INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Exposure to Pollutants and Health of Women Waste Pickers at Dandora Dumpsite in Nairobi, Kenya

Dr. Simon K. Kimani
Head, Department of Public Health, Kenya Medical Training College (KMTC), Kenya

Abstract:
The paper sought to assess the effect of exposure to pollutants on health of women waste pickers at Dandora Dumpsite. Illegal and indiscriminate dumping of waste in urban areas has posed a health risk to the surrounding populations. Whereas everyone who works or lives near dumpsites could potentially be exposed to harmful substances, women, in particular, are at risk of developing reproductive problems due to exposure to harmful substances such as heavy metals and persistent organic pollutants. The study employed a cross-sectional study design. The specific objectives of the study were; to establish the health status of women waste pickers working at Dandora dumpsite; to determine levels of heavy metal and POPs exposure at the Dandora dumpsite; to determine the influence of the work environment on the health status of women waste pickers; to establish current control practices and mitigation measures in place aimed at improving the health status of women waste pickers. Data was collected using an interview schedule, focus group discussion and collection of soil and water samples. Quantitative data were analysed using SPSS version 23 while qualitative data were analysed using NVivo software. The study findings revealed that the dumpsite was the main source of income for 95.6% of the women waste pickers who survived mostly by scavenging for waste at the dumpsite that they sold to the market. 23% of women waste pickers also scavenged for food at the dumpsite. The study further showed that 90.8% of the women waste pickers had been ill in the previous 6 months and the majority (90.8%) believed this was related to the nature of work that they did at the site. In addition, about (2%) n= 7 women reported as having a miscarriage, stillbirth or premature birth while working at the dumpsite. The study recommends the provision of PPEs for the dumpsite workers and the development of a better waste management system for Nairobi City County. There is a need for health promotion interventions on safe practices among women waste pickers so as to mitigate harmful health effects.

Keywords: *Pollution, women health, waste pickers, dumpsite, dandora*

1. Introduction

1.1. Background of the Study

Effective Solid waste management is a key aim that every developing country strives to achieve in order to protect its citizens from exposure to toxic environmental hazards that are dangerous to human and plant health. However, the immediate effects of unplanned population increase without commensurate resource allocation is the mushrooming of informal settlements and poor sanitation has resulted to the current experienced rise of unplanned and unprotected dumping site among the developing countries due to huge amount of waste generated daily from the increasing population. Due to this, Open dumping sites are often chosen without any environmental, health and safety considerations and pose a threat to the health of people living in adjacent areas. In Africa and in particular Kenya, most dumpsites are not fenced and allow unauthorized waste scavenging which exposes waste pickers to health risks. Communities that reside in areas close to dumpsites are likely to be exposed to health risks when they come into contact with contaminated soil, air and water.

The absence of formal waste management strategies in most African countries has encouraged the proliferation of an unregulated informal waste management sector. Considering that some African countries have high unemployment rates, it is encouraging to see members of the public earning a living from waste management a condition that exposes the two toxic environmental hazards such as lead and mercury. For instance, Namibia and South Africa have unemployment rates of 29.1% and 33.4% respectively. Although, other African countries have lower unemployment rates, the ILO reports that up to 70% of African workers are the working poor and are involved in menial jobs such as selling mobile airtime cards. Therefore, scavenging for valuable waste from dumpsites provides these workers with an avenue of earning a living. Most dumpsites IN Africa countries are located near residential, agricultural and surface water sources. This has exposed several people working within or living close to the dumpsites to health-related disorders. For instance, (Ogunrinola and Adepegba, 2012) reported that residents living close to dumpsites experienced more illnesses as compared to those living away from the dumpsite. Makhubele et al (2019) reported a high prevalence (37%) of common mental disorders among dumpsite workers. In Ghana, (Amankwaa, 2014) reported that most e-waste workers had developed a semi-permanent

black pigment on their hands and were exposed to heavy metals such as lead and mercury. Approximately, 30% of these workers complained experiencing coughs, dizziness and chest pain as well as excessive sweating. The reports from these studies indicate that living close or working at the dumpsites is a health hazard and there is need for African countries to develop strategies to manage waste better whilst minimizing adverse effects to human health and the environment. Therefore, dumpsites in most African countries are sources of revenue for a significant number of informal waste pickers. In addition, governments that are faced with a challenge of creating gainful employment are less willing with scrapping away informal sources of employment (Viljoen et al., 2012). However, working at dumpsites and living close to dumpsite exposes these waste pickers to health hazards that could be deleterious to their health.

