was rounded off to 700. Therefore, a sample size of 20 was selected in each buffer level in the five waste collection points giving a total of 140 in each waste collection point. Table 1 summarises the distribution of the sample sizes within each waste collection point. The residential properties from the Municipality of Beitbridge Housing Property Stock Register provided the sampling frame. Properties that were within 50 m, 100 m, 150 m, 200 m, 250 m, 300 m and outside the 300 m from each collection point were first mapped with the aid of geographic information system platform (QGIS 2.18.22). The listed house numbers per each stratum were entered into MS Excel which was programmed to generate random numbers. Stratified random sampling was used in the selection of the residential properties from which the study participants were drawn (see Table 1). Stratified random sampling enabled the study participants from the different strata to be proportionally represented and ensures that each study participant has the same probability of being selected and thereby minimising error (Lim et al., 2012).

2.4. Data collection and tools

Data was collected from the respondents using a piloted researcher-administered structured questionnaire that was adapted from Babs-Shomoye and Kabir (Babs-Shomoye and Kabir, 2016). The questionnaire was piloted on 38 households in Dulibadzimu Township and no adjustments were made (Connelly, 2008). Heads of the households or adult members who were 18 years and above who gave their written consent to participate in the study were surveyed. The questionnaire was divided into 4 sections: with questions seeking to collect information on the demographics and socio-economic characteristics, general waste management practices, health hazards and the health effects

