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FRAMEWORK FOR ASSESSING OCCUPATIONAL HEALTH RISKS OF MUNICIPAL SOLID WASTE HANDLERS FOR USE BY LOCAL GOVERNMENT STRUCTURES

BY

FRANCE NCUBE (14004284)

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PROMOTER: Dr Esper Jacobeth Ncube

CO-PROMOTER: Prof Kuku Voyi

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Summary

Past studies have reported various occupational risks to municipal solid waste handlers (MSWHs). However, no generic framework has been developed for assessing the risks. Therefore, this thesis' aim sought to develop a framework that local government structures can use for such purposes. To accomplish this task, the following objectives were formulated. The first objective was to review available literature regarding human health risks associated with municipal solid waste management operations. The PubMed literature search was used to identify relevant articles, published in the years 1995-2014. Also, references of potential articles were assessed to identify additional papers that conformed to the criteria for inclusion. 379 studies were found but only 72 met the concerned criteria. Methodological shortcomings such as usage of cross-sectional designs, small sample sizes, not enrolling reference groups, enrolling smaller reference groups, and not controlling possible confounders, were the major limitations of the studies. The proposed framework encourages local government structures to engage in or utilise methodologically sound studies that can yield valid and reliable findings.

The second thesis objective determined the workplace hazards of MSWHs. Exposure assessments were done on various workplace hazards. Findings show that MSWHs are occupationally exposed to bioaerosols, chemicals, infectious material, physical and mechanical hazards. In light of the higher summer exposures of MSWHs to ultra-violet radiation and the reported health complaints, the study recommended: i) waste collection to be done at night or early morning and ii) regular breaks, rest and rehydration of MSWHs with oral fluids. A publication to disseminate these findings was made in an accredited open access journal. The findings partly constitute phase 1' output 1 in the framework.

The third thesis' objective assessed the risky job actions of MSWHs. Postural measurements were performed using the Rapid Upper Limbs Assessment method. The findings indicate that MSWHs use unsafe work postures when performing the bin lifting, carrying and emptying tasks. The study recommended: i) mechanisation of refuse bin collection, where feasible, ii) training MSWHs on safe working postures and iii) supervision of waste collection tasks. Also, under phase 1's output 1, the framework stresses the need to examine ergonomic risks of waste collection services. The findings on objective 3 were disseminated in form of a publication.

Objectives 4-7 sought to develop, validate, refine and compile a framework for assessing occupational health risks of MSWHs. An SWOT analysis of available human and environmental risk assessment frameworks was done and the findings were used as a base for the draft framework. The developed draft framework validated and revised through iteration workshops in small, medium and large local government structures. This thesis proves that Mr Ncube is conversant with the nature and purpose of this relevant investigation. From his thesis Mr Ncube has published 3 articles in peer reviewed journals.

Key words: assessment, framework, municipal solid waste handlers, occupational health risks, local government structures

Declaration

I, France Ncube declare that "Framework for assessing occupational health risks of municipal solid waste handlers for use by local government structures", submitted for the degree Philosophiae Doctor (Public Health) at the School of Health Systems and Public Health, University of Pretoria is my own work and has not been submitted by me for any other degree or examination at any other tertiary institution.

France Ncube

Signed on the 14th day of February in 2017

Ethics statement

The author, France Ncube, has obtained approval from the Faculty of Health Sciences Ethics Committee for this research (Ref 343/2014). The author declares that he has observed the ethical standards required by the University of Pretoria's Code of Ethics for Researchers and the Policy Guidelines for Responsible Research. Permission to conduct the study was also received in writing from the study's local authority.

Publications

In line with the thesis' objectives, the following publications were made in non-predatory journals, listed in ISI and Scopus:

1. Ncube F, Ncube EJ, Voyi, K. A systematic critical review of epidemiological studies on public health concerns of municipal solid waste handling. *Perspect in Public Health,* 2017; 137:102-108.
2. Ncube F, Ncube EJ, Voyi, K. Bioaerosols, noise and ultraviolet radiation exposures for municipal solid waste handlers. *Journal of Environmental and Public Health*. https://doi.org/10.1155/2017/3081638.
3. Ncube F, Ncube EJ, Voyi, K. Postural analysis of a developing country's municipal solid waste handlers and a reference group of hospital general hands using the RULA method. *Global Journal of Health Science.* 2017; 9: 194-201.

Conference presentations

1. Ncube F, Ncube E.J, Voyi K. A systematic critical review of epidemiological studies on public health concerns of municipal solid waste handling. Junior Public Health Association South Africa (JuPHASA), 19-22 September 2016.
2. Ncube F, Ncube E.J, Voyi K. Occupational dust, noise, thermal conditions and associated adverse health endpoints for municipal solid waste handlers. Junior Public Health Association South Africa (JuPHASA), 19-22 September 2016.
3. Ncube F, Ncube E.J, Voyi K. A framework for the purposes of assessing solid waste workers' work-related risks. National Conference on Safety and Health at Work (SHAW), Harare, Zimbabwe, 04-06 October 2017.

Dedication

I wish to dedicate the thesis work to municipal solid waste handlers whose job tasks entail exposing their own personal health to diverse work-related risks in the process of safeguarding public health.

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List of abbreviations

Cd	Cadmium
Cfu/m^3	Colony forming units per cubic metre
DEFRA	Department of Environment, Food and Rural Affairs
FVC	Forced expiratory volume
GNB	Gram negative bacteria
HGH	Hospital General Hands
IPCS	International Programme for Chemical Safety
IARC	International Agency for Research on Cancer
ILO	International Labour Organisation
IQ	Intelligence Quotient
LCA	Life Cycle Analysis
Hg	Mercury
Mg/m^3	Milligram per cubic metre
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
MSWHs	Municipal Solid Waste Handlers
NIHL	Noise Induced Hearing Loss
OSHAS	Occupational Health and Safety Assessment Series
OR	Odds Ratio
Pb	Lead
PVC	Polyvinyl chlorides
RULA	Rapid Upper Limbs Assessment
SWOT	Strengths, Weaknesses, Opportunities and Threats
UK	United Kingdom
USEPA	United States of America Environmental Protection Agency
WHO	World Health Organization
WRMSDs	Work Related Musculoskeletal Disorders

Conceptual definitions

Municipal solid waste: means materials collected for safe disposal or further processing by local government structures such as town councils, city councils and municipalities or companies contracted by such local government structures. Such materials may contain harmful physical, chemical, and biological components that may endanger the health of waste collectors. The sources of municipal solid waste include residences, institutions, the construction industry, the commercial sector and street and open areas sweepings.

Municipal Solid Waste management: relates to practices and principles applied to the processes of generation, storage, collection, processing and disposal of waste. It is conducted with the central role of protecting human health and the environment from harm arising from the waste materials and characteristics such as infectiousness, toxicity, putrescibility.

Risk means the likelihood that an accident, injury, ill-health, fatality or damage will occur in the workplace.

Health: as defined by the World Health Organisation means a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Occupational health entails measures aimed promoting and sustaining optimum levels of the physical, mental and social well- being of workers in the workplace. The crux of occupational health is preventing work related injuries, diseases and fatalities. Such occupational injuries, diseases and fatalities arise from workers' performance of tasks which often entail interaction with the work environmental conditions and equipment. This suggests that a generic framework for assessing occupational health risks of waste handlers should not factors like negate the waste workers' work environment, equipment and workers' habits.

Validation is a process performed to determine the correctness of information underpinning the proposed framework. In the validation process each element of the framework critiqued in an open-ended discussion so as to incorporate the richness and diversity of expert input. Review of available literature is done to identify areas that may have been overlooked by the proposed framework.

Local government structures means are an arm of central government and perform various duties on its behalf. They include town councils, city councils, and municipalities and so on.

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CHAPTER 1: GENERAL INTRODUCTION

1.1 Introduction

A growing body of epidemiological literature suggests waste management activities may contribute to various occupational health risks to municipal solid waste handlers (MSWHs). However, to date no generic framework has been developed for assessing such risks. Therefore, the ultimate aim of the current thesis was to develop the concerned framework for use by local government structures.

The foundations for the development of the concerned framework appear to have been laid down by existing environmental and human health risk assessment frameworks [1-6]. A question deserving attention is, "Can such frameworks be utilised for assessing the occupational health of MSWHs?" In chapter two of this document, the strengths and shortcomings of existing frameworks were assessed. The findings on the assessment were used as a base for the proposed framework. Also, the proposed framework is heavily influenced by findings from the primary investigations conducted in line with the thesis' objectives [7-9].

1.2 Background of the study

The link between poor municipal solid waste management and ill- health has long been established [10-12]. The bubonic plague, also known as the Black Death, which claimed many lives of the 14th century Europeans, has been widely attributed to improper waste management practices [13]. Most local government structures in cities of both developed and developing countries now have waste management services focused on safeguarding the health of residents and the environment. Such services are provided by MSWHs whose job tasks may expose them to diverse work related risks [14-17]. These risks entail but are not limited to work related musculoskeletal disorders (WRMSDs) [18-29], respiratory problems [17, 19, 30-40], dermatological conditions [19] and gastro-intestinal complaints [19, 31, 35, 41, 42].

Even though the existing body of research has provided valuable insights on the risks [14-17], two main challenges still remain unresolved. Firstly, the methodological shortcomings of the studies seem to limit the capacity to conclusively provide a cause-effect relationship between waste management tasks and the occupational health complaints of MSWHs [7]. The usage of cross-sectional designs, small sample sizes, enrolling of small control groups or completely non-enrolling of a reference group and the failure to control for possible confounders, are some of the factors limiting the capacity of the studies to demonstrate causality issues.

Secondly, despite the health risks of waste management and suggestions on how to address them [14-17], according to the author's best knowledge, currently there is no framework that has been developed for assessing the exposure of MSWHs to occupational risks. MSWHs safeguard public health from various sanitation related diseases by collecting various waste streams generated in households, businesses and institutions. The thesis provides a generic validated framework for use by local government structures in assessing occupational health risks of MSWHs.

At this point it is crucial to detail some potential benefits of developing a generic framework for assessing occupational health risks of waste handlers. Three fundamental developments are discussed. Firstly, in the waste management industry like in other industries, there are technological disparities between industrialised and developing countries. Previous studies have already ascribed that whilst industrialised countries have automated hydraulic waste collection trucks, developing countries rely on manually operated waste collection systems [30, 33]. The automation of waste collection systems may to reduce the prevalence of musculoskeletal disorders. Furthermore, some industrialised countries now use large underground waste depots which are mechanically emptied using a crane and residents simply put their waste in bins that direct it to such depots [27]. Such a system may reduce the amount of waste physically collected by MSWHs and the associated the musculoskeletal disorders. Ciocoiu et al [43] asserts that differences between countries regarding waste electrical and electronic equipment management are notable in the European Union. Consequently, given these technological disparities with regards to waste collection technologies among European countries, between industrialised and developing countries, methodologically sound epidemiological studies can better unearth the much needed evidence-based interventions that local government structures can use for designing initiatives for promoting waste workers' health. Such studies are envisaged to address the novel risks associated with the state of waste management technology in each country, as well as new occupational health risks ushered in by the adoption of emerging technologies.

Secondly, some studies have reported increasing amount and types of hazardous waste in municipal waste streams [44-47]. Such waste streams may contribute new occupational health risks to MSWHs. This suggest the need to develop a framework to assist local government structures to comprehensively assess the health risks to MSWHs. Thirdly, even though a lot of valuable research has been generated in industrialised countries regarding occupational health risks of waste workers, very little of such studies have been conducted in developing countries

such as Zimbabwe. Given the fact that the nature, characteristics, management practices, capacities and environmental conditions in industrialised countries are not necessarily the same with those of developing, MSWHs in developing countries may be exposed to substantially different occupational risks than their counter parts in industrialised countries. Sabde and Zodpey et al [48] elucidate that in developing countries, there is little, if any, protection to waste workers from direct contact and injury and virtually no dust control exist at the work places. The uniqueness and value of the proposed generic framework is applicability to these existent different scenarios of industrialised and developing countries.

1.3 Problem statement

An emerging theme in available epidemiological literature is the notion that municipal solid waste handling is a job heavily laden with various occupational health risks for waste workers. Yet various methodological flaws in the current body of research limit their capacity to demonstrate causality issues. The proposed generic framework provides mechanisms for addressing these limitations. Additionally, the recent developments in the municipal solid waste management industry such as the adoption of emerging waste collection technologies and methods, emerging hazardous streams like e-waste may come with new work-related risks for MSWHs. Such developments and realities of new occupational risks suggest a need for the scientific community to revisit approaches for assessing the occupational health risks faced by MSWHs. Consequently the crux of this study is to develop a generic framework for use by local government structures in assessing the occupational health risks to MSWHs.

1.4 Aim and objectives

1.4.1 Aim

The aim of thesis was to develop a generic framework for assessing occupational health risks of MSWHs.

1.4.2 Objectives

- To conduct a review of epidemiological literature on human health risks from waste management activities.
- To determine the nature of hazards found in the working environment of MSWHs and associated adverse health endpoints.

- To assess the risky job actions of MSWHs that put them at an elevated risk of developing adverse health end points.
- To develop a generic framework for assessing occupational health risks of MSWHs
- To validate the framework in a prototype local government environment
- To reassess and refine the developed generic framework.
- Compile the final generic framework for assessing occupational health risks of MSWHs.

1.5. Research questions

- What are the strengths, limitations and research needs in available body of epidemiological literature on human health risks of municipal solid waste handling?
- What is the nature of hazards found in the working environment of MSWHs and associated adverse health endpoints?
- What are the risky job actions of MSWHs that put them at an elevated risk of developing adverse health end points?
- How can a generic framework for assessing occupational health risks of MSWHs add value to current practice?

1.6 Thesis structure

This thesis is organised into eight chapters. Chapter 1 presents the background of the study, problem statement, aim, objectives and research questions. Chapter 2 describes the methodology used to develop and validate the framework. Chapter 3 presents findings of a systematic review of epidemiological literature on human health risks in relation to waste management activities. This chapter addresses objective one in the thesis. Chapter 4 presents findings with regard to the thesis' objective two, which determined the nature of hazards found in the working environment of MSWHs and associated adverse health endpoints. Chapter 5 details findings in relation to the thesis' objective three. This objective focused on assessing the risky job actions of MSWHs that put them at an elevated risk of developing adverse health end points. In chapter 6 available environmental and occupational health frameworks were reviewed. Chapter 7 describes the process followed to develop and validate the framework. Lastly, chapter 8 presents the thesis' conclusions and recommendations.

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CHAPTER 2: RESEARCH METHODOLOGY

Introduction

This process of developing a framework for assessing occupational health risk of MSWHs was done in three phases.

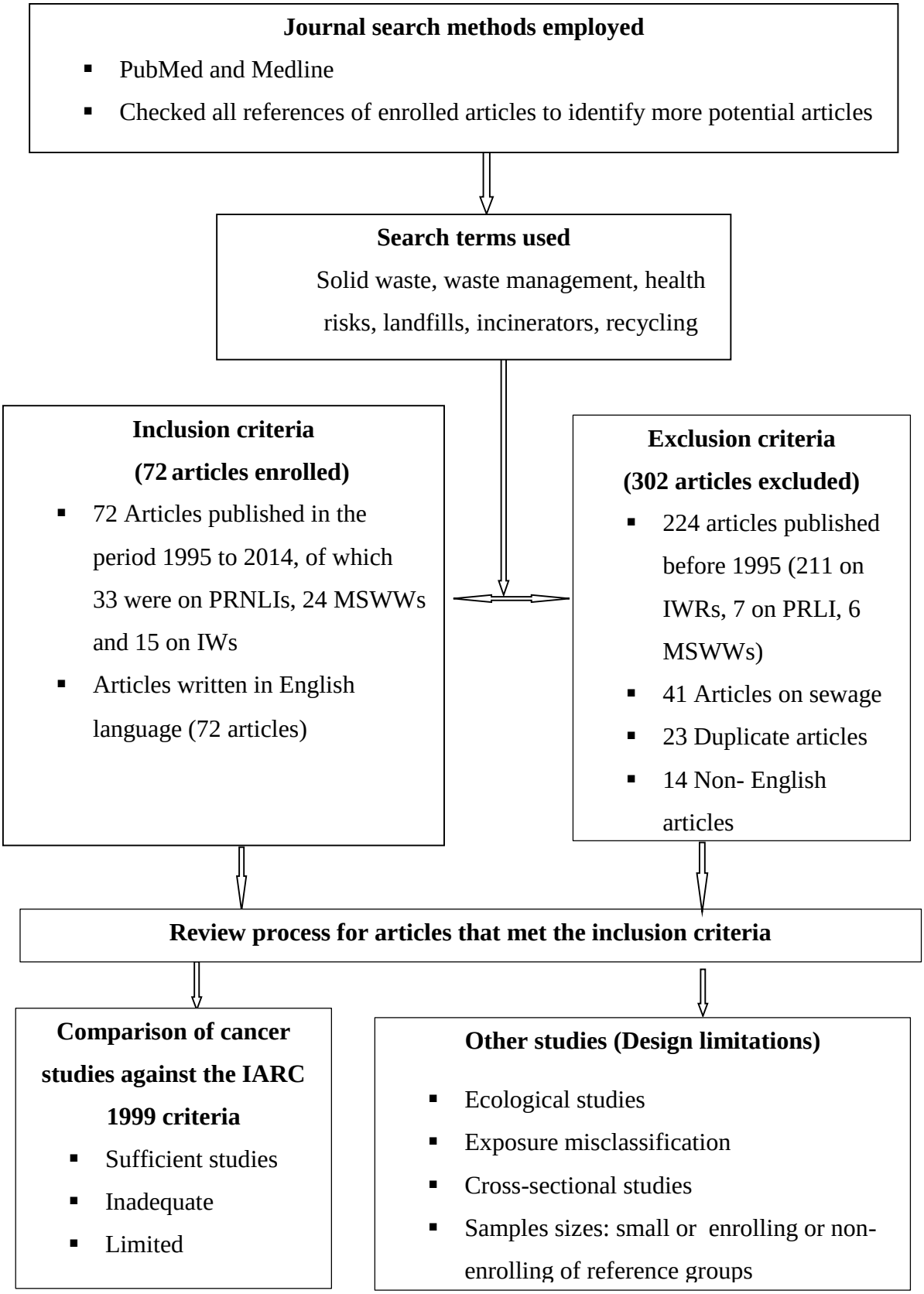
2.1 Phase I: A review of epidemiological studies [1]

The PubMed and Medline computerized literature searches were employed to identify the relevant papers using the key words solid waste, waste management, health risks, recycling, landfills and incinerators. Also, references of all potential papers were assessed to identify more articles that met the inclusion criteria. Noteworthy, further studies may need to consider additional data bases such as Scopus and Google, so as to identify other relevant articles.

A total of 379 papers were identified but after intensive screening only 72 met the inclusion criteria. Of these studies 33 were on adverse health effects in communities living near dumpsites or incinerators, 24 on municipal solid waste workers and 15 on informal waste recyclers. The inclusion criteria needed that the papers reviewed a) be journal articles published in the period 1995 to 2014 b) focus on municipal solid waste management risks to nearby populations, municipal waste workers and informal recyclers c) be articles written in English language.

Articles on sewage were excluded from the review since sewage is not explicitly part of municipal solid waste (MSW). However, further work may need to consider enrolling such articles since biosolids and sludge are often disposed in waste disposal sites such as landfills, energy recovery and composting facilities, and can serve as a source of pathogens and chemicals. Also articles published prior to 1995 were considered to be less recent and were excluded from this review. Various parameters were employed to assess the epidemiologic evidence of human health risks from municipal solid waste management. Firstly, the review assessed epidemiologic evidence in cancer studies guided by the criteria set by the International Agency for Research on Cancer (IARC) of 1999 page 14-25. The criteria allows for ranking of epidemiologic evidence provided by cancer studies in terms of being sufficient, inadequate and limited. Good quality studies revealing a causal or non-causal relationship between exposures and adverse health end points were classified as ‘sufficient’ whilst ‘inadequate’ studies were of poor quality to reliably support the presence or absence of a causal association. On the other hand ‘limited’ scientific evidence denotes a scenario where a positive causal relationship

between exposure and health outcomes has been noted but no provision exists to significantly rule out confounding factors and chance. Secondly, for studies on other health endpoints other than cancer the review assessed their quality by examining strengths and limitations in the study methods used. In particular, this investigation noted whether the studies used a study type capable of proving causality, a large sample size, a large reference group, controlled for possible confounders and whether it was a single-centre or multi-centre study. Figure 2.1 summarises the review criteria used.



PRNLIs: Populations residing near landfills and incinerators, IWR: Informal waste recyclers, MSWWs: Municipal solid waste handlers.

Figure 2.1: Schematic article review process

2.2 Phase II: Primary data collection

Primary data was collected on the: i) bioaerosols, noise and ultra-violet exposures of municipal solid waste handlers (phase IIa) and ii) their postural risks (phase IIb)

2. 3 Phase IIa: Bioaerosols, noise and ultra-violet exposures of MSWHs [2]

Personal sampling was performed using two field monitors mounted in the breathing zone of workers, approximately 1.5 m above ground level. One monitor was for collecting of total dust and the other for bioaerosols (bacteria and fungi). Environmental samples were collected using similar equipment mounted at the breathing zone, from the active landfilling sites, truck cabins and street cleaning sites. Total dust and bioaerosols samples were collected from various sites. Culturing for Gram Negative bacteria (GNB) was done at 37ºC for 24 hours using the McConkey media whist for viable fungi the Malt Extract Agar media diluted with 0.01% chloramphenicol was used. The occupational noise exposure doses were measured using the Quest sound level meter model SOUNDPRO SP-DL-1/3n and the ultraviolet thermal conditions were determined using the AZ thermo-anemometer instrument. Qualitative data on health complaints of waste workers was gathered using self-administered questionnaires. Key informant interviews with waste managers in Local government structures, in the Health department and the Environmental Management Agency were conducted to tap on the richness and diversity of expert input on waste management health risks. Collected data was analyzed using STATA version 13.

2.4 Phase II b: Postural risks of MSWHs [3]

2.4.1 Study design

A cross-sectional design was conducted among MSWHs of Beitbridge Town Council (BTC) and a reference group of HGHs, in the period April to June, 2016. The protocol used in this study was approved in writing by the Ethics Committee at the University of Pretoria (Ref. 343/2014) and the BTC. A two-way dialogue was held with the 60 study participants where the purposes and procedures of the study were discussed. Participants voluntarily signed informed consent forms with the full rights to withdraw from the study without having to give any excuse. There were no facial identities of participants on all photographs that were taken. The study participants were selected using purposive sampling. The inclusion criteria considered MSWHs and HGHs: (1) whose job description entailed lifting, carrying, pulling, pushing and emptying activities, (2) with at least one year work experience and (3) without

known pain related medical conditions which may influence postures, such as arthritis and injuries. The study did not exclude participants on the basis of sex, race or other discriminatory variables and no financial reward was paid for participation. The ages of MSWHs ranged from 27 to 44 years (32.97±4.6 years). They had a mean weight 68±2.88 Kg and a mean height of 163±4 cm. Ages of the HGHs were from 25 to 43 years (32.40±4.2 years), mean weight of 67.50±2.70 Kg and mean height 1.64±4 cm. The differences in the age, weight and height of participants were not statistically different ($p > 0.05$).

2.4.2 Walk-through surveys and direct observations

Several field visits were done to identify the study participants' work activities deserving inclusion in the RULA postural analysis. The study prioritised activities which were routinely done whilst adopting poor postures. Such postures included bending of the neck, trunk, wrist and elevation of the lower and upper arms. Six main activities done by both MSWHs and HGHs were selected for the postural analysis: (1) lifting, (2) carrying, (3) emptying, (4) pushing, (5) pulling and (6) standing. HGHs were used as a reference group in this study because they have considerable commonalities to MSWHs, but they do not handle municipal solid waste. Firstly, the job activities of both HGHs and MSWHs are predominantly performed manually and are physically demanding. For example, HGHs routinely lift patients' meal trays and medical waste bins in hospitals whilst MSWHs routinely lift non-medical waste bins from various waste generation sources such as residences, commercial premises and institutions. The HGHs carry and empty the medical waste bins into the hospital incinerator whilst MSWHs carry and empty the non-medical waste bins into municipal solid waste collection vehicles. Secondly, both MSWHs and HGHs' work entails adopting body positions which involve bending of the upper limbs' joints, which can be analysed using the RULA method to identify unsafe postures and suggest the required corrective interventions.

2.4.3 Posture measurement

The RULA method was used to assess the work postures of each MSWH and HGH, in their work situations. It uses posture scores. For instance, a score of 1 for the upper arm is awarded when it is near neutral ($<20^0$ abduction) or in a neutral position. The RULA scores were obtained using the standard methods described in literature [3-6]. Notably the final RULA scores are interpreted as follows: 1- 2 negligible risk, 3 - 4 low risk and change may be required, 5 - 6 medium risk, further investigation and change soon and 6+ very high risk, change required now. The photographs of participants at work were taken during their normal working hours.

These were used to score the work postures. For each participant, the left and right side of the upper body were rated separately taking note of the angles at the upper limbs joints, the twist of the wrist, neck and trunk as well as abduction of the shoulders. The ratings were used to obtain the final RULA score for each participant.

2.4.4 Statistical analysis

Data on the postural mean RULA scores were tested for normality using the Shapiro-Wilk test. The data were not normal. The Q-Q plots for the mean RULA postural scores on each activity were scattered in manner resembling a sigmoid shape. Hence, parametric tests such as t-tests could not be done. Thus, a non-parametric test, the Wilcoxon rank sum test (Mann-Whitney test) was performed. All analyses were performed using STATA version 13 at 95% level of confidence ($p < 0.05$). The lack of normality could be due to discrete postural risk scores of each worker and the use of relatively small sample sizes of 30 MSWHs and 30 HGHs.

2.5 Phase III: Review of available human and environmental frameworks

An analysis of strengths, weaknesses, opportunities and threats (SWOT) of available human and environmental risk assessment frameworks was done and the findings were used as a base for the framework. Literature searches were conducted using PubMed, Medline, Embase, Scopus and free search to identify relevant frameworks. Search terms used were: framework, model, risk assessment, risk management, environmental and occupational health. For each framework, references were checked to identify additional frameworks meeting the inclusion criteria. Frameworks to be included in the review had to meet the criteria shown in Box 1.

Box 2.1: Framework inclusion and exclusion criteria

Inclusion criteria

(1) had a direct focus on environmental, human health or occupational health issues,

(2) contain a diagrammatic representation of the components,

(3) have a verifiable and authentic source,

(4) written in English language and

(5) latest version of the concerned framework.

Exclusion criteria

(1) frameworks on effluent,

(2) nanomaterial,

(3) water pollution and

(5) cancer

A total of 49 frameworks were found and only 12 met the inclusion criteria described in Box 1. Each selected framework was examined with regards to emphasis on: problem formulation, toxicological assessments, risk judgement criteria, documentation, stakeholder consultation, risk communication, evaluation and consideration of findings from methodologically sound epidemiological studies.

2.6 References

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CHAPTER 3: A SYSTEMATIC CRITICAL REVIEW OF EPIDEMIOLOGICAL STUDIES ON PUBLIC HEALTH CONCERNS OF MUNICIPAL SOLID WASTE HANDLING.[1]

3.1 Abstract

Aims: The ultimate aim of this review was to summarize the epidemiological evidence on the association between municipal solid waste management operations and health risks to populations residing near landfills and incinerators, waste workers and recyclers. To accomplish this, the sub-aims of this review article were to (1) examine the health risks posed by municipal solid waste management activities, (2) determine the strengths and gaps of available literature on health risks from municipal waste management operations, and (3) suggest possible research needs for future studies.

Methods: The article reviewed epidemiological literature on public health concerns of municipal solid waste handling published in the period 1995 - 2014. The PubMed and Medline computerized literature searches were employed to identify the relevant papers using the key words solid waste, waste management, health risks, recycling, landfills and incinerators. Additionally, all references of potential papers were examined to determine more articles that met the inclusion criteria.

Results: A total of 379 papers were identified, but after intensive screening only 72 met the inclusion criteria and were reviewed. Of these studies, 33 were on adverse health effects in communities living near dumpsites or incinerators, 24 on municipal solid waste workers and 15 on informal waste recyclers. Reviewed studies were unable to demonstrate a causal or non-causal relationship due to various limitations.

Conclusion: In light of the above findings, the review concludes that overall epidemiologic evidence in reviewed articles is inadequate mainly due to methodological limitations and future research needs to develop tools capable of demonstrating causal or non-causal relationships between specific waste management operations and adverse health endpoints.

Keywords: Municipal Solid Waste, epidemiological studies, risk

[1] Manuscript published: Perspectives in Public Health 2017; 137(2): 102-108

3.2 Background

Several epidemiological studies conducted in both developed and developing countries have suggested that municipal solid waste management is a risky and life threatening activity for populations residing near landfills and waste incinerators, for municipal waste workers and informal waste recyclers.

A central theme in literature reviewed in this article is the notion that the major health problems of populations residing near landfills and incinerators are cancer, low birth weight, congenital anomalies and Down's syndrome and for municipal waste workers and recyclers are musculoskeletal disorders, injuries, respiratory, gastro-intestinal and skin conditions. Unfortunately these epidemiological studies have essentially neglected several critical aspects on the human health risks of municipal solid waste handling.

Noteworthy all the studies reviewed in this paper on cancer risks on populations residing near landfill sites or on former sites merely suggest either elevated or no risk but none has conclusively identified a casual or non-causal relationship between cancers and landfills for such populations.

Equally important a major limitation of some studies on cancer, low birth weight and congenital anomalies in populations near municipal landfills is their failure to account for potential sources of error like misclassification of waste sites, operating dates of landfills, non-examination of possible effects of multiple or differential exposures from different sites [1-3]. However on the positive it is noteworthy that despite these shortcomings some of these studies were very large and had high power [1, 2, 4].

Some studies of residents potentially exposed to landfills reported an elevated risk of cancers of the pancreas and liver [2], kidneys [2, 5] and bladder [5]. Additionally, Gensburg et al [5] reported higher bladder cancers in exposed children. With regard to the popular Love Canal landfill, Gensburg et al [5] concur that the role of exposure to the landfill is unclear, given such limitations as a relatively small and incomplete study cohort, imprecise measurements, and the exclusion of cancers diagnosed before 1979.

Noteworthy most studies on municipal waste workers have regrettably negated performing exposure assessments for waste handlers. Poulsen and colleagues [6] observe that epidemiologic research with a component on exposure classification are required to identify work conditions in the high risk category and to establish exposure limits with regard to manual

container pulling and tilting. Evidently none conduction of exposure assessments in this body of research does not allow for strong evidence based conclusions to be drawn regarding exposure levels and associated health effects of municipal solid waste handling. There is need for an appropriate risk assessment that informs local government structures and relevant sectors on the health risks associated with different waste management technologies.

Finally whilst most studies on waste handling have revealed abundant evidence on respiratory complaints among waste handlers, a lot of research needs to be done on other associated health problems of waste handling. Whilst moderate evidence is available to support that waste collection increases the risk of respiratory complaints, there is limited evidence on gastro-intestinal complaints and hearing loss [7]. This suggests that research on occupational health risks of waste handlers has not been exhaustive but is rather limited in its coverage of occupational health risks of municipal solid waste handling. There is therefore a paucity of information on other occupational health problems of waste handling.

3.3 Methods

The PubMed and Medline computerized literature searches were employed to identify the relevant papers using the key words solid waste, waste management, health risks, recycling, landfills and incinerators. References of all potential papers were examined to identify more articles that met the inclusion criteria. A total of 379 papers were identified but after intensive screening only 72 met the inclusion criteria. Of these studies 33 were on adverse health effects in communities living near dumpsites or incinerators, 24 on municipal solid waste workers and 15 on informal waste recyclers. The inclusion criteria needed that the papers reviewed a) be journal articles published in the period 1995 to 2014 b) focus on municipal solid waste management risks to nearby populations, municipal waste workers and informal recyclers c) be articles written in English language. Articles on sewage were excluded from the review since sewage is not part of municipal solid waste. Also articles published prior to 1995 were considered less recent and consequently excluded from this review. Notably, various parameters were employed to assess the epidemiologic evidence of human health risks from municipal solid waste management. Firstly, this study assessed epidemiologic evidence in reviewed cancer studies guided by the criteria set by the International Agency for Research on Cancer (IARC) of 1999 page 14-25. The criteria allows for ranking of epidemiologic evidence provided by cancer studies in terms of being sufficient, inadequate and limited. Good quality studies revealing a causal or non-causal relationship between exposures and adverse health end points were classified as ‘sufficient’ whilst ‘inadequate’ studies were of poor quality to reliably

support the presence or absence of a causal association. On the other hand 'limited' scientific evidence denotes a scenario where a positive causal relationship between exposure and health outcomes has been noted but no provision exists to significantly rule out confounding factors and chance. Secondly, for studies on other health endpoints other than cancer this study assessed their quality by examining strengths and limitations in the study methods used. In particular, the review checked whether the study used a design capable of proving causality, a large sample size, a large reference group, controlled for possible confounders and whether it was a single-centre or multi-centre study. Data extraction tables are also provided so that readers can assess the systematic review process used.

3.4 Results and discussions

3.4.1 Cancer

Cancer risks associated with residence near landfill sites have been extensively researched and entail cancers of the stomach, liver, intrahepatic bile ducts, cervix, skin and pancreas. Whilst high incidence of cancers for populations residing near landfills has been reported [2, 3, 5, 8-13], Jarup et al [1] did not find any excess cancer risks for such populations. Clearly there appears to be no complete congruence among researchers on the cancer risk to communities living near landfill sites or waste incinerators. Probably this variation in findings may be due to several factors such as: i) differences on waste types and their composition for the sites investigated and ii) climatic conditions such as wind speed, direction and rainfall patterns, which may influence the severity of impact of waste on human health. The majority of ecological study designs used had no capacity to prove causal or non- causal relationships between residence near landfills or incinerators and investigated adverse health effects. This can mainly be attributed to none performance of individual level exposure assessments and failure to control for confounding variables.

In Great Britain, Jarup et al [1] conducted an ecological study in which they defined the exposed population group as people living within 2 km of 9565 landfill sites that were operational at some time from 1982 to 1997 and the reference group as populations living more than 2 km from a landfill. Notably, Jarup et al [1] did not find any excess risks for bladder cancer, brain cancer, hepatobiliary cancer, adult leukaemia and child leukaemia even after adjusting for age, sex, region, year and deprivation. A remarkable strength of Jarup et al [1] study is that it was large and had high power. In light of the following limitations which grossly impinge on the capacity of Jarup et al [1] to conclusively demonstrate causality, the review considers evidence of non-causal relationship in Jarup et al [1] 'inadequate'. Firstly, with

regard to their own study, Jarup et al [1] concur that potential sources of error like misclassification of waste sites, operating dates of landfills, non-examination of possible effects of multiple or differential exposures from different sites could have dwarfed their study's ability to detect any adverse health effects. Additionally, misclassification of exposure could not be ruled out since the study did not account for potential bias in scenarios where pregnant mothers migrated away from their usual residence in the concerned study period. Moreover, the study was not immune to ecological fallacy since group level rather than individual exposure assessments level assessments were done. Also Jarup et al [1] used a rather small reference group in relation to the exposed group.