In Kenya, the national and county governments are responsible for developing and instituting legal framework for solid waste management. Despite the existence of laws such as the Kenyan constitution, the Environmental Management Coordination Act (EMCA) and the Public Health Act Cap 242 which seek to protect the environment and public health, solid waste management in the country has been poor. (Henry *et al,* 2016) attributes this to a lack of institutional capacity and inadequate funding of solid waste management systems. The situation is compounded by the unprecedented increase in e-waste generation owing to the growth of the information and technology sector in the country. According to (Schluep*et al,* 2009) Kenya's e-waste generation, which currently stands at 17,000 tonnesannually is likely to grow 8-fold by the year 2020. (Njoroge*et al.,* 2014) observes that the regulatory framework concerning solid waste management at the national level is scattered in a number of Acts of parliament which makes enforcement challenging. EMCA Act places the responsibility of waste storage, treatment and collection on the waste generator but requires that local councils facilitate the final disposal of all types of wastes (EMCA, 2010). Further the (Kenya Public Health Act, Cap 242) requires local councils to employ practicable measures to ensure proper sanitation and prevent conditions that could be injurious to health. Poor enforcement of existing laws and regulations relating to solid waste management and the decline in institutional capacity in waste management has worsened the situation. (Henry *et al,.*2016) attributed poor solid waste management in Kenya to poor servicing of waste-trucks, poor enforcement of laws, inadequate funding and social discrimination during waste collection especially against women and the physically challenged among the society and also the groups that come for waste sorting from other regions away from where the waste is dumped.Social discrimination results from the generalization of in-group attributes to the inclusive category, which then become criteria for judging the out-group. In group here implies the women waste pickers who reside near the dumpsite while the out group implies the women waste pickers coming far from the dumpsite locality. Tolerance, on the other hand, is conceptualized as either a lack of inclusion of both groups in a higher order category or as the representation of the inclusive category in such a way as to also include the other group and designate it as normative. Due to these shortcomings in solid waste management, residents have resulted in dumping wastes in rivers, roadsides as well as road reserves which have led to the proliferation of open dumping sites that pose health risks to communities. The selection of landfill sites in Kenya, just like in other African countries has been largely haphazard. For example, the main dumpsite in Eldoret, Kenya is an abandoned sand quarry (Henry, *et al*. 2016) whereas the Dandora dumpsite is an abandoned stone quarry (Njoroge*et al,* 2014). These dumpsites in particular are not fenced and are easily accessible to humans, domestic and wild animal. In addition, the activities at the dumpsite are not controlled which allows for indiscriminate burning of waste and uncoordinated scavenging.

Generally, environments that surround dumpsites and landfills are known to have high concentrations of pollutants such as heavy metals and persistent organic pollutants (POPs) (Chifamba, 2007). A study carried out in Dandora Kenya reported that 42% of soil samples had ten times higher lead levels than normal (Oyaro, 2003). A waste audit revealed that household, industrial, and agricultural and hospital wastes such as sharps and pharmaceuticals were among the wastes dumped at the dumpsite Leachate from the dumpsites eventually finds its way into water bodies through underground seepage or during rains hence transporting the pollutants to other areas. (Njoroge*et al,* 2014) reported toxic levels of lead (10 µg/dl of blood) in approximately half of the children in areas surrounding the Dandora dumpsite which further led to symptoms such as chest pains, muscular weakness and headaches among affected children. In addition, the study reported an abnormally high incidence of respiratory diseases, skin disorders, eye infections, congenital anomalies and gastroenteritis among children at the dumpsite. The findings of these studies suggest that there could be health implications on different cohorts such as adults and workers at the dumpsite. Workers at the Dandora dumpsite are expected to use personal protective equipment such as glove and face masks to mitigate against hazards that are present in the dumpsite.

1.1.Research Question

- Does exposure to heavy metals and POPs negatively affect the health of women waste pickers at the Dandora dumpsite?
- What is the health status of women waste pickers working at the Dandora dump site?
- What are the levels of heavy metal and POPs exposure at the dump Dandora site?

1.2. Objectives

- To establish the health status of women waste pickers working at the Dandora dump site.
- To determine levels of heavy metal and POPs exposure at the dump Dandora site.

2. Literature Review

2.1. Health Status of Women Waste Pickers

Waste pickers are perhaps one of the groups that are adversely affected by pollutants released in dumpsites. This is partly because waste pickers spend a significant amount of time within the dumpsite environment. For example, (Tosengayi*et al,* 2017) reports that waste pickers in Zimbabwe spend most of their time in dumpsites and surrounding environments whereas some of them actually live in the dumpsites. In addition, the study reported that children were involved in waste picking in Zimbabwe. (Mangenda*et al,* 2017) reports that in Kinsasha, the capital of congo, waste is disposed in residential areas as well as along roads and rivers. In addition, illegal dumps of waste are found near schools, hospitals, churches as well as other social amenities. Indiscriminate dumping of waste next to social amenities as well as sources of water can expose people to health hazards.

Waste that gets to the dumpsite is usually handled by waste pickers who are keen on retrieving valuables for sale. Waste pickers in developing countries are involved in activities such as sorting, cleaning, reshaping and combining wastes which significantly increase their exposure to hazards. In some developing countries such as Brazil, (Coelho *et al*, 2016) report that waste pickers are organized in cooperatives which call for more recognition of waste pickers as an important aspect in waste management. However, in most African countries waste pickers are not formally recognized as an essential human resource in the waste management process. In most developing countries, women are involved in precarious work with minimal support due to unfavourable social, cultural and legal circumstances (Coelho *et al,* 2016)

