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Research Article

Factors Impacting on Solid Health Care Waste Generation Rate amongst Health Facilities in Ethiopia

Yeshanew Ayele Tiruneh[1*], Modiba Lebtisi[2], and Zuma Sibusiso[2]

[1]Wachemo University College of Medicine and Public Health, Ethiopia

[2]Department of Health Studies, University of South Africa, South Africa

Abstract

Background: Solid healthcare waste management is a critical aspect of healthcare infrastructure and public health. It includes materials generated in healthcare facilities, laboratories, and research settings that may pose a threat to public health or the environment.

Aim: The purpose of this study is to assess solid health care waste generation and management toward developing guidelines.

Setting: All health facilities and workers in Hossaena town were participated.

Method: Mixed-method study design was used. Qualitative and quantitative samples were taken from the same population. Data were analysed by using relevant statistical tools. Open-ended responses and focused group findings were undertaken by quantifying and coding the data to provide a thematic narrative explanation.

Result: 540 completed questionnaires were collected from 41 health facilities. Health care waste segregation practice was not implemented in 78% of the health facilities. The qualitative observation asserted that inappropriate segregation practice was observed in 98.3% of waste containers. Lack of awareness and commitment are the main causes. Hand washing facilities are not available for 96.4% of the facility workers. 97.56% of infectious wastes were collected daily. Pre-treatment of SHCW before disposal was not practiced. Incinerations are the main method of disposal.

Conclusions: 97.56% of the health facilities were not using colour coded waste bins. Lack of knowledge, absence of training, lack of vaccinations, and inappropriately constructed incinerators are the leading causes of inappropriate SHCWMP.

Contribution: This study provided general information on health care waste generation and management practice for policy makers and health service officials

INTRODUCTION

Waste is generated by human activity; everyone creates it, but some people and organizations want to think about the consequence [1]. Solid waste can be classified into various types. On the basis of composition, solid waste can be divided into inorganic and organic waste; in terms of the form, it can be classified as solid waste, semi-solid waste. In consideration of the pollution characteristics, it can be divided into general and hazardous waste.

In the ancient history of human existence, it was peaceful and harmonious as a result of proper waste management. The major constituents of wastes were left over foods, vegetables, fruits, and wood [2]. During the provision of health services, health facilities generate solid and liquid wastes, such as sharps, blood, body parts, chemicals, pharmaceuticals, medical devices, and radioactive materials [3].

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Solid health care waste (SHCW) is any unwanted and discarded solid wastes generated from any health-related activities involving prevention of disease, promotion of health, rehabilitation, diagnosis treatment, research, and any health-related activities [4].

In developing world, particularly countries including Ethiopia, health care waste management (HCWM) system is an important area of public of health. Many health care providing facilities in this country do not meet the minimum standards of clinical waste management required for proper handling and disposal, this is because of very little attention given for HCWM. Problems are exacerbated by an unexpected increasing number of health care providing facilities like clinics, hospitals, and diagnostic laboratories, etc. The proportion of SHCW generation rate in the health facilities are not proportional to the WHO recommendation [5-7]. Waste that is generated at health care facilities if not managed properly can be of high risk to health facility staff, the patients, the community, the economy, public health, and the environment [8,9]. A growing waste management crisis is facing the African continent. Waste generation rate per capita and the volume of waste generated are relatively small compared to the developed worlds.

Rapid urbanization, consumers purchasing habit, and the increased population in Africa, has led to increased waste production related major socioeconomic transformation causing human health and the environment to be affected by the mismanagement of waste [10].

In Ethiopia, there is no updated separate regulation specific to HCW management in the country to enforce the proper segregation, collection, transportation, and treatment of HCW, though the non-compliance rate on the practice of appropriate waste management is high [11,12].

Wastes that contain disease causing organism from health care

service provision areas are remained a neglected public health problem in developing countries, resulted in polluting the environment and affecting the general masses. Waste management compliance with the standard HCWM practice still has not moved from paper to implementation practice [5].