Goldberg et al [2] conducted a case-control study on municipal solid waste landfills using geographic zone and distance from the landfill site as exposure estimates and found excess risk for cancer of the pancreas (2.2), prostrate (1.5), non-Hodgkin lymphomas (2.0). Arguably, whilst the study by Goldberg et al [2] was remarkably very large and had high power, unfortunately the weight of this study's findings can also be classified as inadequate since a very small control group which was over 7 times less than the study subjects' was used and this may have impaired with the study's results. Also case-control designs have difficulties in proving causality due to their retrospective direction of enquiry, inability to stringently manipulate and control study variables and their excessive reliance on available secondary data that maybe often incomplete and gathered for a different purpose. However Goldberg et al [2] need to be credited for their use of unconditional regression models to estimate odds ratios.

In Helsinki, Pukkala and Pönkä [3] found the relative cancer risk for inhabitants of houses built in a former dumpsite to increase slightly with the number of years lived in the area. Noteworthy evidence of cancer risk on inhabitants of houses built in a former dumpsite in Pukkala and Pönkä [3] study seems inadequate for the following reasons. The study only adjusted for demographic characteristics like age and sex and noted an excess of skin and pancreatic cancers but unfortunately negated adjustment for vital confounding variables like life style risk factors such as smoking and alcoholism. Arguably, this is a major loophole of this study since for pancreatic cancer the World Health Organisation classifies smoking as a sufficient human carcinogen and alcoholism as a carcinogen with limited evidence. Additionally, like many other ecological designs the study succumbs to ecological fallacy since it did not measure or model individual level exposures but rather performed group level environmental measurements for landfill soil and air pollutants. Nevertheless the study had a large sample size with a bigger reference group.

Gensburg et al [5] observed elevations of bladder and kidney cancers for residents and children exposed to the Love Canal landfill. However in explaining these excess risks in Gensburg study, the role of exposure to the landfill is unclear given such limitations as a relatively small and incomplete study cohort, imprecise measurements, and the exclusion of cancers diagnosed before 1979 [5]. Consequently, epidemiologic evidence in this study is inadequate to support causality.

Comba et al [8] investigated the association between occurrence of soft tissue sarcomas (STS) in Mantua and residence near an incinerator of industrial wastes using 37 STS cases and 171 controls matched for sex and age and reported a significant increase in risk of STS associated with residence within 2 km of an industrial waste incinerator. Notably, the strength of this study was the attempt to have about 5 randomly selected controls for each case. However, the evidence of causality is limited in this study. The category for limited is justified on the basis that matching controls and cases was done but case-control designs can't demonstrate causality as already discussed earlier. Nevertheless a small sample size was used and the study did not account for potential confounders like socio-economic factors and other sources of exposures like landfills. According to Portia et al [14] a major limitation of Comba et al [8] study is the possibility that increased attention to the diagnosis for soft tissue sarcoma in the vicinity of the Mantua incinerator plant could have introduced bias in the risk estimate.

In Italy, Zambon et al [9] conducted a population based case- control study on the risk of sarcoma from incinerator and industrial plants on dioxin emissions and found a statistically significant increase in sarcoma risk to both the level and the length of environmentally modelled exposure to dioxin –like substances and their results were more significant for women than for men. Zambon et al [9] tried to minimize the effect of confounding factors by matching 3 controls for age and sex with each of the 205 sarcoma cases thus producing a comparable reference group. Consequently, epidemiologic evidence on sarcoma risk from incinerators is limited. Notably, a small sample size was used and historical data used could have been incomplete for their study purposes and the study did not measure the effect of potential confounders like socio-economic factors and occupational exposures.

In Italy, Biggeri and Catelen [11] investigated the relationship between various sources of pollution and lung cancer using a case-control study and reported higher relative risk towards the source and radical decrease away from it. Epidemiologic evidence linking incinerators with lung cancer is limited in this study. Firstly residual confounders from unmeasured confounders

cannot be excluded [11] and a small sample size used. Additionally, very little information can be obtained from the study regarding the types of chemical pollutants and levels from the incinerators studied. In addition, the purely distance-based surrogate of exposure assessment used further limit demonstration of causality issues.

In Great Britain, an ecological study by Elliott et al. [10] investigated the incidence of cancer in a study population of at least 14 million persons residing near 72 municipal waste incinerators between the year 1974 and 1987. They reported significant decline in risk for various cancer types with regard to distance from the incinerators. This study was large and had more power thus its epidemiologic evidence can be classified as limited. Regrettably their study findings need to be considered with caution since even the authors admitted that residual confounding bias and misdiagnosis might have increased their risk estimates. Additionally, an ecological study design can only provide association but can't prove causality. Thus it is difficult to classify Eliot et al [10] study findings under the sufficient category. However a further study by Elliot et al [15] on histopathological and case note review of primary liver cancers reported as low as 0.53 – 0.78 excess cases compared to the prior 0.95 cases per 105 per year within 1km from the landfill. Noteworthy, the findings from the improved study of Elliot et al [15] need to be treated with caution due to none availability of histopathological material or case notes for half of the 235 cases in their study.

3.4.2 Birth weight

Increased incidence of low birth weight in populations living near landfill sites has been observed [4, 16-19]. Noteworthy none of these studies [16-18] examined the contribution of exposures at individual level for the pregnant mothers studied particularly in terms of exposure doses and duration. Additionally, these studies did not control for possible vital confounders like occupational exposures and migration out of the 1-2 km residence from the landfill for the pregnant mothers in the study period. The purely distance-based surrogate of exposure assessment is not enough to support causality issues. Furthermore, there appears to be no published data that support the basis for the selection of a 2 km radius from landfill sites. Nevertheless, the studies that investigated the relationship between residence near landfill sites and birth weight were large and had more power [4]. Basing on the loopholes, it is not possible to conclude with certainty that maternal residence near landfills during pregnancy has teratogenicity effects culminating in increased risk of giving birth to a baby with a low or very low birth weight.

3.4.3 Congenital malformations

Congenital anomalies in relation to residence near landfill sites are discussed in this article. Two of these studies reported increased risk of congenital anomalies [19, 20] and the remainder found little or no excess risk for such populations [15, 21-23]. On the positive all of these studies [15, 19-23] were multi-centre studies and some used a larger reference group [19, 20]. Notably, results from multi-centre studies unlike those from single-centre studies have wider application. Regrettably, none of the studies [15, 19-23] had mechanisms to address biases arising from possible exposure misclassification. Additionally a few studies adjusted for age as a potential confounder [19, 20] but regrettably negated measuring effect of potential confounders like socio-economic factors. Also none of these studies pushes back the boundaries of ignorance with regard to the types and quantities of toxic chemicals in the various hazardous landfills studied. Conclusively this review argues that very little capacity, if any, is available in these studies with regard to demonstrating causal or none causal relationships between residence closer to hazardous landfills or incinerators and adverse health effects on such populations.

3.4.4 Respiratory and other diseases

In Finland Pukkala and Pönkä [3] investigated cancer and asthma prevalence in residence of dwellings constructed on an abandoned site with both residential and industrial waste materials. Their study revealed that prevalence of asthma was significantly higher in the dump cohort than those living nearby but outside the landfill site. Whilst this study provides some crucial insights its worthiness is questionable given the fact that it unfortunately has not been replicated and the overall evidence may be inadequate [14]. Additionally, in Swaziland, Abul [24] found that residents with houses built less than 200 meters from the dumpsite were victims of malaria, chest pains, cholera, and diarrhoea. However findings from this study need to be treated with caution since a small sample size of 39 exposed participants and 39 participants in the reference group was used. Furthermore, health effects of dumpsites on residents in Abul [24] study are only based on self-reported complaints of research participants which could have introduced recall bias and inflated risk estimates.

3.4.5 Heavy metals in waste disposal sites

Several studies conducted in developing countries have reported high levels of heavy metals in municipal waste disposal sites [25-28]. Most waste disposal sites in developing countries are poorly sited [29, 30], constructed and managed [31-33] despite handling hazardous waste from industries and medical facilities. Arguably, at the heart of the problems of solid waste

management are the absence of adequate policies, enabling legislation, and an environmentally stimulated and enlightened public [33-35]. However none of these studies went a step further to demonstrate causality between the heavy metals found and human health risks for populations residing near such sites.

Overview of study designs for articles on landfills and incinerators

Table 3.1 shows a sample studies reviewed on populations residing near landfills and incinerators. The study designs used were ecological, cross-sectional, cohort and case control. Ecological study designs lack the capacity to prove causal or non- causal relationships between residence near landfills or incinerators and the investigated adverse health effects. This can mainly be attributed to non-performance of individual level exposure assessments and the failure to control confounding variables. The reliance on group rather individual level exposure measurements may contribute to ecological fallacy. On the positive, ecological designs provide valuable data on health risks to a defined exposed group, which can assist in prompt decision making. Some studies used a descriptive cross sectional design and were single centre studies. This suggests that they had no capacity to definitively demonstrate a causal or non-causal relationship between municipal solid waste handling and adverse occupational health endpoints. However, cross-sectional designs provide a useful snapshot on risk factors for disease conditions, which can assist in early planning of required interventions. Case-control studies are less costly and do not require a long follow-up period in relation to the study participants. However, they have difficulties in proving causality due to their: (i) retrospective direction of enquiry, (ii) inability to stringently manipulate and control study the variables and (iii) their excessive reliance on secondary data that maybe often incomplete and gathered for a different purpose. Cohort studies are longitudinal, costly and involve long periods of participant follow-up.

Table 3.1: Sample of studies on landfills and incinerators' risks to nearby communities

Study details	Study design	Exposure Assessment	Results	Comments
Jarup et al (2002)[1], Great Britain.	Ecological design Adjusted for age, sex, year of diagnosis, region and deprivation 341 856 640 person-years for adult cancers and there were 89786 cases of bladder cancer.	Exposed: Residence within 2 km distance from the 9 565 landfill sites operational at some time between 1982 and 1997. Reference group: Resided beyond 2 km from all known landfill sites.	Reported no excess risks of cancer of the bladder in populations living within 2 km of landfill site (rate ratio=1.01; 99% CI=1.00-1.02)	a-c, d, h, i
Elliot et al (1996)[10] Great Britain	Ecological design. The study population was over 14 million people with cancer diagnosed between 1974 and 1986.Stratification done by a deprivation index based on 1981 census small-area statistics.	Defined as residence near 72 solid waste incinerator plants	Reported excess risks for cancers of the pancreas (2.2), prostate (1.5) and non-Hodgkin lymphomas (2.0)	a-c, h, i

Study details	Study design	Exposure Assessment	Results	Comments
Abul, 2010[24] Swaziland	Cross-sectional. Based on self-reported complaints of research participants. Did not account for possible confounders and information and recall bias from participants' self-reports.	Exposed: Residence within 200m distance from the municipal solid waste dumpsite Residence beyond 200m.	Reported that residents with houses built less than 200 meters from the dumpsite were victims of malaria, chest pains, cholera, and diarrhoea.	a-c, e
Chifamba (2007)[25] Zimbabwe	Cross-sectional study. Collected samples of in the dumpsite, downslope from it and from control sites.	Soil and water samples in and around waste disposal sites	Found that some heavy metals tended to accumulate within the site. Some metals declined with further distance from the site.	a, e
Pukkala et al (2001)[3] Finland	Retrospective cohort study Adjusted for age and sex but did measure life style risk factors such as smoking and alcoholism. Exposed cohort had 2014 subjects and control group had 2028.	Residence in houses built on a former dump area containing both industrial and residential waste.	The relative risk was 1.50 (95% CI=1.08-2.09), similar in both sexes, and increased slightly with the number of years lived in the area.	a-d, I, h

Study details	Study design	Exposure Assessment	Results	Comments
Biggeri et al (2005)[11] Italy	Case-control study with 755 lung cancer cases and 755 controls. Spatial models used to evaluate effect of sources of pollution on lung cancer after adjustment for age, smoking habit, likelihood of exposure.	Residence near four sources of environmental pollution (shipyard, iron foundry, incinerator, and city centre)	Reported excess relative risk near the source and a sharp decrease moving away from the incinerator (RR=6.7; p=0.0098).	a-c, e, f, i

a :study type incapable of demonstrating causality b: possibility for exposure misclassification c: Potential for confounders d: Adjusted for possible confounders e: small sample size f: small reference group g:no reference group h: large sample size i: study has statistical power

3.4.6 Studies on MSWHs

Municipal solid waste management has been associated with various adverse health problems for waste workers which entail respiratory problems [36-43], musculoskeletal disorders [36, 44-51], injuries [36, 48, 52- 55], nail infection [42] and inflammation of biomarkers [56]. Noteworthy most of the studies employed a descriptive cross sectional design and were single centre studies. This suggests that they had no capacity to definitively demonstrate a causal or none causal relationship between municipal solid waste handling and adverse occupational health endpoints. Additionally, most studies used a small sample size [38-41, 43, 44, 49-51, 54-56] thus dwarfing the applicability of their findings to a wider population of waste workers. Furthermore, several of these studies negated enrolling a comparison group [50, 51, 54, 55, 57]. Notably most of the few studies that enrolled a reference group tended to use a smaller group than the waste workers cohort [36, 37, 44, 56, 57]. Some studies did not control for possible confounders like selection bias and smoking [38- 41, 56]. One study was longitudinal [43] but regrettably used a small sample size with a very small reference group thus dwarfing its value to the wider scientific community. Another study consisting of a larger sample size and reference was conducted in Denmark [58] but unfortunately it was cross-sectional and had limitations with regard to proving causality. Overall, these various limitations of epidemiological studies for waste workers suggest that their findings need to be interpreted

with caution and those methodologically sound epidemiological studies are needed to yield more reliable insights on health risks of waste workers.

3.4.7 Studies of informal municipal waste recyclers

A central theme in these studies is the fact that waste recyclers are prone to health problems like injuries [59-62], respiratory problems [60, 63-65], diarrhoea [64, 66], infections [64], psychological disorders [62], chemical hazards [61, 67-69] and musculoskeletal complaints [62, 64, 67-70]. Most studies on waste recyclers had more or less similar limitations discussed on studies on waste workers. Notably, most studies used the cross-sectional design thus dwarfing their capacity to prove causality issues. Equally important several of these studies [31, 60-65, 67-69, 71] did not enrol a reference group. Consequently, it is unclear whether it is safe to associate their reported adverse health effects strongly with municipal solid waste management exposures. Still some studies purely relied only on qualitative data in form of verbal reports from research participants [59, 72] which may have introduced recall bias in their results. Probably triangulating respondents' verbal reports using additional techniques like lung function tests and environmental exposure assessments could have added value to such studies.

Overview of study designs for articles on health risks of MSWHs and recyclers

Table 3.2 summarises reviewed studies on health risks to MSWHs and recyclers. The studies used a cross-sectional design, which may assist in providing a snapshot of studied disease conditions. However, cross-sectional designs may face challenges in relation to proving causality issues. Generally, small sample sizes were used and reference groups were largely not enrolled. Further, the studies were single-centre and did not control for confounders. These limitations reduce the capacity to generalise the findings to other waste management facilities.

Table 3.2: Sample of reviewed studies on health risks of MSWHs and recyclers

Study details	Methods	Results	Comments
Yang et al (2001)[36] Taiwan	Cross-sectional study of 533 Household Waste Collection workers in the Department in the County of Kaohsiung and 320 office workers.	Reported that household waste collection is associated respiratory complaints, musculoskeletal disorders and injuries from sharps.	a, b_1,c_1, e_2
Ekram et al (2013)[57] Egypt	Used a cross-sectional design. Participants were 346 waste workers from various sites.	Reported high prevalence of injuries, gastrointestinal, respiratory, skin and musculoskeletal morbidities.	a, b, c_1, d_1
Wouters et al. (2002)[39] Netherlands	Cross sectional study of 47 waste collectors & 15 controls. Questionnaires used to collect data on respiratory symptoms & nasal lavage done		a_1, b_1, d_1, e_2
Thorn et al (1998)[41] Sweden	Cross-sectional study constituting 17 workers collecting unsorted household waste, 8 workers collecting organic or none organic separated waste. The study used various methods such as Measurements of airborne endotoxin and (1→3)—β-D-glucan in their working environments, questionnaire administration, spirometer, blood and sputum sampling.	Higher proportion of waste collectors reported diarrhoea, congested nose, and unusual tiredness as compared to controls. The number of blood lymphocytes was higher among waste collectors and were dose-related to the amount of airborne ((1→3)—β-D-glucan) at the workplaces. The amount of ECP and the number of βmacrophages were lower in sputum among waste collectors than in controls.	a, b_1, c_2, d_1, e_2

Study details	Methods	Results	Comments
Athanasiou et al (2010)[44] Greece	Cross-sectional study involving 104 municipal solid waste workers (MSWW) and 80 controls. Qualitative data gathered using the slightly modified version of the Medical Research Council questionnaire. Spirometry used to evaluate lung function. Adjusted for confounders.	Spirometry revealed reduced mean forced vital capacity (FVC) and forced expiratory volume in MSWWs compared with controls. After adjustment for smoking status, only the decline in FVC was statistically significant. Prevalence of all respiratory symptoms was higher in MSWWs than in controls.	a, b_1, c_2, d_1,e_2
Abou-ElWafa et al (2012)[49] Egypt	Cross-sectional study of 120 male waste collectors at Western Municipality of Mansoura employed for 1 year or more and a control group of 110 male service workers.	60.8% of waste collectors had musculoskeletal disorders compared to male service workers (43.6%). Low back pain was common waste collectors.	a, b_1, d_1, e_1
Gonese et al (2006)[54] Zimbabwe	Retrospective, descriptive cross-sectional survey. Interviewed 153 workers who had been in the section as of January 1, 2001, and 23 senior managers and section supervisors. Reviewed the occupational injury register.	Reported risk factors associated with suffering an injury as age below 25 years (odds ratio [OR] = 3.2; CI = 1.6- 9.2), working as a bin loader (OR = 3.6; CI = 1.1-4.8), not having received pre-employment training (OR = 3.1; CI = 1.3-7.5), and subsequently rating the job as difficult to perform (POR = 2.9; CI = 1.1-7.7).	a, b_1,c_1, d_1

Study details	Methods	Results	Comments
Bongale et al (2014)[55] Ethiopia	Used a cross-sectional study with 876 respondents sampled from 92 unions. Data collected using a pre-tested structured questionnaire and observation check list.	Reported that as compared to workers who used personal protective equipment while being on duty, odds of injury among workers who did not use personal protective equipment were 2.62 higher (AOR = 2.62, 95% CI: 1.48-4.63).	a, b_1, c_1, d_2
Ray et al (2004)[66] India	Cross-sectional study with 98 rag pickers and 60 controls from Delhi, matched for age, sex, and socioeconomic conditions. Methods of data collection used entail questionnaire survey, clinical examination, and laboratory investigations and spirometry to evaluate lung function.	Rag pickers had a higher prevalence of low haemoglobin, high circulating eosinophil and monocyte counts, unhealthy gums, frequent diarrhoea, and dermatitis, when compared with controls.	a, b_1, c_1, d_1, e_1, e_2,
Lenis Ballesteros et al (2012)[67] Colombia	Cross-sectional study, with 100 informal recyclers in five small administrative units of Medellin in 2008.	The biological risks, associated with inadequate body postures, and physical and chemical risks had a particular frequency of exposure according to group.	a, b_1, c_1, d_2
Gwisai et al (2014) [71] Zimbabwe	Cross-sectional study on landfill employees and scavengers and data collected using questionnaires, and key informant interview Sample size =32participants	Headaches (68.8%), body weakness (43.8%), coughing (34.4%), common colds (31.3%), shortness of breath (24.1%)	a, b_1, c_1, d_1

Study details	Methods	Results	Comments
Rachiotis et al (2012)[40] Greece	Seroprevalence study of hepatitis A virus infection (HAV) on 100 municipal solid waste collectors and 108 gardeners as control group. Measured the total HAV antibodies. Interviews were used.	Observed high HAV infection for waste collectors particularly those who smoke, drink or eat when performing waste collection tasks.	a, b_1, d_1, e_2

a: cross-sectional study (unable to prove causality) b_1:small sample size b_2: bigger sample size c_1: no reference group (unexposed) c_2: small reference group c_3: large reference group d_1: single centre study d_2: multi-centre study e_1: adjusted for possible confounding factors e_2: potential for healthy worker effect bias

3.5 Conclusions

In the final analysis studies reviewed in this article have suggested that municipal solid waste management presents adverse health end points not just to formal municipal waste workers but also on informal recyclers and populations residing near waste landfills and incinerators. Noteworthy, a major limitation of the studies reviewed in this article is their failure to provide a causal relationship between waste management processes and adverse health effects. Basing on the major findings from this review, it is recommended that future research studies focus on the development of tools capable of providing causal relationships between adverse health endpoints and specific waste management operations.

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CHAPTER 4: BIOAEROSOLS, NOISE AND ULTRAVIOLET RADIATION EXPOSURES FOR MUNICIPAL SOLID WASTE HANDLERS[2]

4.1 Abstract

Few studies have investigated the occupational hazards of municipal solid waste workers, particularly in developing countries. Resultantly these workers are currently exposed to unknown and unabated occupational hazards that may endanger their health. This study determined municipal solid waste workers' work related hazards and associated adverse health endpoints. A multi-faceted approach was utilised comprising of bioaerosols sampling, occupational noise, thermal conditions measurement and field based waste compositional analysis. Results from our current study showed highest exposure concentrations for Gram-negative bacteria (6.8 x 10^3 cfu/m^3) and fungi (128 x 10^3 cfu/m^3) in the truck cabins. Significant proportions of toxic, infectious and surgical waste were observed. Conclusively, municipal solid waste workers are exposed to diverse work related risks requiring urgent sound interventions. A framework for assessing occupational risks of these workers must prioritize performance of exposure assessment with regards to the physical, biological and chemical hazards of the job.

4.2 Background

Municipal solid waste management is a vital activity in the context of protecting human health and environment [1-3]. Municipal solid waste management workers perform various tasks such as street sweeping [4-6], manually loading waste into waste collection vehicles [7-8] and driving such vehicles [9-11]. Such activities expose these workers to various occupational health risks associated with the characteristics of the waste they handle [12-14], the waste collection methods used [15-17] and the state of the working environment [8, 18-20].

Whilst over the past two decades valuable evidence has accumulated on the occupational dust and noise levels in the mining [21-23], manufacturing [24, 25] and agricultural sectors [26-28], very few studies have investigated such hazards for municipal solid waste workers. Of these few studies, the majority of them have been conducted in industrialized countries. Wichmann and Voyi [29] suggest that findings generated from epidemiologic research conducted in developed countries may have limited applicability to developing nations' scenarios. The

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present study was conducted in a developing country and sought to add value to the existing body of knowledge in relation to hazards associated with the work of MSWHs.

Additionally, most of these few studies primarily focused on waste recycling plants [30-32], composting plants [33-35] and hazardous landfills [36] rather than waste workers responsible for loading municipal solid waste trucks, municipal landfilling operations, central waste collection systems and street cleansing. Resultantly, very little has been documented on the occupational health risks of municipal solid waste workers. This suggests that such workers are currently exposed to more or less unknown dust, bioaerosols and noise levels that may endanger their health. Notably a point of congruence among previous studies is the notion that to date, little has been done to characterize biological hazards associated with waste collection [15, 37, 38].

It is dust which is in the breathing zone or entering the respiratory system which may pose health risks to the employee and should therefore be assessed and monitored [25]. The impetus to the determination of bioaerosols in the present study is the growing body of evidence in contemporary literature associating bioaerosols from organic dusts with respiratory complaints on waste workers [12, 39, 40]. Furthermore, a key recommendation arising from Heida et al. [41] is the need to determine the organic dusts concentrations from waste.

Additionally, assessments of workplace noise exposures are justified on the basis that noise hazards are globally ranked among the top five occupational stressors with grave repercussions on the worker and the organisation [42- 44]. Notably, previous literature has strongly associated continuous occupational noise exposures of 85-90dB (A) with adverse health conditions on the worker such as Noise Induced Hearing Loss (NIHL) [45, 46]. Liu et al [47] further propounds that the large machinery used to dig, transport and compact landfills can generate noise level higher than 85 dB.

In both industrialized and developing countries, very little research is available on the thermal conditions in which waste workers work. More importantly, in tropical countries summer outdoor temperatures can be unbearably hot. Such high temperatures may render outdoor activities such as municipal solid waste collection, street sweeping and landfilling operations a health hazard due to increased risk of excessive sweating, headaches, heat stress, offensive odours and fly infestation from decomposition processes of organic waste fractions.

Conversely, cold outdoor temperatures have been associated with frost bite [48] and hypothermia among gardeners [49].

Consequently this paper aims to determine the occupational dust, noise, thermal exposures in the field of municipal solid waste management so as to build up the much needed evidence for developing a generic framework for assessing occupational health risks of municipal solid waste handlers.

4.3 Materials and methods

Personal sampling was performed using two field monitors mounted in the breathing zone of workers, approximately 1.5 m above ground level. One monitor was for collecting of total dust and the other for bioaerosols (bacteria and fungi). Environmental samples were collected using similar equipment mounted at the breathing zone, from the active landfilling sites, truck cabins and street cleaning sites. Total dust and bioaerosols samples were collected intermittently at 4hr intervals, from various sites (Table 3. 1). Culturing for Gram Negative bacteria (GNB) was done at 37^{o}C for 24 hours using the McConkey media whist for viable fungi the Malt Extract Agar media diluted with 0.01% chloramphenicol was used. The occupational noise exposure doses were measured using the Quest sound level meter model SOUNDPRO SP-DL-1/3n and the ultraviolet thermal conditions were determined using the AZ thermo-anemometer instrument. Qualitative data on health complaints of waste workers was gathered using self-administered questionnaires. Key informant interviews with waste managers in Local government structures, in the Health department and the Environmental Management Agency were conducted to tap on the richness and diversity of expert input on waste management health risks. Collected data was analyzed using STATA version 13.

4.4 Results and discussion

4.4.1 Total dust and bioaerosols exposures

This study found high mean exposure concentrations for total dust, Gram Negative Bacteria (GNB) and fungi for personal samples collected from refuse bin loaders and truck cabin samples (Table 4.1). This suggests the priority for exposure assessment with regard to total dust and bioaerosols should be focused on waste loaders and the truck cabins. Regular proper cleaning, drying and aeration of the waste collection vehicle are essential so as to safeguard the

respiratory health of waste workers. Most GNB are largely pathogens, thus their assessment in this study and other past studies, to determine the risk posed to waste workers.

Table 4.1: Total dust & bioaerosols exposures (mean & range) in different working areas (n =60)

Sampling Site	Description	(n)	Total dust mg/m^3	GNB 10^3 cfu/m^3	Fungi 10^3cfu/m^3
Site A	Bin loaders	12	8.2 (0.8-26)	1.5 (0.16-6.8)	66(7.2 -136)
	Drivers	4	4.2 (0.8-12)	1.6 (0.2-2.8)	36(6.4-68)
	Skip bins	4	3.2 (0.6- 10)	1.2 (0.1- 6.4)	28 (5.8 – 62)
Site B	Truck cabin samples	4	8.6 (0.9-26)	1.6 (0.18- 6.8)	68 (6.4-128)
Site C	Site workers	12	0.4 (0.2-0.8)	6.8 (0.04-28)	3.2 (0.4-8.2)
	Machine Operators	4	0.6 (1.4-2.2)	22 (0.6-120)	21 (0.3- 100)
	Site samples	4	0.3 (0.1-0.8)	6.2 (0.02-24)	2.8 (0.2-7.4)
Site D	Sweepers	12	0.08 (0.04 -0.3)	ND	12 (14-24)
	Site samples	4	0.04 (0.02- 0.5)	ND	8 (12-22)

ND: None detected; GNB: Gram Negative Bacteria; cfu: colony forming units; A: Waste collectors; B: Truck cabin; C: Active landfilling site; D: Street cleaning, n: sample size

The high mean total dust, Gram Negative Bacteria (GNB) and fungi exposure concentrations for waste loaders and truck cabin (Table 4.1) may be attributed to the processes of manual offloading and loading of mixed waste streams without proper containment bags (Figure 3.1).

Figure 4.1: Dust generation from loading mixed waste without proper containment bags

This study reports that transferring waste from stationery bins to other bags (Figure 4.2) contributed to double exposures to dust and bioaerosols for each refuse collector; firstly during transferring process from one bin to the other and secondly during the bin empting process into the truck.

Figure 4.2: Process of transferring of waste from stationery bin to plastic bags

Non-stationery bins that are directly emptied into the refuse collection truck could avert exposures encountered during the waste bin transferring process. Alternatively, all stationery bin containers maybe fitted with removable bin liners that are directly emptied into the waste collection trucks.

The present study found high mean exposure concentrations for total dust, Gram Negative Bacteria (GNB) and fungi for personal samples collected from refuse bin loaders and for truck cabin samples (Table 4.1). Also for all the sampled waste sites concentrations of both Gram Negative Bacteria (GNB) and fungi were basically in the order of 10^3. Similarly the available body of research on bioaerosols from municipal solid waste management activities has reported the mean and range of bacterial and fungal cells per m^3 of air between the order of 10^3 and 10^6. Recently, in Copenhagen, Madsen et al [50] found bacterial cells per cubic meter of air to be in the range of 112 to 4.8×10^4 for waste collector's personal samples and 48 to 2.6×10^3 for truck cab samples.

Park et al. [11] reported exposure levels among Korean waste collectors ranging between $0.13x10^5$ and $23.5x10^5$ for total viable bacteria and $2.4x10^4$ CFU/m^3 and $10.8x10^4$CFU/m^3 for fungi. In Norway, Heldal et al [51] observed slightly higher summer bacterial and fungal exposures for waste collectors ($0.4x10^6$cells/m^3 to $3.6x10^6$ cells/m^3) compared to winter exposures ($0.4x10^6$cells/m^3 to $2.0\ x10^6$ cells/m^3). Lovoie and Dunkerley [37] reported mean bacterial concentrations of 10^3 to 10^4 CFU/m^3 and mean fungal concentrations ranging between $8.3x10^3$ CFU/m^3 to $9.8x10^4$CFU/m^3, among waste collectors in Canada. In a sample of German waste collectors, Neumann [52] reported bacterial concentrations ranging between insignificant levels to 10^6 CFU/m^3 and fungi concentrations between $8.3x10^3$ CFU/m^3 to $9.8x\ 10^4$ CFU/m^3. Evidently, municipal solid waste handling processes exposes waste workers to bioaerosols from organic dusts and such exposure may precipitate onset of respiratory problems [9, 12, 53].

4.4.2 Noise exposures

The highest average noise levels (84.86dBA) were recorded in the central waste collection points whilst the lowest (83dBA) was in the cabin of waste collection truck. In all measured waste management sites (Table 4.2) mean noise levels were within the international threshold limit value (85dBA).

Table 4.2: Noise level measurements (dBA) in various working areas

Site	Site description	Average noise Value (dBA)	ISO standard (dBA)
A	Noise mainly generated by hydraulic waste collection trucks and passing traffic.	84.86	85
B	Waste spreading in cells and soil cover application. Noise generated by waste compactors.	84.32	85
C	Manual offloading of waste bins into waste collection vehicles. Noise mainly generated by hydraulic waste collection trucks and passing traffic.	83.00	85

A: Central collection points, B: active landfilling area, C: offloading area into truck

However, the major sources of noise were waste collection vehicles' running engines, other traffic and landfilling vehicles. Constituents of municipal solid waste such as glass and metal tins also contributed to the occupational noise particularly during emptying of metal bins on the metal floor of waste collection vehicles. High working speed with regard to offloading of waste bins tended to produce a monotonous noise. Additionally, Jerie [54] observes that for informal waste workers, sources of noise entail working closer to heavily frequented roads and other noise sources such as carpentry, metal work and engineering workshops. Unfortunately, all the refuse collection vehicles in the present study had no noise reduction mechanisms such as rubber lined floors.

The present study's findings are far below personal noise levels observed in glass waste collection operations (108 to 131 dB $L_{AE.}$) in the United Kingdom [55]. According to Kuijer et al [17], Stassen and colleagues found personal noise exposure levels as high as 96.4dBA among waste collectors in the Netherlands. Evidently the noise risk exposure differs per each scenario which suggests the need for each authority responsible for waste management to consider performing its own noise assessments so as to yield relevant data for informing decision making on required interventions.

This study reports that none of the municipal solid waste workers wore any hearing protection devices though two workers in the waste collection crew complained of occasional temporary hearing loss. Whilst this study did not find mean noise levels above recommended levels. Moreover, where hearing protection devices are considered as precautionary measures, there is need to consider the possibility of failure to hear warning sounds from other road users which may increase the risk of accidents and injury among waste workers.

4.4.3 Thermal conditions

Outdoor work is associated with greater exposure to hot and cold temperatures [49]. The present study reports that municipal solid management operations such as street sweeping, landfilling activities and door to door waste collection are performed in such hot environments, often in unshaded areas. Also, mean summer temperatures higher than 33^{o}C in most waste management areas were recorded (Table 4.3).

Table 4.3: Summer thermal conditions measured in various waste sites

Work site	Average T°C	Waste workers' concerns
Loading waste collection vehicles	33.34	Sweating, dehydration, heat syncope and heat exhaustion.
Street and open areas sweeping	33.28	Loss of concentration. High risk of being run over by traffic, sweating, dehydration and headache.
Manning waste disposal sites	33.29	Offensive odours and high fly infestation from from increased organic, sweating, heat stress and headaches.
Driving waste collection vehicles	26.25	Sweating and occasional headache.

Temperatures below and above those typically preferred by most people have a significantly detrimental effect on the safety related behavior of workers [56]. This suggests that for optimum promotion of occupational safety behavior of municipal solid waste workers the thermal working environment requires attention by responsible authorities. Furthermore, most waste workers complained of headaches, sunburn, heat stress, excessive sweating, dehydration and difficulties in concentration in assigned tasks. Notably, difficulties in concentration may increase the risk of being run over not only by waste collection vehicles but other traffic, especially during the day when the traffic volume is high. Several past studies conducted among waste collectors of both developing [54, 57] and developed countries [4, 18] report high injury rates among waste workers. In Bulawayo, Gonese and colleagues [57] report that in the period 2001-2002, 97 work-related injuries occurred. In terms of the injury register, 62 waste workers experienced 67 injuries, of which one was fatal [57]. The injuries were common among younger (18-25years) than older workers (>25years). In Gweru 67 injuries were recorded including one in which a waste worker was run over by a waste collection truck [54]. In the United States of America (US), 48.8 fatal injuries per 100 000 refuse workers were reported in the US Bureau of Labour Statics [18]. In Denmark 17% of the waste collectors in a single company of 667 workers experienced an injury [4].