Auler et al, (2014) argue that waste collectors are a vulnerable group that turns to garbage collection for survival. A study conducted in Brazil revealed that waste pickers had a higher prevalence of diabetes, hypertension, dyslipidaemia and obesity as compared to the general population (Auler*et al,* 2014). In addition, the study reported that waste collectors were unaware of this diagnosis and had limited access to public health services. In South Africa, (Makhubele*et al,* 2019) reported that the prevalence of common mental disorders (CMD) among waste pickers was 37.5% higher than that of the general population. In Ghana, (Amankwaa, 2014) reports that 30% of waste pickers who are involved in the burning of e-waste had experienced coughs, dizziness, chest pain and excessive sweating. A survey conducted in South Sudan reported that most waste scavengers did not have access to healthcare services even when they fell ill or were injured (UNEP, 2013, p.20). In addition, most of the waste scavengers lacked the appropriate PPE and hand tools necessary for scavenging waste. Instead, most scavengers used their bare hands to sort waste resulting in hand injuries. (Auler*et al,* 2014) reported that in Brazil, waste pickers took more than one year to consult the doctor because they had limited access to the health facility. In his study, (Megrahi*et al,* 2009) conducted a risk assessment with an aim of identifying the hazards that were present in a MRF and reported that workers who were involved in sorting and segregating of waste were likely to be exposed to significant levels of radon gas, particulate matter, biological hazards as well as volatile organic compounds.

Communities living close to dumpsites are also likely to be exposed to hazards such as obnoxious odours, contaminated water and contaminated agricultural produce (Concern Worldwide, 2012, p. 42). Toxic chemicals from the dumpsite are transported to neighbouring communities through soil, air and water media. Exposure to these hazards has led to serious health challenges such as gastrointestinal problems, skin irritations and eye problems (Sankoh*et al,* 2013). Current information on the long-term health effects of exposure to toxic and infectious materials is insufficient. However, (Zirab*aet al* 2016) proposed a framework for identifying the linkages between exposure to solid waste management and associated health outcomes in developing countries. In developing countries, the most exposed category of waste pickers includes women, vulnerable children and the elderly. A study conducted at the Dandora dumpsite showed the proportion of children living in areas adjacent to the dumpsite to have lead blood levels that exceeded the internationally accepted toxic levels of 10 µg/dl of blood (Kimani*et al, 2007*).

Pregnant women working and living close to dumpsites have a higher risk of delivering babies with congenital anomalies. In Europe, there is a raised risk of congenital anomalies among babies born to mothers living close to landfills with hazardous chemical waste than those living within the same distance from engineered sanitary landfill where leachate and gas management exist (Dolk*et al*, 2003). A case control study showed a significantly raised odds ratio for residence within 3 km of a landfill site as neural-tube defects (odds ratio 1·86), malformations of the cardiac septa (odds ratio 1·49), and anomalies of great arteries and veins (odds ratio 1·81). Odds ratios of borderline significance were found for 96-rachea-oesophageal anomalies (2·25), hypospadias (1·96), and gastroschisis (3·19) (Dolk*et al,* 2013). A research that sought to explore the impact of cleaning up toxic sites on infant health reported a 20% to 25% decrease in congenital anomalies (Currie *et al,* 2011). This decrease in congenital anomalies among infants born to these mothers exemplifies the negative impact that dumpsites and other toxic sites have on the health of adjacent communities.

2.2. Concentration Levels of Lead, Mercury and Cadmium in Soil and Water Samples

According to a study commissioned by (UNEP, 2007), lead, cadmium and mercury are highly concentrated in Dandora dumpsite waste beyond the internationally acceptable standards. Soil samples adjacent to and within the dumpsite revealed high lead concentrations of 264ppm and 13500ppm respectively, all beyond 50ppm reference value of Taiwan and Netherlands lead soil concentrations. Adjacent soil samples for mercury measured up to 18.6ppm while the soil within the dumpsite measured up to 46.7ppm, all above the 2ppm WHO standard. Cadmium levels were as high as 40ppm in adjacent soil and 1058ppm in the soil within the dumpsite which supersede 5pp reference value of Taiwan and Netherlands soil standards. When the mean concentration levels were compared with a control sample from unpolluted Waithaka soil, the difference was significant with a ($p=0.0002$).

Lead concentration was as low as 34.5ppm and Mercury concentration was below the detection limit of 15ppm in Waithaka soil. Mean concentrations of lead in Dandora soil samples were over seven times more than those found in

Waithaka while Zinc concentrations were four times greater and these values exceeded the recommended standard levels as well.Thehigh levels of lead in the soil samples analysed negatively impacted on the communities living near the dumpsite which was evidenced as well by the fact that half of the children examined had blood lead levels equal to or exceeding the internationally accepted toxic levels (10 µg/dl of blood).