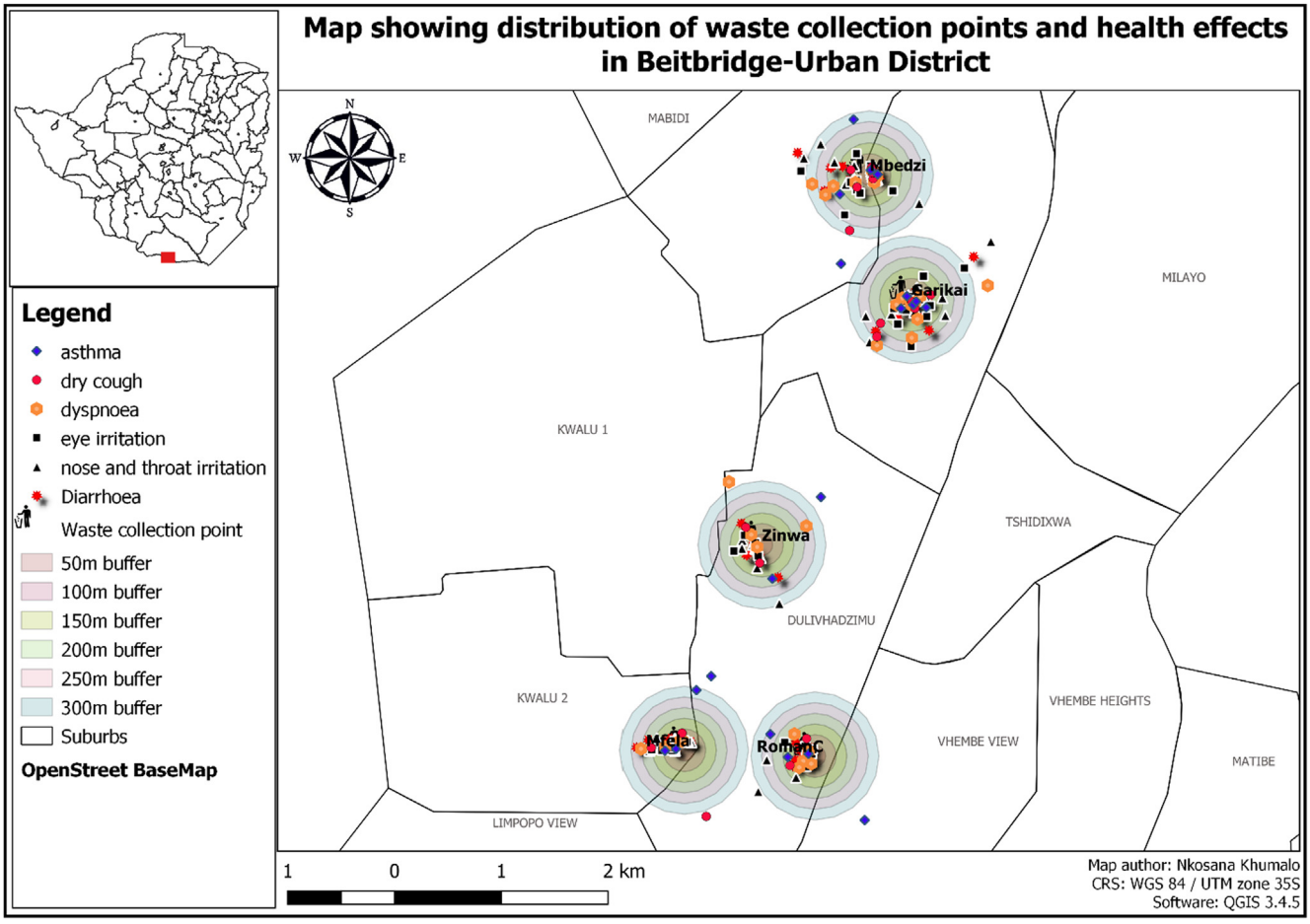

Fig. 1. Distribution of waste collection points and health effects in Beitbridge.

Table 1
Sample Distribution.

Stratum	Sample sizes							TOTALS
	Households found within 50 m	Households found between 50 and 100 m	Households found between 100 and 150 m	Households found between 150 and 200 m	Households found between 200 and 250 m	Households found between 250 and 300 m	Households outside 300 m	
1. Roman Catholic Collection Point	20	20	20	20	20	20	20	**140**
2. Mfelandawonye Collection Point	20	20	20	20	20	20	20	**140**
3. ZINWA Collection Point	20	20	20	20	20	20	20	**140**
4. Garikai Collection Point	20	20	20	20	20	20	20	**140**
5. Mbedzi Collection Point	20	20	20	20	20	20	20	**140**
TOTALS	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**700**

which were experienced by the respondents and their household members during the last 3 months prior to the time of sampling. The questionnaire had pre-determined responses from which the respondents would then choose Yes / No options on whether they had experienced the solid waste-related hazards and/ or suffered from the listed health effects. There were also multiple choices for the different age groups, household waste management practices which may or may not predispose the respondents to the health hazards. Each questionnaire took an average of 15–20 min to administer. Geographical Positioning System (GPS) device Garmin Etrex (with an accuracy of 30 +/− 3 m) (Ganguly et al., 2015) was used for geocoding of the 5 refuse collection points, 700 respondents and for mapping the distribution of the different diseases reported.

2.5. Data analysis

Geographical Information System platform (QGIS 2.18.22) was used to establish the buffers around the waste collection points and to map the spatial distribution of different diseases and conditions. Data from the questionnaire was captured in an Excel spreadsheet and imported into STATA Version 13SE for analysis. The survey results were summarised and presented as a percentage of participants who had a response to each statement. Frequency distributions were calculated to determine the prevalence rates for the health effects on the residents staying within the varying distances from the waste collection points. Fishers' Exact test and Multiple Logistic Regressions (MLR) were employed to determine the presence of associations and their

strength between different variables (residential proximity to waste collection points, demographic characteristics just to mention a few) and the development of health effects. A p-value of <0.05 was considered statistically significant.

3. Results

3.1. Respondents profile

The overall response rate was 98% as 686 of the 700 study participants successfully responded to the questionnaire. Females constituted about 58% of the respondents and this trend was similar across all five sampling sites. The majority of the respondents were in the age group of 26–35 years. Of these respondents, about 35% of them were involved in informal trading. These findings are presented in Table 2.

3.2. Conditions associated with proximity to waste collection points

Health conditions that were detected included diarrhoea, dyspnoea, dry cough, eye irritation and asthma. These findings are presented in Tables 3 and 4. The study further found significant associations between distance and prevalence of health effects. People living within the 50 m buffer were almost 16 times more likely to develop health conditions as compared to those that lived outside the 300 m radius from the waste collection as health effects become clustered as you approach the waste collection points. These findings are presented in Table 5–10 and Fig. 1.