According to Teshiwal et al. (2019: 3), In Ethiopia, there is no updated separate regulation specific to healthcare waste management in the country to enforce the proper segregation, collection, transportation, and treatment of HCW, though the noncompliance rate on the implementation of appropriate waste management is rampant. There are two HCWM guidelines prepared by the food, medicine, and health care administration and control authority (FMHACA), and the Federal Ministry of Health (FMOH), independently. In addition, studies indicate that lack of training, staff resistance, awareness, lack of adequate resources, managerial poor commitment, negligence, and an unfavourable attitude of the health care staff were the main identified challenges [12].

Waste generated during health care activities causes a higher risk of nosocomial infection and injuries. Health care waste is one of the major concerns, to human beings and the environment, which may significantly increase exposure to infectious pollutants. Health care waste management practices in the study area were not studied and the problems are not managed effectively. Limited research has been conducted in the country, making it difficult for decision- makers and experts to bring the issue into the health priority agenda to develop an environmental waste management plan and policy. This study assessed waste management practices toward developing guidelines to improve solid health care waste management practices. Only very few studies conducted in this country regarding solid medical waste and private health facilities were not considered in most of the studies. It is expected that the findings of this study have been enabling policymakers to make a wise decision regarding health care waste management that has been benefited local communities.

The purpose of this study is to investigate solid health care waste management practices toward developing guidelines to improve solid health care waste management practices in Ethiopia.

METHOD

A study setting is an area in which the research will take place [13]. The setting for this study was Hossaena Town health facilities. The health facilities found in the town has been, one university hospital, one private surgical centre, three government health centre, 17 medium clinics, and 19 small clinics were available in the town and, health facility workers who have direct contact on generating and disposal of HCW, and those who are responsible as a manager of health facilities found in Hossaena Town are the study settings.

The target population for the quantitative phase of this study was 556 health workers who have direct contact from generation to disposal and managers of health facilities were included in data collection. For the qualitative part of this study relatively small purposeful samples were considered, and a relatively large sample for the quantitative phase was used to enhance the generalization of the quantitative result. A simple random sampling technique is used, based on the theory of probability [14]. All health workers who have a role in health care waste management practice were included in the quantitative part of this study.

For an in-depth interview to get appropriate data, health facility managers, nurses, laboratory professionals, cleaners, and pharmacy professionals were selected purposefully. One health facility manager from each health facility (41 in number), one nurse from each department (41 in number), one laboratory technician (41 in number) one pharmacy technician (5 in number only from government health facilities), and one cleaner (41 in number) were selected purposely from all health facilities.

Multiple sources of data were collected, the data collection involves gathering both quantitative and qualitative data at roughly the same time, analysing the two databases separately, and then merging or comparing the results from the two databases [15,16].

The quantitative phase of this study assessed different components. Health care waste segregation practice, the availability of equipment for health care waste segregation, temporary storage facilities, transportation to final disposal, and disposal facilities data were collected by using a structured questionnaire, and observation and assessment of health care waste generation. Recycling or reusing practice, waste treatment, the availability of the HCWM committee, and training data were collected.

Ten environmental health technicians with at least a diploma and above were recruited for quantitative data collection including an assessment of the type of waste generated separately from each sampled health facility. The researcher pre-tests the quantitative data collection tool on 5% of the sample size. The qualitative phase of the data collection for this study was employed by using open-ended questionnaires, focus group discussions, and document and visual material analysis. Data collection was commenced with individual interviews by using structured questioners, followed by focus groups. To increase the credibility of the data collected both focus group interviews and observation was conducted by the principal investigator.

Data were analysed quantitatively by using relevant statistical tools. Descriptive statistics and Pearson correlation test were used for the bivariate associations and analysis of variance (ANOVA) to compare the health care waste generation rate by the type of health facilities. Bivariate (correlation) analyses were used to assess the relationships between independent and dependent variables. Then, multiple linear regression analysis, establish the simple correlation matrices between different variables for investigating the strength and form of the relationship between the variables included in the analysis.