2.3. Conceptual Framework

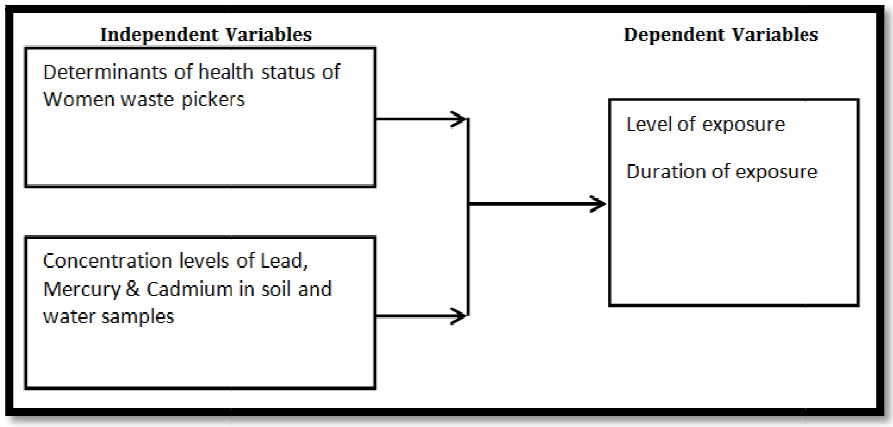

Figure 1: Conceptual Framework

3. Research Methodology

3.1. Research Design

A cross sectional study design was used to determine the health status of women waste pickers and to assess the likely health effects of mercury, cadmium, lead and Pop's exposure on women's health. In addition to the above, the current control practices employed at the site to protect women from the effects of exposure were also assessed. In addition, soil and water samples were collected, transported and analysed in the analytical laboratory to determine the concentration of lead, cadmium, mercury and POPs. This was used to provide a basis for developing mitigation measures for heavy metals toxicity and exposure at the dumpsite. A mixed methods approach was used for data collection. This was warranted by the nature of the study population. Dandora dumpsite is difficult to access since their local authorities have limited access to the site. The identification and access to the study respondents was on the behest the dumpsite's informal management. Therefore, there was need to triangulate the data collected. Triangulation is a strategy that can be used by researchers to gather information by use of more than one method of data collection (Schoonenboom&Johnson, 2017, p. 129).

3.2. Study Population

The study population was all women waste pickers at the Dandora dumpsite.

3.3. Sampling

The sample frame for this study was 6,000 out of a possible number of 10,000 dumpsite workers at Dandora dumpsite. The sample size was determined by using the (Fischer et al, 19986) formula

$$n = \frac{z^2pq}{d^2}$$

Where
n= is the desired sample size (if target population is > 10000)
z- Is the standard normal deviation = 1.96 which corresponds to 95% confidence interval
p= proportion of the target population estimated to have the desired characteristics (0.5)
q=1-p (proportion without the characteristic)
d= the level of statistical significance set at 0.05 degrees of freedom)

$$n = \frac{1.96x1.96x0.5x0.5}{0.5X0.5}$$

n=384

Since the target population was less than 10000, the final estimate for the sample size was calculated using

nf = n/(1+(n/N))

nf = the desired sample size when the population is less than 10,000
n= the desired sample size when the population is more than 10,000
N=the estimate of the population
n= 384/ (1 + (384/6667)
= 362.959
~363 women waste pickers working at the Dandora dumpsite.

3.4. Data Collection

The questionnaire was used for collecting quantitative data and was guided by the research questions, the items in the questionnaire were refined through piloting the questionnaire and rewording the question to ensure that they were capable of measuring the construct. Qualitative focus group questions guide was developed using similar parameters bearing in mind that which will not easily come out in the interview schedule can be captured in the focus group discussion. For the qualitative data NVIVO version 12 analysis Software was used to organise the data that was generated in the focus group discussions.

3.5. Data Analysis

Quantitative data was coded, entered and analysed using SPSS version 23. Descriptive statistics were done and reported in bar charts and bar graphs. While, qualitative Data analysis was conducted using the NVivo software which is a data analysis tool. Qualitative data analysis tools are generally classified under tools that provide automated analysis of data and tools that emphasize on the manual handling of data (Sotiriadou et al, 2014). NVivo and Atlas.ti are two qualitative data analysis tools that require manual handling of data. Unlike the automated tools, NVivo does not use statistics-based algorithms to automatically analyze texts. Instead, the soft way the software helps the researcher to organize and manage the data which facilitates the analysis of data. NVivo also enables the research to identify themes and code the data systematically which allows the researcher to engage more meaningfully with the data. The data was organised as per the study objectives. Pattern coding was used to identify patterns in the data. This generated a130 codes which were further condensed. The coded data was used to generate themes which allowed the researcher gain deeper insight. The identified themes were then summarized as per the research objectives. It was then reported as per the study themes.

4. Findings

4.1. Health status of Women Waste Pickers

This study sought to find out the health status of the women waste pickers by interrogating the respondents and also the health service providers who provide health care to the women waste pickers. The respondents were to give a true representation of their health status based on set parameters while the health service providers were to give exact health facts based on the health records stored in the health facility that attends to women waste pickers six months prior to the study, during and after the study period. Most women waste pickers who worked at the Dandora dumpsite (86.4%) reported to have been unwell in the previous six months prior to the study. In addition, 71.4% of the workers perceived these illnesses to be work related.

Worker Illnesses at the Dumpsite		
Worker experienced illnesses in the last six months	Frequency	Percentage
Yes	311	86.4
No	49	13.6
Worker perceived the Illness as Work Related	Frequency	Percentage
Yes	257	71.4
No	97	26.9

Table 1: Experience of Illnesses among Women Waste Pickers

4.1.1. General Illnesses

Most of the women waste pickers reported having suffered from general illnesses such as headache, dizziness and nausea which are more difficult to attribute to exposures within the dumpsite environment, figure 24. However, the prevalence of these conditions is high considering that 71% of all dumpsite workers reported experiencing headache on a regular basis whereas 50% reported having experienced dizziness within the dumpsite environment. Other conditions such as blood pressure and nausea were reported by a small proportion of workers.