3.3. Distribution of health effects in relation to waste collation points

It was observed that in this study that respondents from Garikai and Mbedzi sampling sites were almost two times more likely to present with health effects as compared to those from Roman Catholic sampling points. These findings are presented in Table 5. The distribution of health conditions is also presented in Fig. 1.

3.4. Relationship between socio-demographic characteristics and health effects

The age of respondents was not a significant contributor to the development of health effects. However, the level of education, nature of occupation and sex were significant contributors to the presence of health effects. Females were 2.2 times more likely to

Table 2
Socio-demographic characteristics of respondents.

Demographic characteristics of Respondents								
Variable	Residential distance from the waste collection point							
	All subjects	within 50 m	between 50 and 100 m	between 100 and 150 m	between 150 and 200 m	between 200 and 250 m	between 250 and 300 m	outside 300 m
Total	686	98	99	100	97	96	97	99
Sex								
Males	289 (42.1)	41 (41.8)	43 (43.4)	42 (42.0)	39 (40.2)	44 (45.8)	37 (38.1)	43 (43.4)
Females	397 (57.9)	57 (58.2)	56 (56.6)	58 (58.0)	58 (59.8)	52 (54.2)	60 (61.9)	56 (56.6)
Age in years								
18–25	67 (9.8)	9 (9.2)	8 (8.1)	11 (11.0)	7 (7.2)	10 (10.4)	10 (10.3)	12 (12.1)
26–35	295 (43.0)	36 (36.7)	41 (41.4)	44 (44.0)	42 (43.3)	46 (47.9)	42 (43.3)	44 (44.4)
36–45	198 (28.9)	34 (34.7)	23 (23.2)	28 (28.0)	29 (29.9)	33 (34.4)	25 (25.8)	26 (26.3)
46–55	65 (9.4)	8 (8.2)	15 (15.2)	9 (9.0)	13 (13.4)	5 (5.2)	7 (7.2)	8 (8.1)
>55	61 (8.9)	11 (11.2)	12 (12.1)	8 (8.0)	6 (6.2)	2 (2.1)	13 (13.4)	9 (9.1)
Educational level								
Primary	140 (20.4)	21 (21.4)	19 (19.2)	22 (22.0)	18 (18.6)	23 (24.0)	17 (17.5)	20 (20.2)
Secondary	438 (63.9)	59 (60.2)	63 (63.6)	61 (61.0)	64 (66)	62 (64.6)	65 (67.0)	64 (64.6)
Tertiary	108 (15.7)	18 (18.4)	17 (17.2)	17 (17.0)	15 (15.5)	11 (11.5)	15 (15.5)	15 (15.1)
Occupation								
clerical / formal	115 (16.8)	17 (17.3)	18 (18.2)	16 (16.0)	15 (15.5)	19 (19.8)	16 (16.5)	14 (14.1)
Construction	94 (13.7)	15 (15.3)	13 (13.1)	12 912.0)	14 (14.4)	16 (16.7)	11 (11.3)	13 (13.1)
Informal trading	242 (35.3)	33 (33.7)	35 (35.4)	34 (34.0)	37 (38.1)	36 (37.5)	35 (36.1)	32 (32.3)
waste recycling	49 (7.2)	12 (12.2)	9 (9.1)	7 (7.0)	6 (6.2)	6 (6.3)	4 (4.1)	5 (5.1)
other	186 (27.1)	21 (21.4)	24 (24.2)	31 (31.0)	25 (25.8)	19 (19.8)	31 (32.0)	35 (35.4)
Children <5 years								
0	124 (18.1)	19 (19.4)	17 (17.2)	21 (21.0)	16 (16.5)	17 (17.7)	15 (15.5)	19 (19.2)
One –three	406 (59.2)	56 (57.1)	59 (59.6)	57 (57.0)	61 (62.9)	56 (58.3)	63 (64.9)	54 (54.5)
Four or more	156 (22.7)	23 (23.5)	23 (23.2)	22 (22.0)	20 (20.6)	23 (24.0)	19 (19.6)	26 (26.3)

Table 3
Summary of reported health effects around each waste collection point in Beitbridge.