Inhalation of toxic emissions like carbon monoxide, carbon diode from traffic exhausts pipes may further exacerbate the situation. This suggests the need for waste managers, particularly in tropical countries, to consider rescheduling summer waste collection services for early morning hours or at night when temperatures are cooler low and traffic volume low. Additionally, waste workers need to be encouraged to take regular breaks and rest in cooler shades where oral rehydration fluids can be given to refresh them.

4.4.4 Other hazards

The current study found that on average the monthly total amount waste collected in the study area, in tones, was on average 566.08 of which 518.88 was from residential suburbs, 18.88 was from commercial enterprises and 28.32 from industries. Results from the physical waste compositional analysis revealed that residential waste on average constituted 24% food waste, metal containers 4%, glass and ceramics 2%, diapers 2%, toxic waste streams 1%, plastics and paper 13% and 54% miscellaneous waste streams. The commercial waste stream was mainly dominated by food waste 42%, metal tins containers 24%, glass 1%, paper and plastics 7% and other waste streams 24%. Evidently wastes from both the residential and commercial sources had significant proportions of biodegradable food waste. Biodegradation of such organic waste produces offensive odors and supports fly breeding and infestation particularly in summer when temperature are high. The presence of diapers, though in small proportions, in residential waste is a cause of concern since this poses risks of transmission of pathogenic organisms into waste workers' hands. Waste from the industries was mainly scrap metals, rumble, glass and food remains.

Hazardous waste streams

Results from the present study revealed that the major toxic waste streams in municipal solid waste included hair sprays, shampoos, expired medicines, pesticides and e-waste, shoe and floor polish, carpet and furniture cleaning agents, motor vehicle brake fluid, battery acid and nail paints. Although available in small quantities (1%), toxic waste inevitably renders the entire municipal solid waste potentially toxic and can lead to various occupational health risks for waste collectors through inhalation, ingestion and dermal exposure pathways. Pesticide residues such as organophosphates could affect the central nervous system through inhibition of the choline esterase enzyme. The present investigation found discarded pesticide containers

in household waste streams. These can be a source of arsenic exposures for waste workers. The International Agency on Research on Cancer [58] categorises arsenic as a known human carcinogen. Arsenic can lead to cellular toxicity [59-61], neurotoxicity [57, 62], immuno-toxicity [63], cardiovascular diseases [58] developmental and reproductive toxicity [62, 64, 65]. Additionally, this study reports presence of e-waste streams in household municipal solid waste streams.

The major e-waste components found in the present study include fluorescent and non-fluorescent bulbs, circuit boards, lead and acid car batteries, printer inks and tonner, spark plugs, motherboards, keyboards, monitors, electrical switches and thermostats. Fluorescent and non-fluorescent bulbs, circuit boards, car batteries in municipal solid which can be source of lead (Pb) and mercury (Hg). Similarly, inks and tonner for printers, NiCd rechargeable batteries can be a source of cadmium (Cd). Also, monitors and keyboards in municipal solid waste streams are a cause of concern since they can be primary sources of Polyvinyl chlorides (PVC) which may emit harmful gaseous substances such hydrogen chloride gas.

Previous literature has associated lead (Pb), cadmium (Cd), mercury (Hg) and Polyvinyl chlorides from e-waste with various adverse mental health effects such cognitive disturbances and reduced intelligence quotient (IQ) [66 - 670]. Most of these chemicals from e-waste have been found to heavily contaminate ambient air [6, 71, 72]. Such high ambient air concentrations of toxic e-waste chemicals could lead to relatively high inhalational exposures for waste workers. This suggests the need for waste managers to periodically conduct exposure monitoring for waste workers and engage the generators of hazardous waste in efforts such as extended producer responsibility in sound waste management, Life Cycle Analysis (LCA) and regulatory compliance. Table 4.4 summarises the observed hazardous waste streams and potential occupational risks for MSWHs.

Table 4.4: Household hazardous waste compositional analysis & associated hazards

Waste type	Components	Potential hazards for waste handlers
Toxic (1%)	Hair sprays, lotions, shampoos, expired medicines, pesticides	Can lead to systemic intoxication from inhalational exposures. Can also lead to severe burns from accidental or spontaneous ignition of flammable materials
	E-waste (e.g. Fluorescent bulbs, printer ink & tonner)	Toxic metals in e-waste may damage target organs leading to various toxicity effects.
Infectious (2%)	Diapers & used tissue	Infectious waste can transmit bacteria responsible for spreading diarrhoeal diseases. Biodegradation of faecal matter in diapers generates offensive odours that can induce anorexia, nausea and vomiting.
Mechanical Hazards	Scrap metal, broken glass, razor blades, needles.	Can cause injuries through piecing and bruises and facilitate transmission of Hepatitis B.

*Average % by weight calculated per weekly waste generation rates, Total mass evaluated 314.1kgs

Quantities of hazardous materials in waste

Table 4.4 above showed that toxic materials in household waste constituted 1% of the household e-waste. The toxic materials vary geographically and temporally. In Guiyu, high Pb concentrations (0.4 mg/L) were found for surface water that was downstream in relation to the e-waste recycling industry. In Romania, the major substances recovered in e-waste are iron and steel (48%), flammable plastics (15%), copper (7%), aluminium (5%), glass (5%) [73]. Table 4.5 provides a summary table on the health risks of e-waste ingredients and the potential interventions.

Table 4.5: Health risks of e-waste substances and potential interventions

Substance	Health risk	Potential intervention	Source/s
Arsenic	Skin lesions, carcinogenicity, neurotoxicity, cardiovascular diseases and developmental toxicity	Life Cycle Assessment of the fate of electrical equipment Legislation and policy enforcement	IARC [58],
Lead	Teratogenic, harmful to the renal and nervous systems, brain damage lead to blood disorders Psychiatric diseases	Life Cycle Assessment of the fate of electrical equipment Legislation and policy enforcement	Kiddee et al [74] Babu et al [75] Opler et al [76]
Mercury	Teratogenic and causes damage to the kidneys and brain	Legislation and policy enforcement	Babu et al [75]
PCBs	Damages the liver, carcinogenic to animals	Legislation and policy enforcement	Babu et al [75]
PBDEs	Neurodevelopmental effects: impairment of physical and mental development Poor attention, cognition, fine motor coordination	Confirmation through other longitudinal investigations	Herbstman et al [77] Eskanezi et al [78]
Cadmium	Damages the kidneys, lower intelligence in childhood	Legislation and policy enforcement	Babu et al [75] Kippler et al [79]
PVC	Respiratory complaints,	Legislation and policy enforcement	Babu et al [75]

Substance	Health risk	Potential intervention	Source/s
Dioxin emissions	Sarcoma	Conducting methodologically sound epidemiological studies Financing of waste management initiatives Capacity building through training Extended producer responsibility Take back programs for e-equipment	Zambon et al [80], Ncube et al [38], Jerie and Tevera [81], Ciocoiu et al [73], Grant et al [82]

Results from the physical waste compositional analysis revealed considerable proportions of infectious materials in municipal solid waste (2%), such as diapers and used tissue (table 3.4). Contact with such contaminated materials may contribute to transmission of faecal-oral diseases such as hepatitis A. Previous work has richly detailed the Hepatitis A (HAV) risk associated with waste management]. In Greece, Dounias and Rachiotis [83] observed a significantly increased prevalence of HAV infection among solid waste collectors and suggested among other measures vaccination of waste workers against HAV.

The present study found relatively high levels of mechanical waste components such as scrap metal, broken glass and razor blades (Table 4.4). Such components have potential to inflict physical harm to municipal solid waste workers in form of cuts, open wounds and bruises. Although gloves were provided for waste workers, they were not puncture- proof and were worn out (Figure 4.3). In light of epidemiologic evidence linking Hepatitis B and needle stick injury [84], such an unhealthy status of waste workers' gloves is a cause of concern. Tsovili et al [84] found significantly higher prevalence of Hepatitis B virus infection ($p<0.01$) in waste collectors (15%) in comparison with the control group (2.5%). Thus municipal solid waste collection is a job heavily laden with biological risks that may endanger waste workers' health.

Figure 4.3: waste collector wearing non-puncture proof and worn out gloves

4.5 Strengths and limitations

This paper presents the strength of the inclusion of occupational hygiene measurements related to several occupational hazards. Particularly, bioaerosols exposure determination, occupational noise and thermal conditions measurement were done. However, this study did not measure exposures through other routes such as hand contact with contaminated materials. Thus it is unable to estimate the microbiological risk through the ingestion route. Particularly, this study did not collect swabs of waste workers' hands and nails to determine the remaining concentrations of e-coli and faecal after washing their hands. Nonetheless since results from our physical waste compositional analysis revealed faecal waste (diapers) in municipal solid waste streams (Table 4.4), waste workers may be at risk of faecal- oral transmitted diseases through contaminated hands following handling of such waste materials. Therefore, further studies may need to determine the efficiency of hand washing methods utilised by municipal solid waste workers.

To date, very limited studies have been conducted on the GNB and fungi exposure concentrations at municipal solid waste management sites such as active landfilling sites, refuse bin collection points and truck cabins. This study enriches and broadens the existing body of knowledge in this negated area (Table 4.4). Moreover, the findings have positive implications on the planning and conduction of municipal solid waste collection activities. Some proposed changes include rescheduling summer waste collection for early morning or at night when

temperatures are cooler, provision of resting shades and oral rehydration fluids to cushion waste workers from heat exhaustion and syncope.

4.6 Conclusion

The study found high mean exposure concentrations for total dust, Gram Negative Bacteria (GNB) and fungi for personal samples collected from refuse bin loaders and for truck cabin samples. This suggests the priority for exposure assessment with regard to total dust and bioaerosols should be focused on waste loaders and the truck cabins. Also, the mean summer temperatures were higher than 33^{o}C in most waste management areas and workers complained of headaches, sunburn, heat stress, excessive sweating, dehydration and difficulties in concentration in assigned tasks. Consequently this study suggests that in tropical countries it's better to perform summer waste collection services in early morning hours or at night when temperatures are cooler. Waste workers should be encouraged to take regular breaks and rest in cooler shades where oral rehydration fluids can be given to refresh them. In light of the results from the physical waste compositional analysis, this study concludes that municipal solid waste workers are exposed diverse toxic, mechanical and infectious hazards which require sound mitigation measures.

4.7 Ethical approval

Approval of the University of Pretoria's Faculty of Health Sciences Ethics Committee was obtained (Ref 343/2014). Approval from the study area's town council was received in writing. A two-way dialogue was held with all the study participants where the purposes and procedures of the study were discussed and all participating workers voluntarily signed informed consent with the full rights to withdraw from the study without having to give any excuse. No samples of blood or body fluids were collected from participants in this study. Where images of workers were used deliberate attempts taken to hide the facial appearance of workers and all data collected was treated with utmost confidentiality and the anonymity of respondents greatly respected.

4.8 Competing interests

There is no conflict of interest regarding the publication of this paper. The paper was presented at the Public Health Practitioners Association conference (PHASA) of South Africa, held in the period 19-22 September 2016, but is not under consideration for publication in any journal.

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CHAPTER 5: POSTURAL ANALYSIS OF A DEVELOPING COUNTRY'S MUNICIPAL SOLID WASTE HANDLERS AND A REFERENCE GROUP OF HOSPITAL GENERAL HANDS USING THE RULA METHOD[3]

5.1 Abstract

Background: Municipal solid waste handlers perform various work activities which may contribute to the onset of work-related musculoskeletal disorders (WRMDs). This study conducted a postural analysis of these workers and a reference group of hospital general hands in order to identify unsafe working postures requiring correction.

Methods: The Rapid Upper Limb Assessment (RULA) methodology was used for postural analysis to 30 municipal solid waste handlers (MSWHs) and a reference group of 30 hospital general hands (HGHs) involved in similar work activities. Field observations and photography were used to collect data. Collected data was analysed using STATA version 13.

Results: The Mann-Whitney test was used to compare the two groups. Results showed significant differences ($p < 0.05$) for lifting, carrying and emptying activities. For both groups, the mean postural scores for pushing, pulling and standing activities were mainly in the low risk category and not statistically significant ($p > 0.05$).

Conclusion: Results of the present study show unsafe RULA postural scores to MSWHs with regard to lifting, carrying and emptying of refuse bins. Such scores are suggestive of an elevated risk to developing WRMDs in these workers compared to the reference group.

Keywords: municipal solid waste handlers, musculoskeletal disorders, postural assessment, RULA

5.2 Background

Poor working postures have been associated with an elevated risk of developing WRMDs. [1-4] The activities performed in poor working postures have been richly investigated in occupations such as dentistry [4-6], computer work [2, 3, 7] and agriculture [8, 9]. Such efforts assist in the identification of the poor postures requiring correction in the given occupations. In contrast, very few of such investigations have focused on MSWHs. The few available studies are mostly from developed countries [10, 11], with almost none from the developing world. In the Netherlands, Hoozemans and colleagues [10] focused on pushing and pulling of refuse carts

[3] Manuscript published: Global Journal of Health Science; 9 (10): 194-200

and estimated the loading of the low back and joints at the shoulder using biomechanical models. This dimension appears crucial with regards to estimating the ergonomic impact of measures on the pulling and pushing activities [10]. Similarly, Kuijer and colleagues [11] used advanced biomechanical models to study the mechanical and perceived workload with regard to pushing and pulling a redesigned refuse cart.

In the present article the focus, scope and method is different from the above studies. Particularly, the study used the RULA methodology to identify and analyse the poor postures used during the performance of various municipal solid waste management activities. The analysis involves systematically observing work activities of the study participants and assigning risk scores on the postures used [12]. Systematic observation methods can provide particular information about postures and suggestions to rectify them before onset of discomfort [13]. Rectifying poor postures before the onset of WRMDs is indeed a proactive rather than reactive approach and is the essence of primary prevention. Further, RULA is a validated postural method for rapid upper limbs assessment [12, 14]. Thus, it can yield more reliable findings than unvalidated methods. Moreover, the RULA methodology is useful for quickly screening worker exposures which contribute to disorders of the upper limbs [14]. Furthermore, it is relatively easy to use when one has undergone brief training on its application [15]. To the best of the author's knowledge, very few studies have applied direct observation methods such as the RULA in the real life work activities of MSWHs. Yet the RULA method has been demonstrated to be valuable in identifying priority work postures requiring correction [12, 14].

Some developed countries now use underground waste depots and automated waste loading mechanisms [16]. For underground depots it is not MSWHs who carry and empty refuse bins but citizens. In automated loading, bins are mechanically lifted and emptied into a truck. The physical job demands of waste collection and emptying are greatly reduced in both of these systems. This limits human risks to musculoskeletal disorders due to poor postures. However, most developing countries rely on manual waste collection systems [17, 18], which may contribute to WRMDs due to use of unsafe postures. An investigation to identify such postures may inform waste managers on required interventions to safeguard the occupational health of MSWHs. Therefore, the present study conducted a postural analysis of MSWHs using the RULA methodology.

5.3 Methods

5.3.1 Study design

A cross-sectional design was conducted among MSWHs of Beitbridge Town Council (BTC) and a reference group of HGHs, in the period April to June, 2016. The protocol used in this study was approved in writing by the Ethics Committee at the University of Pretoria (Ref. 343/2014) and the BTC. A two-way dialogue was held with the 60 study participants where the purposes and procedures of the study were discussed. Participants voluntarily signed informed consent forms with the full rights to withdraw from the study without having to give any excuse. There were no facial identities of participants on all photographs that were taken. The study participants were selected using purposive sampling. The inclusion criteria considered MSWHs and HGHs: (1) whose job description entailed lifting, carrying, pulling, pushing and emptying activities, (2) with at least one year work experience and (3) without known pain related medical conditions which may influence postures, such as arthritis and injuries. The study did not exclude participants on the basis of sex, race or other discriminatory variables and no financial reward was paid for participation. The ages of MSWHs ranged from 27 to 44 years (32.97±4.6 years). They had a mean weight 68±2.88 Kg and a mean height of 163±4 cm. Ages of the HGHs were from 25 to 43 years (32.40±4.2 years), mean weight of 67.50±2.70 Kg and mean height 1.64±4 cm. The study participants were healthy and non-smokers. None had known underlying conditions which may influence body postures, such as back pain, spina bifida and injuries. The differences in the age, weight and height of participants were not statistically different ($p > 0.05$).

5.3.2 Walk-through surveys and direct observations

Several field visits were done to identify the study participants' work activities deserving inclusion in the RULA postural analysis. The investigation prioritised activities which were routinely done whilst adopting poor postures. Such postures included bending of the neck, trunk, wrist and elevation of the lower and upper arms. Six main activities done by both MSWHs and HGHs were selected for the postural analysis: (1) lifting, (2) carrying, (3) emptying, (4) pushing, (5) pulling and (6) standing. HGHs were used as a reference group in this study because they have considerable commonalities to MSWHs, but they do not handle municipal solid waste. Firstly, the job activities of both HGHs and MSWHs are predominantly performed manually and are physically demanding. For example, HGHs routinely lift patients' meal trays and medical waste bins in hospitals whilst MSWHs routinely lift non-medical waste bins from various waste generation sources such as residences, commercial premises and

institutions. The HGHs carry and empty the medical waste bins into the hospital incinerator whilst MSWHs carry and empty the non-medical waste bins into municipal solid waste collection vehicles. Secondly, both MSWHs and HGHs' work entails adopting body positions which involve bending of the upper limbs' joints, which can be analysed using the RULA method to identify unsafe postures and suggest the required corrective interventions.

5.3.3 Posture measurement

The RULA method was used to assess the work postures of each MSWH and HGH, in their work situations. It uses posture scores. For instance, a score of 1 for the upper arm is awarded when it is near neutral ($<20^0$ abduction) or in a neutral position. The RULA scores were obtained using the standard methods described in literature [12, 14, 19]. Notably the final RULA scores are interpreted as follows: 1- 2 negligible risk, 3 - 4 low risk and change may be required, 5 - 6 medium risk, further investigation and change soon and 6+ very high risk, change required now. The photographs of participants at work were taken during their normal working hours. These were used to score the work postures. For each participant, the left and right side of the upper body were rated separately taking note of the angles at the upper limbs joints, the twist of the wrist, neck and trunk as well as abduction of the shoulders. The ratings were used to obtain the final RULA score for each participant.

5.3.4 Statistical analysis

Data on the postural mean RULA scores were tested for normality using the Shapiro-Wilk test. The data were not normal. The Q-Q plots for the mean RULA postural scores on each activity were scattered in manner resembling a sigmoid shape. Hence, parametric tests such as t-tests could not be done. Thus, a non-parametric test, the Wilcoxon rank sum test (Mann-Whitney test) was performed. All analyses were performed using STATA version 13 at 95% level of confidence ($p < 0.05$). The lack of normality could be due to discrete postural risk scores of each worker and the use of relatively small sample sizes of 30 MSWHs and 30 HGHs.

5.4 Results

Table 5. 1 depicts the mean postural scores of MSWHs and HGHs. LHS stands for Left hand side and RHS for right hand side, of the body. The results in this table show significant differences ($p < 0.05$) for the lifting, carrying and emptying activities. Particularly, the postural mean scores of MSWHs on these activities were unsafe as they are above the low risk category of 3-4 rating. They require urgent corrective changes and further investigations [12, 14]. In lifting the refuse bins trunk severe flexion ($20\text{-}60^0$) was commonly practised. The refuse bins were quickly and forcefully lifted, the neck flexed ($>20^0$), and without prior efforts to first

maintain a safe posture and reaching out distance. The postural scores of HGHs were lower than of MSWHs and were mainly in the low risk category. For both MSWHs and HGHs, the mean postural scores for pushing, pulling and standing activities were mainly in the low risk class and not statistically significant ($p > 0.05$).

Table 5.1. Postural analysis for MSWHs and HGHs (Mean in terms of standard errors, SE)

Mean RULA scores

Activity	MSWHs (n=30)	HGHs (n=30)	Z	P-value
Lifting RHS	5.87 ± 0.19	3.7 ± 0.21	5.54	0.0001*
Lifting LHS	6.5 ± 0.15	4.17 ± 0.25	5.29	0.0001*
Carrying RHS	5.17 ± 0.19	3.73 ± 0.22	4.67	0.0001*
Carrying LHS	4.9 ± 0.21	3.73 ± 0.22	3.92	0.0001*
Emptying RHS	5.53 ± 0.26	4.2 ± 0.26	3.30	0.0010*
Emptying LHS	4 ± 0.25	3.5 ± 0.21	3.32	0.0009*
Pushing RHS	2.67 ± 0.20	3.13± 0.67	- 1.36	0.17
Pushing LHS	3.13± 0.06	3.13 ± 0.10	0.80	0.43
Pulling RHS	3.23 ± 0.11	3.13 ± 0.06	0.41	0.68
Pulling LHS	3.2 ± 0.09	3.17 ± 0.08	0.35	0.73
Standing RHS	3.5 ± 0.23	3.17 ± 0.07	0.54	0.59
Standing LHS	3.23 ± 0.18	3.17 ± 0.07	- 0.27	0.79

***** Statistically significant at $p < 0.05$, RULA scores interpretation according to McAtamney & Corlett [12] : 1 - 2 negligible risk, 3 - 4 low risk, change may be required, 5 - 6 medium risk, further investigation and change soon, 6+ very high risk, change required now.

Figure. 5. 1 shows a MSWH (A) with a colleague, emptying a refuse bin into a non-compactor vehicle at a height > 1.5 m. The neck is bent in flexion and side-twisted, the trunk severely bent in extension ($20 - 60^0$), the right shoulder is raised, and the right upper arm is abducted ($> 90^0$) whilst manually emptying a load more than 100Kg above shoulder height in a static posture. For both workers (Figure. 5. 1) the right hand wrist is bent in extension ($> 15^0$) whilst supporting a heavy load. In figure 5. 1, there is severe physical loading of the MSWHs' shoulders particularly from three key sources: (1) weight of the elevated upper and lower arms, (2) the metal bin and (3) the waste itself. Such poor postures when lifting, carrying and emptying heavy refuse bins contributed to high RULA scores for MSWHs (Table 5. 1).

Figure 5.1 Loader (A) neck side-bending in extension and twisted, trunk in extension (20^0-60^0), right shoulder raised, right upper arm abducted (> 90 ^{0}) whilst manually emptying load > 100Kg above shoulder height

Although the mean RULA scores for standing were in the low risk category (Table 5. 1), this study observed extreme cases that require corrective measures particularly for MSWHs of automated self-compacting vehicles (Figure. 5.2). In Figure 5.2, the worker is standing in an awkward position whilst at the rear of a moving automated compactor truck. Notably, there is severe trunk flexion (> 60^o), neck flexion (> 20^o) and neck slight bending to the right. Also, the right upper arm is in a prolonged, abducted and stressful position. The right shoulder is raised. The legs and feet are not supported but almost resting on toes even though the worker is not wearing slippery-resistant footwear, whilst on smooth and slippery metallic floors.

Figure 5. 2 MSWH in poor standing posture: Trunk bent > 60^0, right shoulder raised, upper arm (right) abducted, left foot imbalanced whilst inside loading bay of a moving automatic compactor vehicle

5.5 Discussion

The section presents a discussion of the present study's results on the postural analysis of MSWHs and HGHs using the RULA methodology. It outlines the implications of the findings with regard to the risk developing of WRMDs. It also provides suggestions for improvement, the strengths and limitations of the present study.

5.5.1 MSWHS' postural risk scores

There are a number of crucial findings on MSWHs which deserve highlighting. The mean postural RULA risk scores exceeded the low risk category of 3-4 with regard to lifting, carrying and emptying refuse bins. Such scores are unsafe and require urgent corrective changes and further investigations [12, 14]. The corrective changes should focus on the poor working postures in the upper limbs which include: i) excessive trunk bending ($20\text{-}60^0$), ii) neck flexion ($>20^0$), iii) sustained shoulder raising, iv) abduction of upper arms ($>90^0$) and v) wrist bending in extension (>15). Kuijer & Frings-Dresen [16] describe two possible measures which may limit the manual lifting, carrying and emptying activities, thus address some of the poor postures observed in the present study. The measures are: i) adoption of underground depots where citizens deposit their waste rather than MSWHs and ii) mechanising the waste collection

activities. However, such measures may present new risks to MSWHs [16]. Moreover, the financial handicaps of most developing countries may limit the adoption of such measures. This challenge suggests the need for such nations to prioritise some low-cost interventions such as postural competency based training to correct the poor postures employed in the lifting, carrying and emptying activities. Such training may empower MSWHs with knowledge and skills for safely performing the activities.

Further, the present study's findings on postural deficits of MSWHs are suggestive of an elevated risk to developing WRMDs. Poor working postures have been associated with the risk of developing WRMDs in previous studies. [3, 20] Particularly, non-neutral trunk postures have been associated with low back pain [8], shoulder abduction with shoulder pain [21, 22], and neck twist and flexion with neck pain [1]. Kaliniene and colleagues [3] conducted a cross-sectional investigation of musculoskeletal disorders and occupational factors among computers users. They found that participants reporting musculoskeletal disorders had high mean RULA scores that were statistically significant. They also reported a positive association between experiencing wrist/hand pain and high quantitative work demands. Kaliniene et al [3] also observed that an increase in RULA scores by a point corresponded to an increased probability of having complaints of the wrist/hand, upper and low back pain. In the present study, lifting, carrying and emptying refuse bins by MSWHs had high mean RULA postural scores which were statistically significant in comparison to those of HGHs. Thus evidence from Kaliniene and colleagues [3] suggests that the high postural RULA scores of MSWHs with regard to lifting, carrying and emptying activities, may predispose these workers to WRMDs. This suggests that in the long term, waste managers may need to phase out manual lifting, carrying and emptying of refuse bins in favour of mechanically lifted and emptied bins, in order to reduce the risk of developing WRMDs in this group of workers. Also, task performance supervision and safety training with demonstrations on the desirable work postures maybe adopted.

In the United States, Cakit [23] applied RULA in a laboratory setup. The participants were non-MSWHs performing refuse bin lifting and dumping (emptying) activities. The findings showed high RULA scores for the activities. The similarity of the findings between this laboratory study and the current field based investigation suggests that despite the differences in design, the two studies are mutually complementary.

5.5.2 HGHs' postural risk scores

The study's results indicate that HGHs' mean postural risk scores were mainly in the low risk category and were significantly different ($p < 0.05$) compared to MSWHs for the lifting, carrying and emptying work activities. Thus, the HGHs used safe postures at the upper limbs in comparison to MSWHs. Such safe postures are suggestive of a low risk to developing WRMDs. Further follow-up studies may need to investigate whether the differences in the risk scores could be attributed to factors such as the: i) types of training required, ii) rate of turnover in the workforce and iii) study setting. The mean postural RULA scores of HGHs and MSWHs with regard to pulling, pushing and standing activities were low and not statistically significant ($p < 0.05$). Some authors associated these activities with less biomechanical load on the trunk [11, 24]. In light of this, pushing and pulling activities seem to pose a low risk of progressing to WRMDs. Thus, it appears safer for managers of HGHs and MSWHs to promote wide usage of pushed or pulled bins than manually lifted and carried ones.

5.6 Strengths and limitations

There some strengths and limitations of this study. One of its main strengths is the utilisation of a validated method for data collection. A validated tool may offer better opportunities to provide valid and reliable findings compared to subjective tools like questionnaires, which may introduce biases from the respondents' verbal reports. Also, this study managed to identify and analyse risk levels of priority work activities performed using poor postures. These are lifting, carrying and emptying of refuse bins. The findings have practical implications to the organisation of municipal solid waste handling activities. Particularly, the evidence of elevated postural scores when performing these activities suggests that corrective measures are urgently required to safeguard MSWHs from WRMDs. A major limitation of this study is that it is a single centre cross-sectional study. This may limit the capacity to generalise the findings to waste management situations in other local government structures. Further work may consider using multi-centre longitudinal studies. Furthermore, although both MSWHs and HGHs performed similar work activities in the present study, some characteristics of their work settings are slightly different. For example HGHs' work is predominantly performed indoors whilst that of MSWHs is primarily done outdoors. Previous literature has associated outdoor activities with greater occupational exposure to ultra-violet radiation [25, 26] and low temperatures [26], which may affect the level of physical exhaustion and the postures used. Thus, the differences in the occupational settings may limit the capacity of the present study to draw completely comparable conclusions on MSWHs and the reference group. Another

limitation relates to the possibility of selection bias since the study used a non-random method: purposive sampling to enrol the participants. Future studies may consider replicating the present study's findings using random sampling methods.

5.7 Conclusion

Overall, results of the present study show higher RULA postural scores to MSWHs with regard to lifting, carrying and emptying of refuse bins. Such scores may contribute to an elevated risk of developing WRMDs in these workers compared to the reference group. This suggests that waste managers need to prioritise interventions such as adopting mechanically lifted and emptied bins, conducting safety training for MSWHs and task performance supervision, so as to reduce the risk of developing WRMDs.

5.8 Acknowledgments

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5.9. Competing interests statement

There are no competing or potential conflicts of interest.

5.10. References

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CHAPTER 6: A REVIEW OF AVAILABLE FRAMEWORKS

6.1 Introduction

This chapter reviews published frameworks on environmental pollution [1, 2], health risks to general populations [3-8] and generic occupational settings [9-12]. The findings from the review were used as a base for the proposed framework. Particularly, the proposed framework builds on the strengths and limitations of reviewed frameworks. Chapter 7 describes: i) how the review's findings were utilised to produce a draft framework and ii) the process used to validate the draft framework.

6.2 Methods

An analysis of strengths, weaknesses, opportunities and threats (SWOT) of available human and environmental risk assessment frameworks was done and the findings were used as a base for the framework. Literature searches were conducted using PubMed, Medline, Embase, Scopus and free search to identify relevant frameworks. The search terms used were: framework, model, risk assessment, risk management, environmental and occupational health. For each framework, references were checked to identify additional frameworks meeting the inclusion criteria. Frameworks to be included in the review had to meet the criteria shown in Box 1.

Box 6.1 Framework inclusion and exclusion criteria

Inclusion criteria

(1) had a direct focus on environmental, human health or occupational health issues,

(2) contain a diagrammatic representation of the components,

(3) have a verifiable and authentic source,

(4) written in English language and

(5) latest version of the concerned framework.

Exclusion criteria

(1) frameworks on effluent,

(2) nanomaterial,

(3) water pollution and

(5) cancer

A total of 49 frameworks were found and only 12 (see table 5.1) met the inclusion criteria described in Box 1. Each selected framework was examined with regards to emphasis on: problem formulation, toxicological assessments, risk judgement criteria, documentation, stakeholder consultation, risk communication, evaluation and consideration of findings from methodologically sound epidemiological studies. The methodology employed in the current article for the identification, inclusion and exclusion of frameworks presents various strengths and limitations. The use of diverse data bases, free search and cross-checking references of all potential frameworks broadened the study's capacity to identify the frameworks meeting the inclusion criteria. The application of predesigned criteria to assess each framework facilitated the conduction of the review process in a consistent, objective and reliable procedure. The inclusion of frameworks with diagrammatic illustrations enriched the study's potential to analyse high quality frameworks and minimise possibilities of overlooking their overarching fundamental components. However, inclusion of only English language frameworks may have limited the study's ability to consider some relevant non-English language frameworks. Additionally, no framework was found from developing countries. Thus, the reviewed frameworks were probably moulded basing on data and scenarios from industrialised countries.

Therefore, the conclusions drawn from the review of these frameworks must be treated with caution in context of developing countries where conditions may be entirely different. This suggests that a framework developed from a review of such frameworks may require validation in a developing country's context.

6.3 Results and discussion of reviewed frameworks

A SWOT analysis of available environmental and human risk assessment frameworks was done. Table 6. 1 shows the findings of the SWOT analysis on the enrolled frameworks. The absence of a component on problem formulation in all occupational health frameworks [9-12], may make it difficult to set risk assessment objectives and to select required methods for their accomplishment [1, 3, 4]. Additionally, all the frameworks lacked emphasis on the input of findings from methodologically sound epidemiological studies, a risk judgment criteria and a stakeholder consultation guideline. Methodologically sound epidemiological studies have been observed to be requirement for establishing cause-effect relationships between waste management activities and associated health problems [13], whilst a risk judgment criterion is vital for decision making purposes. Some reviewed frameworks lacked emphasis on documentation and the few which contained it lacked a stakeholder consultation and documentation guideline.

Table 6.1: Strengths and shortcomings of reviewed frameworks

Framework focus / ***Criterion***	***UK [1]***	***HCN[2]***	***Canada[3]***	***USEPA[4]***	***Australia[5]***	***CRA[6-8]***	***Rampal & Sadhra[9]***	***NSOM[10]***	***ILO[11]***	***OSHAS 18001[12]***
	Assessment & management	Assessment & management	Assessment & management	Assessment & Decision making	Assessment & management	Combined exposures & effects	Assessment & management	Worker & environment surveillance	Worker & environment surveillance	Accidents & injuries prevention
Problem Formulation	✓	✓	✓	✓	✓	✓	-	-	-	-
Stakeholder consultation	✓	✓	✓	✓	✓	-	-	✓	✓	-
MSES	-	-	-	-	-	-	-	-	-	-
Risk judgement criteria	-	-	-	-	-	-	-	-	-	-
Toxicological assessments	✓	-	✓	✓	✓	✓	✓	-	-	-
Risk communication	✓	-	≠	≠	≠	≠	×	**	**	-
Documentation	✓	✓	✓	✓	-	✓	-	✓	✓	✓
Consultation guideline	-	-	-	-	-	-	-	-	-	-
Review or Auditing or Evaluation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

MSES: Methodologically sound epidemiological studies, OHS: Occupational health surveillance ✓= present; - = absent; × = present but terminal; ≠ = implied; ** = embodied in feedback; HCN: Health Council of Netherlands; NSOM: Netherlands Society of Occupational Medicine

6.3.1 UK Guidelines for Environmental Risk Assessment and Management [1]

The presence of the problem formulation component is a key strength of this framework (Table 6.1). This component helps to focus the entire risk assessment process [1]. Similarly, the framework contains emphasis on consultation of stakeholders and risk communication. Stakeholder consultation may yield desirable outputs and lasting risk management decisions [1]. However, it appears that this framework may benefit from improvements such as i) input of findings from methodologically sound epidemiological studies, ii) development of a risk judgement criteria and iii) a stakeholder consultation and documentation guideline (Table 6.1).