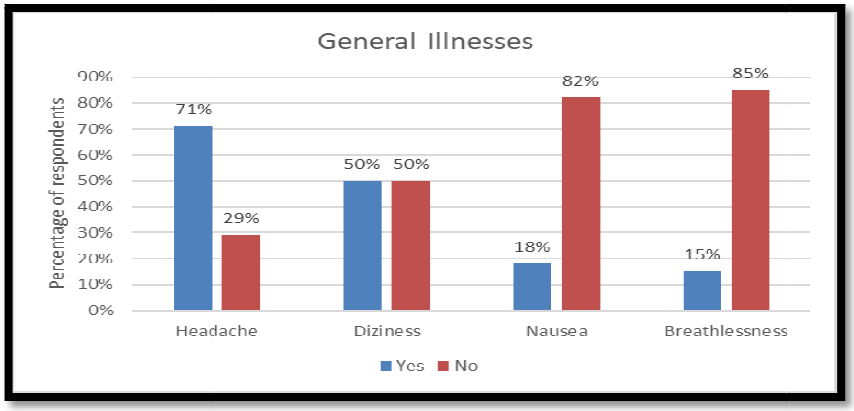

Figure 2: General Illnesses among Women Waste Pickers

4.1.2. Pregnancy among Women Waste Pickers

Since the study sought to find out the health status of women waste pickers, child bearing while working at the dumpsite was considered as an important factor because of the health of the mother and that of the child especially when conceived while working at the dumpsite. Mothers who deliver while working at the dumpsite environment also tend to raise their children within the same environment. Such children are exposed to contaminants at a very early age and are likely to experience harmful health effects in the long run. This study has shown that slightly more than half 51.9% (n=188) of the women waste pickers reported to having been pregnant while working at the dumpsite. About 11% of the women waste pickers, who had been pregnant, reported to have experienced pregnancy related problems such as a miscarriage, still birth or a premature birth.

Pregnant While Working at Dumpsite	**Frequency**	**Percentage**
Yes	187	51.9
No	172	47.8
Type of Pregnancy Related Problem	Frequency	Percentage
Miscarriage	3	4.5%
Still birth	3	4.5%
Premature birth	1	1.5%

Table 2: Pregnancy and Pregnancy Related Problems among Women Waste Pickers

4.2. Levels of Heavy Metal and Pops Exposure

The mean concentrations of cadmium, lead, and mercury were found to be 450 mg/kg, 4498 mg/kg and 7.5 mg/kg respectively in soil samples collected in areas surrounding the Dandora dumpsite. These levels of lead and Cadmium in soil samples were found to be higher than the recommended 400mg/kg and 10 mg/kg respectively in residential and agricultural soils (ATDSR, 2007). Human exposure to lead, cadmium and mercury can lead to various illnesses some of which take a long duration before they manifest (Musa & Abdullahi, 2013). This can occur through indirect consumption of leafy vegetables and crops that are grown in contaminated soils (Mutune et al, 2013; Cortez & Ching, 2014). Free range animals in the region are likely to bioaccumulate hazardous waste when they consume contaminated food and water (Envilead, 2012). Human beings are exposed to heavy metals upon consumption of products from such animals. Several studies have reported a high concentration of heavy metals in soils surrounding dumpsites in Africa (Tsuma *et al,* 2013; Odhiambo *et al,* 2015; Mohammed & Mohammed, 2012). A study in Zimbabwe revealed that children, men and women who scavenge at the dumpsites are exposed to various lead levels on a daily basis (Tosengai *et al,* 2017). A similar study in Ghana by (Twumasi *et al,* 2016) reported that the lead and cadmium in agricultural soils was above the recommended limits of 420ppb and 270 ppb.

	Heavy Metal Tests in Soil Samples				
Element Sample	**Sample Code**	**Sample Site**	**Concentration ppm**	**Mean Concentration**	**Recommended Limit**
Cadmium	D-P4	Dandora Phase 4	360	375±45.184	10 mg/kg
	D-P2	Dandora Phase 2	380		
	D-N1	Dandora Phase 1	490		
	D-K1	Dandora Phase 3	270		
Lead	D-P4	Dandora Phase 4	2121	4498±843	400mg/kg
	D-P2	DandoraPhase 2	4589		
	D-N1	Dandora Phase 1	6001		
	D-K1	Dandora Phase 3	5282		
Mercury	D-P4	Dandora Phase 4	8	7.5±0.29	10mg/kg
	D-P2	Dandora Phase 2	8		
	D-N1	Dandora Phase 1	7		

