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## **Handling and disposal practices of compact fluorescent lamps (CFLs) at a village in Limpopo Province, South Africa**

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### **Abstract**

This study investigated the practices of households concerning the handling and disposal of used and broken Compact fluorescent lamps (CFLs) at a village in Limpopo Province of South Africa. Cross-sectional quantitative design was used. A self-administered structured questionnaire was used to collect data. Cluster random sampling was used to select a sample of 338 households who participated in the study. The results indicated that 53.6 % of the households had improper handling and disposal practices while 46.4% had proper handling and disposal practices of broken and used CFLs. The results further indicated a relationship between gender, age and employment status with practice on the handling and disposal of broken and used CFLs. The study concluded that more than half of respondents had improper handling and disposal practice of CFLs. These results necessitate community education about proper disposal methods and handling of broken and used CFLs as well as establishment of disposal site by the municipality.

**Keywords:** Waste handling, waste disposal, compact fluorescent lamps, mercury exposure, practices, rural village.

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### **Introduction**

One compact fluorescent lamp (CFL) contains up to 30 mg of mercury (Hg) which is released as vapour when the lamp is broken (Lombard & Webb, 2008; Nance, Patterson, Willis, Foronda & Dourson, 2012; Hu & Chen, 2012; Kesavarao, Sridevi, Lakshmi & Modi, 2013). Compact fluorescent lamps can break accidentally during use and used CFLs can break when improperly disposed. Mercury, a natural element found in the rocks, is a toxic metal which causes damage to the central nervous system, reproductive system in human beings and can also pollute the environment (Thakur, Prinja, Singh, Rajwanshi & Prasad, 2010; Thapa, Sharma, Kang & Sillanpää, 2014). Siziba, Naicker, Mathee and Swart (2014) and Lombard and Webb (2008) found that there is a lack of awareness amongst the public regarding health and environmental hazards resulting from broken CFLs in South Africa. Furthermore, there is also a lack of

policies and guidelines on the handling and disposal of broken and used CFLs in South Africa. As CFLs use less electricity than ordinary incandescent light bulbs (Wagner, 2011; [Nance et al., 2012](#)), the South African government has been distributing free CFLs to households in the village since 2007 as a means to save electricity, but these distributions are being done without putting much effort on raising awareness about potential environmental and health hazards of mercury release and proper disposal methods of broken and used CFLs.

This study was conducted to determine the practices of households concerning the disposal of used and broken CFLs at a village in South Africa. In this study practices refer to the usual way of handling and disposing used and broken CFLs by household members.

## **Methodology**

### *Study design*

The study followed a quantitative design. The cross sectional quantitative design was chosen because the researchers wanted to determine the practices of villagers concerning disposal and handling practices of used and broken CFLs and the associations between demographic variables with the practices.

### *Study site*

The study was conducted at a village in the Greater Tzaneen local municipality, about 75 kilometres on the eastern side of a town called Tzaneen, in the Mopani District of Limpopo Province, South Africa. The village was supplied with electricity in 1993 and at the time of the study, there was no formal landfill and refuse collection services provided by the local municipality. As such, disposal of refuse was a challenge to people in the village.

### *Population and sampling*

According to the population register kept by the traditional leader (*ntona*), the village had 3500 residents who lived in 650 households arranged into three sections which were called Block 10, Block 11A and Block 11B. Block 10 had 500 households with each household having a stand number starting from stand number 1 to 500. Block 11A had 95 households numbered from 1 to 95 while Block 11B had 55 households numbered 1 to 55.

The target population for the study included males and females of 15 years and older who could read and write as the questionnaire was self-administered. A sample of 338 households was randomly selected using a cluster random sampling method as described by Polit and Beck (2012). The sections of the

village became clusters for sampling purpose and 217 households were randomly selected from Block 10, 76 households from Block 11A while 45 households were randomly selected from Block 11B. Krejcie and Morgan's (1970) formula was used to calculate the sample size at 95% and 99% confidence levels.

#### *Data collection*

Data were collected over a period of two months by means of a self-administered structured questionnaire which had three sections. Section A had questions on the demographic information; Section B had questions about practices concerning the handling of broken CFLs while Section C had questions on the disposal methods of used CFLs. The questionnaire was translated from English to *Sesotho sa Lebowa* (Northern Sotho) which was according to Greater Tzaneen Municipality (2014), a local language spoken by the majority of the citizens in the village. A pilot study was conducted with ten respondents to check the reliability and validity of the questionnaire and as a result, the questionnaire was refined with the help of a statistician at the University of Limpopo. The questionnaires were distributed to the respondents to complete and were handed back to the researchers after about 45 minutes.

#### *Validity and reliability*

To ensure validity and reliability, the questionnaire was reviewed by two researchers during its development and a pilot study was done where the questionnaire was administered to 10 participants from the village and those participants did not form part of the main study. The results of the pilot study indicated that all the items in the questionnaire were understood by the participants.

#### *Data analysis*

Data were analysed with the help of a statistician using Statistical Package for the Social Sciences (SPSS) version 18. Descriptive statistics were provided and Spearman correlation was used to compare the relationship between variables.

