

Evaluation of the Living Conditions and Health Perceptions of Waste Electrical and Electronic Equipment Handlers in the Informal Sector in Dakar

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Abstract

Electrical and electronic devices are becoming an increasingly important part of our society. In Africa, and in Senegal in particular, the handling and management of electronic and electrical equipment (EEE) that has reached the end of its life is mainly informal. This professional environment is characterized by the disintegration of the sector and the social heterogeneity that can be found there. The objective of this study is to assess the standard of living of electrical and electronic equipment waste handlers in the Dakar region, as well as their perception of their health. A survey was used to obtain information on sociodemographic background, living arrangements, perception of health status, and good practices to be implemented in case of work-related health problems. Life style, perception of general health and health problems were ranged as excellent, very good, good, average and poor. Informal recyclers in the Dakar region lived mainly in rooms and buildings as tenants (49.1%), or in family homes (48.4%) before starting this activity, and 51.2% continue to live in rooms and buildings as tenants compared to 41.4% who still live in a family home. The perception of health status ranged from poor to excellent, and 4.9% believe that they are limited in work due to a disability or health problem. Informal work is a heterogeneous phenomenon that makes research and policymaking particularly complex. There are several external factors within informal WEEE re-cyclers that can cause health prob-

lems or functional disability. However, the living conditions and the perception they have of their state of health are contradictory to the working conditions and the social environment to which they belong. A biomedical approach would consolidate these achievements by confirming or invalidating them.

Keywords

E-Waste, Informal Work, Living Arrangements, Health Perception, Occupational Exposure

1. Introduction

Electronic and electrical devices are now equipment that is part of daily life in our society. They are increasingly equipped with state-of-the-art technology and work by an electric current or an electromagnetic field [1]. Regardless of the field of activity that society faces, the demand for electrical and electronic equipment is constantly increasing, with even greater demand, which has resulted in the birth of a new generation of waste called waste electrical and electronic equipment (WEEE) [2] [3]. WEEE is one of the fastest growing solid waste products in the world [4]. The “*Global E-waste Statistics Partnership*” (GESP) reported that the e-waste generated worldwide has increased by more than 21% in the last five years. In 2021, an average of 57.4 million tons (Mt) of electronic waste were generated worldwide. Of these wastes, approximately 17.4% ended up in formal recycling sites and the rest ended up in open landfills, incinerators, or exported to low-income countries where it is recycled [5].

Originally designed to improve people’s living environment, electronic equipment contains chemicals known to be toxic, making informal recycling and disposal dangerous to people’s health on the one hand and the environment on the other [6]. In fact, when they are not handled under adequate sanitary and environmental conditions, electrical and electronic equipment releases a set of pollutants that contribute to air, soil and water pollution [7] [8]. These pollutants include lead, cadmium, mercury, arsenic, polycyclic aromatic hydrocarbons, and brominated flame retardants [9] [10] [11].

In Africa, and in Senegal in particular, the handling and management of electronic and electrical equipment (EEE) that has reached the end of its life is mainly informal. The typology of the mode of work observed in the informal economy in several regions of the world is distinguished by the disintegration of the sector and the social heterogeneity that can be found within it [12]. In West Africa, and specifically in Senegal, the informal economy represents a group of units whose activities are carried out at a reduced level of organisation, with or without divisions between labour and capital, considered as factors of production, with support and solidarity in employment generally established through family, social or cultural ties. This solidarity also plays an important role in

health care for employees in the informal sector [13]. In Senegal's cities and regions, the informal work environment is characterized by a lack of regulations, a lack of respect for good practices in terms of health and safety at work, and a precariousness of working and living conditions, which represents a real environmental and health problem due to the many chemical pollutants contained in this waste. Informal occupations such as the handling and processing of WEEE in Africa are a long-term reality that also faces the absence of an employment protection system with all the consequences that can flow from it [14]. Every day, working in an informal environment negatively affects the mental and physical health of workers, as well as their perception of living and working conditions, taking into account the environment in which they find themselves [15].

Faced with such a problem and in view of the place that waste electrical and electronic equipment occupies every day in Africa, this study was carried out to determine the living conditions of employees in the informal e-waste processing sector in the Dakar region of Senegal and their perception of their state of health.

2. Materials and Methods

2.1. Study Population

The study population consisted of workers in the informal sector of the treatment and handling of electrical and electronic waste in the Dakar region. Within this occupational category, groups of WEEE repairers, collectors, and dismantlers were selected as target groups.