Table 3: Heavy Metal Contamination in Soil Samples

The concentrations of cadmium, lead and mercury in water samples collected at the Nairobi River were found to be significantly higher than the WHO recommendation of these elements in drinking water (WHO, 2008).Heavy metal pollutants can cause harmful effects in plants, animals and humans as a result of long-term or frequent exposure to high concentrations in air, water or soil (European Environmental Agency, 2018).In a study on birth outcome measures and maternal exposure, cadmium depicts potential passage through the placenta had the most prominent effects on birth outcome (Iman Al-Saleh, Neptune Shinwari et al., 2014). Cadmium binds strongly to organic matter and can be taken up by plants and accumulated by aquatic organisms such as fish hence entering the food supply (Hossain et al., 2012). Most cadmium absorbed by the body is taken to the kidney and liver and can remain there for many years. Green leafy vegetables such as spinach and kales, potatoes and grains, peanuts and soya beans readily take up cadmium and may contain high levels of the heavy metals (Chaney et al., 2018). Cadmium exposure is associated with decreased birth weight, cancer, delayed ossification, kidney damage, skeletal malformations, bone fracture, low bone mineral density and impaired early life development (Dwiveldi et al., 2013).DNA methylation is essential for embryogenesis and for maintaining cell line embryogenesis whereas dysregulation of epigenetic process such as DNA methylation could lead to impaired childhood

development or chronic diseases later in life including cancer (Hossain et al., 2012). Different studies have also shown that environmental exposure to cadmium among children and adults is associated with bone reabsorption, decreased bone mineral density and osteoporosis (Engstrom et al, 2011). Adenkuleet al. (2017) reported that portable water obtained from hand-dug wells in rural areas had concentrations of heavy metals that were higher than WHO permissible levels for portable water, the concentrations of heavy metals in portable water increased with increased proximity to dumpsites

	Heavy Metals in Water Samples				
Element Sample	**Sample Code**	**Sample Site**	**Concentration ppm**	**Mean Concentration**	**Recommended Limit**
Cadmium	R1C	River lower section	0.002	.005± 0.003	0.0006
	R2C	River middle section	0.010		
	R3C	River Upper section	0.003		
Lead	R1L	River lower section	0.820	0.746 ± 0.089	0.01
	R2L	River Upper section	0.850		
	R3L	River Upper section	0.570		
Mercury	R1M	River lower section	0.01	0.01±0.003	0.003
	R2M	River Upper section	0.01		
	R3M	River Upper section	0.01		

Table 4: Heavy Metal Contamination in Water Samples

4.2.1. Correlation Analysis

The number of hours per day spent working on tasks was positively correlated with knowledge on exposure to diseases r (325) = 0.147, P<0.001. This means that workers who spent a longer duration of time at the dumpsite every day perceived that exposure to pollutants at the dumpsite was a risk factor to developing diseases.

Correlations				
			Indicate hours per week spend performing the task	Working in the dumpsite can expose one to diseases
Spearman's rho	Indicate hours per week spend performing the task	Correlation Coefficient	1.000	.147**
		Sig. (2-tailed)	.	.008
	Working in the dumpsite can expose one to diseases	Correlation Coefficient	.147**	1.000
		Sig. (2-tailed)	.008	.
**. Correlation is significant at the 0.01 level (2-tailed).				
b. Listwise N = 325				

Table 5: Correlations between Numbers of Hours Spent Working on a Task and Knowledge of Exposure to Diseases

The duration of working (years) at the dumpsite was positively correlated with knowledge on whether waste pickers are exposed to diseases because of working at the dumpsite, spearman's r (335) = 0.218, P=0.008. This means that the waste pickers who had worked at the dumpsite for a long duration of time perceived working at the dumpsite as a risk factor for developing diseases.

Correlations				
			When did you start working at your current workplace	**Working in the dumpsite can expose one to diseases**
Spearman's rho	When did you start working at your current workplace?	Correlation Coefficient	1.000	.218**
		Sig. (2-tailed)	.	.000
	Working in the dumpsite can expose one to diseases	Correlation Coefficient	.218**	1.000
		Sig. (2-tailed)	.000	.
**. Correlation is significant at the 0.01 level (2-tailed).				
b. Listwise N = 335				

Table 6: Correlation between the Numbers of Years Spent Working at the Dumpsite and the Knowledge on Whether Waste Pickers Are Exposed to Diseases

4.3. Qualitative Analysis

4.3.1. Effects on Health

Majority of women waste pickers claimed that the community complains mostly about miscarriages, pungent smell and respiratory illnesses. For example, another women waste picker 'Participant 7' reported that;

> *'They [community] claim to have experienced miscarriages because they live next to dumpsites but we who work here at the dumpsite get pregnant often and still deliver our new-borns successfully and our children are going to school daily'*