	All cases	Roman Catholic	Mfelandawonye	Zinwa	Garikai	Mbedzi
Diarrhoea	47	9	10	5	12	11
Dyspnoea	29	5	4	4	9	7
Dry cough	18	1	3	2	5	7
Eye irritations	56	9	10	7	16	14
Nose, throat irritations	64	9	12	6	19	18
Asthma	19	3	4	2	6	4

Table 4
Distribution of health effects in relation to waste collection points.

Disease Prevalence Rates in relation to waste collection points								
Residential distance from the waste collection point								
Variable	All subjects	<50 m	50–100 m	100–150 m	150–200 m	200–250 m	250–300 m	>300 m
Disease prevalence rates	686	98	99	100	97	96	97	99
Diarrhoea	47 (6.9)	16 (16.3)	9 (9.1)	6 (6.0)	5 (5.2)	4 (4.2)	3 (3.1)	4 (4.0)
Dyspnoea	29 (4.2)	11 (11.2)	5 (5.1)	4 (4.0)	2 (2.1)	3 (3.1)	2 (2.1)	2 (2.0)
Dry cough	18 (2.6)	7 (7.1)	2 (2.0)	3 (3.0)	2 (2.1)	1 (1.0)	2 (2.1)	1 (1.0)
Eye irritations	56 (8.2)	17 (17.3)	13 (13.1)	9 (9.0)	5 (5.2)	6 (6.3)	3 (3.1)	3 (3.0)
Nose, throat irritations	64 (9.3)	19 (19.4)	15 (15.2)	8 (8.0)	7 (7.2)	7 (7.3)	4 (4.1)	4 (4.0)
Asthma	19 (2.8)	5 (5.1)	4 (4.0)	2 (2.0)	2 (2.1)	3 (3.1)	2 (2.1)	1 (1.0)
Risk factors								
Tobacco smoking	111 (16.2)	13 (13.3)	17 (17.2)	12 (12.0)	19 (19.6)	18 (18.8)	16 (16.5)	16 (16.2)
Flies and pests	339 (49.4)	84 (85.7)	71 (71.7)	49 (49.0)	37 (38.1)	33 (34.4)	33 (34.0)	32 (32.3)
Odours	192 (28.0)	52 (53.1)	41 (41.4)	31 (31.0)	23 (23.7)	18 (18.8)	19 (19.6)	8 (8.1)
Waste burning smoke	255 (37.2)	72 (73.5)	53 (53.5)	31 (31.0)	30 (30.9)	27 (28.1)	21 (21.6)	21 (21.2)
Burn waste	87 (12.7)	21 (21.4)	17 (17.2)	15 (15.0)	11 (11.3)	10 (10.4)	8 (8.2)	5 (5.1)
Visit the collection point 3 or more times a week	181 (26.4)	42 (42.9)	39 (39.4)	37 (37.0)	26 (26.8)	19 (19.8)	11 (11.3)	7 (7.1)

Table 5
Relationship between different variables and development of health effects.

Variable	Fisher Exact	MLR-OR	MLR-95% CI	MLR P-value
Age				
18–25	0.567	***		
26–35		0.354	0.212–0.594	0.000
36–45		1.360	0.357–0.655	0.192
46–55		0.961	0.655–1.410	0.838
>55		1		
Education				
Primary	0.029*	1.387	1.028–1.872	0.032*
Secondary		0.056	0.044–0.073	0.000*
Tertiary		***		
Sex				
Male	0.000*	***		
Female		2.236	1.714–2.918	0.000*
Occupation				
Clerical/Formal	0.032*	***		
Construction		1.382	0.826–2.315	0.218
Informal trading		1.781	1.082–2.933	0.023*
Waste recycling		1.936	1.218–3.077	0.005*
Other		1.804	1.128–2.884	0.014*
Distance (m)				
0–50	0.000*	15.931	7.677–33.056	0.000*
51–100		7.385	3.488–15.633	0.000*
101–150		2.478	1.083–5.672	0.032*
151–200		1.885	0.793–4.480	0.151
201–250		1.888	0.794–4.488	0.150
251–300		2.136	0.915–4.989	0.079
>300		***		
Waste Collection Point				
Roman Catholic	0.000*	***		
Mfelandawonye		0.716	0.428–1.197	0.202
Zinwa		1.229	0.780–1.934	0.374
Garikai		1.937	1.276–2.939	0.002*
Mbedzi		1.766	1.156–2.698	0.009*