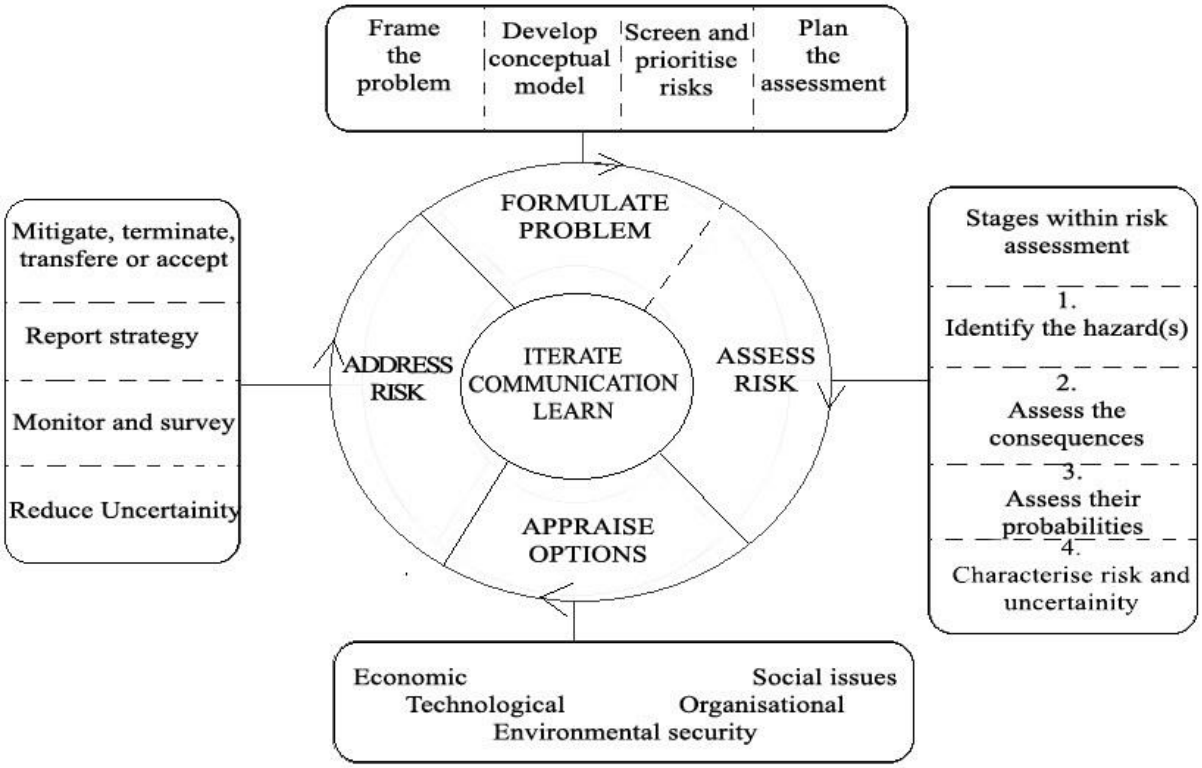

Figure 6.1: UK framework for Environmental risk assessment and management [2]

6.3.2 Netherlands Environmental Risk Management Approach [2]

The framework lacks some vital components such as risk communication, a stakeholder consultation guideline, input of findings from methodologically sound epidemiological studies and a judgement criterion for assessing risks (Table 6.1). This conceptual framework was developed by the Netherlands Health Council and provides the guidance for decision making on environmental risks [2]. It is clearly delineated between the processes of risk assessment and risk management (Figure 6.2). Three major issues are emphasized under the risk assessment component of this framework. Firstly, the problem definition is portrayed as the

first step in risk assessment. It requires a two-way interactive participation between the risk assessor and risk manager [2]. Secondly, the analysis stage is focused on determination of the stressors, exposures and effects. Thirdly, risk characterisation is described as the last stage of risk assessment that also needs reciprocal consultations between the risk assessor and risk manager. The risk management phase is depicted not only as being informed by results of the risk assessment process but also as being instrumental in guiding the risk assessment process (Figure 6.2). The framework only emphasizes consultation between the risk assessor and risk manager, thus negating valuable input from other stakeholders.

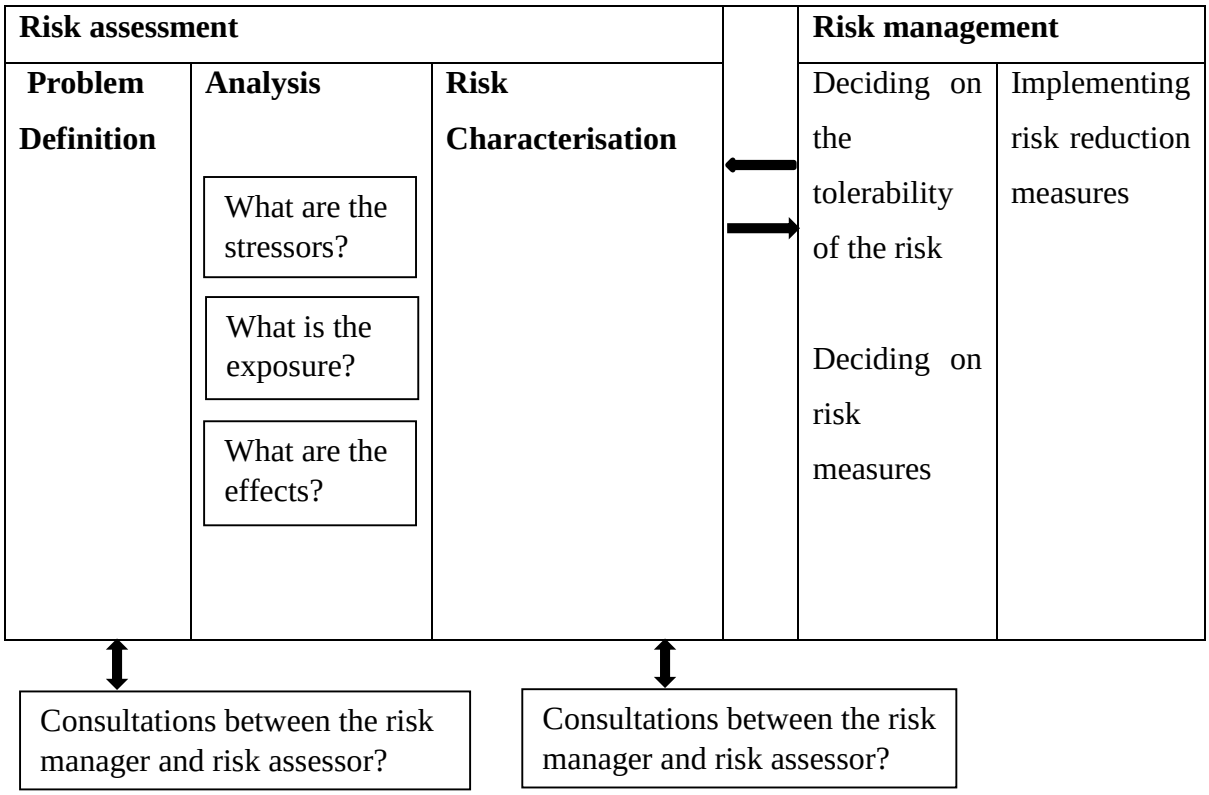

Figure 6.2: Netherlands Environmental Risk Management Approach [2]

6.3.3 Health Canada Framework [3].

The Canadian framework [3] provides a broad based and comprehensive approach for the identification, assessment and management all health related risks (Figure 6.3). Appropriate and sound risk assessment is portrayed as aiding the subsequent risk management process [3]. The framework justifies the problem identification component as necessary for the purposes of developing and selecting appropriate objectives, methods, resources and options for addressing the problem. The consultations of interested and affected stakeholder are also considered useful in the risk assessment process. Such wide consultation may breed a sense of ownership and

stakeholder identification with the framework. Also, the framework highlights that the assessment of risks and benefits requires a multi-disciplinary team and should be strongly hinged on utilization of sound scientific information. The framework needs to be hailed for its emphasis on evaluation of implemented interventions. Such evaluation enables responsible authorities to determine the framework's key strengths, areas for continual improvement as well as to equitably allocate and utilize available resources with regard to risk assessment and management. On the negative, this framework does not contain: i) a stakeholder consultation guideline, ii) emphasis on input of findings from methodologically sound epidemiological studies and iii) a judgement criteria for assessing risks (Table 6.1). Also, the risk communication component appears implied than clearly stated. Risk communication is briefly and cursorily refereed to terminally under process related tasks in issue and context identification. The reference to risk communication is made to highlight what information the risk information library must contain [3]. Incorporating risk communication as an on-going integral component of both risk assessment and management framework might greatly add value to this framework.

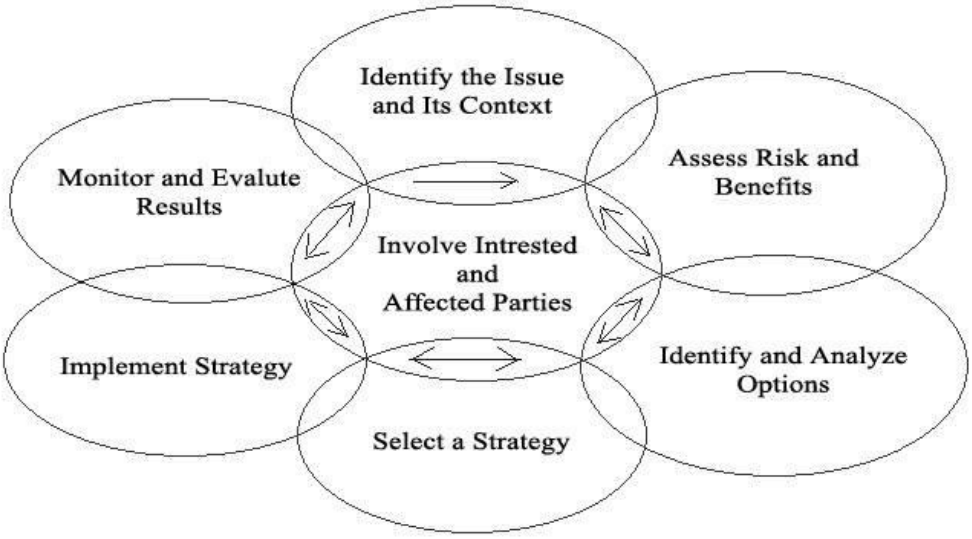

Figure 6.3: Health Canada Framework [3].

6.3.4 USEPA Framework for Human Health Risk Assessment to Inform Decision Making

The framework emerged as a direct consequence of the USEPA 2010 Colloquium on Human Health Risk Assessment [4]. Notably, its thrust was to increase USEPA's ability to maximize the utility of risk assessment by emphasizing the need to focus the design of risk assessments on the decision-making process [4]. On the positive the framework has strong emphasis on the

problem formulation component (Figure 6.4). An important outcome of the problem formulation step is a conceptual model [4]. Such a conceptual model details the hazards, population at risk, exposure pathways, the adverse health endpoints to be dealt with in the risk assessment. Additionally, problem identification is portrayed as culminating in the production of an analysis plan which addresses the methods, approaches and metrics to be employed in the assessment of exposures and their adverse health effects. Furthermore the role of science is equally emphasized. Specifically, the framework depicts risk assessment as constituting the following broad steps: exposure assessment, effects assessment and risk characterisation. Moreover, the public, stakeholder and community involvement is portrayed as critical throughout the entire risk assessment process. Nevertheless, there are various shortcomings of this framework. It lacks emphasis on role of methodologically sound epidemiological studies in informing the risk assessment process. However, it is essential to note that methodologically sound epidemiological studies are often costly and typically conducted in response to some trigger. In particular, longitudinal studies are conducted "after the fact" and therefore maybe less useful in protecting the exposed population from known and unknown hazards. Thus the precautionary principle, whose thrust is on prevention based on available scientific evidence, may be a useful alternative to risk assessment approaches.

In the USEPA framework there is no clear emphasis on risk communication, a stakeholder consultation and documentation guideline and a judgement criterion for assessing risk. Documentation yields valuable information for evaluation purposes. Unfortunately formative evaluation emphasis is equally missing in this framework since emphasis is placed on summative evaluation in the risk characterisation phase. Yet formative evaluation is essential in unearthing and addressing of deficiencies so as to achieve continual improvement. Furthermore, the USEPA framework is chemical specific. This makes it tedious and cumbersome for informing decisions in the municipal solid waste arena where there are multiple concurrent hazards and threats.

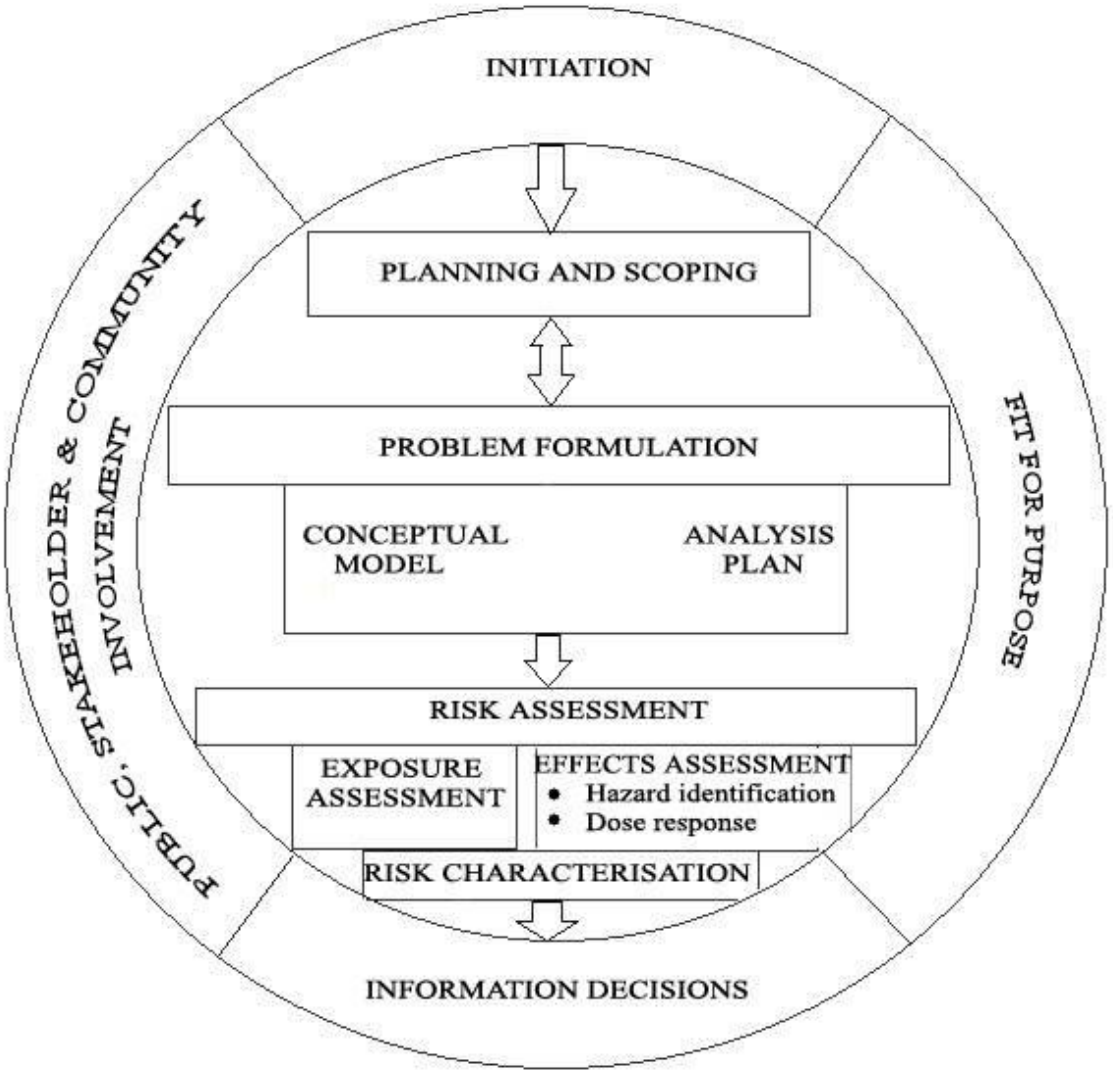

Figure 6.4: USEPA Framework for Human Health Risk Assessment to Inform Decision Making [4]

6.3.5 Australia's Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards, 2002 [5]

The framework was fundamentally developed to guide national efforts in the conduction of sound environmental health risk assessments [5]. It demarcates risk assessment and risk management. Among other issues, the framework covers problem formulation, stakeholder consultations, risk communication, monitoring and evaluation of results. Also, it illustrates how findings from risk characterisation should lead to review and reality checks for the processes of hazards identification and exposure assessment. The framework pinpoints that community and stakeholder involvement does not only serve the purposes of consensus

building but more importantly assists the processes of risk assessment and management. Thus community consultation and involvement needs to be thorough and use appropriate and effective methodologies so as to yield meaningful, durable and reliable outcomes [5]. Although the framework lacks emphasis on methodologically sound epidemiological studies, it however reinforces the need for consideration of role of science in risk assessment by highlighting the significance of dose-response and exposure assessments in risk assessment. Additionally, the framework has strong emphasis on both formative and summative evaluation. Formative evaluation is stressed under review and reality checks whilst summative is emphasized under the risk management component.

However the framework has some missing components (Table 6.1). It does not contain emphasis on documentation of risk assessment procedures and stakeholders input. It does not specify whether input from stakeholders not considered should be recorded. Neither does the framework require recording of the reasons for non-consideration of such input. Thus it is possible that stakeholders may be consulted for merely endorsing risk assessors' resolutions rather than for the purposes of learning from them. It is therefore fundamental that this framework goes a step further into detailing the procedures to be adopted for handling stakeholders' input, particularly documentation issues.

6.3.6 Cumulative Risk Assessment Frameworks

Cumulative risk assessments (CRA) [6-8] place strong emphasis on assessment of combined exposures, their multiple effects, sources, pathways and routes of exposure rather than single stressor's source, pathway, exposure route and effect. Evidently they seem to portray a more holistic and embracing approach to real life environmental stressors by embracing the notion of possible additive, synergistic or antagonistic reactions of stressors of human health. A point of congruence in these frameworks is the emphasis on problem formulation as a point of departure with regard to conducting combined multiple exposures and multiple effects (Table 5.1). However, these frameworks appear predominantly science- centric rather than worker-centric. Their emphasis is purely on exposure assessments, dose response and risk characterisation. Emphasis on: i) the consultation of stakeholders such as workers and risk communication, ii) input methodologically sound epidemiological studies, iii) a stakeholder consultation guideline and risk communication is lacking (Table 6.1). Also, since CRA seem to be resource intensive and complicated even for developed countries with the best technologies and expertise, their application in assessing occupational risks of waste workers in resource constrained scenarios like in developing countries may pose a real challenge.

6.3.7 Rampal & Sadhra's Proposed Model for Occupational Health Risk Assessment and Management, 1999 [9]

The model provides a roadmap for occupational risk assessment and management. It consists of two distinct phases: risk assessment and risk management. These phases are supported by results from the audit and review process (Figure 6.5). Overall, the model has various limitations that dwarf its value in the context of occupational health risk assessment and management (Table 6.1). Firstly, it does not have a component on problem formulation (Figure 6.5). Yet a cross-cutting theme in contemporary frameworks for human health risk assessment is the heavy emphasis placed on the relevance of the problem formulation component [1-8]. Without deliberate efforts to identify the real problems in work environments, to set objectives and action plans, this model appears difficult to implement. Evidently, embracing the component of problem formulation may add value to this model.

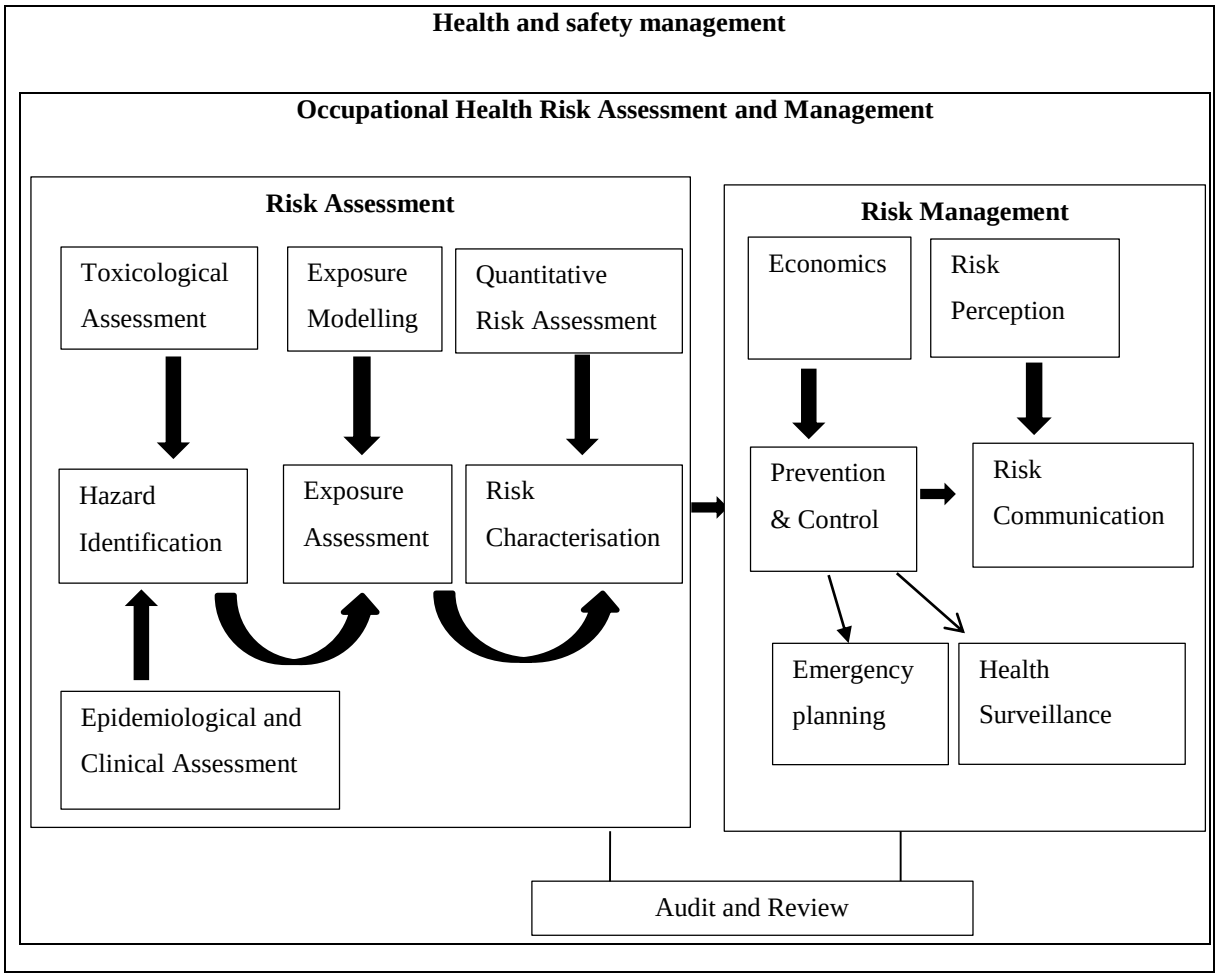

Figure 6.5: Sadhra and Rampal proposed model for occupational health risk assessment and management [9]

Additionally, the model appears non-collaborative and not interactive. This assertion is justified on the basis that it lacks emphasis on the value of stakeholder consultations in both the processes of risk assessment and risk management (Figure 6.5). Applied in the waste management occupation, the model implies that stakeholders like municipal solid waste workers whose occupational tasks entail coming into contact with diverse chemical, biological, mechanical, ergonomic and physical risks have no say in both the assessment and management of their work-related risks. Clearly the model shuns out the concerns and preferences of both affected and interested parties. Resultantly, this oversight negates the richness, depth and diversity of stakeholders' input and feedback in various aspects in relation to the application of the model. Inevitably, this may further cripple the opportunity for the risk assessors and risk managers to learn from the stakeholders. Additionally, this in turn may limit the potential for continual improvement in the conduction of the occupational health risk assessment and management processes.

Rampal and Sadhra's model [9] heavily dwells on the scientific rather than the social influences of the risk assessment process. Notably social influences such as stakeholder's opinions are completely left out in favour of purely scientific inputs to risk assessment such as toxicological assessment, exposure modelling, quantitative risk assessment and epidemiological and clinical assessment. Therefore, this model is grossly science-centric rather than stakeholder-centric in its approach to risk assessment and management. Contemporary literature [14, 15] has supported the notion of stakeholder engagement, particularly workers, with regard to workplace safety promotion. Consequently, a possible improvement to this model could be embracing the need to engage in sound, multi-disciplinary stakeholder consultations.

Paradoxically, whilst stakeholders' consultations are encouraged in modern bottom-up governance systems, they are often costly in terms of financial, human resources and time requirements. Thus on the positive, Rampal and Sadhra's model is cost-effective by not subscribing to the notion of stakeholders' consultation. In the waste management industry stakeholders include waste workers, their safety committees, waste managers, researchers and all categories of waste generators. Given the diversity of concerns of each of these parties there is no guarantee that stakeholders' consultation will yield consensus, thus reinforcing the position for negating stakeholders' consultation in some discussed frameworks.

Whilst Rampal and Sadhra's model embraces the role of epidemiological assessments in informing the hazard identification process, it does not explicitly enlighten us on the required quality of such epidemiological assessments. Arguably, methodologically sound epidemiological studies with emphasis on better sample sizes of both study groups and control groups may yield valuable information on the nature of health risks faced by workers.

Although this model contains a component on risk communication, this component appears misplaced. More explicitly, risk communication has been unfairly relegated to a terminal process that comes after completing the risk assessment process (Figure 6.5). Given the value of risk communication in the problem formulation stage and in the conduction of the entire risk assessment processes, the current study observes that this loophole in the model may be rectified by adoption of risk communication as an on-going rather than as a terminal process.

Similarly, portraying surveillance as an end product in the model defeats the rationale of surveillance as a concept and secondly as a component of this model. According to the World Health Organisation [16] surveillance refers to the on-going systematic collection, analysis, interpretation and dissemination of data for the purpose of prevention, improving health, work

ability and well- being of the labour force. Arguably, portraying surveillance as an end-product alienates both the "on-going" cardinal feature of surveillance and the purpose of surveillance as propounded by the World Health Organization. Resultantly, surveillance does not seem to serve any purpose in this model since prevention and control are portrayed as leading to surveillance and not otherwise.

Moreover, the model has no deliberate emphasis on documentation of procedures and results of either risk assessments or management. Yet documentation provides a reference point for tracking progress, auditing and review purposes as well planning new changes and improvements. Finally the model offers no judgement criteria in assessing occupational health risks.

6.3.8 Netherlands Periodic Medical Surveillance [10]

Kuijer and Frings-Dresen [17] contend that a job specific periodic medical surveillance was developed in the Netherlands to detect the early signs of work related disease and to regularly monitor refuse collectors' work ability. The surveillance approach does not contain a problem formulation component (Table 6.1). Worker's consultations are emphasized through highlighting the need to use predesigned questionnaires for collecting qualitative data from workers. But it is unclear whether these are job specific standardised and validated questionnaires. Unstandardized and unvalidated data collection instruments have limitations with regard to validity and reliability issues. Moreover, previous research has registered concerns on the questionnaire reliability [18, 19] and sensitivity [20]. The Netherlands approach [10] to assessing health risks of waste workers has provision for subsequent triangulation of gathered questionnaire data using medical tests such as lung function tests. In light of the complexity of resource management, such a screening level approach could be a useful decision - point prior to conducting an in depth analysis.

The concept of periodic medical surveillance appears narrower in scope with regard to assessing occupational health risks of municipal solid waste workers. Firstly, periodic medical surveillance is just a small component of workers' health surveillance. Workers' health surveillance includes but is not confined to pre-placement or pre-employment medical examinations, exit or termination of employment medical examinations and post sickness resumption of duty medical examinations. Evidently, the Netherlands periodic medical surveillance merely covers a small portion of workers' health surveillance. Also, work environment surveillance is not covered. Clearly Netherlands surveillance approach [10]

appears concerned about certifying whether the worker is fit to work in an unsafe environment rather than certifying whether the environment is fit for workers to work in it. Therefore, this model requires broadening to incorporate the assessment of the work environment. Additionally, embracing of input of toxicological assessments in the model is lacking (Table 6.1). However the Netherlands surveillance approach does not specify the judgement criteria to be used for describing the worker fitness status for various waste management tasks. Such a scenario has the potential to generate and foster inconsistencies and ambiguity with regard to how medical practitioners describe and communicate the outcomes of such surveillance efforts. Probably inclusion of judgement criteria may add value to the Netherlands Periodic Medical Surveillance approach with regard to consistency and uniformity of surveillance results description and communication. It will be a step in the right direction for the model to clearly emphasize the value of risk communication.

6.3.9 ILO's Occupational Health Surveillance approach [11]

Assessment of workers' health is one of the main components of any programme of prevention in the workplace [11]. Notably, the ILO [11] occupational health surveillance approach is a comprehensive and broad based guideline designed for various job scenarios. Central to this framework is the emphasis on both workers' health surveillance and surveillance of the working environment [11]. A risk assessment of the workplace entails the processes of hazard identification, dose-response assessment, exposure assessment and risk characterisation which are science centric components. Additionally ILO [11] emphasises the need for sound record keeping and documentation with regard to the development, implementation and evaluations of workers' health surveillance systems. The essence of data collection, analysis and evaluation is portrayed by ILO [11] as implementation with subsequent follow-up so as to continually improve working conditions and workers' health. Further, the ILO approach [11] stresses the relevance of feedback with regard to improving the utility of collected information. Such feedback embodies the valuable concept of risk communication. The ILO approach has several limitations that may dwarf its applicability as a tool for assessing occupational health risks of municipal solid waste workers (Table 6.1). Firstly, it omits the vital component of problem formulation and merely starts by emphasizing collection of information from various sources. Also, at the level of both European countries and the international level there is currently no common ground or guidelines on the content and procedures of occupational health surveillance [11]. Such lack of a universally agreed approach to occupational health surveillance suggests a lack of uniformity and consistency in their performance. Nevertheless

it is encouraging to observe that article 6.3(a), 9.1(a) and 14 of the 1989's European Communities Framework Directive detailing the need for embracing occupational health and safety measures offers a solid foundation for the development of universal guidelines on workers' health surveillance. The emphasis on the need for methodologically sound epidemiological studies and judgement criteria is missing in this framework (Table 6.1).

6.3.10 Occupational Health and Safety Assessment Series (OHSAS) 18001 of 2007 [12]

The OHSAS 18001 [12] standard is a widely accepted British standard for which organisations undergo certification in order to use it. It defines Occupational Health and Safety Management system as part of an organization's management system used to develop and implement its Occupational Health and Safety (OH&S) policy and manage its OH&S risks [12]. The components of the OSHAS 18001 standard offer a comprehensive basis for establishing, maintenance and promotion of a safe working environment. OSHAS 18001 recognises that no organisation is perfect and accommodates room for continual improvement by embracing the plan, do, check and act approach. The OSHAS system has no deliberate component on problem formulation (Table 6.1). Also, the emphasis on stakeholder consultation particularly workers is missing. Consequently, Wachter and Yorio [21] categorized OSHAS 18001 among the group of standards that are primarily manager or process-centric, rather than employee-centric, in terms of defining roles, responsibilities, and requirements. Currently, OSHAS 18001 only emphasizes organisational requirements for a sound safety system in terms of policies, procedures, processes and negates the aspect of employees' safety behaviours that may generate safety risks. For instance unsafe work behaviours like repairing machinery whilst in motion and not wearing protective gear can contribute to injuries for such workers or their workmates. This suggests that OSHAS 18001 needs to place more emphasis not just on processes for delivering and assessing safety but also employee functional participation in risk assessment, management and communication.

The benefits of using occupational health and safety management systems (OHSMS) have been typically restricted to large scale, multi-site organisations, often from the manufacturing sector [22]. Transferring these benefits to smaller businesses has been fraught with difficulty, with the mechanics and bureaucracy of the system itself sometimes becoming overwhelming [22]. These limitations apply to OSHAS 18001 in relation to the municipal solid waste management sector. Firstly since this field is a primarily a service delivery job and not manufacturing sector the success of this system in this field appears less likely. Secondly, if such success may by chance realised, it will most probably be in small local government structure scenarios hence

the system appears to have narrow application as viewed from this perspective. Noteworthy, OSHAS 18001 has no emphasis on : i) the input of methodologically sound epidemiological studies and toxicological assessments in the process of risk assessment, ii) risk communication component and a judgement criteria in assessing risk (Table 6.1). However the system has remarkably strong emphasis on documentation and evaluation of results (Table 6.1).

6.4 General discussions

In light of the above discussions the following general observations can be made:

6.4.1 Strengths

- All reviewed frameworks richly stressed the value of documentation in relation to conduction of risk assessments (Table 6.1). Such documentation facilitates progress tracking and records produced constitute useful reference material.
- Several frameworks contained a component on stakeholder consultation [Table 6.1]. Such consultations may yield valuable input for informing the risk assessment process.
- The frameworks had strong emphasis review, auditing and evaluation processes [1-12]. These processes can assist in continual improvement in relation to how organisations perform risks assessments, through identifying required changes.

6.4.2 Shortcomings

- The absence of a component on problem formulation in all occupational health frameworks [9-12], may make it difficult to set risk assessment objectives and to select required methods for their accomplishment [1, 3, 4]. This suggests that the proposed occupational framework may benefit from incorporating this valuable component, which is currently emphasized by frameworks on environmental pollution [1, 2] and on health risks to general populations [3-8].
- All the frameworks lacked emphasis on the input of findings from methodologically sound epidemiological studies, a risk judgment criteria and a stakeholder consultation guideline. Methodologically sound epidemiological studies have been observed to be requirement for establishing cause-effect relationships between waste management activities and associated health problems [13], whilst a risk judgment criterion is vital for decision making purposes.
- Some reviewed frameworks lacked emphasis on documentation and the few which contained it lacked a stakeholder consultation and documentation guideline (Table 6.1) These issues deserve strong emphasis in the proposed framework.

- Equally noteworthy the frameworks lacked strong emphasis on risk communication (Table 6. 1). In most frameworks it was implied [3-8], embodied in feedback [10, 11], in some it was completely absent [2, 12], whilst in others it was not on-going but terminally positioned such that it did not influence the risk assessment process [9]. In the proposed framework, risk communication is viewed as on-going and not terminal, and should be considered in the implementation of all phases of the framework.
- Most of the risk assessment frameworks reviewed [1-5, 10] were national frameworks probably designed for local conditions and may find limited applicability when applied in the wider global context. Notably, the frameworks were mainly of industrialised countries and none were found from developing countries such as Southern African countries. Technological gaps, financial, technical limitations may limit the capacity to apply these frameworks to developing countries. This suggests that a framework developed from the review of such frameworks requires validation in a developing country context so as to improve its applicability to circumstances in developing
- To date no generic framework has been developed for assessing occupational health risks of MSWHs. The envisaged contribution of the current study to the scientific community is to develop this framework for use by local government structures can use for such purposes.
- Rampal & Sadhra [9] proposed a model for Occupational Health Risk Assessment and Management. However this model appears less applicable to the task of assessing occupational risks of municipal solid waste workers due to the following reasons: firstly, the model does not have the valuable component of problem formulation. Without deliberate efforts to identify the real problems in waste management it is unforeseeable how the model can be implemented. Secondly the model is deafeningly silent on the value of stakeholder consultations. This regrettably shuns out the richness, depth and diversity of stakeholders' input in various phases of the framework. Finally, the model relegates the processes of risk communication and surveillance to the last stage of the framework yet these are on-going processes that should inform every stage of the model.