The accurate and truthful depiction of the participant's lived experience was achieved in this study through prolonged engagement and persistent observation to learn the context of the phenomenon in which it is embedded and to minimise distortions. To assure the quality of the data, the questionnaire was translated from English into Amharic, considering the ease of comprehension of respondents, and again translated back to English by a language expert to check the consistency of meanings.

Data analysis

The data were entered into Epi data version 3.1 to minimize the data entering mistakes and exported to the statistical package for social science SPSS window version 27.0 for analysis. Data were analyzed both qualitatively and quantitatively using relevant statistical tools. Different tests are used to analyses data including frequencies, means, percentage, descriptive statistics and Pearson correlation tests are used for the bi-variate associations and analysis of variance (ANOVA) is performed to compare healthcare waste generation rate by the type of health facilities. Bivariate (correlation) analyses are used to assess the relationships between independent and dependent variables. Then, multiple linear regression analysis, establish the simple correlation matrices between different variables for investigating the strength and form of the relationship between the variables included in the analysis.

In this single-phase approach, the researchers of this study collected both quantitative and qualitative data, analysed them separately, and then compares the results to see if the findings confirm or disconfirm with each other. The key assumption of this approach is that both qualitative and quantitative data provide different types of information often detailed views of participants qualitatively and scores on instruments quantitatively [17].

Analysis, presentation, and description of the research findings

In this study, appropriate and scientific care was taken to maintain the quality of the data before, during, and after data collection by preparing the appropriate data collection tools, pretesting the data collection tools, providing training for data collectors, and appropriate data entry practice.

Data were cleaned during data collection practice on daily basis, during data entry, and before analysis of its completeness and consistency.

Data analysis in a convergent design consists of three phases. First, analyse the quantitative database in terms of statistical results. Second, analyse the qualitative database by coding the data and collapsing the codes into broad themes. Third, comes the mixed-method data analysis. This is the analysis that consists of integrating the two databases. This integration consists of merging the results from both the qualitative and the quantitative findings. After the data were entered by the researcher by using the computer software SPSS version 27, the analysis was done by the researcher with close technical support from an experienced researcher specialised in data management and analysis.

Descriptive analysis was conducted to describe and summarise the data obtained from the samples used for this study. Reliability statistics for constructs, means and modes of each item, frequencies and percentage distributions, chi-square test of association, and correlations (Spearman rho) were used to portray the respondents' responses.

All health facilities were included in this study, and the generation rate of health care waste and composition has assessed the practice of segregation, collection, transportation, and disposal system was observed quantitatively by using structured questionnaires. To ensure representativeness, various levels of health facilities were considered from the town.

RESULT

A total of 556 individual respondents from sampled health facilities were interviewed to complete the questionnaire. The total number of filled questionnaires collected were 540 (97.1), from individuals representing these 41 health facilities.

The quantitative part of this research finding is presented in two sections by using different data collection tools used for data collection in this study. The first section presents the results from the data gathered from participants' questionnaires, and this is presented in statistical and thematic narrative form, and the narrative stemmed from open-ended responses. The second section comprises a data presentation from a checklist used to inspect solid healthcare waste management practices. The qualitative part of these research findings obtained using FGD was presented using thematic analysis. The findings of the study are organised according to the specific objectives identified by the study.

The participant distribution according to the level of a health facility is that five hundred forty participants were involved in this study, 303 (65.4%) of the participants were from government health facilities and 187 (34.6%) were from private health facilities. Three hundred forty-three

(58%) of the respondents are female and 227 (42%) are male. The mean and median age of respondents is 29.09 (CI: 28.56-29.61) and 28 respectively, with a standard deviation of 5.82 (95%CI: 5.38-6.40), the minimum age of respondents was 18 and the maximum age of respondents was 56 years. Most of the research participants, 215 (39.8%) are in the age group of 26-30 (Table 1).