2.2. Data Collection

This was a cross-sectional study in which data were collected using a semi-directed questionnaire with open and closed questions administered to waste electrical and electronic equipment handlers. Before the study started, a validation phase of the questionnaire was carried out. During this validation phase, the questionnaire was randomly passed to different groups of individuals. Based on the responses and observations made during this step and taking into account the individual level of understanding of each respondent, some questions were modified. Throughout the study period, a daily assessment of the difficulties encountered was carried out in order to ensure proper data collection. Workers were interviewed at their workplaces and questions were asked about sociodemographic background, employment history, past and current living conditions, general health and working conditions. Living conditions, perception of general health and health problems were classified as excellent, very good, good, average and poor.

2.3. Data Analysis

Before data analysis, all questionnaires were reviewed for completeness and accuracy and compiled into a database and used. The living arrangements of the

workers were assessed taking into account current and past life. Workers' perceptions of work-related health status were assessed using questions about workers' perceptions of occupational accidents, illnesses resulting from absence from work, workers' perceptions (*i.e.*, concerns about work) of their health and their main health problems.

The Schwartz formula was used to determine the number of participants to include in our survey, and the sample size was calculated based on the prevalence of respiratory problems among workers in the e-waste sector in Chile (24.7%) [16]. The desired accuracy was set at 7%. The sample size was 161, with an error of 10%. Data were analyzed using R Studio version 1.2.5001 (RStudio, PBC, Boston, MA, USA). In the bivariate analysis, the dependence of stress variables on other study variables was tested using the Chi-square test. The results are presented as average and percentage. To build the initial model, all variables with a p value less than 0.20 in the bivariate analysis with perceived stress were introduced. A significance level of 5% was defined and used.

2.4. Ethical Considerations

The study was approved by the Ethics and Research Committee of the Faculty of Medicine, Pharmacy, and Stomatology of the Cheikh Anta Diop University of Dakar under the number 039912019/CERTCAD. The verbal and written consent of the workers was obtained at the beginning of the interview, after explaining to the workers their full rights to refuse and withdraw at any time during the interview. To ensure that the participant remained anonymous, each questionnaire was coded with numeric identifiers. They were also assured that the data will not be used for any purpose other than scientific reasons and for the development of safety promotion programs for the sector.

3. Results

3.1. Sociodemographic Characteristics

The results of our survey show that the average age of the employees is 35.74 ± 12.49 years. The sociodemographic study (Table 1) of our population reveals that almost all (98.1%) of the targets are male. More than half (58.6%) of WEEE handlers are married. Furthermore, most of the surveys studied up to primary school (40.7%) and 21.6% reached the first cycle of secondary school (Table 1).

3.2. Current Living Arrangements

More than half, or 76.4%, of the survey respondents sleep more than 1 km from the work site (Table 2). Almost all targets (94.4%) bathed once they returned home and 88.9% ate at the work site. Of the study population, 51.2% carry work clothes when they go home at the end of their shift. Of the respondents, 56.8% said they usually slept in rooms where they were tenants or in a building. Regarding physical possession, 26.5% of the respondents to the questionnaire are in the highest tertile (tertile 3). The median age of the surveys in their current dwelling was 8.12 years, with the extremes being 5.16 years and 18.91 years.

Table 1. Sociodemographic characteristics of WEEE handlers.

Variables	Weighted headcount	Weighted Percentage (%)
Sex		
Wife	3	1.9
Man	159	98.1
Marital status		
Single	64	39.5
Married	95	58.6
Widower	3	1.9
Level of education		
None	39	24.1
Primary	66	40.7
Secondary 1st cycle (6th-3rd)	35	21.6
Secondary 2nd cycle (2nd-Tle)	18	11.1
Academic	4	2.5

Table 2. Living arrangements of WEEE handler surveys.