4.3.2. Health Effects as Result of Exposure to Heavy Metals among Women Waste Pickers

Health effects were found to be very high. Health records indicate that there a number of reported injuries and illnesses that women waste pickers were exposed to. The study also showed that women waste pickers were exposed to numerous health hazards at the dumpsite which increased their risk of developing various illnesses and injuries. Majority of women waste pickers (90.8%) had been sick during the past six months preceding the study with more than half reporting to have experienced joint pain (73%), headache (71%) and dizziness (50%). In addition, most workers were often injured through cuts and pricked by sharp objects that were present in solid waste at the dumpsite. Subsidized health care services were provided to dumpsite workers by nearby government sponsored health care facilities while non-subsidized services were provided by private health care facilities. However, most dumpsite workers visited these health care facilities only when they experienced serious illnesses or injuries otherwise the dumpsite workers administer first aid to themselves and continue working until the situation gets out of control when they now see medical care at the health facilities. The situation is exacerbated by consumption of food at the dumpsite leading to exposure to contaminants through ingestion. Some cooked food stuffs end up at the Dandora dumpsite from various catering units in the Central Business District. Most women waste pickers (76%) ate food at the dumpsite with 24% scavenging for their meals from the dumpsite which exposed them to contaminants such as carcinogens which are common in a dumpsite environment (Aknfe, 2015; Kimani et al, 2007; Magaji, 2012). In addition, workers reported having been exposed to physical hazards such as pricks and cuts some of which emanated from health care waste disposed at the dumpsite from various hospitals in Nairobi County. A similar study conducted in Pakistan that explored municipal wastes found that healthcare wastes and other hazardous waste were disposed at dumpsites (Ali et al, 2015). This type of waste exposure heightens the health risks among waste scavengers because it increases the likelihood of contracting blood borne infections. In addition, women waste pickers complained of runny nose, sneezing, visual problems and burning eyes which are likely to arise from pungent smell at the dumpsite as well as particles that find their way into the eyes. With approximately half of the women waste pickers (51.9%) having been pregnant at least once at the dumpsite, only 7 (3.7%) had experienced a pregnancy related problem such as still births, premature birth and miscarriage. Waste dumpsite environments are known to contain carcinogenic and teratogenic elements such as lead, cadmium and mercury which upon exposure can cause birth defects and pregnancy related problems (Musa &Abdullahi, 2013; Ren et al, 2011).

4.3.3. None Utilization of Appropriate Personal Protective Equipment by Women Waste Pickers

Women waste pickers that had been previously ill attributed these illnesses to exposure to hazards at the dumpsite for lack of wearing appropriate personal protective equipment (PPE). In addition, most women waste pickers (77%) claimed that wearing PPE was necessary in preventing illness and injuries at the dumpsite. Despite this awareness among women waste pickers, no dumpsite worker had appropriate PPE. However, there was partial use of inappropriate PPE in an attempt to provide protection against some of the most common hazards. For instance, most women waste pickers used open shoes or torn rubber boots instead of safety boots to protect their feet from injuries. Appropriate PPE at the dumpsite to help women waste pickers minimize injuries and illnesses should include a helmet to protect the head from falling objects dropped by municipal trucks, a nose mask to protect the nose from the dust emitted by bulldozers pushing away the waste as well the ash emanating from burning waste, an apron to protect the inner garments from caring contaminants home, goggles to protect the eyes from sharp objects that are churned by other scavengers, heavy duty gloves to protect the hands from injuries arising from scavenging for recyclable goods and safety boots to protect the feet from sharp objects in the dumpsite. These appropriate PPEs would protect women waste pickers against falling objects, particulate matter and obnoxious waste, chemicals as well as injuries from sharps. Only a very small proportion of women waste pickers wore torn gloves substandard goggles whereas none had a respirator to prevent inhalation of obnoxious fumes. Considering the high level of awareness on the importance of PPE in preventing injuries and diseases among dumpsite workers, it is highly likely that workers are unable to meet the cost of acquiring appropriate PPE. The cost of appropriate PPE would seem very high to a dumpsite worker compared with the average income per day

5. Conclusion and Recommendations

Kenya being a developing country, the country is faced with a serious challenge when it comes to waste management especially in its urban areas. The growing population as well as increase in industrialization has led to increased generation of solid waste in many cities. There is minimal allocation of resources in this area that ends up with poor waste management practices. This has given rise to the proliferation of ineffective informal waste management system where women play a key role in recovering recyclable waste. This study sought to explore the health (effects) outcomes associated with working for long hours, days, months and years at the dumpsite among women waste pickers and the level of lead and mercury level at Dandora dumpsite.

The study has shown that women waste pickers at the Dandora dumpsite are characterised with various health disorder due to existing environmental condition at their work place. Further, a high level of mercury and lead metals were established to be in waters and soil within Dandora dumpsite. The absence of a mitigation framework by relevant authorities on how to combat the negative environmental and health effects at the dumpsite means that the situation is likely to continue in the future. Thus, it would be recommendable for the Nairobi County Government management to adopt a sanitary landfill to further reduce pollution and minimize negative health effects among workers by setting up a sanitary landfill. Also, there is need to establish intermediate treatment facilities at the ward level to reduce health hazards at theDandora dumpsite. These will be small scale waste composting plants that can provide employment, enable communities to generate income and alleviate poverty among women and the youth. Additionally, there is need for provision of health care services with strong surveillance for women waste pickers. This should also include the provision of basic training on how to manage cuts and wounds aseptically. There should be close monitoring of women's' health and the level of exposure to various pollutants in the body