Nurses, cleaners, and health officers make up the largest number of professionals who are participated in this study. 194 (35.9%), 97 (18%), and 67 (12%) of the respondents are nurses, health care waste collection workers, and health officers, respectively in their profession. 354(65.5%) of the workers who participated in this study were from government health facilities and the rest were from private health institutions.

The smallest educational background working in health facilities is reading and understanding of written documents to facilitate the appropriate segregation of waste. The mean number of years spent in the facility was 3.66 (95%CI: 2.99-3.73) years. About 319 (59.1%) and 54 (28.5%) of the respondents are first-degree and diploma holders. Outpatient, emergency, inpatient, laboratory, cleaning department, laundry, imaging, Anti-retroviral therapy (ART), pharmacy, physiotherapy, ophthalmology, central intensive care unit (CICU), radiology, and dental department staff participated in this study. The work experience of the participants revealed that most of the study participants, 153 (28.3%) served their institution for less than one year. The majority (26.3%) of the respondents are working at outpatient departments followed by cleaning, laboratory, and obstetric departments. One thousand forty-two workers are working in the facilities found in Hossaena town; out of this 550 of them have direct contact with solid health care waste generation and disposal. Many of the staff 976 (91.7%) are working in government health facilities than private health facilities. 28,658 of patients have visited the health facilities in one month in Hossaena town.

Health care waste generation rate assessment was done at all study health facilities in the study area. Before starting to measure the generated solid health care wastes (SHCW) all solid health care wastes generated

Table 1: Health facilities and health facility workers participated in this study

Type of health facility	Facilities participated in this study		Health facility workers participated in this study		
	Number	%	Frequency	Percent	Cumulative Percent
Hospital	1	2.43	258	47.8	47.8
Government health centres	3	7.31	95	17.6	65.4
Medium clinics	17	41.46	79	14.6	80.0
Small clinics	19	46.34	92	17.0	97.0
Surgical Centre	1	2.43	16	3.0	100.0
Total	41	100	540	100.0	

before the study time was removed and disposed to a disposal site to get the accurate generation rate per day. The measuring and identification of SHCW were done for one week starting from Monday morning to the next Monday morning. To get an accurate measurement of the solid wastes generated in each health facility the principal investigator checked the digital weight scale three times per day for accuracy.

The health care waste generation rate was proportional to the number of patients who visited the health facilities and the type of service provided. The highest number of patients who visited the health facilities was in NEMMCSH, and the type of service provided was diverse and the waste generation rate was higher than other health facilities.

A total of 272 inpatient beds are available in the town, 95% of the inpatient beds are found in NEMMCSH. 33 (80.5%) of health facilities in Hossaena town have no inpatient services, these are medium and small clinics (private institutions). A total of 439.78 kilograms of waste are generated per day. Orthopedics ward, obstetric ward, neonatal intensive care unit, laboratory, and kitchen generated much amount of solid health care wastes compared to others which are, 56.1 kg, 53 kg, 34.4 kg, 34.08 kg, 31.7 kg of wastes generated daily respectively.

Paper and cardboard (141.65kg), leftover food (81.71 kg), and contaminated gloves (42.96 kg) are the leading health care waste generated per day. 128.22 kg (29.1%) and 311.5 kg (70.9%) of wastes are infectious and non-infectious wastes respectively. Diapers and metal tins used for powder milk packages are exclusively generated from the neonatal intensive care unit and pediatrics department. One hundred forty-three patients were admitted on average in different wards per day, and the average daily generation rate of solid health care waste per patient per bed per day was 1.67 Kg. The orthopedics' ward generates 2.24 Kg of waste per patient per bed per day, and the least SHCW generation rate per patient per bed per day was observed in the maternity ward which is 0.55 kg per patient per bed (Table 2).