Variables	Weighted headcount	Weighted Percentage (%)
Location of accommodation		
On-site (workshop/landfill)	5	3.1
Off-site, but less than 1 km away	33	20.5
More than 1 km away	123	76.4
Bathing place		
On the job site	6	3.7
Back Home	152	94.4
Away from the workplace and home	3	1.9
Meals on site		
Yes	144	88.9
Not	18	11.1
Returning home with the clothes worn to work		
Yes	83	51.2
Not	79	48.8
Type of accommodation		
Rented Room/Building	92	56.8

Continued

Kiosk/Rented Shop	1	0.6
Open space (no walls and/or ceilings)	0	0.0
Mosque	0	0.0
Detached house	1	0.6
Family Home	67	41.4
Mud/bamboo/sheet metal house	0	0.0
Other	1	0.6
Material Possessions		
Tertile 1	49	30.2
Tertile 2	70	43.2
Tertile 3	43	26.5
Kitchen inside the accommodation		
Yes	68	43.0
Not	90	57.0
Kitchen used as a dormitory		
Yes	21	29.2
Not	51	70.8
Kitchen room		
In a separate room from the one where I sleep. but in the accommodation	34	24.3
Outside the dwelling	45	32.1
No cooking done in the accommodation	61	43.6
Other (in the living room)	0	0.0

For cooking meals, the survey reveals the use of several types of fuels, including charcoal and butane gas (**Figure 1**) and different cooking methods, including coal-fired boilers without ventilation and gas stoves (**Figure 2**). The fuel most commonly used to cook food is butane gas (89.1%) (**Figure 1**), followed by coal (34.7%) and wood fire. The main cooking method used is the gas stove (84.4%) and the open fire cooking is the last (4.20%) (**Figure 2**).

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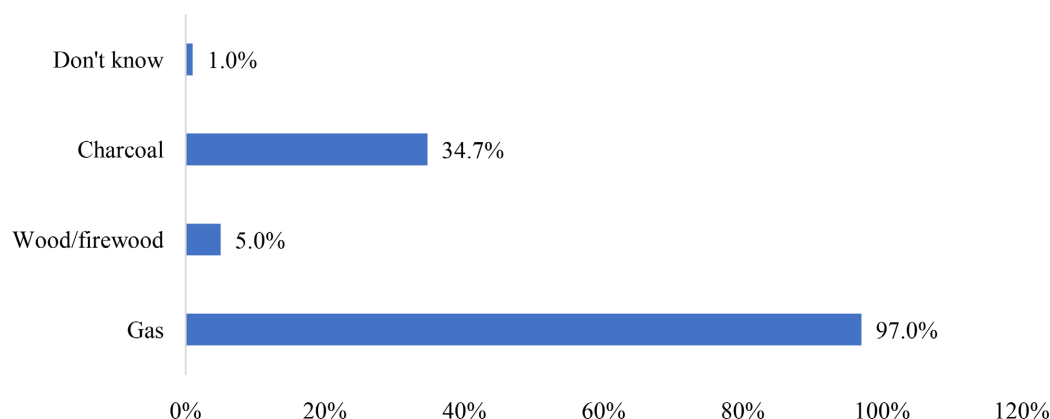


Figure 1. Fuels used to cook food in surveys.

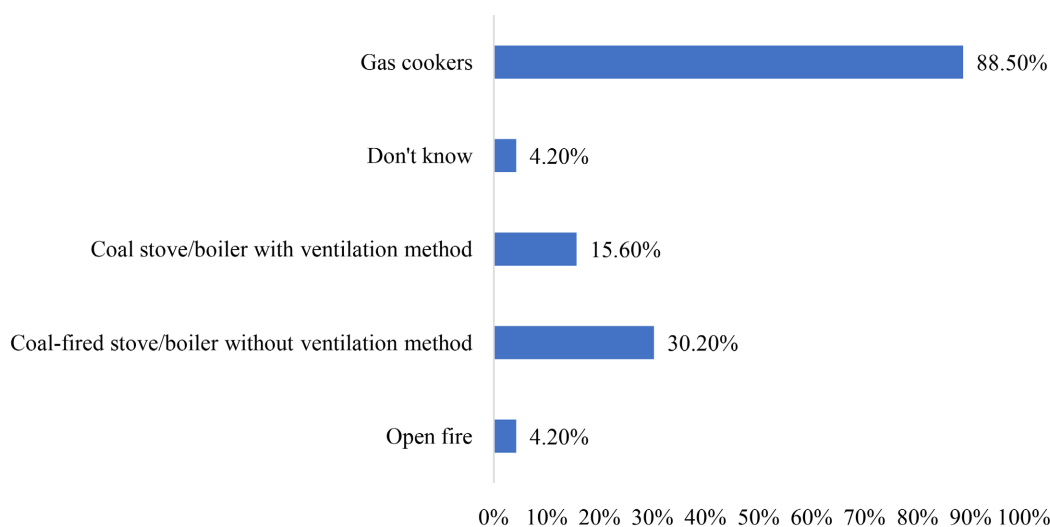


Figure 2. Cooking methods used in the surveys.