6. References

i. Amankwaa, E. F. (2014). E-waste livelihoods, environment and health risks: Unpacking the connections in Ghana. West African Journal of Applied Ecology, 22(2): pp. 1-15.
ii. Auler, F., Nakashima, A. T., &Cuman, R. K. (2014). Health conditions of recyclable waste pickers, Journal of community health, 39(1): 17-22.
iii. Chifamba, P. (2007). Trace metal contamination of water at a solid waste disposal site at Kariba, Zimbabwe. African Journal of Aquatic Science, 32(1): pp. 71-78.
iv. Coelho, A. P. F., Beck, C. L. C., Fernandes, M. N. D. S., Freitas, N. Q., Prestes, F. C., &Tonel, J. Z. (2016). Women waste pickers: living conditions, work, and health. Revistagaucha de enfermagem, 37(3): pp. 24-32.
v. Coelho, A. P. F., Beck, C. L. C., Fernandes, M. N. S., Silva, R. M., & Reis, D. A. M. (2016). Organization of the work in a recycling cooperative: implications for the health of female waste pickers. Retrieved from: http://revistas.ufpr.br/cogitare/article/view/42241/27510
vi. Concern Worldwide. (2012). Trash and Tragedy: The impact of garbage on human rights in Nairobi city. Nairobi. Concern Worldwide. 37(1): pp. 36-45.
vii. Currie, J., Greenstone, M., &Moretti, E. (2011). Superfund Cleanups and Infant Health. American Economic Review, 101(3): pp. 435-441.
viii. Dolk, H., Vrijheid, M., Armstrong, B., Abramsky, L., Bianchi, F., Garne, E., Nelen, V., Robert, E., Stone, D., &Tenconi, R. (2013). Risk of congenital anomalies near hazardous-waste landfill sites in Europe: The EUROHAZCON study. The Lancet, 352(9126): pp 423-4307.
ix. Environmental Management and Coordination Regulations (EMCA). (2015). Retrieved from http://www.nema.go.ke/images/Docs/Legislation%20and%20Policies/EMCA%20Act%202015.pdf
x. Makhubele, M., Ravhuhali, K., Kuonza, L., Mathee, A., Kgalamono, S., Made, F., ...&Naicker, N. (2019). Common Mental Health Disorders among Informal Waste Pickers in Johannesburg, South Africa. A Cross-Sectional Study. International Journal of Environmental Research and Public Health, 16(14): p. 2618.
xi. Mangenda, H. H., Nedeff, V., Kunyima, K., Barsan, N., Moşneguţu, E., &Tomozei, C. (2017). Municipal waste management in Limete, Mont Amba District of Kinshasa, Democratic Republic of the Congo. Journal of Engineering Studies and Research, 20(2): pp.14-29.
xii. Megrahi, M. (2009). PhD Thesis, Cardiff Metropolitan University, School of Health Sciences.
xiii. Megrahi, M., (2009). Case study to evaluate working environment at materials recycling facilities in South Wales, United Kingdom. University of Wales. 13(2), pp. 56-72.
xiv. Njoroge, B.N.K., Kimani, M., &Ndunge, D. (2014). Review of municipal waste management: A case study of Nairobi, Kenya. International Journal of Engineering and Science, 4(2): pp. 16-20.
xv. Ogunrinola, I. O., &Adepegba, E. O. (2012). Health and economic implications of waste dumpsites in cities: The case of Lagos, Nigeria. International Journal of Economics and Finance, 4(4): pp.239-251.
xvi. Oyaro, K. (2003). Month after dump scare, problems persist. JohannesburgInterPress Service News Agency (Johannesburg), 21(1): pp. 76-80.
xvii. Sankoh, F. P., Yan, X., & Tran, Q. (2013). Environmental and Health impact of Solid waste disposal in developing cities. A case study of Granville brook dumpsite. Freetown, Sierra Leone. Journal of Environmental Protection, 4(7): pp. 665-670.
xviii. Schluep, M., Hagelueken, C., Kuehr, R., Magalini, F., Maurer, C., Meskers, C. & Wang, F. (2009). Recycling-from e-waste to resources, Sustainable innovation and technology transfer industrial sector studies. United Nations Environment Programme (UNEP), Paris, France. 23(2): pp. 52-76.
xix. Schoonenboom, J., & Johnson, R. B. (2017). How to construct a mixed methods research design. KZfSSKölnerZeitschriftfürSoziologie und Sozialpsychologie, 69(2): pp. 107-131.
xx. Sotiriadou, P., Brouwers, J., & Le, T. A. (2014). Choosing a qualitative data analysis tool: A comparison of NVivo and Leximancer. Annals of Leisure Research, 17(2): pp. 218- 234.
xxi. UNEP. (2013). Health and Safety Guidelines for Waste Pickers in South Sudan. South Sudan: United Nations Environmental Programme., International Environmental Technology Centre. Osaka: CalRecovery, Inc.11(1): pp.17-21.

xxii. UNEP., October, (2007, October). Environmental Pollution and Impacts on Public Health, The impact of the Dandora Dumping Site in Nairobi, Kenya. 22(3), pp.33-41. Retrieved from https://file.ejatlas.org/docs/dandora-landfill-nairobi-kenya/dandorawastedump-reportsummary.pdf
xxiii. Viljoen, J. M. M., Blaauw, P. F., &Schenck, C. J. (2012). The role and linkages of buy-back centres in the recycling industry: Pretoria and Bloemfontein (South Africa). ActaCommercii, 12(1): pp. 1-12.
xxiv. Ziraba, A. K., Haregu, T. N., &Mberu, B. (2016). A review and framework for understanding the potential impact of poor solid waste management on health in developing countries. Achieve of Public Health, 74(1): p. 55-69.