Solid health care waste management practice (SHCWMP) was observed by the principal investigator for all the study health facilities. 240 health care providing rooms were observed in 41 health facilities. The result shows that 29.58% of the observed rooms were from outpatient departments and 40.41% of the observed health facilities were from medium clinics.

Three hundred one (55.7%) of the respondents responded to the availability of colour-coded waste bins in the facilities, and 239 (44.3%) of the respondents reported that there were no colour-coded waste bins in the facilities, but the observational finding confirmed that there is a separate container only in 2 (4.87%) (Government hospital and surgical centre) of the health facilities for infectious and non-infectious waste segregation practice and the rest were collected the generated SHCW by using single and non-colour coded containers.

The absence of colour coded waste bins is observed at medium and small clinics in the study areas. This is because the clinics are privately owned, and the regulatory bodies have poor controlling mechanisms. The main problem encountered in the effective management of

SHCWMP was a lack of awareness and commitment in relation to appropriate SHCW segregation practices. Providing practical-based SHCWM refresher training and continuous follow-up will improve the management of waste. This idea was supported by the study findings of Kist et al 2017 [18].

Three hundreds of the respondents, foot-operated dust bins are available in their health care facility to dispose of the generated solid HCW, and the rest of the respondents indicated that there are no foot-operated dustbins in the facility. The mean availability of foot-operated dust bins was 55.6% (CI: 51.5-59.5) and 212 (82.1%), 46 (48.42%), 17 (21.5%), 16 (17.39%), 9 (56.2%) in NEMMCSH, government health centres, medium clinics, small clinics, and surgical centre respectively.

Table 2: Infectious and non-infectious solid health care waste generated in the study health Facilities Health facilities

Health facilities	Number	Infectious waste generated		Non-infectious waste generated		Average total SHCW generation per day per facility
		KG	%	KG	%	
Hospital	1	128.22	77.2	311.5	84.99	439.72 kg
Health centres	3	6.8	4.09	9.2	2.51	5.33 kg
Medium clinics	17	15.3	9.21	20.38	5.56	1.22 kg
Small clinics	19	14.7	8.85	23.9	6.52	2.03 kg
Surgical centre	1	1	0.60	1.5	0.40	1.4 kg
Total		166.02		366.48		

Figure 1: Plastic bottles segregation and loading to transport for recycling

Health facility leaders have interviewed questions about the health care waste management practices of their respective health facilities. Health care waste generation rate assessment was not done at all health facilities found in Hossaena town. Figure 1 below shows only one health facility out of 41 health facilities recycled plastic bottles, and 50.6 kg of waste is generated and recycled by private organisations outside the facility per day. This finding was similar to the study findings of Debalkie & Kumie in Addis Ababa health facilities, reusing and recycling were not employed by any of the health facilities except recycling of plastic water bottles [19]. Healthcare waste minimization at the source of generation, reusing, and recycling was not employed by any of the case teams except recycling plastic water bottles. Health care waste generation rate assessment was not done at all health facilities found in Hossaena town. Only one health facility out of 41 recycled plastic bottles and 50.6 kg of wastes are generated daily and recycled by a private organisation outside the facility per day. This finding was similar to the study findings of Debalkie & Kumie in Addis Ababa health facilities, reusing and recycling was not employed by any of the health facilities except recycling of plastic water bottles [19]. Health care waste minimization at the source of generation, reusing, and recycling was not employed by any of the case teams except for recycling of plastic water bottles.

All the research participants who participated in this study are either generate or manage health care wastes generated in the study institution, but 434 (80.4% (95%CI:77-83.5) of the respondents are agreed for their responsibility is to manage properly the generated solid health care waste and the rest, even though they are responsible for appropriate management of solid health care waste generated in the institution, responded that for they have no role or responsibility for any solid waste management practices.