* Significant
*** Comparison Group

suffer from health effects as compared to males. Those with primary education were 1.4 more times likely to present with health effects as compared to those with a tertiary level of education. Furthermore, respondents involved in waste recycling were 1.9 times more likely to develop health effects as compared to those employed in the formal / clerical work. These findings are presented in Table 5.

4. Discussion

Refuse collection points were located in Dulibadzimu which is a high-density suburb. The possible reasons for their location could be due to the low value of the land, the areas densely populated and have high waste generation per capita and that most of the residents might not be having standard waste receptacles for

Table 6
Roman Catholic waste collection point.

Residential distance from the waste collection point																
Diseases	All subjects		<50 m		50–100 m		100–150 m		150–200 m		200–250 m		250–300 m		>300 m	
	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased
Diarrhoea	**9**	**129**	4	16	3	17	2	18	0	20	0	20	0	19	0	19
Dyspnoea	**5**	**133**	2	18	2	18	0	20	1	19	0	20	0	19	0	19
Dry cough	**1**	**137**	0	20	1	19	0	20	0	20	0	20	0	19	0	19
Eye irritations	**9**	**129**	6	14	2	18	0	20	1	19	0	20	0	19	0	19
Nose, throat irritations	**9**	**129**	4	16	2	18	1	19	0	20	1	19	0	19	1	18
Asthma	**3**	**135**	1	19	0	20	1	19	0	20	0	20	1	18	0	19

Table 7
Mfelandawonye collection point.

Residential distance from the waste collection point																
Diseases	All subjects		<50 m		50–100 m		100–150 m		150–200 m		200–250 m		250–300 m		>300 m	
	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased
Diarrhoea	**10**	**127**	5	14	3	17	0	20	1	18	1	18	0	20	0	20
Dyspnoea	**4**	**133**	2	17	1	19	0	20	0	19	0	19	1	19	0	20
Dry cough	**3**	**134**	0	19	1	19	0	20	1	18	0	19	0	20	1	19
Eye irritations	**10**	**127**	5	14	3	17	1	19	1	18	0	19	0	20	0	20
Nose, throat irritations	**12**	**125**	7	12	2	18	2	18	0	19	1	18	0	20	0	20
Asthma	**4**	**133**	1	18	1	19	1	19	0	19	0	19	1	19	1	19

Table 8
Zinwa collection point.

Residential distance from the waste collection point																
Diseases	All subjects		<50 m		50–100 m		100–150 m		150–200 m		200–250 m		250–300 m		>300 m	
	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased
Diarrhoea	**5**	**133**	2	18	2	18	0	20	1	18	0	20	0	19	0	20
Dyspnoea	**4**	**134**	1	19	1	19	0	20	0	19	1	19	0	19	1	19
Dry cough	**2**	**136**	0	20	1	19	1	19	0	19	0	20	0	19	0	20
Eye irritations	**7**	**131**	4	16	2	18	1	19	0	19	0	20	0	19	0	20
Nose, throat irritations	**6**	**132**	2	18	3	17	1	19	0	19	0	20	1	18	0	20
Asthma	**2**	**136**	0	20	0	20	0	20	1	18	0	20	0	19	1	19

Table 9
Garikai collection point.