3.3. Previous Life Dispositions

The survey on previous living arrangements revealed that the majority of the employees in our cohort lived in rooms and buildings as tenants (49.1%), or in family homes (48.4%) (Table 3) and mainly in the city of Dakar (88.4%). Of the respondents, 3.1% had lived for 6 months or more in a home where cooking was done inside the dwelling (Table 3) and only one manipulator in our study population reported sleeping in the same room where cooking was done.

3.4. Investigation Health Status

The highest number of people surveyed believe they are in good health overall (48.1%). Only 4.9% of manual workers report being limited in the type or amount of work they need to do due to a disability or health problem (Table 4). Abdominal pain, dizziness, headaches, hemorrhoids, toothaches, hemorrhoids, malaria, and difficulty breathing are the main health problems that have caused impairment.

Table 3. Previous arrangements for the life of investigations.

Variables	Weighted headcount	Weighted Percentage (%)
Previous Housing		
Rented Room/Building	79	49.1
Kiosk/Rented Shop	1	0.6
Open space	0	0.0
Mosque	0	0.0
Detached house	0	0.0
Family Home	78	48.4
Mud/bamboo/sheet metal house	1	0.6
Other	2	1.2
Previous housing situation		
In today's city	137	88.4
Outside the current city	18	11.6
Cooking inside a dwelling or dwelling for 6 months or more		
Yes	5	3.1
Not	157	96.9
Kitchen used as a dormitory in this unit*		
Yes	1	
Not	4	

*Proportions not calculated due to total enrollment of less than 30.

Table 4. General health status and disability of surveys.

Variables	Weighted headcount	Weighted Percentage (%)
Appreciation of general health		
Excellent	9	5.6
Very good	29	17.9
Good	78	48.1
Average	41	25.3
Bad	4	2.5
Refusal to answer	1	0.6
Limited in the type or amount of work done due to an impairment or medical condition		
Yes	8	4.9
Not	154	95.1

Continued

Impairment or medical condition*	
Abdominal pain	1
Pain, dizziness, headaches	1
Haemorrhoids	1
Toothache	1
Malaria	1
Sensation of back pain	1
Feeling of tightness in the chest when breathing	1
Dizziness	1
Effect of the impairment or health problem on the work*	
Difficulty working	8

*Proportions not calculated due to total enrollment of less than 30.

Of all the problems identified in the surveys, only 7.4% sought treatment for any of these problems. Among the solutions, consultation in a private clinic or hospital was the most common recourse (83.3%) adopted by the latter in the search for a cure (Table 5). When they did not go to a health facility, they resorted to traditional medicine (16.7%).

4. Discussion

The informal economy covers a wide range of situations and types of employment that are not recognized or adequately protected by law and regulation, and is therefore more vulnerable to external shocks and business cycles compared to the formal environment [17]. The objective of this study was to determine the past and current living conditions of the electrical waste handlers in the Dakar region and to have an inventory of the perceptions of the electrical waste handlers on their state of health and on the sanitary arrangements for care when they suffer from any health problem.

The results show that 76.4% of our study population does not reside in the vicinity of the work site, but at least 1 km from the worksite. They usually live in rented rooms or with their families in temporary accommodation. In India, Ram Singh Bora, 2014, noted that informal workers generally reside in slums outside the states of Delhi, Haryana, and Uttar Pradesh where they work [18]. In fact, they tend to commute from the home to the workplace every day [19]. Although there is little research that attempts to understand the impact of occupational activity on the social environment of the worker and his contribution to occupational health and safety, our study has attempted to explore this aspect.

Table 5. Use of care for health problems encountered by surveys.

Variables	Weighted headcount	Weighted Frequency (%)
Self-medication*		
No	12	
Yes	0	
Traditional healer*		
No	10	
Yes	2	
Drug Store/Pharmacy*		
No	11	
Yes	1	
Clinic/Hospital*		
No	2	
Yes	10	
Other*		
No	12	
Yes	0	

*Proportions not calculated due to total enrollment of less than 30.