KNOWLEDGE ON THE INVOLVEMENT OF THE STAFF IN SHCWM PRACTICE

Segregation, educating the patient and attendants, protecting the environment from pollution, and I don't know are the answer for the question on the involvement of individual staff on SHCW management. 229 (42.4%) of the staff response shows their involvement in the segregation of SHCW and 192 (35.55%) of the respondents don't know their involvement in SHCWMP on the institution (Table 3).

Kumar, Somrongthong, Ahmed, and Almarabheh (2018: 2) found that a positive relationship between the knowledge and practice of the health facility workers (r=0.541 and P=<0.001). This signifies that the increase in knowledge of health workers about HCWM was positively related with their practices. However, 251 (46.48%) of the respondents did not know the national policy of SHCWM practice. Therefore, 17 (13.14%), 69 (12.77%), 95 (17.59%), 54(10%), 251 (46.48%) of the respondent's knowledge on national policy of SHCWM was red for infectious, yellow for infectious, segregation of waste, and preventing from air pollution respectively. About 108 (41.8%), 41 (43.15%), 43 (54.43%), 48 (52.17%), 11 (68.75) of the respondents were lack of knowledge on Ethiopian national SHCWMP for NEMMCSH, government health centres, medium clinics, small clinics, and surgical centers respectively (2018).

Table 3: Involvement of the staff on SHCWM practice in different levels of health facilities

Variable	Please describe your involvement in solid health care wastemanagement?					
Health facilities	Response					
	Proper disposal	Segregation	Educatingthe people	Protecting the environment	I don't know	Total
NEMMCSH N=1	33(12.7%)	111(43.02)	35(13.56)	7(2.71)	72(27.9)	**258**
Government health centresN =3	5(5.26)	34(35.7)	9(9.47)	5(5.26)	42(44.2)	**95**
Medium clinics N=17	4(5.06)	38(48)	5(5.26)	1(1.05)	31(32.6)	**79**
Small clinics N= 19	5(5.43)	39(42.3)	5(5.43)	2(2.1)	41(44.5)	**92**
Surgical centre N=1	1(6.25)	7(43.75)	1(6.25)	1(6.25)	6(37.5)	**16**
Total	**48 (8.88)**	**229(42.4%)**	**55 (10.1)**	**16 (2.96)**	**192 (35.55)**	**540**

All the facilities complain visitors, attendants, and patients' knowledge are poor on SHCW segregation practice; even they do not read the labels posted on SHCW containers. Health care waste (HCW) containers are not colour coded, but we are trying to label infectious and non-infectious in Amharic languages. 40 (97.5%) of the health facilities were not providing health education on SHCW management practice for the patient and visitors. One of the facilities (WUNEMMCSH) has given health education to patients and visitors, but it was not continuous and some of the attendants waiting areas were missed in the health education program.

Fifty-three percent of the research participants responded they have knowledge of the national policy of SHCWM practice. These findings were nearly similar to the study findings in India which are 55% of respondents were aware of the existing BMW management policy systems in India [20]. But the qualitative observational result of this study shows that the practice of waste management was not similar to the findings of the respondent's answer.

DISCUSSION

Out of 540 participants in this research 343 (58%) of the respondents were female. This finding is similar to the study conducted in KwaZulu Natal province South Africa, and Egypt, female respondents are greater than male and contrary to the study findings conducted in Palestine by Tabash, et al [21-23].

The health care waste generation rate was proportional to the number of patients who visited the health facilities and the type of service provided. This finding was consistent with the study findings in Vhembe District of Limpopo Province is dependent on the type (or hierarchy) of the healthcare facility, the type of services being rendered, the number of patients attended to on a daily basis, and whether or not there is provision for admission of patients [24].