Residential distance from the waste collection point																
Diseases	All subjects		<50 m		50–100 m		100–150 m		150–200 m		200–250 m		250–300 m		>300 m	
	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased
Diarrhoea	**12**	**123**	5	15	3	16	1	19	1	18	1	17	0	19	1	19
Dyspnoea	**9**	**126**	4	16	2	17	0	20	1	18	0	18	1	18	1	19
Dry cough	**5**	**130**	2	18	1	18	0	20	1	18	1	17	0	19	0	20
Eye irritations	**16**	**119**	9	11	3	16	2	18	0	19	1	17	1	18	0	20
Nose, throat irritations	**19**	**116**	8	12	5	14	2	18	1	18	1	17	1	18	1	19
Asthma	**6**	**129**	3	17	2	17	0	20	0	19	0	18	1	18	0	20

Table 10
Mbedzi collection point.

Residential distance from the waste collection point																				
Diseases	All subjects		<50 m		50–100 m		100–150 m		150–200 m		200–250 m		250–300 m		>300 m					
	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased	Diseased	Not diseased				
Diarrhoea	**11**	**127**	4	15	3	17	1	19	1	19	1	18	0	20	1	19				
Dyspnoea	**7**	**131**	3	16	1	19	0	20	1	19	1	18	1	19	0	20				
Dry cough	**7**	**131**	4	15	2	18	0	20	0	20	0	19	1	19	0	20				
Eye irritations	**14**	**124**	6	13	4	16	2	18	0	20	1	18	0	20	1	19				
Nose, throat irritations	**18**	**120**	7	12	2	18	1	19	1	19	0	19	2	18	1	19				
Asthma	**4**	**134**	2	17	0	20	0	20	1	19	0	19	1	19	0	20				

onsite storage of household waste. Waste per capita refers to the amount of waste generated by a person on average per day in different settings (Kawai and Tasaki, 2016; Hockett et al., 1995). These findings are anchored by Haregu et al. (2017) who examined the health risks associated with municipal solid waste management in Mombasa, Kenya established that only 52% of the households in the high-density suburbs had standard waste receptacles and that 85% of such communities used communal bins (Haregu et al., 2017).

The study found that close to 60% of the respondents were females. These findings are consistent with findings from a study conducted by Mudonhi et al. (2019) that reported a similar trend of participants if they are followed up at their homes (Mudonhi et al., 2019). In Beitbridge, females are usually at or around their homes whilst males trade or work in areas where they are likely to get a higher income (Njaya, 2016). It is also reported in some studies that females usually have low capital investment in their vending activities as compared to males and would usually run small vending stalls closer to their homes (Achudume and Olawale, 2007; Manyanhaire et al., 2007; Njaya, 2016). Furthermore, it was observed from this study that the majority of respondents (35%) were involved in informal trading. Due to high unemployment rates in Zimbabwe, the majority of people resort t informal trading to sustain their livelihoods (Manyanhaire et al., 2007).

Health conditions that were reported by respondents were diarrhoea, dyspnoea, dry cough, eye irritation and asthma. The prevalence of these conditions has been reported to be influenced by exposure to and presence biodegradable waste as well as aerosols (Breum et al., 1996; Poulsen et al., 1995). The study further found a strong association between distance from waste collection point and prevalence of health effects. The closer one is to the waste collection point the higher the chances of suffering from the reported health conditions compared to those that are further from the waste collection points. These findings are supported by studies from literature that found a strong association between distance from waste sinks, waste storage facilities and development of health conditions (Elliott et al., 2001; Porta et al., 2009; Vrijheid, 2000). Those closer to waste sinks or waste handling sites were reported to be at a higher risk of developing health conditions as compared to those that were staying furthest from the waste collection sites. Studies further highlight that waste dumping sites create a conducive environment for the breeding of vectors and therefore those staying proximal to these waste dumps are at a higher risk of suffering from diseases associated with flies, mosquitoes and rats just to name a few (Suleman and Agyemang-Duah, 2015).

It was observed from the study that respondents from two sampling sites (Garikai and Mbedzi) were more likely to present with health conditions as compared to other sites. The nature of waste and the volume generated could have been higher as the two waste collection points are closer to the Central Business District where there is a lot of activity. The higher per capita generation of waste and its nature could have been a significant contributor to the higher prevalence of health effects around these two sampling points (Ogbonna et al., 2007).