6.5 Conclusions

The following conclusions can be drawn from the above discussion:

- The scientific community requires a generic framework for assessing occupational health risks of MSWHs.

- The proposed framework needs to contain the following: i) problem formulation, ii) input of findings from methodologically sound epidemiological studies, iii) a stakeholder consultation and documentation guideline and iv) emphasis on a risk judgement criteria.
- Also it should consider risk communication as an on-going process rather than negate or place it at the terminal end of the proposed framework.
- Conclusively, reviewed frameworks portrayed various limitations but had rich prospects for further improvements. They provide a base for developing a robust framework for assessing occupational health risks of municipal solid waste workers.

6.6 References

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CHAPTER 7: DEVELOPMENT AND VALIDATION OF THE FRAMEWORK FOR ASSESSING OCCUPATIONAL HEALTH RISKS OF MUNICIPAL SOLID WASTE HANDLERS FOR USE BY LOCAL GOVERNMENMENT STRUCTURES[4]

7.1 Introduction

MSWHs are exposed to various unique occupational risks that may endanger their personal health [1-8]. Such risks may include bioaerosols [3, 7], physical stressors such heat, dusts, vibrations [3, 5] and mechanical hazards [3, 5, 6]. Other risks may arise from new waste collection methods [8] and the hazardous streams in domestic solid wastes [3, 5]. According to the author's best knowledge, currently there is no framework that has been developed for assessing the exposure of MSWHs to occupational risks. The current chapter will describe how the findings: i) of the analysis of available epidemiological literature (chapter 3), ii) primary data collection (chapter 4 and 5) and iii) a review of available frameworks (chapter 6), were used to develop a draft framework for assessing occupational health risks of MSWHs. This will require a brief revisit and elaboration of some key findings in these previous chapters

Also, the present chapter will discuss how the developed framework was validated and the resolutions from the workshop validation iterations. These resolutions were used to revise and refine the framework. Lastly, the current chapter will elaborate on the final components of the validated framework.

7.2 Input data for the framework

Evidence from an earlier review of epidemiological studies (chapter 3) on MSWM showed that most studies could not conclusively link waste management processes with adverse health effects, due to their methodological shortcomings [2]. Basing on these conclusions, the proposed framework emphasizes the need for local government structures' waste managers to engage in methodologically sound investigations and use findings from methodological sound studies in the risk assessment process. This is input 1 in the framework as illustrated later in Figure 7.1.

Identification of hazards to be considered in the framework for assessing occupational health risks of MSWHs and exposure assessment of biological, physical and chemical are reported in

[4] Manuscript under review: Global Journal of Health Science

the thesis' chapters 4. The chapter showed that MSWHs are exposed to biological, chemical and physical hazards that may jeopardise their personal health

Chapter 5 elaborated the risky jobs actions of MSWHs. Particularly, MSWHs use unsafe working postures when performing waste collection tasks. Taken together, research findings from chapter 4 and 5 constitute output 1 in phase 1 of the framework (Figure. 7.1). This output details the categories of waste management hazards to be addressed in the risk assessment process.

Chapter 6 presented the findings of a review of existing frameworks. Their strengths and limitations were discussed. This chapter will briefly revisit the sections on how the frameworks were selected and reviewed prior to showing how the review findings were used to develop the draft framework.

7.3 Framework selection

This section was elaborated in chapter 6. However it is briefly revisited in this section to show how the framework learns from available frameworks. The internet framework search process involved using combinations of the terms: assessment, environmental, framework, management, model, occupational, risk and waste. Frameworks to be included in the review had to meet the criteria shown in Box 1. For each framework, references were checked to identify additional frameworks meeting the inclusion criteria.

Box 7. 1: Framework inclusion and exclusion criteria

Inclusion criteria

(1) had a direct focus on environmental, human health or occupational health issues,

(2) contain a diagrammatic representation of the components,

(3) have a verifiable and authentic source,

(4) written in English language and

(5) latest version of the concerned framework.

Exclusion criteria

(1) frameworks on effluent,

(2) nanomaterial,

(3) water pollution and

(5) cancer

A total of 49 frameworks were found and only 12 met the inclusion criteria described in Box 1. Each selected framework was examined with regards to emphasis on: problem formulation, toxicological assessments, risk judgement criteria, documentation, stakeholder consultation, risk communication, evaluation and consideration of findings from methodologically sound epidemiological studies.

7.4 Development of MSWH focused framework

A SWOT analysis of available environmental and human risk assessment frameworks was done. Table 6.1 shows the findings of the SWOT analysis on the enrolled frameworks. Most frameworks were freely available online for public use. The reviewed frameworks focused on three main issues: (1) environmental pollution [9, 10], (2) health risks to general populations [11-16] and (3) generic occupational settings [17 - 20]. The absence of a component on problem formulation in all occupational health frameworks [17-20], may make it difficult to set risk assessment objectives and to select required methods for their accomplishment [9, 11, 12]. Therefore, problem formulation has been considered a core component of the proposed framework (Figure. 7.1). Additionally, all the frameworks lacked emphasis on the input of findings from methodologically sound epidemiological studies, a risk judgment criteria and a stakeholder consultation guideline (Table 7.1). Methodologically sound epidemiological studies have been observed to be requirement for establishing cause-effect relationships between waste management activities and associated health problems [2], whilst a risk judgment criteria is vital for decision making purposes. Some reviewed frameworks lacked emphasis on documentation and the few which contained it lacked a stakeholder consultation and documentation guideline (Table 7.1). Wachter and Yorio [21] conclude that because of lack of worker engagement, the Occupational Safety and Health Assessment Series (OSHAS 18001) [20] is not worker centric but process-centric. In the light of the lack of a stakeholder consultation and documentation guideline, the proposed framework provides this required guideline (Figure. 7.3). Equally noteworthy, the frameworks lacked strong emphasis on risk communication (Table 7.1). In most frameworks it was implied [11, 12-16], embodied in feedback [18, 19], in some it was completely absent [10, 20], whilst in others it was not on-going but terminally positioned such that it did not influence the risk assessment process [17]. In the proposed framework, risk communication is viewed as on-going and not terminal, and should be considered in the implementation of all phases of the framework.

Table 7.1: Strengths and shortcomings of reviewed frameworks

Framework focus / ***Criterion***	***UK [1]***	***HCN [2]***	***Canada [3]***	***USEPA[4]***	***Australia [5]***	***CRA [6-8]***	***Rampal & Sadhra [9]***	***NSOM [10]***	***ILO [11]***	***OSHAS 18001[12]***
	Assessment & management	Assessment & management	Assessment & management	Assessment & Decision making	Assessment & management	Combined exposures & effects	Assessment & management	Worker & environment surveillance	Worker & environment surveillance	Accidents & injuries prevention
Problem Formulation	✓	✓	✓	✓	✓	✓	-	-	-	-
Stakeholder consultation	✓	✓	✓	✓	✓	-	-	✓	✓	-
MSES	-	-	-	-	-	-	-	-	-	-
Risk judgement criteria	-	-	-	-	-	-	-	-	-	-
Toxicological assessments	✓	-	✓	✓	✓	✓	✓	-	-	-
Risk communication	✓	-	≠	≠	≠	≠	×	**	**	-
Documentation	✓	✓	✓	✓	-	✓	-	✓	✓	✓
Consultation guideline	-	-	-	-	-	-	-	-	-	-
Review or Auditing or Evaluation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

MSES: Methodologically sound epidemiological studies, OHS: Occupational health surveillance ✓= present; - = absent; × = present but terminal; ≠ = implied; ** = embodied in feedback, HCN: Health Council of Netherlands; NSOM: Netherlands Society of Occupational Medicine

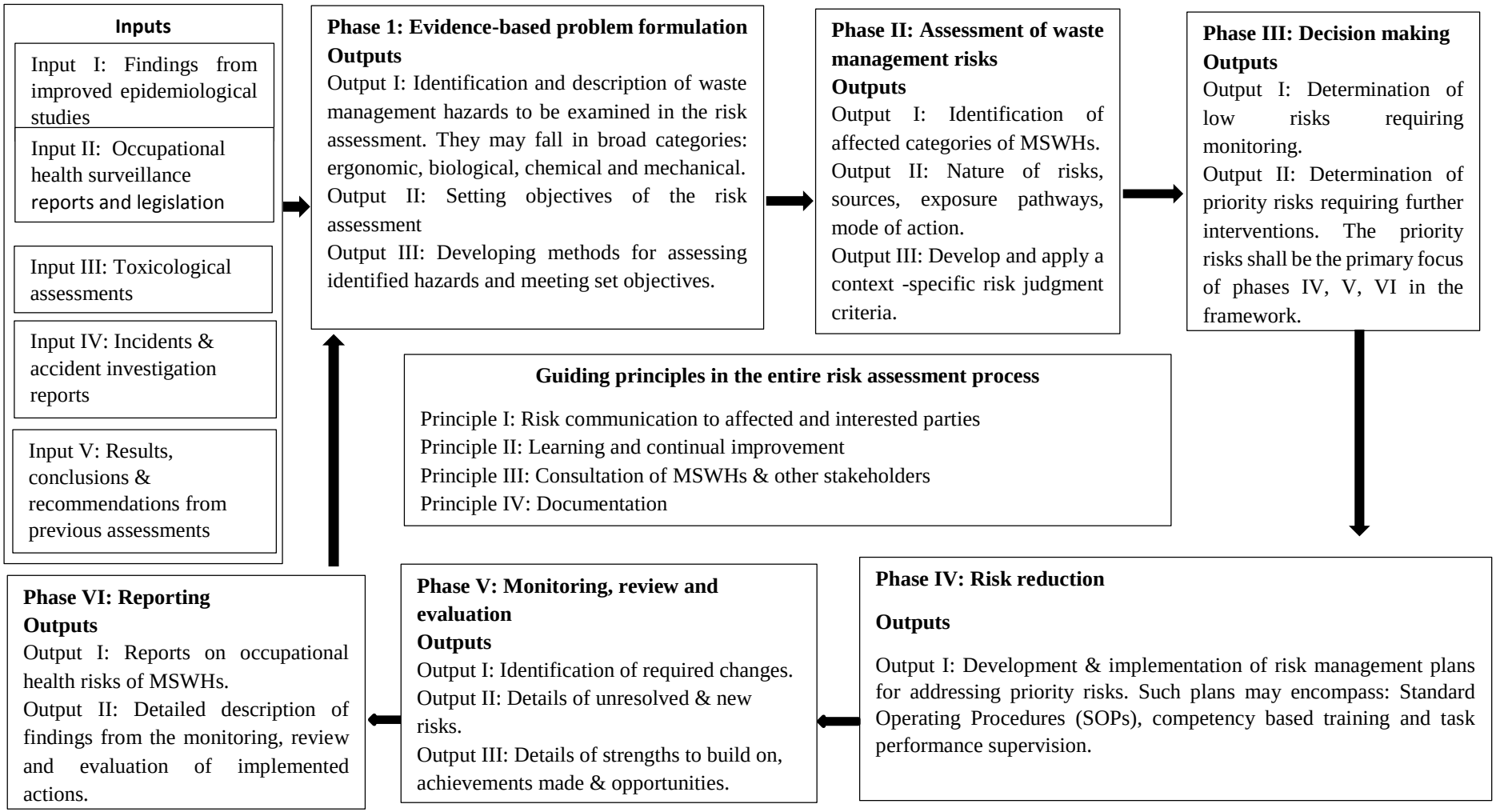

Figure 7.1: Draft framework for assessing occupational health risks of MSWHs.

7.5 Validation process for the developed framework

A multi-step approach was used to validate the developed framework through conducting workshops in large, medium and small local government structures. The purpose of the validation workshops was to test the applicability of the developed framework to the circumstances of different local government structures and improve it guided by their experiences and expertise.

7.6 Setting for framework validation

Validation workshops for the proposed framework were conducted in Zimbabwe, a low income country [24]. The rationale was to develop a framework which could be used by municipalities in countries with similar resource-constrained economies. The study used a local government structure in the form of a municipality, city or town council.

Three different local government structures were used for the validation exercise: Bulawayo City Council, the municipality of Gwanda and of Bindura. Bulawayo City Council was chosen on the basis that it is a large town (second largest in Zimbabwe) with diverse expertise in municipal solid waste management. Gwanda town has a medium sized municipality with few waste management officers but works with the health ministry and local tertiary education colleges, to deliver sound waste management programmes. In this town, participants who took part in the validation exercise were environmental health officers, technicians, health training officers and lecturers from local colleges. Bindura is a small town with three officers in charge of waste management activities: a director and two Environmental Health Technicians. Furthermore, the framework was presented in a Safety and Health at Work (SHAW) conference, which was held in Harare in the period 4-6 October 2017, at Rainbow towers. Figure 7.2 shows the four towns in which the validation of the framework was done. These are: Gwanda, Bulawayo, Harare and Bindura.

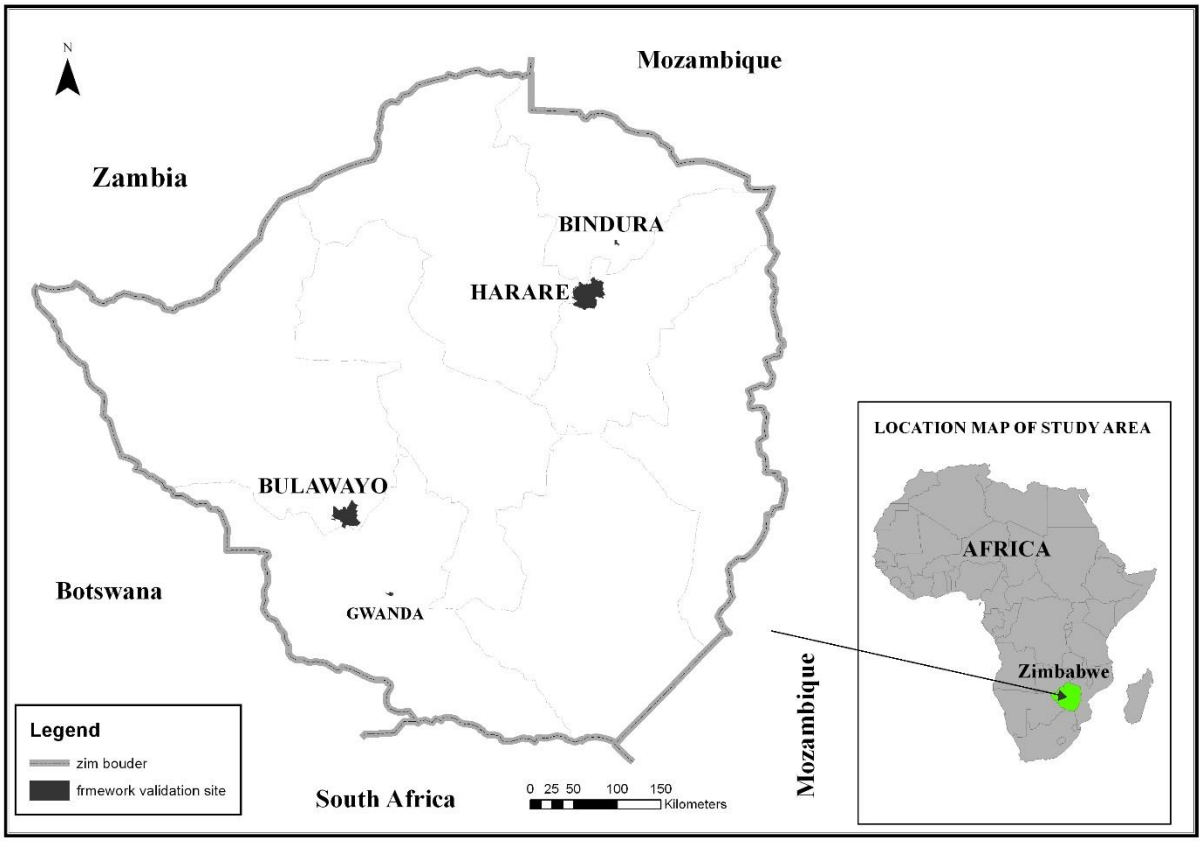

Figure 7.2: Map of Zimbabwe depicting the towns in which the framework was validated

7.7 Stakeholder composition

Attendees of the validation workshop included the Acting Director of Health Services, the Assistant Director of Environmental Health Services, the Deputy Chief Nursing Officer, Environmental Health Officers, Public Health Officers, Health Promotion Officers, Health and Safety Officers, Pest Control Officers, Cleansing Supervisors, Cemeteries and Crematorium Officers and Sanitary Engineers. Such diverse expertise and experiences provided valuable opportunities to learn and improve the proposed framework. The attendees of the safety and health conference were occupational health and safety officers, researchers and policy makers.

7.8 Process for stakeholder input

The proposed framework was presented in the workshops, including description of how it was developed, its purpose, components and principles. Participants were split into groups of 5 - 10 members, given copies of the proposed framework and tasked to determine: (1) if there were any required improvements or changes on each component of the framework, (2) whether there were additional components deserving inclusion and (3) and the suitable conditions for the usage of the framework. In this context suitable conditions meant whether the framework needed to be used as a pre- assessment tool or as an assessment tool or whether it was completely not useable. The groups presented their work and discussions were held.

Group discussions were used to engage participants in critical thinking [22] and provide different interpretations of the given situation, [23] both of which could have contributed to the identification of required framework improvements (Table 7.3).

7.9 Iterations towards proposed framework

The resolutions iterations from the validation workshops were used to improve the draft framework to its current status (Figure. 7.3). Several resolutions were made on the framework in the validation workshops (Table 7.3). Firstly, the draft framework (Figure. 7.1) contained the input, "results from improved epidemiological studies," prior to validating it. However, in the validation workshops, participants felt that such phraseology was less clear and not self-explanatory to waste management practitioners who should understand it without referring to the review article [2]. They recommended replacing it with, "results from methodologically sound epidemiological studies." Since the limitations identified pertained to methodological shortcomings [2], this constructive suggestion was incorporated in the framework and constitutes input 1 (Figure. 7.3).

Secondly, policies and legislation were recommended for inclusion as another input (input II) to the proposed framework. This addition was justified on the basis that requirements, omissions and contraventions of available policies and legislation are a source of information which waste managers can use in phase 1 of the proposed framework. In the workshops, participants operationalised the term legislation to mean applicable local by-laws, national laws and international conventions, protocols and agreements, in the context of the proposed framework.

Thirdly, participants suggested combining two of the initial framework inputs into one. These were “toxicological assessments” and “incident and accident investigations.” These were observed to be qualifying as sub-components of the broader proposed input, “occupational health surveillance." Resultantly, the refined framework contains occupational health surveillance, which is input III. Further, results, conclusions and recommendations from previous assessments were highlighted to a valuable input in subsequent risk assessments. They were stressed as instrumental in identifying needed changes and improvements. Additionally, the workshop participants suggested inclusion of waste characterisation to the list of phase 1’s outputs. They defined waste characterisation as the physical waste compositional analysis and emphasized that the composition of municipal solid waste generated in each town differs in terms of quantities of health-threatening ingredients such as toxic, infectious and mechanical hazards.

Finally, the concept of consultation of workers was reinforced and the principle was broadened to elaborately highlight not only consultation of MSWHs but also managers. The widening of the pool of stakeholders to be consulted, particularly the inclusion of practitioners such as waste managers improves the opportunities to yield valuable input for informing the risk assessment processes. Further, the framework validation workshops culminated in a recommendation to include the development of an organisational occupational safety and health (OSH) policy as phase IV’s output I (Figure. 7.3). Such a policy was understood to be the springboard for uniting MSWHs, waste managers and relevant stakeholders, in efforts towards safety and health promotion.

Table 7.2: Resolutions from framework validation workshops

Participants	No.	Workshop resolutions
Bulawayo City Council - Director of Health Services - Deputy Director Environmental Health - Deputy Director of Nursing Services. - Environmental Health Officers and Technicians - Public Health Officers - Health Promotions Officers - Cleansing Supervisors - Senior Health and Safety officer - Senior Pest control Supervisor - Crematories and crematorium officers - Sanitary engineers - Administration officers	 1 1 1 7 2 2 5 1 1 1 1 4	- The first framework's input, "improved epidemiological studies" was considered to be less direct and was refined to, "methodologically sound epidemiological studies." - The practitioners suggested adding "policy and legislation requirements" to the framework inputs - The term legislation was operationalised to mean applicable local by-laws, national laws and international conventions, protocols and agreements - Also added "waste characterisation" to the list of phase 1outputs. - The framework inputs, "toxicological assessments" and "incident and accident investigations," were combined into the broader term, "Occupational Health Surveillance." - An additional output was added to phase IV: "formulation of occupational health policies." - Principle I revised to read, "Consultation of MSWHs, managers and other stakeholders." Initially, it read, "consultation of MSWHs and other stakeholders. - Framework noted to be suitable as an assessment tool.
Gwanda Municipality - Environmental Health Officers and Technicians - Lecturers and tutors of local colleges - Health Training Officers	 7 2 1	- Psychological hazards were added to possible hazards, in phase 1. - Waste characterisation was added to the list of phase 1's outputs. - Waste characterisation was contextualised to mean the physical waste compositional analysis. - Framework observed to be a crucial assessment tool.
Bindura Municipality - Director of Environmental Health Services - Environmental Health Technicians	 1 1	- The comments were similar to those raised by the personnel from Gwanda Municipality. - Framework was endorsed as an assessment tool, without major changes
Safety and Health Conference Occupational health and safety officers, researchers and policy makers	>200	- The framework endorsed as a useful assessment tool for occupational health risks of MSWHs.

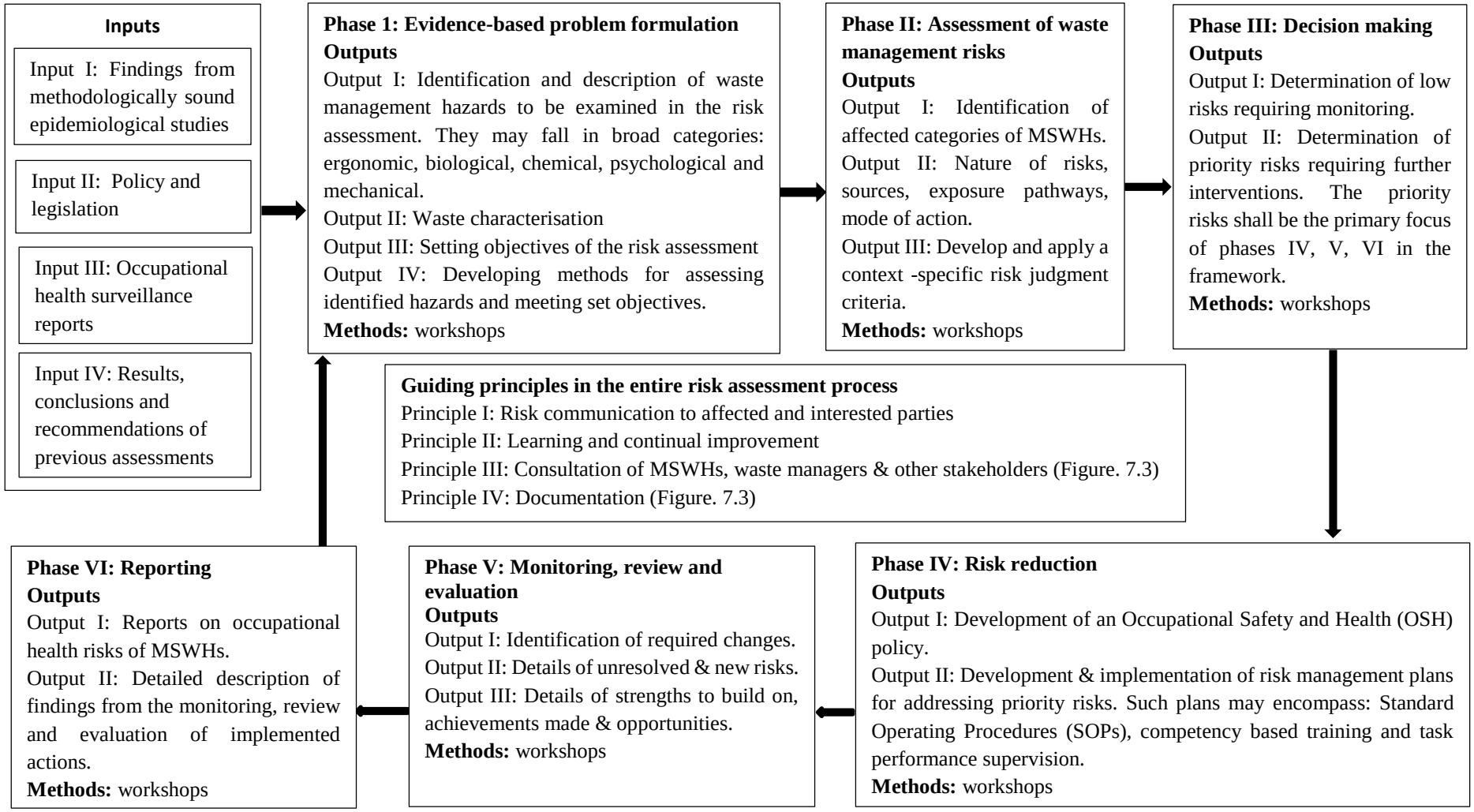

Figure 7.3: Final framework for assessing occupational health risks of MSWHs.

7.10 Description of components of the developed framework.

The structure of the developed framework follows the risk assessment and management decision process. The four inputs (Figure. 7.3) provide crucial evidence for the formulation of waste management problems to be addressed in the risk assessment. The framework's outputs in each phase serve to guide and focus the risk assessment process. Figures 7.3 and 7.4 constitute the final format of the developed framework and should be used together. The framework should be implemented following the chronological order in which the phases are labelled. Thus phase one is the starting point and is informed by the framework inputs. At each phase of the framework there are key envisaged outputs. It is not advisable to proceed to the next phase without meeting all the envisaged outputs of the previous phase.

7.10.1 Phase 1: Evidence-based problem formulation

In phase I, output I's thrust is on the identification and description of waste management hazards to be examined in the risk assessment. In order to achieve this, the sources of information are the framework inputs (Figure. 7.3). Output II focuses on waste characterisation. This involves performing a physical waste compositional analysis to identify the potential hazards associated with each waste stream. Collectively, output I and II culminate in the tabulation of a complete list of hazards deserving consideration in phase II. The list is the basis for setting objectives of the risk assessment (output III) and developing or identifying methods for assessing each hazard (output IV).

7.10.2 Phase II: Assessment of waste management risks

Once phase I has been completed, the specific categories of MSWHs affected by each identified hazard are defined. This may facilitate identification of priority risks for each category. From validation workshops, the main categories of MSWHs were identified as: waste collectors, street and open areas sweepers, drivers, landfill operators, and those who man central waste collection points. Some issues to be addressed at the assessment phase are: what are the sources, exposure pathways mode of action of the identified hazards? Where information is not available it is advisable to make use of data bases such as IRIS and TOXNET.

Since outcomes of the assessment process influence the contents of the risk management plan (Figure. 7.3), precautions must be taken to ensure that results are accurate and reflective of real

situations on the ground. This may require assembling a multi-disciplinary team so that members complement each other's competencies and measures such as field visits to observe and document hazards of waste management operations. One key concern missing in reviewed frameworks was a risk judgement criterion (Table. 7.2). This shortcoming is a key output of the developed framework (Figure. 7.3). A resolution made from the validation workshops was that each local government structure should develop its own risk judgement criteria to address local scenarios. Further, participants recommended that the concerned criteria needs to address the following issues: (1) regardless of the likelihood of occurrence being low or moderate, risks contributing to death, incapacitation and irreversible health damage required inclusion in the priority risk management plan and (2) risks with low, moderate or high probability of occurrence but low severity need to be considered under a routine monitoring plan.

7.10.3 Guiding principles in the developed framework

The proposed framework emphasises adherence to four main principles when assessing waste management risks (Figure. 7.3). Since the principles apply to all phases of the framework, they were placed at a central position rather than under a particular phase.

Principle I "learning and continual improvement" recognises that no local government structure is perfect but opportunities exist for improvement with regard to assessing occupational health risks of MSWHs. Considering findings from the framework inputs in problem formulation (Figure. 7.3) could assist in continual improvement.

Principle II pertains to prompt communication of all identified risks to MSWHs and other stakeholders. Such communication is envisaged to increase workers' awareness of the workplace hazards and appreciation of the importance of the risk management plans highlighted in phase IV (Figure. 7.3). In the developed framework risk communication together with other principles were centrally positioned, in order to show they should be considered in every phase of the framework (Figure. 7.3). Methods of risk communication may include competency based training, feedback meetings, signage and publication of research findings.

Principle III of the framework refers to consultation of MSWHs, managers and other stakeholders. Since MSWHs and their managers' routine work activities entail dealing with waste, consultation might help to fully identify occupational risks and to instil a sense of ownership and positive identification with the proposed framework. The notion of involvement

of workers and management in safety promotion is strongly supported by several past studies [25-27].

Principle IV is on documentation. Identified documents which local government structures may need to keep include standard operating procedures, reports from job safety analysis, safety inspections, epidemiological studies and surveillance. A reference document may foster uniformity, consistency, continual improvement and ultimately perfection in the performance of waste management tasks. The framework contains a stakeholder consultation and documentation guideline (Figure. 7.4). The guideline describes the approach and content of stakeholder consultation and documentation of input. The purpose of the guidelines is to improve on the management of information generated from stakeholder consultations and other phases of the framework. It highlights the need to record both accepted consensus discussion points during stakeholder consultations and rejected input together with reasons for no-consideration. Figure 7.4 also depicts the approximate time required to perform each step. However, the timeframe is merely a guide and is subject adjustment to suit local circumstances.

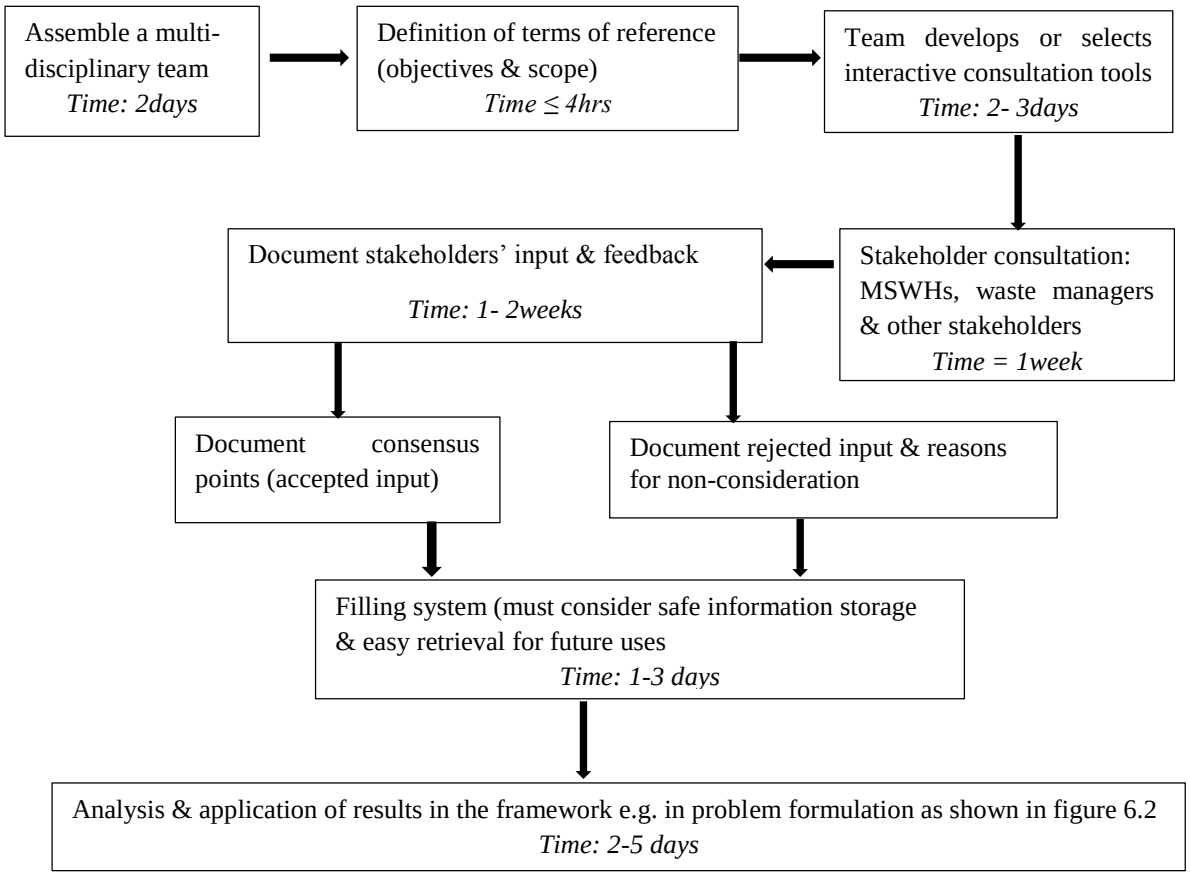

Figure. 7.4: Stakeholder consultation and documentation guideline

7.10.4 Phase III: Decision making

In the developed framework, the assessment of risks encountered by MSWHs culminates in decision making. Decision making in this context means making judgement on which risks are priority risks requiring further interventions and the low risks requiring continuous monitoring. The priority risks shall be the primary focus of phases IV, V and VI in the framework. A checklist with scores maybe used in decision making. For example, postural risks at the upper limbs when lifting, carrying and emptying a refuse bin can be assessed using the Rapid Upper Limb Assessment Methodology (McAtamney and Corlett, 1993; Mukhopadhyay & Khan, 2015).The cumulative risk scores show the level of the postural risk associated with the work practices when performing the task and the required action. For example: 1- 2 depict a negligible risk, 3 - 4 low risk meaning changing may be required, and 5 - 6 medium risk requiring corrective changes, above 6 risk is unsafe and changes are required urgently. The process of quantification of the risk associated with each risk should consider the applicable legislative requirements, standards and guidelines.

7.10.5 Phase IV: Risk reduction

Output 1 pertains to the development of an organisational OSH policy as phase IV's output I (Figure. 7.3). The policy is envisaged to unite MSWHs, waste managers and relevant stakeholders in efforts towards safety and health promotion. Thus, it should detail the organisational vision, mission, values and aims. Output II emphasizes the need to develop and implement a risk management plan on the identified priority risks. The plan may encompass standard operating procedures, competency based training and task performance supervision (Figure. 7.3). During implementation there is need to collect data or feedback on the applicability of selected interventions and areas for further improvement.