The average daily generation rate of solid health care waste per patient per bed per day was 1.67 Kg. These findings show a less generation rate compared to the findings of the study conducted in Iran which is 2.72 kg of waste per patient per bed per day [25]. And higher than the study findings in Nigeria and Addis Ababa which is 0.181 and 0.668 kg per patient per day respectively [26]. The highest solid health care waste generation (SHCWG) per patient per day was observed in the orthopedics ward which is 2.24 kg per patient per bed per day. This finding was contrary to the study conducted in the study by Asrat et al and Rafiee et al respectively which is the highest SHCWG were observed at obstetric ward and operation theatre [27,25].

165 kg (31.16%) of the generated wastes per day in the study health facilities were infectious and 366.48 kg (68.84%) of the waste generated is non-infectious or household waste. This finding was contrary to world health organisation findings, which is 15 % of the generated wastes are infectious, which is twofold greater than the WHO study. In contrary to the WHO findings another study conducted in Ethiopia and Iran by Asrat, et al and Rafiee et al shows greater than 57% and 42.2 % of the generated wastes respectively were infectious and which is greater than the study findings of this research [27,25].

This indicates that the segregation of different types of wastes at the source of generation wasn't properly implemented in the studied health facilities. Average health care waste generation in government health centre was 5.33 kg per day. Medium and small clinics generate a very small amount of solid health care waste compared to the government health centres which is 1.2 and 2.03 kg of SHCW per day per facility respectively. This finding was consistent with the study findings of Khan et al., in Pakistan shows consolidated waste generation rate of waste measured at clinics was calculated to be 2.01 kg/day/clinic [28]. In this study site, government health facilities generate more waste compared to private health facilities. This finding was consistent to the study findings of Debre et al., in three government and three private health facilities in Addis Ababa. And contrary to the study findings done in Mongolia, which shows in the private health facilities, the percentage of medical wastes was higher in the public facilities [29].

The observational finding confirmed that there is a separate container only in 2 (4.87%) (Government hospital and surgical centre) of the health facilities for infectious and non- infectious waste segregation practice and the rest were collected the generated SHCW by using single and non-colour coded containers. This finding was similar to the study findings of Debalkie and Kumie at Menelik II referral hospital in Addis Ababa [19]. One out of the 4 government health facilities and one out of the 37 private health facilities uses colour coded waste bins. This finding was contrary to the study findings of Berihun & Solomon in Addis Ababa, all government health facilities use two types of color coded labeling containers and these findings are similar for private health facilities that is all private health facilities are used uncovered plastic buckets of any type for on-site waste storage until collected for disposal [30].

The absence of colour coded waste bins is observed at medium and small clinics in the study areas. This is because of the clinics are privately owned and the regulatory bodies have poor controlling mechanisms. This finding was similar to the study findings of Khan et al., in Pakistan, no colour coding or labelling procedure was found [31].

CONCLUSIONS

Availability of colour coded waste bins was asked for respondents and observation was conducted to confirm the availability. But the qualitative observation shows 97.56% of the health facilities were not using the colour coded waste bin and this leads to mixing of infectious and non-infectious solid health care waste together and the mixed health care wastes are more contaminated than segregated SHCW. In addition to these private clinics are disposing of SHCW except sharps to the municipal solid waste disposal (SWD) dumping site, and this affects the solid waste disposal crew and the municipal disposal sites.

ETHICS APPROVAL

Before the data collection all research participants were asked to participate in this study and oral consent was taken from all health facilities and health care workers. This is a normal mixed method study and none of the experimental technique was applied in this study. Ethical approval was obtained from university of south Africa department of health studies and zonal health department and, the hospital medical ethical and research ethics review committee.

CONSENT TO PARTICIPATE

The authors declare that they have no competing interests both financially and non-financially that is associated to this manuscript, and they are consented to the publication.

CONSENT TO PUBLISH

All the authors are consented for publication and there is no conflict of interest.

AUTHORS CONTRIBUTION

Yeshanew ayele is a researcher of this study and professor Modiba and Dr Zuma are supervisors for this study. This study manuscript was written together with supervisors. Finally, the three authors are read and

approved the final version of the manuscript.

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