A significant relationship between the sex of respondents and the likelihood to suffer from health effects associated with exposure to waste was found. Females were more likely to present with health effects associated with exposure to waste as compared to their male counterparts. Studies conducted by Manyanhaire et al. (2007) and Njaya (2016) reveals that man are usually involved in vending of durable items which generate less waste whilst women are usually involved in vending of food items which usually are perishable and generate a lot of waste that decomposes and attract micro-organisms and vectors thereby increasing their risk of developing health effects (Manyanhaire et al., 2007; Njaya, 2016).

The level of education was also found to be a predisposing factor to the likelihood of presenting with health effects due to exposure to waste. Those with secondary and tertiary levels of education were less likely to suffer from health effects as compared to those with primary education. Level of education is a significant predictor of the nature of activities that one does and is a significant contributor to the behavioural outcomes of that specific individual (Nunu et al., 2018). Educated people are more likely to avoid health risks associated with waste and get employment that does not expose them through the adoption of best practices (Nunu et al., 2018; Nunu and Munyewende, 2017). This, therefore, explains these findings and suggest that lack of knowledge is a significant predisposing factor. Educated people would easily understand the health risks and possibly put measures in place to minimise exposure and thus reduce the impacts of these health risks.

Respondents that were involved in waste recycling were 1.9 times more likely to develop health effects as compared to those in clerical and any other formal work. These findings are consistent with the explanations provided by studies by Yang et al. (2001); Vimercati et al. (2016); Heldal et al. (2003); Sigsgaard et al. (1994) who found a strong association between health effects prevalence and waste handling (Heldal et al., 2003; Sigsgaard et al., 1994; Vimercati et al., 2016; Yang et al., 2001). Those handling waste have an increased risk of developing health effects as they are exposed to aerosols, decomposing organic matter, micro-organisms that are pathogenic and many more (Achudume and Olawale, 2007; Heldal et al., 2003; Sigsgaard et al., 1994; Vimercati et al., 2016; Yang et al., 2001; Thakur et al., 2018).

5. Limitations of the study

This study only relied on self-reported health effects and the perceived hazards which could have led to subjectivity as well as prone to recall bias by the respondents. This research did not establish the cause-effect relationships therefore they could be other factors that could have influenced the trends that were observed. It should also be noted that in this study waste characterisation and percentage composition determination of the types of waste that are deposited on the waste collection points were not done. A handheld (Garmin Extrex device with an accuracy of 30 +/− 3 m) was used to collect coordinates. Since this device was not 100% accurate they could have been misclassification of respondents particularly those that were close to the boundaries.

6. Conclusion

The study found that people in close proximity to waste collection points were at a higher risk of suffering from health effects compared to those staying furthest. Different types of waste gave rise to different types of ailments (diarrhoea, dyspnoea, dry cough, eye irritation, and asthma). These diseases have been noted to be associated with vectors that breed in conditions that can be found in waste dumps as well as individuals staying in close proximity to waste dump sites. Despite financial constraints that the country is facing, the Local Authority should abolish these waste collection point and provide waste receptacles for the residents at the same time forging relations with different stakeholders to invest on conventional waste management systems that aim at zero waste through reuse, recycling and reduction of waste that is being generated as a long term solution to the waste management problems that affect people's health. In the meantime there is a need for the Local Authority should try to provide efficient waste collection schedules at the household level.

Ethical approval

High levels of ethical considerations were observed. Written permission to conduct the study was obtained from the Municipality of Beitbridge and the Department of Environmental Science and Health at the National University of Science and Technology. Helsinki Declaration Principles on Human Ethics were applied. Written consent was obtained from the participants and the participants were made aware that their participation was voluntary and they could opt out of the study at any given time without any explanation. Participants were neither coerced nor given tokens of appreciation for being part of the study. The questionnaires were also translated into local languages that participants understood so as for them to understand and participate fully in the study.

Funding sources

The research was not funded.

Declaration of Competing Interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

Acknowledgements

Not Applicable.

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