7.10.6 Phase V: Monitoring, review and decision making

The focus of this phase is on coming-up with a monitoring frequency, requirements and methods for each hazard in the priority risk management plan. Some hazards to be monitored include bioaerosols, noise, heat and working postures. This framework does not attempt to prescribe a fit all frequency of monitoring but encourages responsible authorities to: (i) determine a workable monitoring frequency and (ii) affordable and reliable tools to monitor each hazard contained in priority risk management plan. Where available it may be helpful to prioritise using validated standard techniques. As an incentive to adoption and usage of the

framework, the author is willing to provide further guidance and training in relation to its implementation. Also, the framework will be published to communicate it to the wider scientific community.

In the framework, phase v has three outputs. Output I stresses the need to identify required changes. The changes may relate to the process and methods used in the risk assessment or existing plans to address waste management risks. The idea behind identifying required changes is to learn from the shortcomings and further improve in line with principle II (Figure. 7.3). New and unresolved risks need to be documented for further consideration (output II). Achievements made and limitations encountered should be recorded (output III), in order to show the nature of improvements made.

7.10.7 Phase VI: Reporting

Phase VI focuses on reporting. The framework places the responsibility of reporting the outcomes of the risk assessment on waste managers. The reports on occupational health surveillance, vehicle safety inspections, epidemiological studies and job safety analysis should be compiled, reported to relevant authorities and properly filed. Reports may yield valuable information not just for review but problem formulation (Figure. 7.3).

7.11 Conclusions

This study has benefited from the contributions of the varied pool of expertise who participated in the framework validation workshops. The applicability of the framework to situations of resource-constrained economies has been tested through validation workshops in small, medium and large local government structures of a low income country. The framework was revised and refined based on the validation outcomes. In light of the multi-methods used in developing the framework and the input of practitioners in validation workshops, the framework appears relevant for the purposes of assessing occupational health risks of MSWHs. Its emphasis is on evidence-based problem formulation, defined outputs per each risk assessment phase and is hinged on four principles: i) risk communication, ii) consultation of MSWHs, waste managers and other stakeholders, iii) learning and continual improvement and iv) documentation. The developed framework fills the existing gap of lack of a framework for use by local government structures in assessing occupational health risks of MSWHs.

7.12 References

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CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

The chapter provides the thesis' general conclusions and recommendations. These were derived from the thesis' investigations.

8.2 General conclusions

In this thesis, the author sought to develop a generic framework for assessing occupational health risks of municipal solid waste handlers (MSWHs). The framework has been developed, validated, revised, refined and submitted for examination. Conclusively, the aim of this thesis has been attained.

To accomplish the aim of the study, objectives were formulated. Objective 1 sought to systematically review epidemiological literature on public health concerns of municipal solid waste handling. The objective was fully accomplished. A publication in a referred, peer reviewed and scientific public health journal was produced as a research output and means of disseminating the study findings to the wider scientific community. The review concluded that evidence provided by the current body of epidemiological literature was inadequate to demonstrate causal or non-causal relationships between municipal solid waste management and adverse health endpoints due to methodological limitations. Basing on these conclusions, the proposed framework substantially emphasizes the need for local government structures' waste managers to engage in methodologically sound investigations and use findings from methodological sound studies in the risk assessment process.

The thesis' objective 2 sought to determine the work related hazards of MSWHs. The core findings from this objective are that MSWHs are exposed to biological, chemical and physical hazards that may jeopardise their personal health. A publication in an open access, scientific and referred public health journal was made so as to widely communicate the findings to the entire community of waste workers, managers, policy makers and the scientific community. A conference presentation was made in a public health forum in East London, South Africa, in the period 19-22 September 2016. More importantly, taken together, findings from this objective partly constitute phase 1 of the proposed framework, in particular output one. The output details the categories of waste management hazards to be addressed in the risk assessment process. In light of the findings and efforts made to disseminate them, the author is convinced that this second thesis' objective has been achieved and chapter 4 fully details the findings on this objective.

Furthermore, this thesis' objective 3 investigated the risky jobs actions of MSWHs. The study showed that MSWHs use unsafe working postures at the upper limbs when performing waste collection tasks. Consequently, output 1 under the framework's phase 1 stresses the need to examine ergonomic risks of waste collection services. A publication on this objective was made in an open access health science journal. Chapter 5 of the current thesis details the nature of unsafe work postures employed by MSWHs and required intervention measures. Therefore, the third objective of the current thesis has been attained.

Finally, objectives 4-7 of the current thesis, sought to develop, validate, refine, and compile a framework for assessing occupational health risks of MSWHs. The framework has been developed and validated in small, medium and large local government structures. Expert contributions have been incorporated into the framework resulting in its refinement and revision. In particular, validation outcomes entailed addition of new components, removal of less relevant ones, renaming some inputs and retaining some components. Conclusively, objectives 4-7 have been successful accomplished.

8.3 Recommendations

This section details the recommendations drawn the information gathered in the investigations conducted in line with the thesis' objectives. The author proposes how local government structures and relevant stakeholders can utilise framework. Future research needs are also provided.

8.3.1 Dissemination of the framework

A multi-methods approach was utilised to produce and validate the framework for assessing occupational health risks of municipal solid waste handlers. A systematic review of available epidemiological studies was done and published in a referred journal. Field investigations based on thesis objectives were done and results communicated to the wider scientific community through publications. Peer-reviewer's comments during the manuscripts review process enriched the articles. The framework was validated though conduction of workshops with its intended users in large, medium and small local government structures. In light of these crucial steps observed in developing the framework and validating the framework, the author proposes disseminating it to a wider community of local government structures, policy makers and researchers through:

8. 3.1.1 Framework publication

Publication of the framework is an essential step towards communicating the framework's aims, components and principles to local government structures charged with the responsibilities for safeguarding municipal solid waste handlers' occupational health.

8.3.1.2 Conference presentations

Conference presentations were done in the period 19-22 September 2016 in the Public Health Practitioners Association Conference held in East London, South Africa. Findings on the thesis' objectives 1 and 2 were presented and peer-reviewed. Also, the validated framework was presented in the Safety and Health Conference held at Rainbow Towers in the period 4-6 October 2017, Harare, Zimbabwe. Further presentations of the validated framework in international conferences are required in order to: i) further disseminate it to the wider scientific community and ii) improve it guided by the varied expert input. Equally important, findings on the thesis' objective 3 need to be shared through conference presentations. The conference presentations shall seek to convince the scientific community that municipal solid waste workers are at risk from various work related hazards that require a sound framework for assessing them.

8.3.1.3 Framework utilisation by local government structures

To the best of the author's knowledge, no framework has to date been developed for assessing occupational risks of municipal solid waste handlers. Results from the validation of the framework demonstrated that the framework is suitable as an assessment tool for identifying, prioritising and managing risks for waste workers. The thesis recommends unrestricted application of the framework for such purposes provided the author's original work is correctly acknowledged. Organisations interested in utilising this framework can benefit from the following incentives: i) supportive guidance from the author in relation its use, ii) sharing of experiences and lessons on how to further improve it, iii) scheduled training and refresher courses on the framework. Targeted consumers of the framework entail local government structures such as city councils, town councils, municipalities and rural district councils, charged with municipal solid waste management responsibilities. Other potential beneficiaries of the framework include health ministries' environmental health departments who manage various waste streams generated in health institutions. The author would be glad to receive feedback in terms of experiences, lessons and suggestions for further improvement of the framework.

8.3.2 Recommendations on future research needs

In line with findings and conclusions drawn from the studies conducted in the current thesis, the following recommendations were made:

8.3.2.1 Methodologically sound studies

The thesis' objective 1 sought to review epidemiological literature on human health risks from waste management activities. Results from the review demonstrated that the major challenge with regard to tackling causality issues for epidemiological studies on waste management were on methodological limitations. Consequently, future research in the field should utilise sound research designs in form of:

- Longitudinal rather than cross-sectional studies
- Using larger sample sizes
- Enrolling reference groups of comparable size to the study group
- Minimising confounders

8.3.2.2 Surface sampling of waste workers' hands and nails

The second objective of the thesis was to determine the nature of hazards found in the working environment of waste handlers and associated adverse health endpoints. The manuscript on this objective details several measurements of hazards in the work environment of municipal solid waste workers. Unfortunately this paper did not examine risks to workers through the ingestion route and this is detailed in the limitations of the study. Therefore further work is required with regard to conduction of surface sampling of waste handlers' nails and palms for Escherichia coli and faecal coliform indicators after hand washing.

Appendix 1: University of Pretoria, Faculty of Health Sciences Ethics Certificate

The Research Ethics Committee, Faculty Health Sciences, University of Pretoria complies with ICH-GCP guidelines and has US Federal wide Assurance.
- FWA 00002567, Approved dd 22 May 2002 and Expires 20 Oct 2016.
- IRB 0000 2235 IORG0001762 Approved dd 22/04/2014 and Expires 22/04/2017.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Health Sciences Research Ethics Committee

14/11/2014

Approval Certificate
New Application

Ethics Reference No.: 243/2014

Title: FRAMEWORK FOR ASSESSING OCCUPATIONAL HEALTH RISKS OF MUNICIPAL SOLID WASTE HANDLERS FOR USE BY LOCAL GOVERNMENT STRUCTURES

Dear France Ncube

The **New Application** as supported by documents specified in your cover letter for your research received on the 23/06/2014, was approved by the Faculty of Health Sciences Research Ethics Committee on the 14/11/2014.

Please note the following about your ethics approval:
- Ethics Approval is valid for 3 years.
- Please remember to use your protocol number (**243/2014**) on any documents or correspondence with the Research Ethics Committee regarding your research.
- Please note that the Research Ethics Committee may ask further questions, seek additional information, require further modification, or monitor the conduct of your research.

Ethics approval is subject to the following:
- The ethics approval is conditional on the receipt of 6 monthly written Progress Reports, and
- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.

We wish you the best with your research.

Yours sincerely

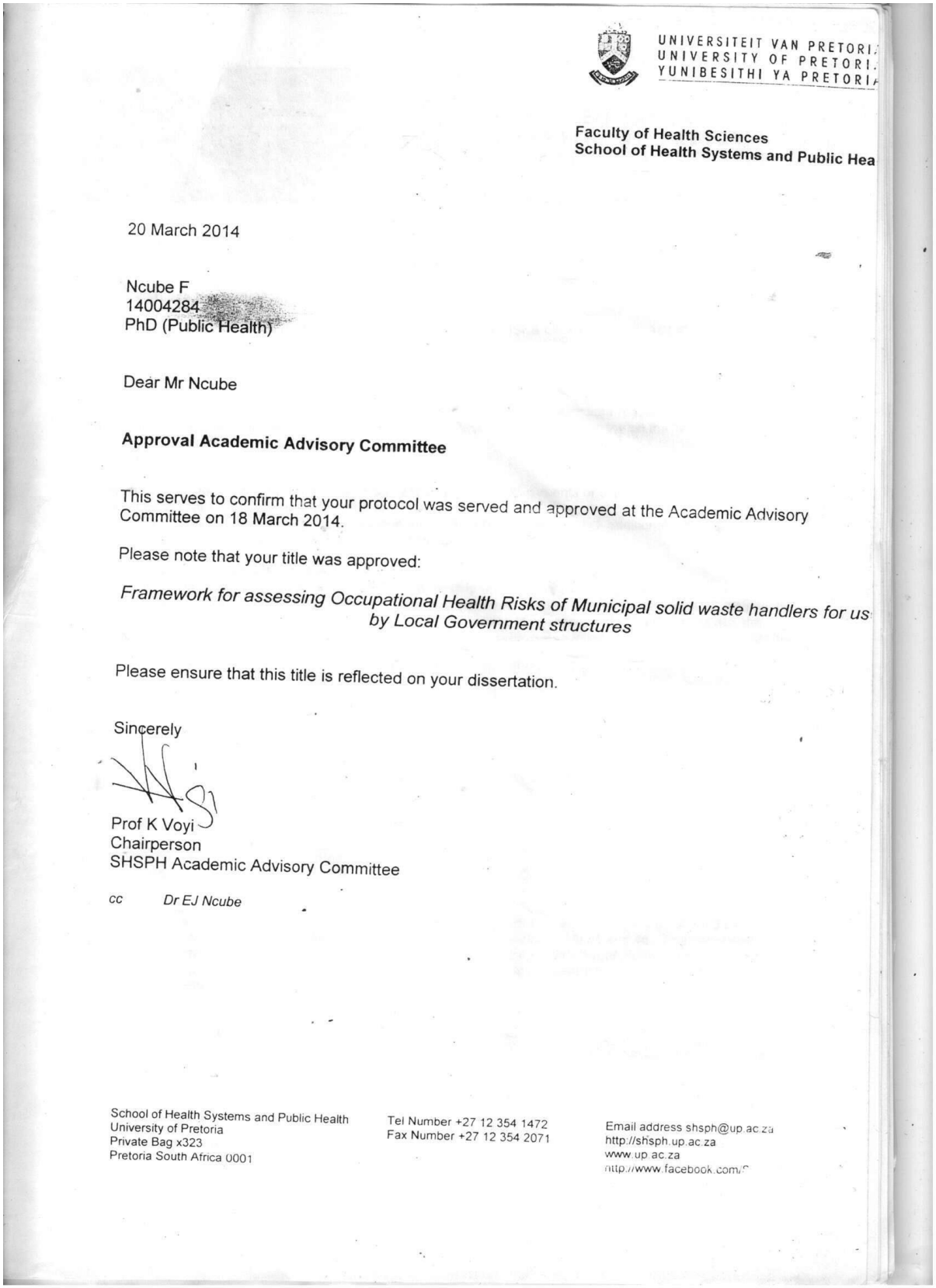
*** Kindly collect your original signed approval certificate from our offices, Faculty of Health Sciences, Research Ethics Committee, H W Snyman South Building, Room 2.33 / 2.34.*

Dr R Sommers; MBChB; MMed (Int); MPharMed.
Deputy Chairperson of the Faculty of Health Sciences Research Ethics Committee, University of Pretoria

The Faculty of Health Sciences Research Ethics Committee complies with the SA National Act 61 of 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 and 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

☎ 012 354 1677 🖷 0866516047 deepeka.behari@up.ac.za http://www.healthethics-up.co.za
✉ Private Bag X323, Arcadia, 0007 - 31 Bophelo Road, HW Snyman South Building, Level 2, Room 2.33, Gezina, Pretoria

Appendix 2: Academic Advisory Board Approval Letter



UNIVERSITEIT VAN PRETORI
UNIVERSITY OF PRETORI
YUNIBESITHI YA PRETORI

Faculty of Health Sciences
School of Health Systems and Public Hea

20 March 2014

Ncube F
14004284
PhD (Public Health)

Dear Mr Ncube

Approval Academic Advisory Committee

This serves to confirm that your protocol was served and approved at the Academic Advisory Committee on 18 March 2014.

Please note that your title was approved:

Framework for assessing Occupational Health Risks of Municipal solid waste handlers for us by Local Government structures

Please ensure that this title is reflected on your dissertation.

Sincerely

Prof K Voyi
Chairperson
SHSPH Academic Advisory Committee

cc *Dr EJ Ncube*

School of Health Systems and Public Health
University of Pretoria
Private Bag x323
Pretoria South Africa 0001

Tel Number +27 12 354 1472
Fax Number +27 12 354 2071

Email address shsph@up.ac.za
http://shsph.up.ac.za
www.up.ac.za
http://www.facebook.com/

Appendix 3: Biostatistician Clearance Letter

Date: / /20

LETTER OF CLEARANCE FROM THE BIOSTATISTICIAN

This letter is to confirm that the student(s),

with the Name(s) FRANCE NCUBE

Studying at the University of PRETORIA

discussed the Project with the title FRAMEWORK FOR ASSESSING OCCUPATIONAL HEALTH RISKS OF MUNICIPAL SOLID WASTE HANDLERS with me.

I hereby confirm that I am aware of the project and also undertake to assist with the Statistical analysis of the data generated from the project.

The analytical tool that will be used will be STATA VERSION 12. SHAPIRO-WILK TEST NORMALITY TESTING OF THE MEAN RULA SCORES OF MSWHs and REFERENCE GROUP. MANN-WHITNEY TEST IF DATA NOT NORMAL.
to achieve the objective(s) of the study.

Name LN DZIKITI Date 18-06-14

Signature [signature] Tel: 012 354 1179

Department or Unit SHSPH

Official Stamp of Biostatistician

Appendix 4: Beitbridge Town Council Research Approval Letter

Permission to do Research and access Records / Files / Data base at the Beitbridge Town Council

To: Town Secretary **From:** The Investigator: France Ncube

Re: Permission to do the following research at Beitbridge Town Council

I France Ncube , a student at the School of Health Systems and Public Health and my supervisors are Professor Kuku Voyi and Dr Esper J. Ncube of the School of Health Systems and Public Health. I am requesting permission on behalf of all of us to conduct a study on the Beitbridge Town Council Municipal solid waste processes that involves administering questionnaires to your workers.

The title of the study is: Framework for assessing occupational health risks of municipal solid waste handlers

We intend to publish the findings of the study in a professional journal and/ or at professional meeting like symposia, congresses, or other meetings of such a nature.

We furthermore request in terms of the requirements of the Promotion of Access to Information Act. No. 2 of 2000 that we be granted access to clinical records, files and databases.

We undertake not to proceed with the study until we have received approval from the Faculty of Health Sciences Research Ethics Committee, University of Pretoria.

Yours sincerely

Signature of the Principal Investigator

Permission to do the research study at this Town Council and to access the information as requested is hereby approved.

Town Secretary

Dr/Mr/Mrs/Ms M. Muleya

Signature of the Town Secretary

BEITBRIDGE TOWN COUNCIL
2014 -05- 12
Official Stamp
THE TOWN SECRETARY
P.O. BOX 164 BEITBRIDGE
TEL:086 23728/23793

Appendix 5: Proof of Article Publication (Perspectives in Public Health Journal)

PEER REVIEW

A systematic critical review of epidemiological studies on public health concerns of municipal solid waste handling

Authors

France Ncube
University of Pretoria, Private Bag 323, Pretoria 0007, South Africa
Email: france.ncube2579@gmail.com

Esper Jacobeth Ncube
University of Pretoria, Pretoria, South Africa

Kuku Voyi
University of Pretoria, Pretoria, South Africa

Corresponding author:
France Ncube, as above

Keywords
municipal solid waste; epidemiological studies; risk

Abstract

Aims: The ultimate aim of this review was to summarise the epidemiological evidence on the association between municipal solid waste management operations and health risks to populations residing near landfills and incinerators, waste workers and recyclers. To accomplish this, the sub-aims of this review article were to (1) examine the health risks posed by municipal solid waste management activities, (2) determine the strengths and gaps of available literature on health risks from municipal waste management operations and (3) suggest possible research needs for future studies.

Methods: The article reviewed epidemiological literature on public health concerns of municipal solid waste handling published in the period 1995–2014. The PubMed and MEDLINE computerised literature searches were employed to identify the relevant papers using the keywords solid waste, waste management, health risks, recycling, landfills and incinerators. Additionally, all references of potential papers were examined to determine more articles that met the inclusion criteria.

Results: A total of 379 papers were identified, but after intensive screening only 72 met the inclusion criteria and were reviewed. Of these studies, 33 were on adverse health effects in communities living near waste dumpsites or incinerators, 24 on municipal solid waste workers and 15 on informal waste recyclers. Reviewed studies were unable to demonstrate a causal or non-causal relationship due to various limitations.

Conclusion: In light of the above findings, our review concludes that overall epidemiological evidence in reviewed articles is inadequate mainly due to methodological limitations and future research needs to develop tools capable of demonstrating causal or non-causal relationships between specific waste management operations and adverse health endpoints.

INTRODUCTION

Several epidemiological studies conducted in both developed and developing countries have suggested that municipal solid waste management is a risky and life-threatening activity for populations residing near landfills and waste incinerators, for municipal waste workers and for informal waste recyclers.

A central theme in literature reviewed in this article is that the major health problems of populations residing near landfills and incinerators are cancer, low birth weight, congenital anomalies and Down's syndrome and for municipal waste workers and recyclers the health problems are musculoskeletal disorders, injuries, respiratory, gastro-intestinal and skin conditions. Unfortunately, these epidemiological studies have essentially neglected several critical aspects on the human health risks of municipal solid waste handling.

Noteworthy, all the studies reviewed in this article on cancer risks on populations residing near landfill sites or former sites merely suggest either elevated or no risk, but none has conclusively identified a causal or non-causal relationship between cancers and landfills for such populations.

Equally important, a major limitation of some studies on cancer, low birth weight and congenital anomalies in populations near municipal landfills is

ISSN 1757-9139 DOI: 10.1177/1757913916639077

Appendix 6: Proof of Article Publication (Journal of Environmental and Public Health)

Hindawi
Journal of Environmental and Public Health
Volume 2017, Article ID 3081638, 8 pages
https://doi.org/10.1155/2017/3081638

Research Article

Bioaerosols, Noise, and Ultraviolet Radiation Exposures for Municipal Solid Waste Handlers

France Ncube, Esper Jacobeth Ncube, and Kuku Voyi

School of Health Systems and Public Health (SHSPH), Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa

Correspondence should be addressed to France Ncube; france.ncube257@gmail.com

Received 5 October 2016; Accepted 25 December 2016; Published 12 January 2017

Academic Editor: Evelyn O. Talbott

Few studies have investigated the occupational hazards of municipal solid waste workers, particularly in developing countries. Resultantly these workers are currently exposed to unknown and unabated occupational hazards that may endanger their health. We determined municipal solid waste workers' work related hazards and associated adverse health endpoints. A multifaceted approach was utilised comprising bioaerosols sampling, occupational noise, thermal conditions measurement, and field based waste compositional analysis. Results from our current study showed highest exposure concentrations for Gram-negative bacteria (6.8×10^3 cfu/m^3) and fungi (12.8×10^3 cfu/m^3), in the truck cabins. Significant proportions of toxic, infectious, and surgical waste

Appendix 7: Proof of Article Publication (Global Journal of Health Science)

Global Journal of Health Science; Vol. 9, No. 10; 2017
ISSN 1916-9736 E-ISSN 1916-9744
Published by Canadian Center of Science and Education

Postural Analysis of a Developing Country's Municipal Solid Waste Handlers and a Reference Group of Hospital General Hands using the RULA Method

France Ncube[1], Esper J. Ncube[1] & Kuku Voyi[1]

[1]School of Health Systems and Public Health, Faculty of Health Sciences, University of Pretoria, South Africa

Correspondence: France Ncube, School of Health Systems and Public Health, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa. Tel: 277-81-321-247. E-mail: france.ncube257@gmail.com

Received: August 12, 2017 Accepted: September 12, 2017 Online Published: September 18, 2017

doi:10.5539/gjhs.v9n10p194 URL: https://doi.org/10.5539/gjhs.v9n10p194

Abstract

Background: Municipal solid waste handlers perform various work activities which may contribute to the onset of work-related musculoskeletal disorders (WRMDs). This study conducted a postural analysis of these workers and a reference group of hospital general hands in order to identify unsafe working postures requiring correction.

Methods: The Rapid Upper Limb Assessment (RULA) methodology was used for postural analysis to 30 municipal solid waste handlers (MSWHs) and a reference group of 30 hospital general hands (HGHs) involved in similar work activities. Field observations and photography were used to collect data. Collected data was analysed using STATA version 13.

Results: The Mann-Whitney test was used to compare the two groups. Results showed significant differences ($p < 0.05$) for lifting, carrying and emptying activities. For both groups, the mean postural scores for pushing, pulling and standing activities were mainly in the low risk category and not statistically significant ($p > 0.05$).

Appendix 8: Proof of Manuscript Submission (Global Journal of Health Science)

Erica Grey <gjhs@ccsenet.org> Oct 14 (9 days ago)

to me

Dear Mr France Ncube:

Thank you for submitting the manuscript, "Validation of the Framework for Assessing Occupational Health Risks of Municipal Solid Waste Handlers" to Global Journal of Health Science. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

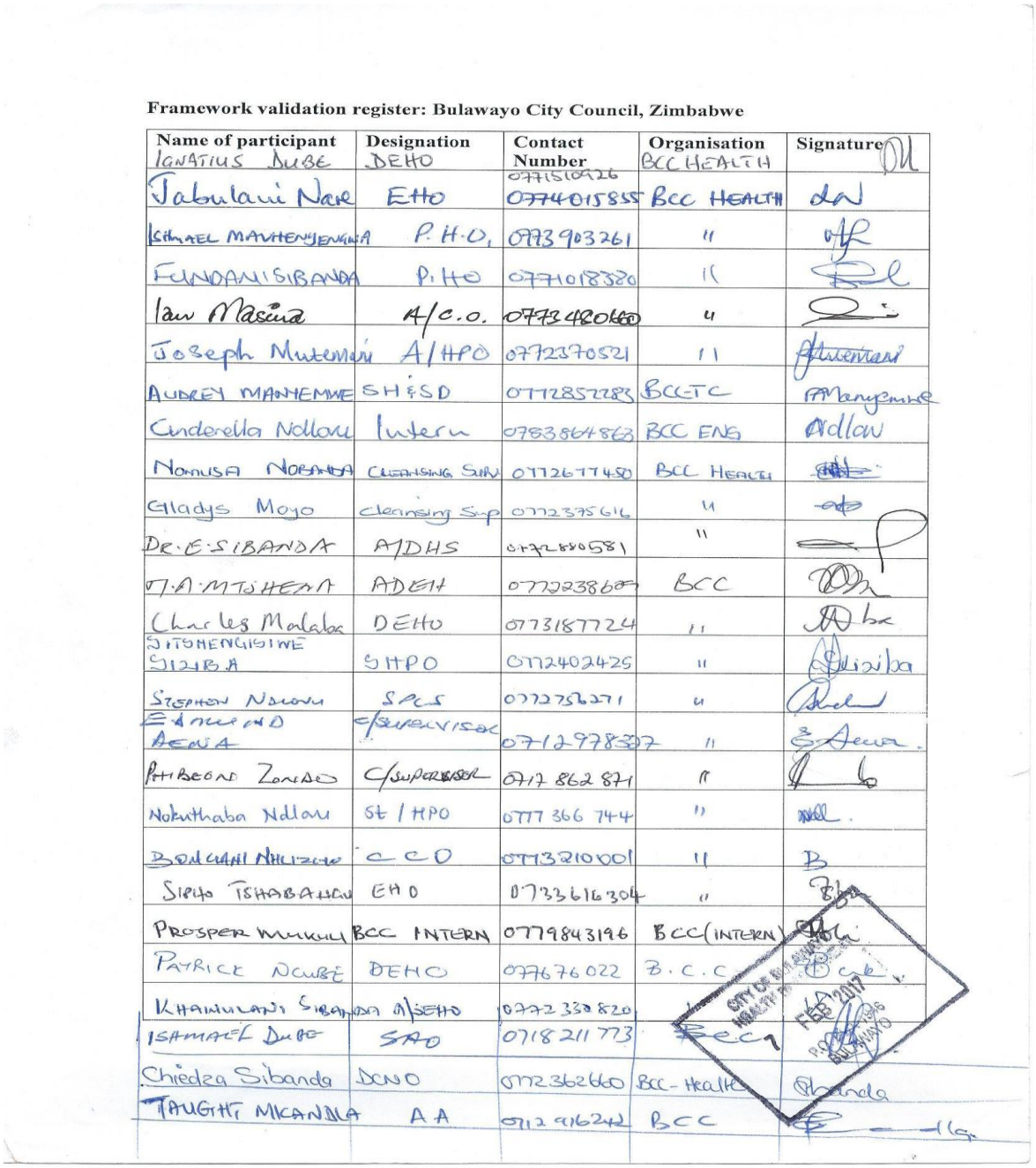
Manuscript URL:
http://www.ccsenet.org/journal/index.php/gjhs/author/submission/71178
Username: ncube

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.
Best Regards,

Erica Grey
Editorial Assistant, Global Journal of Health Science
Canadian Center of Science and Education

Add: 1120 Finch Avenue West, Suite 701-309, Toronto, ON., M3J 3H7, Canada
Tel: 1-416-642-2606 ext.217
Fax: 1-416-642-2608
E-mail: gjhs@ccsenet.org
Website: http://gjhs.ccsenet.org

Appendix 9: City and Town Councils Framework Validation Workshop Registers



Framework validation register: Bulawayo City Council, Zimbabwe

Name of participant	Designation	Contact Number	Organisation	Signature
IGNATIUS DUBE	DEHO	0771510926	BCC HEALTH	
Tabulani Nare	EHO	0774015855	BCC HEALTH	
ISHMAEL MAVHENYENGWA	P.H.O,	0773903261	"	
FUNDANI SIBANDA	P.HO	0771018380	"	
Ian Masuna	A/C.O.	0773480660	"	
Joseph Mutemeri	A/HPO	0772370521	"	
AUDREY MANHEMWE	SH&SD	0772857283	BCC-TC	
Cinderella Ndlovu	Intern	0783564863	BCC ENG	
NOMUSA NDABANA	CLEANSING SUP	0772677450	BCC HEALTH	
Gladys Moyo	cleansing Sup	0772375616	"	
DR. E. SIBANDA	A/DHS	0772880581	"	
M.A. MTSHENA	ADEH	0772238607	BCC	
Charles Malaba	DEHO	0773187724	"	
SITSHENGISIWE SIBANDA	SHPO	0772402425	"	
STEPHEN NSIONI	SAS	0772756271	"	
EMMANUEL AENIA	C/SUPERVISOR	0712778307	"	
PHIBEON ZONDO	C/SUPERVISOR	0717 862 871	"	
Nokuthaba Ndlovu	St / HPO	0777 366 744	"	
BONGANI NHLIZIYO	C C O	0773210001	"	
SIPHO TSHABALALA	EH O	0733616304	"	
PROSPER MUKUKU	BCC INTERN	0779843196	BCC(INTERN)	
PATRICK NCUBE	DEHO	0776 76 022	B.C.C	
KHANYISANI SIBANDA	A/SEHO	0772 338 820		
ISHMAEL DUBE	SAO	0718 211 773	BCC	
Chiedza Sibanda	DCNO	0772 362 660	BCC-Health	
TAUGHT MKANDLA	A A	0712 916242	BCC	

Framework validation register: Bulawayo City Council, Zimbabwe

Name of participant	Designation	Contact Number	Organisation	Signature
N. NDLOVU	ACTING CLEANSING SUPERINTENDENT	0772347637	BCC HEALTH	
N.P. TSHUMA	EHT	0772742925	BCC	
S. Sibanda	A/DEHO	0773[illegible]	BCC	Sibanda.

CITY OF BULAWAYO
HEALTH DEPARTMENT
7 FEB 2017
P.O. BOX 1946
BULAWAYO

Gmail

Priscillar Nkala <gwandatownclerk@gmail.com>

VALIDATION OF OUR PROPOSED FRAMEWORK FOR ASSESSING OCCUPATIONAL HEALTH RISKS OF MUNICIPAL SOLID WASTE HANDLERS

2 messages

Town Clerk Gwanda <gwandatownclerk@gmail.com> 30 January 2017 at 16:19
To: france.ncube257@gmail.com

Reference is made to your letter dated 19th January 2017 on the above subject.

Please be informed that your request has been granted.

Thank you.

MUNICIPALITY OF GWANDA
TOWN CLERK'S OFFICE
30 JAN 2017
P.O. BOX 70, GWANDA
TEL.: 0284-22206/22240

P. NKALA
TOWN CLERK

Town Clerk Gwanda <gwandatownclerk@gmail.com> 30 January 2017 at 16:23
To: Valerie Mbulawa <mbulawavie@gmail.com>

[Quoted text hidden]

Framework validation register: Gwanda Town, Zimbabwe

Name of participant	Designation	Contact Number	Organisation	Signature
M. NGWENYA	LECTURER	0772392417	JMN POLY	
B. MASVAURE	EHO	0779012456	ENVIRONMENTAL HEALTH	
V. NGULUBE	EHO	0712540258	MOHCC	
N.T. KHUMALO	EH O	0773374159	MOHCC	
K DUBE	EHT	0715032564	MUNICIPALITY OF GWANDA	
M.W. MPOFU	EHO	0772778860	MOHCC	
M. SIWANA	EH	0776110024	MUNICIPALITY OF GWANDA	
R. Moyo	PEHT	0772557613	MOHCC	
M. Maphosa	E HO	0772942980	MOHCC	
T. KWASIMPA	RHT.	0776229462	ENVIRONMENTAL HEALTH.	
T. Tshuma	E.H. Tutor	0786683483	JMN Poly	
L. Ndlovu	DEHO	0772939536	MOHCC	
C. NCUBE	H.T.O	0772289802	GWANDA MULTI DISCIPLINARY SCHOOL	

ENVIRONMENTAL HEALTH
MUNICIPALITY OF GWANDA
2017 -02- 10
BOX 70, GWANDA
TEL: 0284 - 22040/22080

Framework validation register: Bindura Municipailty, Zimbabwe

Name of participant	Designation	Contact Number	Organisation	Signature
DZAPASI JACK	E.H.T	0772970889	BINDURA MUNICIPALITY	
CHINOWAITA KELTON	DHES	0772367436	BINDURA MUNICIPALITY	

MUNICIPALITY OF BINDURA
DIRECTOR OF HEALTH & ENV. SERVICES
10 MAR 2017
P.O. BOX 15 BINDURA
TEL: 0271-7391-4
FAX: 0271-6986

Appendix 10: Waste Compositional Analysis Form

Waste Category	DATE		DATE		DATE		DAE		DATE		SUMMARY			
	No of bins		No of bins		No of bins		No of bins		No of bins		No of bins			
	Total weight		Total weight		Total weight		Total weight		Total weight		Total weight			
	Total volume		Total volume		Total volume		Total volume		Total volume		Total volume			
	Vol	Wt	Vol	Wt	Vol	Wt	Vol	Wt	Vol	Wt	Vol	Wt	Vol %	Wt %
Food waste														
Paper														
Plastics														
Glass														
Toxic waste														
Potentially infectious waste														
Rubber														
Metal containers														
Other wastes														

Appendix 11: Waste Managers' Questionnaire

Researcher's Name: France Ncube

Student Number: 14004284

Department of: SCHOOL OF HEALTH SYSTEMS AND PUBLIC HEALTH

University of Pretoria

Dear Participant

(FRAMEWORK FOR ASSESSING OCCUPATIONAL HEALTH RISKS OF MUNICIPAL SOLID WASTE HANDLERS FOR USE BY LOCAL GOVERNMENT STRUCTURES)

I am a **PHD** student in **Public Health** in the SCHOOL of HEALTH SYSTEMS AND PUBLIC HEALTH University of Pretoria. You are invited to volunteer to participate in our research project on **FRAMEWORK FOR ASSESSING OCCUPATIONAL HEALTH RISKS OF MUNICPAL SOLID WASTE HANDLERS FOR USE BY LOCAL GOVERNMENT STRUCTRES.**

This letter gives information to help you to decide if you want to take part in this study. Before you agree you should fully understand what is involved. If you do not understand the information or have any other questions, do not hesitate to ask us. You should not agree to take part unless you are completely happy about what we expect of you.