This is because informal WEEE recyclers face a high level of exposure to contaminants every day. By bringing home work clothes or bathing only once they get home, they increase the risk of bringing home the pollutants to which they have been exposed and their families at the same time. This set of facts contributes to the promotion of paraoccupational exposure, which is a consequence of the attitude of workers on the job and at home, and whose economic, social and health consequences are not negligible [20] [21]. A study conducted by Wang *et al.* 2016 on WEEE recycling showed that pollutants eliminated during various e-waste treatment processes are found in the homes of workers at these sites [22]. In this case, the precariousness of living conditions is an aggravating factor in exposure, knowing that they cannot avoid it by choosing to live in a less polluted place.

Regarding the perception of health, informal recyclers of WEEE in the Dakar region have a good perception of their state of health, contrary to studies conducted in Latin America that highlight a causal link between informal employment and the poor health of workers [23] [24]. According to the results of our study, more than half of the study population believe that they are in good health in general and are not limited in their work. This perception among WEEE recyclers in the Dakar region is in conflict with the conclusions of Quinlan M *et al.*, 2001, attributed to the high prevalence of poor health status of informal workers with precarious working conditions and poor living conditions [25].

However, several risk and vulnerability factors coexist in the informal sector. These factors include overcrowding on the job, poor food hygiene, poor sanitation, and poverty, which not only concern workers, but also take into account the families and environments [20] [26]. On the one hand, workers' views on their health reflect the importance of this work for them. In addition, it is not always easy to understand the health and safety behavior of informal sector workers, but also to be able to accurately identify the factors that influence their behaviour [27]. For example, some authors mean that women have a much more negative perception of their health compared to men, despite men's difficult working conditions, and a lower prevalence among informal workers [24] [28] [29]. According to the authors, women's perceptions of their health can be explained by a lack of protective determinants of health [29].

Recycling of electrical and electronic waste is an activity that promotes exposure to pollutants that are known in occupational health and safety to be harmful to health [30]. In addition to the considerations made about the perception of general health, the WEEE recyclers who were the subject of our study did not complain of major difficulties or deficiencies that would lead to a work stoppage. According to the findings of the study conducted by Ohajinwa CM *et al.* 2017 in Nigeria, the majority of recyclers in the e-waste sector do not perceive workplace injuries to be so serious that they require and worry about a work stoppage [31]. Within this population, the hazardous working conditions and pollutants to which they are exposed do not seem to be capable of causing health problems [31] [32]. For these workers, several other external determinants are more likely to cause health problems or functional disability [32]. In the face of such structural complexity, further research should lead to a better understanding of the health consequences of informal employment and its mechanisms, given that informal work is a heterogeneous phenomenon that makes research and policy-making particularly complex [12].

This study has some limitations. This is a cross-sectional study, which means that it does not make it possible to unequivocally establish a causal link between the variables such as a longitudinal study. Another limitation of the study is the fact that it is limited only to actors in the informal sector and does not take into account those in the formal sector, which would have made it possible to compare the two sectors of activity.

5. Conclusion

The living conditions of informal workers and their perception of their health status are not always documented. The informal recycling of electrical and electronic waste is characterized by a predominance of men, with a majority of students attending school up to primary school. This professional environment is inclined to promote paraprofessional exposure to pollutants present on work sites, with significant economic, social, and health consequences. The results of this study provide a foundation for occupational health and safety among in-

formal WEEE recyclers. They show that WEEE recyclers in the Dakar region have a good perception of their state of health, despite the precariousness of some housing and the difficult working conditions encountered in this professional environment. However, understanding the health of informal WEEE recyclers is not limited to determining their level of perception of this issue. A biomedical approach would consolidate these achievements by confirming or invalidating them. In order to assess the impact that the activity of handling waste electrical and electronic equipment can have on the health of these workers, we plan to carry out a chemical characterization of pollutants such as heavy metals in dust and air at WEEE sites, and to investigate these metals in the biological matrices of e-waste workers.

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Authors Contributions

Conceptualization: M.K., M.F.; methodology: M.K. and M.F.; investigation: R.F.F., M.F., C.D., and A.N.; data curation: R.F.F., M.K. and M.F.; supervision: M.K. M.C., C.D., A.T., A.L., and M.F.; validation: M.K. and M.F.; original draft: R.F.F.; writing—review and editing: R.F.F., A.N., F.B., M.C., A.T., and A.L. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study received approval from the research ethics committee of the Université Cheikh Anta Diop de Dakar (039912019/CERTCAD). The necessary ethical measures were taken to guarantee the anonymity, confidentiality and proper management of the data collected throughout the study.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data presented in this study are available upon request from the corresponding author.

Conflicts of Interest

The authors declare no conflict of interest.

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