The purpose of the study is to develop a generic framework for assessing occupational health risks of municipal solid waste handlers

We would like you to complete a questionnaire. This may take about **45** minutes. France Ncube will collect the questionnaire from you at your work station. It will be kept in a safe place to ensure confidentiality. Please do not write your name on the questionnaire. This will ensure confidentiality. France Ncube will be available to help you with the questionnaire or to fill it in on your behalf.

Kindly note that should you find any questions sensitive you are free not to answer them. The Research Ethics Committee of the University of Pretoria, Faculty of Health Sciences, telephone numbers 012 3541677 / 012 3541330 granted written approval for this study.

Your participation in this study is voluntary. You can refuse to participate or stop at any time without giving any reason. As you do not write your name on the questionnaire, you give us the information anonymously. Once you have given the questionnaire back to us, you cannot recall your consent. We will not be able to trace your information. Therefore, you will also not be identified as a participant in any publication that comes from this study.

In the event of questions asked, which will cause emotional distress, then the researcher is able to refer you to a competent counselling.

Note: The implication of completing the questionnaire is that informed consent has been obtained from you. Thus any information derived from your form (which will be totally anonymous) may be used for e.g. publication, by the researchers.

We sincerely appreciate your help.

Yours truly,

France Ncube

SECTION A – PERSONAL DETAILS

Designation of officer..... Agency.....

Qualifications.....

Instructions to respondents

You are kindly requested to answer the following questions either by:

- Filling in the blank spaces provided or
- Putting a cross in the appropriate box

SECTION B – HAZARD SOURCES, NATURE AND RISKS IN MUNICIPAL SOLID WASTE HANDLING

1) Is the organisation you work for involved in municipal solid waste management issues?
   Yes ☐
   No ☐

2) If yes to question 1, how is it involved? Monitoring & laboratory analysis ☐
   Awareness creation ☐
   Enforce legislation ☐
   Waste management ☐
   Other (Specify) ☐

3) In relation to your response in question 2 complete tables a- f that relate to your organisation's roles in waste management

Table 3(a) Monitoring or laboratory analysis

Environmental Component	**Parameters currently being monitored**	**Test procedure/ method of monitoring in place**	**Potential adverse human health effects**	**Other relevant parameters currently not monitored**	**Reason for not monitoring the other relevant parameters**
Land pollution	Littering Odours Fly infestations Toxic wastes Soil samples in and around waste disposal sites a. Sulphides b. Lead c. Cadmium levels				

	d. Infiltration rates e. Other chemicals				
Air quality in solid waste disposal sites	Bio aerosols Methane Carbon monoxide Dioxins				
Leachate	Aromatic hydrocarbons eg benzene Volatile hab-carbons Acids Other chemicals Water content				
Water quality down around waste disposal sites	E. coli Total coli forms Pesticides Other chemicals				

3b. Awareness creation

Observed /reported human health hazards in solid waste management	Sources of the hazards	Risk factors	At risk persons	Existent interventions	Required Interventions

3c. legislation enforcement for protection of human health

Statutes enforced	Key sections in relation to waste management	Shortcomings in legislation on protection of waste handlers' health	Suggested legislative improvements

3d. Waste management

Waste process	Potential hazards	Existent interventions	Required control measures	Challenges
Collection				
Transportation				
Processing				
Incineration				
Recycling				
Open dumping				

APPENDIX 12: WASTE HANDLERS' NORDIC MUSKULOSKELETAL QUESTIONNAIRES

Researcher's name: FRANCE NCUBE

Student Number: 14004284

Department of : SCHOOL OF HEALTH SYSTEMS AND PUBLIC HEALTH

University of Pretoria

Dear Participant

(FRAMEWORK FOR ASSESSING OCCUPATIONAL HEALTH RISKS OF MUNICPAL SOLID WASTE HANDLERS FOR USE BY LOCAL GOVERNMENT STRUCTURES)

I am a PHD student in **Public Health** in the SCHOOL of HEALTH SYSTEMS AND PUBLIC HEALTH University of Pretoria. You are invited to volunteer to participate in our research project on **FRAMEWORK FOR ASSESSING OCCUPATIONAL HEALTH RISKS OF MUNICPAL SOLID WASTE HANDLERS. The completion of the questionnaire may take about 1hour and 45 minutes and you may complete at your even at home and it will be collected a month after being given to you.**

This letter gives information to help you to decide if you want to take part in this study. Before you agree you should fully understand what is involved. If you do not understand the information or have any other questions, do not hesitate to ask us. You should not agree to take part unless you are completely happy about what we expect of you.

The purpose of the study is to develop a generic framework for assessing occupational health risks of municipal solid waste handlers

We would like you to complete a questionnaire. This may take about **1 hour and 45** minutes. France Ncube will collect the questionnaire from you a month after administration. It will be kept in a safe place to ensure confidentiality. Please do not write your name on the questionnaire. This will ensure confidentiality. France Ncube will be available to help you with the questionnaire or to fill it in on your behalf.

Kindly note that should you find any questions sensitive you are free not to answer them. The Research Ethics Committee of the University of Pretoria, Faculty of Health Sciences, telephone numbers 012 3541677 / 012 3541330 granted written approval for this study.

Your participation in this study is voluntary. You can refuse to participate or stop at any time without giving any reason. As you do not write your name on the questionnaire, you give us the information anonymously. Once you have given the questionnaire back to us, you cannot recall your consent. We will not be able to trace your information. Therefore, you will also not be identified as a participant in any publication that comes from this study.

In the event of questions asked, which will cause emotional distress, then the researcher is able to refer you to a competent counselling.

Note: The implication of completing the questionnaire is that informed consent has been obtained from you. Thus any information derived from your form (which will be totally anonymous) may be used for e.g. publication, by the researchers.

We sincerely appreciate your help.

Yours truly,

France Ncube

INSTRUCTIONS TO THE RESPONDENTS

You are kindly requested to answer the following questions either by :

- filling the blank spaces or
- putting a cross in the appropriate box

Part 1: Respondents' personal characteristics

1. What is your year of birth? 19____
2. What is your sex?
   ❒ Male ❒ Female
4. What is your weight? __Kg
5. What is your marital situation?
   ❒ single ❒ married
   ❒ divorced ❒ widow/widower
8. Do you exercise?
   ❒ Yes ❒ No
   If yes:
   How many hours a day do you exercise? _____ hours a day
   How many days a week do you exercise? _____ days a week
10. What is your employment status?
    Permanently employed❒ Contract worker❒
14. Please briefly describe your routine duties

_____
_____
_____
_____
_____
_____
_____
_____

Part 2: Education and current job

1. What is the **highest education** that you have received?
   - ❒ Tertiary education
   - ❒ Secondary education
   - ❒ Primary education
2. Which year did you start this job? ____
3. What is your current title? ----------
4. How many hours a week do you work in this job?
6. How many days a week do you work in this job?
   ____days a week
10. In what shift do you work?
    - ❒ Only morning shift ❒ only evening shift ❒ only night shift
    - ❒ From morning to evening ❒ Other (Specify)

1 Part 3: Physical Risk Factor associated with the working conditions in the current job

2 Indicate which activities in your current job you perform seldom, sometimes, often, or always?

	never	sometimes	often	always
1. Standing for long periods…….	❒	❒	❒	❒
2. Sitting for long periods…….	❒	❒	❒	❒
3. Walking for long periods…….	❒	❒	❒	❒
4. Working prolonged periods squatting/kneeling	❒	❒	❒	❒
5. Working with your hands above shoulder height	❒	❒	❒	❒
6. Working with your hands below knee height…….	❒	❒	❒	❒
7. Lifting or carrying loads (below 5 Kg)……..	❒	❒	❒	❒
8. Lifting or carrying loads (over 5 Kg)…….	❒	❒	❒	❒
9. Pushing or pulling loads (over 5 Kg)	❒	❒	❒	❒
10. Slipping or falling during transport of loads	❒	❒	❒	❒
11. Regularly applying force with hands or arms	❒	❒	❒	❒
12. Working with vibrating hand tools	❒	❒	❒	❒
13. Driving in vehicles	❒	❒	❒	❒
14. Bending and/or twisting with your upper body	❒	❒	❒	❒
15Working in awkward postures	❒	❒	❒	❒
16Working prolonged periods in the same posture	❒	❒	❒	❒
17. Repeating the same movement of your arms or hands many times per minute	❒	❒	❒	❒

20. Could you indicate at this scale how you perceive your physical load during regular activities at work?

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

E.g. 6 Very, very little

7 Very little

11 Little

13 Big

15 Heavy

17 Very big

19 Very, very big

Indicate how true the following statements are for your current job? You may choose between never, sometimes, often or always

Decision authority	**never**	**sometimes**	**often**	**always**
1. Do you have freedom in doing your tasks?	❒	❒	❒	❒
2.Do you have influence in planning your tasks?	❒	❒	❒	❒
3. Can you influence the pace of your work?	❒	❒	❒	❒
4. Can you decide yourself how you carry out your asks?	❒	❒	❒	❒
5. Can you briefly interrupt your work if needed?	❒	❒	❒	❒
6. Can you decide in which order you carry out your asks?	❒	❒	❒	❒
7. Do you have a say on completion deadlines?	❒	❒	❒	❒
8. Can you decide for yourself how much time you spend on a particular task?	❒	❒	❒	❒
9. Do you solve day-to-day work problems yourself?	❒	❒	❒	❒
10.Can you plan your own work?	❒	❒	❒	❒
11.Do you determine the content of your work?	❒	❒	❒	❒

Skill discretion	**never**	**sometimes**	**often**	**always**
1.Do you do the same things time often?	❒	❒	❒	❒
2.Does your work require creativity?	❒	❒	❒	❒
3.Is your work varied?	❒	❒	❒	❒
4. Does your work call for your own input?	❒	❒	❒	❒
5. Does your work make sufficient demands on all your skills and abilities?	❒	❒	❒	❒
6. Do you have enough variation in your work?	❒	❒	❒	❒

Indicate how true the following statements are for your current job? You may choose between never, sometimes, often or always

Work demands	never	sometimes	often	always
1. Do you have to work very fast?	❒	❒	❒	❒
2. Do you have too much to do?	❒	❒	❒	❒
3. Do you have to work extra hard to finish something?	❒	❒	❒	❒
4. Do you have to work against the clock?	❒	❒	❒	❒
5. Can you briefly interrupt your work if needed?	❒	❒	❒	❒
6. Do you have to hurry?	❒	❒	❒	❒
7. Do you have to deal with getting behind with your work?	❒	❒	❒	❒
8. Do you have too little work to do?	❒	❒	❒	❒
9. Do you have problems with the pace of work?	❒	❒	❒	❒
10. Do you have problems with the pressure of work?	❒	❒	❒	❒
11. Would you like to work at gentler pace?	❒	❒	❒	❒

Support	never	sometimes	often	always
1.Can you count on your colleagues if you run into difficulties?	❒	❒	❒	❒
2. Can you ask your colleagues for help if necessary?	❒	❒	❒	❒
3. Are you on good terms with colleagues?	❒	❒	❒	❒
4.Do you have conflicts with your colleagues?	❒	❒	❒	❒
5. Do you feel respected for your work by your colleagues?	❒	❒	❒	❒
6.Do you have to deal with hostility from your colleagues?	❒	❒	❒	❒
7. Are your colleagues friendly towards you?	❒	❒	❒	❒
8.Is there a good atmosphere between you and your colleagues ?	❒	❒	❒	❒
9.Do unpleasant situations arise between you and your colleagues?	❒	❒	❒	❒

Indicate how true the following statements are for your current job.

Choose between never, sometimes, often or always

Supervisor support	**never**	**sometime**	**often**	**always**
1. Can you rely on your immediate supervisor when you experience work problems?	❒	❒	❒	❒
2. Can you ask your immediate supervisor for help if necessary?	❒	❒	❒	❒
3. Are you on good terms with your immediate supervisor?	❒	❒	❒	❒
4. Do you have conflicts with your immediate supervisor?	❒	❒	❒	❒
5. Do you feel respected for your work by your immediate supervisor?	❒	❒	❒	❒
6. Do you have to deal with hostility from your supervisor?	❒	❒	❒	❒
7. Is there a good atmosphere between you and your immediate supervisor?	❒	❒	❒	❒
8. Do unpleasant situations arise between you and your colleagues?	❒	❒	❒	❒

Indicate if the following statements are true or not for your current job?

1. I find it hard to relax at the end of a working day	❒	❒
2.At the end of a working day I am really feeling worn – out	❒	❒
3.My job causes me to feel rather exhausted at the end of a working day	❒	❒
4.Generally speaking, I am still feeling fresh after supper	❒	❒
5.Generally speaking, I am able to relax only on a second day off	❒	❒
6.I have complaints concentrating in the hours off after my working day	❒	❒
7.I find it hard to show interest in other people when I just came home from work	❒	❒
8. In general, it takes me over an hour to feel recovered after work	❒	❒
9.When I get home, people should leave me alone for some time	❒	❒
10. After a working day, I am often too tired to start other activities…	❒	❒
11. During the last part of the working day I cannot optimally perform my job because of fatigue sometimes	❒	❒

Subjective Questions

1. Do you often have pains in the chest or heart region?	❒	❒
2. Do you often have a squeezing or blown – up feeling in the stomach?	❒	❒
3. Are you often short of breath?	❒	❒
4. Is your stomach regularly upset?	❒	❒
5. Do your bones or muscles ever ache?	❒	❒

6. Are you often troubled by back – ache? ❒ ❒
7. Do you often feel tired? ❒ ❒
8. Do you often have headaches? ❒ ❒
9. Do you often feel dizzy? ❒ ❒
10. Do your arms and legs often numb or tingle? ❒ ❒
11. Do you often feel listless? ❒ ❒
12. Do you normally feel tired when you get up in the morning? ❒ ❒
13. Do you get tired sooner than you would consider normal? ❒ ❒

NECK COMPLAINTS

1. Have you ever had neck complaints? ❒ yes ❒ no

If you answered **no** to question 1, please go to **Shoulder** section

2. Have you **ever** been hospitalized because of neck complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of neck complaints? ❒ yes ❒ no
4. In the past **12 months** have you had neck complaints? ❒ yes ❒ no

What was the diagnosis

If you answered **no** to question 4, please go to **Shoulder** section

5. Where your neck complaints **in the past 12 months** associated with:
   - work? ❒ yes ❒ maybe ❒ no
   - sports? ❒ yes ❒ maybe ❒ no
   - other activities in leisure time? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of neck complaints **in the past 12 months?**
   ❒ 1-7 days
   ❒ between 2 and 3 weeks
   ❒ between 3 and 4 weeks
   ❒ between 2 and 3 months
   ❒ longer than 3 months

7. What was the **total length of time** (all spells added-up) that you have had neck complaints **in the past 12 months?**
   ❒ shorter than 4 weeks
   ❒ between 2 and 3 months
   ❒ between 3 and 6 month
   ❒ longer than 6 months

8. How **often in the past 12 months** have you had separate spells of neck complaints?
   ❒ 1 time
   ❒ between 2 and 5 times
   ❒ more than 5 times

9. Was the onset of your neck complaints **in the past 12 months** sudden or gradual?
   ❒ sudden
   ❒ gradual

10. Could you describe the nature of your neck complaints **in the past 12 months** ?

(more than one answer is possible)

- ❒ stiffness
- ❒ nagging feeling
- ❒ numbness
- ❒ tingling
- ❒ loss of strength
- ❒ cramp, spasm
- ❒ pain
- ❒ Other……

11. Have you experienced in the past 12 months that your neck complaints radiated to:

- left elbow? ❒ yes ❒ no
- right elbow? ❒ yes ❒ no
- left wrist/ hand? ❒ yes ❒ no
- right wrist/ hand? ❒ yes ❒ no

12. How often have you been seen by an expert because of your neck complaints **in the past 12 months?**

- ❒ Your GP _____times
- ❒ A physiotherapist ___ _times
- ❒ A specialist ____ times
  Specify
- ❒ no visit

13. Which treatment(s) have you received **in the past 12 months** because of your neck complaints?

……
……
……

14. How often have you taken sick leave **in the past 12 months** because of your neck complaints?

- ❒ 0 times
- ❒ 1 time
- ❒ 2 to 5 times
- ❒ over 5 times

15. What is the total number of days with sick leave **in the past 12 months** because of your neck complaints?

- ❒ 0 days
- ❒ 1 to 7 days
- ❒ 8 to 14 days
- ❒ over 2 week

6. In the past 12 months, how much has your neck pain changed your ability to work, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

1. Have you ever had shoulder complaints?
   - yes
   - no

2. Have you **ever** been hospitalized because of shoulder complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of shoulder complaints? ❒ yes ❒ no
4. In the past 12 months have you had shoulder complaints? ❒ yes ❒ no

If you answered no to question 4, please go to **Elbows** section

5. Where your shoulder complaints **in the past 12 months** associated with:
   - -in your work? ❒ yes ❒ maybe ❒ no
   - -sports? ❒ yes ❒ maybe ❒ no
   - -other activities in leisure time? ❒ yes ❒ maybe ❒ no

❒ 1-7 days

6. How long was the **longest spell** of shoulder complaints **in the past 12 months?**
   - ❒ between 2 and 3 weeks
   - ❒ between 3 and 4 weeks
   - ❒ between 2 and 3 months
   - ❒ longer than 3 months

7. What was the **total length of time** that you have had shoulder complaints **in the past 12 months?**
   - ❒ shorter than 4 weeks
   - ❒ between 2 and 3 months
   - ❒ between 3 and 6 month
   - ❒ longer than 6 months

8. How often **in the past 12 months** have you had separate spells of shoulder complaints?
   - ❒ 1 time
   - ❒ between 2 and 5 times
   - ❒ more than 5 times

9. Was the onset of your shoulder complaints **in the past 12 months** sudden or gradual?
   - ❒ sudden
   - ❒ gradual

10. Could you describe the nature of your shoulder complaints **in the past 12 months**?

(more than one answer is possible)

- ❒ stiffness
- ❒ nagging feeling
- ❒ numbness
- ❒ tingling
- ❒ loss of strength
- ❒ cramp, spasm
- ❒ pain
- ❒ others…….

11. How often have you been seen by an expert because of your shoulder complaints **in the past 12 months?**
   - ❒ Your GP _____times
   - ❒ A physiotherapist _____times
   - ❒ A specialist ____ times

specify……..

12. Which treatment(s) have you received **in the past 12 months** because of your shoulder complaints?

……
……

13. How often do you have taken sick leave **in the past 12 months** because of your shoulder complaints?

❒ 0 times
❒ 1 time
❒ 2 to 5 times
❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** because of your shoulder complaints?

❒ 0 days
❒ 1 to 7 days
❒ 8 to 14 days
❒ over 2 week

15. In the past 12 months, how much has your shoulders pain changed your ability to work, where 0 is "no change" and 10 is extreme change"?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

ELBOW COMPLAINTS

1. Have you ever had elbow complaints? ❒ yes ❒no

If you answered **no** to question 1, please go to **Wrist/hand** section

2. Have you **ever** been hospitalized because of elbow complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of elbow complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had elbow complaints? ❒ yes ❒ no

What was the diagnosis……..

If you answered no to question 4, please go to **Wrist/hand** section

5. Where your elbow complaints **in the past 12 months** associated with:

-work? ❒ yes ❒ maybe ❒ no
-sports? ❒ yes ❒ maybe ❒ no
-other activities in leisure time? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of elbow complaints **in the past 12 months?**

❒ 1-7 days
❒ between 2 and 3 weeks
❒ between 3 and 4 weeks
❒ between 2 and 3 months
❒ longer than 3 months

7. What was the **total length of time** that you have had elbow complaints **in the past 12 months?**

- ❒ shorter than 4 weeks
- ❒ between 2 and 3 months
- ❒ between 3 and 6 month
- ❒ longer than 6 months

8. How often **in the past 12 months** have you had separate spells of elbow complaints?

- ❒ 1 time
- ❒ between 2 and 5 times
- ❒ more than 5 times

9. Was the onset of your elbow complaints **in the past 12 months** sudden or gradual?

- ❒ sudden
- ❒ gradual

10. Could you describe the nature of your elbow complaints **in the past 12 months**?

(more than one answer is possible)

- ❒ stiffness
- ❒ nagging feeling
- ❒ numbness
- ❒ tingling
- ❒ loss of strength
- ❒ cramp, spasm
- ❒ pain
- ❒ others…….

11. How often have you been seen by an expert because of your elbow complaints **in the past 12 months?**

- ❒ Your GP _____times
- ❒ A physiotherapist _____times
- ❒ A specialist ____ times
  Specify
- ❒ no visit

12. Which treatment(s) have you received **in the past 12 months** because of your elbow complaints?

……
……

13. How often do you have taken sick leave **in the past 12 months** because of your elbow complaints?

- ❒ 0 times
- ❒ 1 time
- ❒ 2 to 5 times
- ❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** because of your elbow complaints?

- ❒ 0 days
- ❒ 1 to 7 days
- ❒ 8 to 14 days
- ❒ over 2 week

15. In the past 12 months, how much has your elbows pain changed your ability to work, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

HAND AND WRIST PROBLEMS

1. Have you ever had hand/wrist complaints? ❒ yes ❒ no

If you answered **no** to question 1, please go to **Upper back** section

2. Have you **ever** been hospitalized because of hand/wrist complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of hand/wrist complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had hand/wrist complaints? ❒ yes ❒ no

What was the diagnosis……

If you answered **no** to question 4, please go to **Upper back** section

5. Where your hand complaints **in the past 12 months** associated with:

- work? ❒ yes ❒ maybe ❒ no
- sports? ❒ yes ❒ maybe ❒ no
- other activities in leisure time? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of hand/wrist complaints **in the past 12 months?**
   - ❒ 1-7 days
   - ❒ between 2 and 3 weeks
   - ❒ between 3 and 4 weeks
   - ❒ between 2 and 3 months
   - ❒ longer than 3 months

7. What was the **total length of time** (all spells added-up) that you have had hand/wrist complaints **in the past 12 months?**
   - ❒ shorter than 4 weeks
   - ❒ between 2 and 3 months
   - ❒ between 3 and 6 month
   - ❒ longer than 6 months

8. How **often in the past 12 months** have you had separate spells of hand/wrist complaints?
   - ❒ 1 time
   - ❒ between 2 and 5 times
   - ❒ more than 5 times

9. Was the onset of your hand/wrist complaints **in the past 12 months** sudden or gradual?

❒ sudden
❒ gradual

10. Could you describe the nature of your hand/wrist complaints **in the past 12 months**?

(more than one answer is possible)

❒ stiffness
❒ nagging feeling
❒ numbness
❒ tingling
❒ loss of strength
❒ cramp, spasm
❒ pain
❒ others……..

11. How often have you been seen by an expert because of your hand/wrist complaints **in the past 12 months?**

❒ Your GP _____times
❒ A physiotherapist _____times
❒ A specialist _____times
specify……..
❒ no visit

12. Which treatment(s) have you received **in the past 12 months** because of your hand/wrist complaints?

……
……
……

13. How often have you taken sick leave **in the past 12 months** because of your hand/wrist complaints?

❒ 0 times
❒ 1 time
❒ 2 to 5 times
❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** because of your hand/wrist complaints?

❒ 0 days
❒ 1 to 7 days
❒ 8 to 14 days
❒ over 2 week

15. In the past 12 months, how much has your hands/wrists pain changed your ability to work, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

❒ yes ❒ no

UPPER BACK COMPLAINTS

1. Have you ever had upper back complaints?

If you answered **no** to question 1, please go to **Lower back** section

2. Have you ever been hospitalized because of upper back complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of upper back complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had upper back complaints? ❒ yes ❒ no
What was the diagnosis……..

If you answered **no** to question 4, please continue with **Lower back** section

5. Where your back complaints **in the past 12 months** associated with :

- work ? ❒ yes ❒ maybe ❒ no
- sports ? ❒ yes ❒ maybe ❒ no
- other activities in leisure time ? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of upper back complaints **in the past 12 months ?**

❒ 1-7 days
❒ between 2 and 3 weeks
❒ between 3 and 4 weeks
❒ between 2 and 3 months
❒ longer than 3 months

7. What was the **total length of time** that you have had upper back complaints **in the past 12 months**?

❒ shorter than 4 weeks
❒ between 2 and 3 months
❒ between 3 and 6 month
❒ longer than 6 months

8. How often in the past 12 months have you had separate spells of upper back complaints?

❒ 1 time
❒ between 2 and 5 times
❒ more than 5 times

9. Was the onset of your upper back complaints in the past 12 months sudden or gradual?

❒ sudden
❒ gradual

10. Could you describe the nature of your upper back complaints **in the past 12 months** ?

(more than one answer is possible)

❒ stiffness
❒ nagging feeling
❒ numbness
❒ tingling
❒ loss of strength
❒ cramp, spasm
❒ pain
❒ others…..

11. How often have you been seen by an expert because of your upper back complaints **in the past 12 months** ?

❒ Your GP ____times
❒ A physiotherapist _times
❒ A specialist __ _ times
specify……..
❒ no visit

12. Which treatment(s) have you received in the past 12 months because of your upper back complaints?

……
……

13. How often do you have taken sick leave **in the past 12 months** because of your upper back complaints?

❒ 0 times
❒ 1 time
❒ 2 to 5 times
❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** because of your upper back complaints?

❒ 0 days
❒ 1 to 7 days
❒ 8 to 14 days
❒ over 2 weeks

15. In the past 12 months, how much has your upper back pain changed your ability to work, where 0 is "no change" and 10 is extreme change"?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

1. Have you ever had low back complaints? ❒ yes ❒ no

If you answered **no** to question 1, please go to **Hip/thigh** section

2. Have you **ever** been hospitalized because of back complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of back complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had low back complaints? ❒ yes ❒ no
   What was the diagnosis……..

5. Where your lower back complaints **in the past 12 months** associated with:

If you answered **no** to question 4, please continue with **Hip/thigh** section

- work ? ❒ yes ❒ maybe ❒ no
- sports ? ❒ yes ❒ maybe ❒ no
- other activities in leisure time ? ❒ yes ❒ maybe ❒ no
- pregnancy (only to answer by female)? ❒ yes ❒ maybe ❒ no
- menstrual period (only to answer by female)? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of back complaints **in the past 12 months ?**

- ❒ 1-7 days
- ❒ between 2 and 3 weeks
- ❒ between 3 and 4 weeks
- ❒ between 2 and 3 months
- ❒ longer than 3 months

7. What was the **total length of time** that you have had low back complaints **in the past 12 months** ?

- ❒ shorter than 4 weeks
- ❒ between 2 and 3 months
- ❒ between 3 and 6 month
- ❒ longer than 6 months

8. How often in the past 12 months have you had separate spells of back complaints?

- ❒ 1 time
- ❒ between 2 and 5 times
- ❒ more than 5 times

9. Was the onset of your back complaints in the past 12 months sudden or gradual?

- ❒ sudden
- ❒ gradual

10. Could you describe the nature of your back complaints **in the past 12 months** ?

(more than one answer is possible)

- ❒ stiffness
- ❒ nagging feeling
- ❒ numbness
- ❒ tingling
- ❒ loss of strength
- ❒ cramp, spasm
- ❒ pain
- ❒ others……

11. Have you experienced **in the past 12 months** back complaints radiating to

- left knee? ❒ yes ❒ no
- right knee ? ❒ yes ❒ no
- left ankle/foot? ❒ yes ❒ no
- right ankle/foot ? ❒ yes ❒ no

12. How often have you been seen by an expert because of your back complaints **in the past 12 months** ?

- ❒ Your GP _____times
- ❒ A physiotherapist _____times
- ❒ A specialist ____ times
- ❒ no visit

13. Which treatment(s) have you received in the past 12 months because of your back complaints?

……
……
……
…….

14. How often do you have taken sick leave **in the past 12 months** because of your back complaints?

- ❒ 0 times
- ❒ 1 time
- ❒ 2 to 5 times
- ❒ over 5 times

15. What is the total number of days with sick leave **in the past 12 months** because of your back complaints?

- ❒ 0 days
- ❒ 1 to 7 days
- ❒ 8 to 14 days
- ❒ over 2 weeks

On the next seven questions we would like to know how serious you rate your back pain and whether your back pain affected your regular daily activities. You are asked to indicate your opinion on a scale from 0 ‘‘no problems’’ to 10 ‘‘problems as serious as possible’’

1. How would you rate your back pain at the present time on a 0-10 scale, where 0 is ‘‘no pain’’ and 10 is ‘‘pain as bad as possible’’

No pain	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Pain as bad could be

2. In the past 12 months, how intense was your worst back pain rated on a 0-10 scale, where 0 is ‘‘no pain’’ and 10 ‘‘pain as bad possible’’?

No pain	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Pain as bad could be

3. In the past 12 months, on the average, how intense was your back pain rated on a 0-10 scale, where 0 is ‘‘no pain’’ and 10 ‘‘pain as bad possible’’?

No pain	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Pain as bad could be

4. How many days **in the past 12 months** have you been kept from your usual activities because of back pain (work, school, house work) ?

days

5. In the **past 12 months**, how much has your back pain interfered with your daily activities (work, school, housework) rated on 0-10 scale, where 0 is “no interference” and 10 is unable to carry on any activities”?

No interference	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Unable to carry on any activities

6. In the past 12 months, how much has your back pain changed your ability to take part in recreational, social and family activities, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

7. In the past 12 months, how much has your back pain changed your ability to work, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

HIP AND THIGH COMPLAINTS

1. Have you ever had hip/thigh complaints? ❒ yes ❒ no

If you answered **no** to question 1, please go to **Knees section**

2. Have you **ever** been hospitalized because of hip/thigh complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of hip/thigh complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had hip/thigh complaints? ❒ yes ❒ no

What was the diagnosis…….

If you answered **no** to question 4, please go to **Knees section**

5. Where your hip/thigh complaints **in the past 12 months** associated with:

- work?	❒ yes	❒ maybe	❒ no
- sports?	❒ yes	❒ maybe	❒ no
- other activities in leisure time?	❒ yes	❒ maybe	❒ no

6. How long was the **longest spell** of hip/thigh complaints **in the past 12 months?**

❒ 1-7 days
❒ between 2 and 3 weeks
❒ between 3 and 4 weeks
❒ between 2 and 3 months
❒ longer than 3 months

7. What was the **total length of time** (all spells added-up) that you have had hip/thigh complaints **in the past 12 months?**

❒ shorter than 4 weeks
❒ between 2 and 3 months
❒ between 3 and 6 month
❒ longer than 6 months

8. How **often in the past 12 months** have you had separate spells of hip/thigh complaints?

❒ 1 time
❒ between 2 and 5 times
❒ more than 5 times

9. Was the onset of your hip/thigh complaints in the past 12 months sudden or gradual?

❒ sudden
❒ gradual

10. Could you describe the nature of your hip/thigh complaints **in the past 12 months** ?

(more than one answer is possible)

❒ stiffness
❒ nagging feeling
❒ numbness
❒ tingling
❒ loss of strength
❒ cramp, spasm
❒ pain
❒ others……

11. How often have you been seen by an expert because of your hip/thigh complaints **in the past 12 months?**

❒ Your GP ___times
❒A physiotherapist ___times
❒ A specialist ____times
❒ no visit

12. Which treatment(s) have you received **in the past 12 months** because of your hip/thigh complaints?

……
……

13. How often have you taken sick leave **in the past 12 months** because of your hip/thigh complaints?

❒ 0 times
❒ 1 time
❒ 2 to 5 times
❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** because of your hip/thigh complaints?

- ❒ 0 days
- ❒ 1 to 7 days
- ❒ 8 to 14 days
- ❒ over 2 week

15. In the past 12 months, how much has your hip/thigh pain changed your ability to work, where 0 is "no change" and 10 is "extreme change"?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

KNEE COMPLAINTS

1. Have you ever had knee complaints? ❒ yes ❒ no

If you answered **no** to question 1, please go to **Ankle/feet section**

2. Have you **ever** been hospitalized because of knee complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of knee complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had knee complaints? ❒ yes ❒ no
   What was the diagnosis……

If you answered **no** to question 4, please go to **Ankle/feet section**

5. Where your knee complaints **in the past 12 months** associated with:
   - work? ❒ yes ❒ maybe ❒ no
   - sports? ❒ yes ❒ maybe ❒ no
   - other activities in leisure time? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of knee complaints **in the past 12 months?**

- ❒ 1-7 days
- ❒ between 2 and 3 weeks
- ❒ between 3 and 4 weeks
- ❒ between 2 and 3 months
- ❒ longer than 3 months

7. What was the **total length of time** (all spells added-up) that you have had knee complaints **in the past 12 months?**

- ❒ shorter than 4 weeks
- ❒ between 2 and 3 months
- ❒ between 3 and 6 month
- ❒ longer than 6 months

8. How **often in the past 12 months** have you had separate spells of knee complaints?

- ❒ 1 time
- ❒ between 2 and 5 times
- ❒ more than 5 times

9. Was the onset of your knee complaints in the past 12 months sudden or gradual?

- ❒ sudden
- ❒ gradual

10. Could you describe the nature of your knee complaints **in the past 12 months** ?

(more than one answer is possible)

- ❒ stiffness
- ❒ nagging feeling
- ❒ numbness
- ❒ tingling
- ❒ loss of strength
- ❒ cramp, spasm
- ❒ pain
- ❒ others……

11. How often have you been seen by an expert because of your knee complaints **in the past 12 months?**

- ❒ Your GP ___times
- ❒ A physiotherapist ___times
- ❒ A specialist ____times
- ❒ no visit

12. Which treatment(s) have you received **in the past 12 months** because of your knee complaints?

……
……

13. How often have you taken sick leave **in the past 12 months** because of your knee complaints?

- ❒ 0 times
- ❒ 1 time
- ❒ 2 to 5 times
- ❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** due to knee plaints?

- ❒ 0 days
- ❒ 1 to 7 days
- ❒ 8 to 14 days
- ❒ over 2 week

15. In the past 12 months, how much has your knee pain changed your ability to work, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

1. Have you ever had ankle/feet complaints? ❒ yes ❒ no

2. Have you **ever** been hospitalized because of ankle/feet complaints? ❒ yes ❒ no

3. Have you **ever** changed jobs because of ankle/feet complaints? ❒ yes ❒ no

4. **In the past 12 months** have you had ankle/feet complaints? ❒ yes ❒ no

What was the diagnosis……..

If you answered **no** to question 4, please do not continue

5.

Where your ankle/feet complaints **in the past 12 months** associated with:

- work?	❒ yes	❒ maybe	❒ no
- sports?	❒ yes	❒ maybe	❒ no
- other activities in leisure time?	❒ yes	❒ maybe	❒ no

6. How long was the **longest spell** of ankle/feet complaints **in the past 12 months?**

- ❒ 1-7 days
- ❒ between 2 and 3 weeks
- ❒ between 3 and 4 weeks
- ❒ between 2 and 3 months
- ❒ longer than 3 months

7. What was the **total length of time** that you have had ankle/feet complaints **in the past 12 months?**

- ❒ shorter than 4 weeks
- ❒ between 2 and 3 months
- ❒ between 3 and 6 month
- ❒ longer than 6 months

8. How **often in the past 12 months** have you had separate spells of ankle/feet complaints?

- ❒ 1 time
- ❒ between 2 and 5 times
- ❒ more than 5 times

9. Was the onset of your ankle/feet complaints in the past 12 months sudden or gradual?

- ❒ sudden
- ❒ gradual

10. Could you describe the nature of your ankle/feet complaints **in the past 12 months** ?

(more than one answer is possible)

- ❒ stiffness
- ❒ nagging feeling
- ❒ numbness
- ❒ tingling
- ❒ loss of strength
- ❒ cramp, spasm
- ❒ pain
- ❒ others……

11. How often have you been seen by an expert because of your ankle/feet complaints **in the past 12 months?**

- ❒ Your GP ___times
- ❒ A physiotherapist ___times
- ❒ A specialist ____times
  specify……..

- ❒ no visit

12. Which treatment(s) have you received **in the past 12 months** for the ankle/feet complaints? ……
……

APPENDIX 13: GENERAL HANDS (COMPARISON GROUP) NORDIC MUSKULOSKELETAL QUESTIONNAIRE

Researcher's name: FRANCE NCUBE

Student Number: 14004284

Department of: SCHOOL OF HEALTH SYSTEMS AND PUBLIC HEALTH

University of Pretoria

Dear Participant

(FRAMEWORK FOR ASSESSING OCCUPATIONAL HEALTH RISKS OF MUNICPAL SOLID WASTE HANDLERS FOR USE BY LOCAL GOVERNMENT STRUCTURES)

I am a PHD student in **Public Health** in the SCHOOL of HEALTH SYSTEMS AND PUBLIC HEALTH University of Pretoria. You are invited to volunteer to participate in our research project on **FRAMEWORK FOR ASSESSING OCCUPATIONAL HEALTH RISKS OF MUNICPAL SOLID WASTE HANDLERS. The completion of the questionnaire may take about 1hour and 45 minutes and you may complete at your even at home and it will be collected a month after being given to you.**

This letter gives information to help you to decide if you want to take part in this study. Before you agree you should fully understand what is involved. If you do not understand the information or have any other questions, do not hesitate to ask us. You should not agree to take part unless you are completely happy about what we expect of you.

The purpose of the study is to develop a generic framework for assessing occupational health risks of municipal solid waste handlers

We would like you to complete a questionnaire. This may take about **1 hour and 45** minutes. France Ncube will collect the questionnaire from you a month after administration. It will be kept in a safe place to ensure confidentiality. Please do not write your name on the questionnaire. This will ensure confidentiality. France Ncube will be available to help you with the questionnaire or to fill it in on your behalf.

Kindly note that should you find any questions sensitive you are free not to answer them. The Research Ethics Committee of the University of Pretoria, Faculty of Health Sciences, telephone numbers 012 3541677 / 012 3541330 granted written approval for this study.

Your participation in this study is voluntary. You can refuse to participate or stop at any time without giving any reason. As you do not write your name on the questionnaire, you give us the information anonymously. Once you have given the questionnaire back to us, you cannot recall your consent. We will not be able to trace your information. Therefore, you will also not be identified as a participant in any publication that comes from this study.

In the event of questions asked, which will cause emotional distress, then the researcher is able to refer you to a competent counselling.

Note: The implication of completing the questionnaire is that informed consent has been obtained from you. Thus any information derived from your form (which will be totally anonymous) may be used for e.g. publication, by the researchers.

We sincerely appreciate your help.

Yours truly,

France Ncube

INSTRUCTIONS TO THE RESPONDENTS

You are kindly requested to answer the following questions either by :

- filling the blank spaces or
- putting a cross in the appropriate box

Part 1: Respondents' personal characteristics

1. What is your year of birth? 19____
2. What is your sex?
   ❒ Male ❒ Female
4. What is your weight? __Kg
5. What is your marital situation?
   ❒ single ❒ married
   ❒ divorced ❒ widow/widower
8. Do you exercise?
   ❒ Yes ❒ No
   If yes:
   How many hours a day do you exercise? _____ hours a day
   How many days a week do you exercise? _____ days a week
10. What is your employment status?
    Permanently employed❒ Contract worker❒
14. Please briefly describe your routine duties

_____
_____
_____
_____
_____
_____
_____
_____

Part 2: Education and current job

1. What is the **highest education** that you have received?
   - ❒ Tertiary education
   - ❒ Secondary education
   - ❒ Primary education
2. Which year did you start this job? ____
3. What is your current title? ----------
4. How many hours a week do you work in this job?
6. How many days a week do you work in this job?
   ____days a week
10. In what shift do you work?
    - ❒ Only morning shift ❒ only evening shift ❒ only night shift
    - ❒ From morning to evening ❒ Other (Specify)

3 Part 3: Physical Risk Factor associated with the working conditions in the current job

4 Indicate which activities in your current job you perform seldom, sometimes, often, or always?

	never	sometimes	often	always
1. Standing for long periods…….	❒	❒	❒	❒
2. Sitting for long periods…….	❒	❒	❒	❒
3. Walking for long periods…….	❒	❒	❒	❒
4. Working prolonged periods squatting/kneeling	❒	❒	❒	❒
5. Working with your hands above shoulder height	❒	❒	❒	❒
6. Working with your hands below knee height…….	❒	❒	❒	❒
7. Lifting or carrying loads (below 5 Kg)……..	❒	❒	❒	❒
8. Lifting or carrying loads (over 5 Kg)…….	❒	❒	❒	❒
9. Pushing or pulling loads (over 5 Kg)	❒	❒	❒	❒
10. Slipping or falling during transport of loads	❒	❒	❒	❒
11. Regularly applying force with hands or arms	❒	❒	❒	❒
12. Working with vibrating hand tools	❒	❒	❒	❒
13. Driving in vehicles	❒	❒	❒	❒
14. Bending and/or twisting with your upper body	❒	❒	❒	❒
15Working in awkward postures	❒	❒	❒	❒
16Working prolonged periods in the same posture	❒	❒	❒	❒
17. Repeating the same movement of your arms or hands many times per minute	❒	❒	❒	❒

21. Could you indicate at this scale how you perceive your physical load during regular activities at work?

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

E.g. 6 Very, very little

7 Very little

11 Little

13 Big

15 Heavy

17 Very big

19 Very, very big

Indicate how true the following statements are for your current job? You may choose between never, sometimes, often or always

Decision authority	**never**	**sometimes**	**often**	**always**
1. Do you have freedom in doing your tasks?	❒	❒	❒	❒
2.Do you have influence in planning your tasks?	❒	❒	❒	❒
3. Can you influence the pace of your work?	❒	❒	❒	❒
4. Can you decide yourself how you carry out your asks?	❒	❒	❒	❒
5. Can you briefly interrupt your work if needed?	❒	❒	❒	❒
6. Can you decide in which order you carry out your asks?	❒	❒	❒	❒
7. Do you have a say on completion deadlines?	❒	❒	❒	❒
8. Can you decide for yourself how much time you spend on a particular task?	❒	❒	❒	❒
9. Do you solve day-to-day work problems yourself?	❒	❒	❒	❒
10.Can you plan your own work?	❒	❒	❒	❒
11.Do you determine the content of your work?	❒	❒	❒	❒

Skill discretion	**never**	**sometimes**	**often**	**always**
1.Do you do the same things time often?	❒	❒	❒	❒
2.Does your work require creativity?	❒	❒	❒	❒
3.Is your work varied?	❒	❒	❒	❒
4. Does your work call for your own input?	❒	❒	❒	❒
5. Does your work make sufficient demands on all your skills and abilities?	❒	❒	❒	❒
6. Do you have enough variation in your work?	❒	❒	❒	❒

Indicate how true the following statements are for your current job? You may choose between never, sometimes, often or always

Work demands	never	sometimes	often	always
1. Do you have to work very fast?	❒	❒	❒	❒
2. Do you have too much to do?	❒	❒	❒	❒
3. Do you have to work extra hard to finish something?	❒	❒	❒	❒
4. Do you have to work against the clock?	❒	❒	❒	❒
5. Can you briefly interrupt your work if needed?	❒	❒	❒	❒
6. Do you have to hurry?	❒	❒	❒	❒
7. Do you have to deal with getting behind with your work?	❒	❒	❒	❒
8. Do you have too little work to do?	❒	❒	❒	❒
9. Do you have problems with the pace of work?	❒	❒	❒	❒
10. Do you have problems with the pressure of work?	❒	❒	❒	❒
11. Would you like to work at gentler pace?	❒	❒	❒	❒

Support	never	sometimes	often	always
1.Can you count on your colleagues if you run into difficulties?	❒	❒	❒	❒
2. Can you ask your colleagues for help if necessary?	❒	❒	❒	❒
3. Are you on good terms with colleagues?	❒	❒	❒	❒
4.Do you have conflicts with your colleagues?	❒	❒	❒	❒
5. Do you feel respected for your work by your colleagues?	❒	❒	❒	❒
6.Do you have to deal with hostility from your colleagues?	❒	❒	❒	❒
7. Are your colleagues friendly towards you?	❒	❒	❒	❒
8.Is there a good atmosphere between you and your colleagues ?	❒	❒	❒	❒
9.Do unpleasant situations arise between you and your colleagues?	❒	❒	❒	❒

Indicate how true the following statements are for your current job.

Choose between never, sometimes, often or always

Supervisor support	**never**	**sometime**	**often**	**always**
1. Can you rely on your immediate supervisor when you experience work problems?	❒	❒	❒	❒
2. Can you ask your immediate supervisor for help if necessary?	❒	❒	❒	❒
3. Are you on good terms with your immediate supervisor?	❒	❒	❒	❒
4. Do you have conflicts with your immediate supervisor?	❒	❒	❒	❒
5. Do you feel respected for your work by your immediate supervisor?	❒	❒	❒	❒
6. Do you have to deal with hostility from your supervisor?	❒	❒	❒	❒
7. Is there a good atmosphere between you and your immediate supervisor?	❒	❒	❒	❒
8. Do unpleasant situations arise between you and your colleagues?	❒	❒	❒	❒

Indicate if the following statements are true or not for your current job?

1. I find it hard to relax at the end of a working day	❒	❒
2.At the end of a working day I am really feeling worn – out	❒	❒
3.My job causes me to feel rather exhausted at the end of a working day	❒	❒
4.Generally speaking, I am still feeling fresh after supper	❒	❒
5.Generally speaking, I am able to relax only on a second day off	❒	❒
6.I have complaints concentrating in the hours off after my working day	❒	❒
7.I find it hard to show interest in other people when I just came home from work	❒	❒
8. In general, it takes me over an hour to feel recovered after work	❒	❒
9.When I get home, people should leave me alone for some time	❒	❒
10. After a working day, I am often too tired to start other activities…	❒	❒
11. During the last part of the working day I cannot optimally perform my job because of fatigue sometimes	❒	❒

Subjective Questions

1. Do you often have pains in the chest or heart region?	❒	❒
2. Do you often have a squeezing or blown – up feeling in the stomach?	❒	❒
3. Are you often short of breath?	❒	❒
4. Is your stomach regularly upset?	❒	❒
5. Do your bones or muscles ever ache?	❒	❒

6. Are you often troubled by back – ache? ❒ ❒
7. Do you often feel tired? ❒ ❒
8. Do you often have headaches? ❒ ❒
9. Do you often feel dizzy? ❒ ❒
10. Do your arms and legs often numb or tingle? ❒ ❒
11. Do you often feel listless? ❒ ❒
12. Do you normally feel tired when you get up in the morning? ❒ ❒
13. Do you get tired sooner than you would consider normal? ❒ ❒

NECK COMPLAINTS

1. Have you ever had neck complaints? ❒ yes ❒ no

If you answered **no** to question 1, please go to **Shoulder** section

2. Have you **ever** been hospitalized because of neck complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of neck complaints? ❒ yes ❒ no
4. In the past **12 months** have you had neck complaints? ❒ yes ❒ no

What was the diagnosis

If you answered **no** to question 4, please go to **Shoulder** section

5. Where your neck complaints **in the past 12 months** associated with:
   - work? ❒ yes ❒ maybe ❒ no
   - sports? ❒ yes ❒ maybe ❒ no
   - other activities in leisure time? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of neck complaints **in the past 12 months?**
   ❒ 1-7 days
   ❒ between 2 and 3 weeks
   ❒ between 3 and 4 weeks
   ❒ between 2 and 3 months
   ❒ longer than 3 months

7. What was the **total length of time** (all spells added-up) that you have had neck complaints **in the past 12 months?**
   ❒ shorter than 4 weeks
   ❒ between 2 and 3 months
   ❒ between 3 and 6 month
   ❒ longer than 6 months

8. How **often in the past 12 months** have you had separate spells of neck complaints?
   ❒ 1 time
   ❒ between 2 and 5 times
   ❒ more than 5 times

9. Was the onset of your neck complaints **in the past 12 months** sudden or gradual?
   ❒ sudden
   ❒ gradual

10. Could you describe the nature of your neck complaints **in the past 12 months** ?

(more than one answer is possible)

- ❒ stiffness
- ❒ nagging feeling
- ❒ numbness
- ❒ tingling
- ❒ loss of strength
- ❒ cramp, spasm
- ❒ pain
- ❒ Other……

11. Have you experienced in the past 12 months that your neck complaints radiated to:

- left elbow? ❒ yes ❒ no
- right elbow? ❒ yes ❒ no
- left wrist/ hand? ❒ yes ❒ no
- right wrist/ hand? ❒ yes ❒ no

12. How often have you been seen by an expert because of your neck complaints **in the past 12 months?**

- ❒ Your GP _____times
- ❒ A physiotherapist ___ _times
- ❒ A specialist ____ times
  Specify
- ❒ no visit

13. Which treatment(s) have you received **in the past 12 months** because of your neck complaints?

……
……
……

14. How often have you taken sick leave **in the past 12 months** because of your neck complaints?

- ❒ 0 times
- ❒ 1 time
- ❒ 2 to 5 times
- ❒ over 5 times

15. What is the total number of days with sick leave **in the past 12 months** because of your neck complaints?

- ❒ 0 days
- ❒ 1 to 7 days
- ❒ 8 to 14 days
- ❒ over 2 week

6. In the past 12 months, how much has your neck pain changed your ability to work, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

1. Have you ever had shoulder complaints?
   - yes
   - no

2. Have you **ever** been hospitalized because of shoulder complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of shoulder complaints? ❒ yes ❒ no
4. In the past 12 months have you had shoulder complaints? ❒ yes ❒ no

If you answered no to question 4, please go to **Elbows** section

5. Where your shoulder complaints **in the past 12 months** associated with:
   - -in your work? ❒ yes ❒ maybe ❒ no
   - -sports? ❒ yes ❒ maybe ❒ no
   - -other activities in leisure time? ❒ yes ❒ maybe ❒ no

❒ 1-7 days

6. How long was the **longest spell** of shoulder complaints **in the past 12 months?**
   - ❒ between 2 and 3 weeks
   - ❒ between 3 and 4 weeks
   - ❒ between 2 and 3 months
   - ❒ longer than 3 months

7. What was the **total length of time** that you have had shoulder complaints **in the past 12 months?**
   - ❒ shorter than 4 weeks
   - ❒ between 2 and 3 months
   - ❒ between 3 and 6 month
   - ❒ longer than 6 months

8. How often **in the past 12 months** have you had separate spells of shoulder complaints?
   - ❒ 1 time
   - ❒ between 2 and 5 times
   - ❒ more than 5 times

9. Was the onset of your shoulder complaints **in the past 12 months** sudden or gradual?
   - ❒ sudden
   - ❒ gradual

10. Could you describe the nature of your shoulder complaints **in the past 12 months**?

(more than one answer is possible)

- ❒ stiffness
- ❒ nagging feeling
- ❒ numbness
- ❒ tingling
- ❒ loss of strength
- ❒ cramp, spasm
- ❒ pain
- ❒ others…….

11. How often have you been seen by an expert because of your shoulder complaints **in the past 12 months?**
   - ❒ Your GP _____times
   - ❒ A physiotherapist _____times
   - ❒ A specialist ____ times

specify……..

12. Which treatment(s) have you received **in the past 12 months** because of your shoulder complaints?

……
……

13. How often do you have taken sick leave **in the past 12 months** because of your shoulder complaints?

❒ 0 times
❒ 1 time
❒ 2 to 5 times
❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** because of your shoulder complaints?

❒ 0 days
❒ 1 to 7 days
❒ 8 to 14 days
❒ over 2 week

15. In the past 12 months, how much has your shoulders pain changed your ability to work, where 0 is "no change" and 10 is extreme change"?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

ELBOW COMPLAINTS

1. Have you ever had elbow complaints? ❒ yes ❒no

If you answered **no** to question 1, please go to **Wrist/hand** section

2. Have you **ever** been hospitalized because of elbow complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of elbow complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had elbow complaints? ❒ yes ❒ no

What was the diagnosis……..

If you answered no to question 4, please go to **Wrist/hand** section

5. Where your elbow complaints **in the past 12 months** associated with:

-work? ❒ yes ❒ maybe ❒ no
-sports? ❒ yes ❒ maybe ❒ no
-other activities in leisure time? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of elbow complaints **in the past 12 months?**

❒ 1-7 days
❒ between 2 and 3 weeks
❒ between 3 and 4 weeks
❒ between 2 and 3 months
❒ longer than 3 months

7. What was the **total length of time** that you have had elbow complaints **in the past 12 months?**

- ❒ shorter than 4 weeks
- ❒ between 2 and 3 months
- ❒ between 3 and 6 month
- ❒ longer than 6 months

8. How often **in the past 12 months** have you had separate spells of elbow complaints?

- ❒ 1 time
- ❒ between 2 and 5 times
- ❒ more than 5 times

9. Was the onset of your elbow complaints **in the past 12 months** sudden or gradual?

- ❒ sudden
- ❒ gradual

10. Could you describe the nature of your elbow complaints **in the past 12 months**?

(more than one answer is possible)

- ❒ stiffness
- ❒ nagging feeling
- ❒ numbness
- ❒ tingling
- ❒ loss of strength
- ❒ cramp, spasm
- ❒ pain
- ❒ others…….

11. How often have you been seen by an expert because of your elbow complaints **in the past 12 months?**

- ❒ Your GP _____times
- ❒ A physiotherapist _____times
- ❒ A specialist ____ times
  Specify
- ❒ no visit

12. Which treatment(s) have you received **in the past 12 months** because of your elbow complaints?

……
……

13. How often do you have taken sick leave **in the past 12 months** because of your elbow complaints?

- ❒ 0 times
- ❒ 1 time
- ❒ 2 to 5 times
- ❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** because of your elbow complaints?

- ❒ 0 days
- ❒ 1 to 7 days
- ❒ 8 to 14 days
- ❒ over 2 week

15. In the past 12 months, how much has your elbows pain changed your ability to work, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

HAND AND WRIST PROBLEMS

1. Have you ever had hand/wrist complaints? ❒ yes ❒ no

If you answered **no** to question 1, please go to **Upper back** section

2. Have you **ever** been hospitalized because of hand/wrist complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of hand/wrist complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had hand/wrist complaints? ❒ yes ❒ no

What was the diagnosis……

If you answered **no** to question 4, please go to **Upper back** section

5. Where your hand complaints **in the past 12 months** associated with:

- work? ❒ yes ❒ maybe ❒ no
- sports? ❒ yes ❒ maybe ❒ no
- other activities in leisure time? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of hand/wrist complaints **in the past 12 months?**
   - ❒ 1-7 days
   - ❒ between 2 and 3 weeks
   - ❒ between 3 and 4 weeks
   - ❒ between 2 and 3 months
   - ❒ longer than 3 months

7. What was the **total length of time** (all spells added-up) that you have had hand/wrist complaints **in the past 12 months?**
   - ❒ shorter than 4 weeks
   - ❒ between 2 and 3 months
   - ❒ between 3 and 6 month
   - ❒ longer than 6 months

8. How **often in the past 12 months** have you had separate spells of hand/wrist complaints?
   - ❒ 1 time
   - ❒ between 2 and 5 times
   - ❒ more than 5 times

9. Was the onset of your hand/wrist complaints **in the past 12 months** sudden or gradual?

❒ sudden
❒ gradual

10. Could you describe the nature of your hand/wrist complaints **in the past 12 months**?

(more than one answer is possible)

❒ stiffness
❒ nagging feeling
❒ numbness
❒ tingling
❒ loss of strength
❒ cramp, spasm
❒ pain
❒ others…….

11. How often have you been seen by an expert because of your hand/wrist complaints **in the past 12 months?**

❒ Your GP _____times
❒ A physiotherapist _____times
❒ A specialist _____times
specify……..
❒ no visit

12. Which treatment(s) have you received **in the past 12 months** because of your hand/wrist complaints?

……
……
……

13. How often have you taken sick leave **in the past 12 months** because of your hand/wrist complaints?

❒ 0 times
❒ 1 time
❒ 2 to 5 times
❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** because of your hand/wrist complaints?

❒ 0 days
❒ 1 to 7 days
❒ 8 to 14 days
❒ over 2 week

15. In the past 12 months, how much has your hands/wrists pain changed your ability to work, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

❒ yes ❒ no

UPPER BACK COMPLAINTS

1. Have you ever had upper back complaints?

If you answered **no** to question 1, please go to **Lower back** section

2. Have you ever been hospitalized because of upper back complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of upper back complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had upper back complaints? ❒ yes ❒ no
What was the diagnosis……..

If you answered **no** to question 4, please continue with **Lower back** section

5. Where your back complaints **in the past 12 months** associated with :

- work ? ❒ yes ❒ maybe ❒ no
- sports ? ❒ yes ❒ maybe ❒ no
- other activities in leisure time ? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of upper back complaints **in the past 12 months ?**

❒ 1-7 days
❒ between 2 and 3 weeks
❒ between 3 and 4 weeks
❒ between 2 and 3 months
❒ longer than 3 months

7. What was the **total length of time** that you have had upper back complaints **in the past 12 months**?

❒ shorter than 4 weeks
❒ between 2 and 3 months
❒ between 3 and 6 month
❒ longer than 6 months

8. How often in the past 12 months have you had separate spells of upper back complaints?

❒ 1 time
❒ between 2 and 5 times
❒ more than 5 times

9. Was the onset of your upper back complaints in the past 12 months sudden or gradual?

❒ sudden
❒ gradual

10. Could you describe the nature of your upper back complaints **in the past 12 months** ?

(more than one answer is possible)

❒ stiffness
❒ nagging feeling
❒ numbness
❒ tingling
❒ loss of strength
❒ cramp, spasm
❒ pain
❒ others…..

11. How often have you been seen by an expert because of your upper back complaints **in the past 12 months** ?

❒ Your GP ____times
❒ A physiotherapist _times
❒ A specialist __ _ times
specify……..
❒ no visit

12. Which treatment(s) have you received in the past 12 months because of your upper back complaints?

……
……

13. How often do you have taken sick leave **in the past 12 months** because of your upper back complaints?

❒ 0 times
❒ 1 time
❒ 2 to 5 times
❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** because of your upper back complaints?

❒ 0 days
❒ 1 to 7 days
❒ 8 to 14 days
❒ over 2 weeks

15. In the past 12 months, how much has your upper back pain changed your ability to work, where 0 is "no change" and 10 is extreme change"?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

1. Have you ever had low back complaints? ❒ yes ❒ no

If you answered **no** to question 1, please go to **Hip/thigh** section

2. Have you **ever** been hospitalized because of back complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of back complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had low back complaints? ❒ yes ❒ no
   What was the diagnosis……..

5. Where your lower back complaints **in the past 12 months** associated with:

If you answered **no** to question 4, please continue with **Hip/thigh** section

- work ? ❒ yes ❒ maybe ❒ no
- sports ? ❒ yes ❒ maybe ❒ no
- other activities in leisure time ? ❒ yes ❒ maybe ❒ no
- pregnancy (only to answer by female)? ❒ yes ❒ maybe ❒ no
- menstrual period (only to answer by female)? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of back complaints **in the past 12 months ?**

- ❒ 1-7 days
- ❒ between 2 and 3 weeks
- ❒ between 3 and 4 weeks
- ❒ between 2 and 3 months
- ❒ longer than 3 months

7. What was the **total length of time** that you have had low back complaints **in the past 12 months** ?

- ❒ shorter than 4 weeks
- ❒ between 2 and 3 months
- ❒ between 3 and 6 month
- ❒ longer than 6 months

8. How often in the past 12 months have you had separate spells of back complaints?

- ❒ 1 time
- ❒ between 2 and 5 times
- ❒ more than 5 times

9. Was the onset of your back complaints in the past 12 months sudden or gradual?

- ❒ sudden
- ❒ gradual

10. Could you describe the nature of your back complaints **in the past 12 months** ?

(more than one answer is possible)

- ❒ stiffness
- ❒ nagging feeling
- ❒ numbness
- ❒ tingling
- ❒ loss of strength
- ❒ cramp, spasm
- ❒ pain
- ❒ others……

11. Have you experienced **in the past 12 months** back complaints radiating to

- left knee? ❒ yes ❒ no
- right knee ? ❒ yes ❒ no
- left ankle/foot? ❒ yes ❒ no
- right ankle/foot ? ❒ yes ❒ no

12. How often have you been seen by an expert because of your back complaints **in the past 12 months** ?

- ❒ Your GP _____times
- ❒ A physiotherapist _____times
- ❒ A specialist ____ times
- ❒ no visit

13. Which treatment(s) have you received in the past 12 months because of your back complaints?

……
……
……
…….

14. How often do you have taken sick leave **in the past 12 months** because of your back complaints?

- ❒ 0 times
- ❒ 1 time
- ❒ 2 to 5 times
- ❒ over 5 times

15. What is the total number of days with sick leave **in the past 12 months** because of your back complaints?

- ❒ 0 days
- ❒ 1 to 7 days
- ❒ 8 to 14 days
- ❒ over 2 weeks

On the next seven questions we would like to know how serious you rate your back pain and whether your back pain affected your regular daily activities. You are asked to indicate your opinion on a scale from 0 ‘‘no problems’’ to 10 ‘‘problems as serious as possible’’

4. How would you rate your back pain at the present time on a 0-10 scale, where 0 is ‘‘no pain’’ and 10 is ‘‘pain as bad as possible’’

No pain	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Pain as bad could be

5. In the past 12 months, how intense was your worst back pain rated on a 0-10 scale, where 0 is ‘‘no pain’’ and 10 ‘‘pain as bad possible’’?

No pain	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Pain as bad could be

6. In the past 12 months, on the average, how intense was your back pain rated on a 0-10 scale, where 0 is ‘‘no pain’’ and 10 ‘‘pain as bad possible’’?

No pain	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Pain as bad could be

4. How many days **in the past 12 months** have you been kept from your usual activities because of back pain (work, school, house work) ?

days

5. In the **past 12 months**, how much has your back pain interfered with your daily activities (work, school, housework) rated on 0-10 scale, where 0 is “no interference” and 10 is unable to carry on any activities”?

No interference	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Unable to carry on any activities

6. In the past 12 months, how much has your back pain changed your ability to take part in recreational, social and family activities, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

7. In the past 12 months, how much has your back pain changed your ability to work, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

HIP AND THIGH COMPLAINTS

1. Have you ever had hip/thigh complaints? ❒ yes ❒ no

If you answered **no** to question 1, please go to **Knees section**

2. Have you **ever** been hospitalized because of hip/thigh complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of hip/thigh complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had hip/thigh complaints? ❒ yes ❒ no

What was the diagnosis…….

If you answered **no** to question 4, please go to **Knees section**

5. Where your hip/thigh complaints **in the past 12 months** associated with:

- work?	❒ yes	❒ maybe	❒ no
- sports?	❒ yes	❒ maybe	❒ no
- other activities in leisure time?	❒ yes	❒ maybe	❒ no

6. How long was the **longest spell** of hip/thigh complaints **in the past 12 months?**

❒ 1-7 days
❒ between 2 and 3 weeks
❒ between 3 and 4 weeks
❒ between 2 and 3 months
❒ longer than 3 months

7. What was the **total length of time** (all spells added-up) that you have had hip/thigh complaints **in the past 12 months?**

❒ shorter than 4 weeks
❒ between 2 and 3 months
❒ between 3 and 6 month
❒ longer than 6 months

8. How **often in the past 12 months** have you had separate spells of hip/thigh complaints?

❒ 1 time
❒ between 2 and 5 times
❒ more than 5 times

9. Was the onset of your hip/thigh complaints in the past 12 months sudden or gradual?

❒ sudden
❒ gradual

10. Could you describe the nature of your hip/thigh complaints **in the past 12 months** ?

(more than one answer is possible)

❒ stiffness
❒ nagging feeling
❒ numbness
❒ tingling
❒ loss of strength
❒ cramp, spasm
❒ pain
❒ others……

11. How often have you been seen by an expert because of your hip/thigh complaints **in the past 12 months?**

❒ Your GP ___times
❒A physiotherapist ___times
❒ A specialist ____times
❒ no visit

12. Which treatment(s) have you received **in the past 12 months** because of your hip/thigh complaints?

……
……

13. How often have you taken sick leave **in the past 12 months** because of your hip/thigh complaints?

❒ 0 times
❒ 1 time
❒ 2 to 5 times
❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** because of your hip/thigh complaints?

- ❒ 0 days
- ❒ 1 to 7 days
- ❒ 8 to 14 days
- ❒ over 2 week

15. In the past 12 months, how much has your hip/thigh pain changed your ability to work, where 0 is "no change" and 10 is "extreme change"?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

KNEE COMPLAINTS

1. Have you ever had knee complaints? ❒ yes ❒ no

If you answered **no** to question 1, please go to **Ankle/feet section**

2. Have you **ever** been hospitalized because of knee complaints? ❒ yes ❒ no
3. Have you **ever** changed jobs because of knee complaints? ❒ yes ❒ no
4. **In the past 12 months** have you had knee complaints? ❒ yes ❒ no
   What was the diagnosis……

If you answered **no** to question 4, please go to **Ankle/feet section**

5. Where your knee complaints **in the past 12 months** associated with:
   - work? ❒ yes ❒ maybe ❒ no
   - sports? ❒ yes ❒ maybe ❒ no
   - other activities in leisure time? ❒ yes ❒ maybe ❒ no

6. How long was the **longest spell** of knee complaints **in the past 12 months?**

- ❒ 1-7 days
- ❒ between 2 and 3 weeks
- ❒ between 3 and 4 weeks
- ❒ between 2 and 3 months
- ❒ longer than 3 months

7. What was the **total length of time** (all spells added-up) that you have had knee complaints **in the past 12 months?**

- ❒ shorter than 4 weeks
- ❒ between 2 and 3 months
- ❒ between 3 and 6 month
- ❒ longer than 6 months

8. How **often in the past 12 months** have you had separate spells of knee complaints?

- ❒ 1 time
- ❒ between 2 and 5 times
- ❒ more than 5 times

9. Was the onset of your knee complaints in the past 12 months sudden or gradual?

- ❒ sudden
- ❒ gradual

10. Could you describe the nature of your knee complaints **in the past 12 months** ?

(more than one answer is possible)

- ❒ stiffness
- ❒ nagging feeling
- ❒ numbness
- ❒ tingling
- ❒ loss of strength
- ❒ cramp, spasm
- ❒ pain
- ❒ others……

11. How often have you been seen by an expert because of your knee complaints **in the past 12 months?**

- ❒ Your GP ___times
- ❒ A physiotherapist ___times
- ❒ A specialist ____times
- ❒ no visit

12. Which treatment(s) have you received **in the past 12 months** because of your knee complaints?

……
……

13. How often have you taken sick leave **in the past 12 months** because of your knee complaints?

- ❒ 0 times
- ❒ 1 time
- ❒ 2 to 5 times
- ❒ over 5 times

14. What is the total number of days with sick leave **in the past 12 months** due to knee plaints?

- ❒ 0 days
- ❒ 1 to 7 days
- ❒ 8 to 14 days
- ❒ over 2 week

15. In the past 12 months, how much has your knee pain changed your ability to work, where 0 is “no change” and 10 is extreme change”?

No change	❒ 0	❒ 1	❒ 2	❒ 3	❒ 4	❒ 5	❒ 6	❒ 7	❒ 8	❒ 9	❒ 10	Extreme change

1. Have you ever had ankle/feet complaints? ❒ yes ❒ no

2. Have you **ever** been hospitalized because of ankle/feet complaints? ❒ yes ❒ no

3. Have you **ever** changed jobs because of ankle/feet complaints? ❒ yes ❒ no

4. **In the past 12 months** have you had ankle/feet complaints? ❒ yes ❒ no

What was the diagnosis……..

If you answered **no** to question 4, please do not continue

5.

Where your ankle/feet complaints **in the past 12 months** associated with:

- work?	❒ yes	❒ maybe	❒ no
- sports?	❒ yes	❒ maybe	❒ no
- other activities in leisure time?	❒ yes	❒ maybe	❒ no

6. How long was the **longest spell** of ankle/feet complaints **in the past 12 months?**

❒ 1-7 days
❒ between 2 and 3 weeks
❒ between 3 and 4 weeks
❒ between 2 and 3 months
❒ longer than 3 months

7. What was the **total length of time** that you have had ankle/feet complaints **in the past 12 months?**

❒ shorter than 4 weeks
❒ between 2 and 3 months
❒ between 3 and 6 month
❒ longer than 6 months

8. How **often in the past 12 months** have you had separate spells of ankle/feet complaints?

❒ 1 time
❒ between 2 and 5 times
❒ more than 5 times

9. Was the onset of your ankle/feet complaints in the past 12 months sudden or gradual?

❒ sudden
❒ gradual

10. Could you describe the nature of your ankle/feet complaints **in the past 12 months** ?

(more than one answer is possible)

❒ stiffness
❒ nagging feeling
❒ numbness
❒ tingling
❒ loss of strength
❒ cramp, spasm
❒ pain
❒ others……

11. How often have you been seen by an expert because of your ankle/feet complaints **in the past 12 months?**

❒ Your GP ___times
❒ A physiotherapist ___times
❒ A specialist ____times
specify……..

❒ no visit

12. Which treatment(s) have you received **in the past 12 months** for the ankle/feet complaints? ……
……