#### *Ethical consideration*

The research proposal for the study was approved by the Senior Degrees Committee of the School of Health Sciences while ethical clearance was given by the Medunsa Research and Ethics Committee of the Faculty of Health Sciences at the University of Limpopo. Permission to enter the village and collect data was obtained from the traditional leader (*ntona*) of the village. All adult respondents signed a consent form to participate voluntarily in the study while those who were minor had their parents consenting for them after they

were given information about the study as suggested by Strode, Slack and Essack (2010) and Strode and Slack (2011). The researchers maintained anonymity and confidentiality of the data throughout the study by not writing the names of respondents on the questionnaires and keeping the questionnaires in a locked place.

## Results

### *Demographic data*

Table 1 shows the demographic profile of the 338 respondents.

**Table 1:** Demographic data

Variables		Score (%)
1. Gender	Male	33%
	Female	67%
2. Age Distribution in Years	15-35	65.7%
	36-60	28.7%
	61+	5.6%
3. Employment Status	Employed	10.9%
	Unemployed	36.4%
	Student	52.7%

More females (67%) than males (33%) completed the questionnaire. The majority of the respondents (65.7%) were between the ages of 15 to 35 years; 28.7% were between 36 to 60 years while only 5.6% were above 60 years. The majority (52.7%) were students as compared to 10, 9% of those employed and 36.4% who were unemployed.

### *Handling of Broken CFLs*

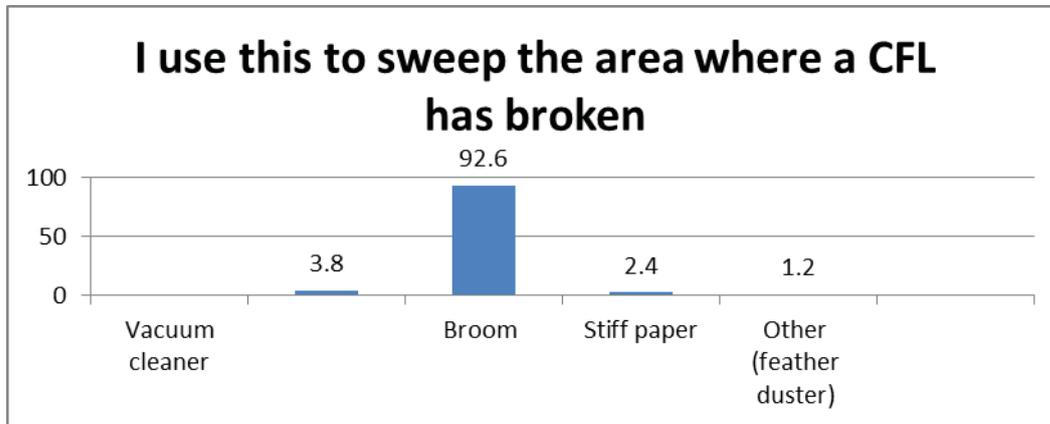
Table 2 indicates that 64.5% of respondents never ventilated the room in which a CFL has broken before cleaning as compared to only 19.2% who always ventilated it and 16.3% who ventilated it sometimes. The majority (71.9%) never puts on gloves as compared to only 12.1% who always wear gloves while 16% sometimes put on gloves when removing pieces of broken CFL glass. More than three quarters (76.9%) never removed people and pets from a room in which a CFL has broken while 14.5% did so always and 8, 6% did so sometimes. Only 8, 3% always used a sticky tape to pick pieces of glass and mercury powder from the floor while 7.4% used it sometimes as compared to 84.3% who never used it. The majority (71.3%) never kept a heater or fan switched on when a CFL has broken as compared to only 12.4% who always kept them switched on while 16.3% kept them switched on sometimes. More than half (63.9%) of the

respondents never disposed debris in a sealed plastic bag after cleaning a broken CFL as compared to only 11.2% who always did so while 24.9% did so sometimes. Only 32.5% of the respondents always washed their hand and faces, and also changed clothing after cleaning a broken CFL as compared to 43.8 % who never did so while 23.7% indicated that they sometimes washed and changed clothing after cleaning a broken CFL. Three quarters of the respondents (75.7%) indicated that they never took measures to prevent breakage of used CFLs by placing linen on the floor in case they fall while replacing them as compared to only 13% who always took measures to prevent breakages while 11.2% took measures sometimes.

**Table 2:** Handling and disposal practices concerning broken and used CFLs

<b>Item</b>	<b>Always</b>	<b>Sometimes</b>	<b>Never</b>
1. I separate fused CFLs from household waste	34.9%	0%	65.1%
2. I burn my used CFLs with my household waste	39.3%	0%	60.7%
3. I break or crush my used CFLs before disposal	23.7%	0%	76.3%
4. I place linen on the floor when changing a fused CFL to avoid breakage in case it falls.	13%	11.2%	75.7%
5. I ventilate my room before I start to clean broken CFLs	19.2%	16.3%	64.5%
6. I use gloves to remove pieces of broken CFLs glass	12.1%	16%	71.9%
7. I remove people and pets from the room in which CFL has broken	14.5%	8.6%	76.9%
8. I use a sticky tape to pick pieces of broken glass and mercury powder from the floor	8.3%	7.4%	84.3%
9. I keep a heater or fan turned off when a CFL has broken	12.4%	16.3%	71.3%
10. I dispose the debris in a sealable plastic bag after cleaning a broken CFL	11.2%	24.9%	63.9%
11. I wash my hands, face and change clothes after cleaning broken CFLs	32.5%	23.7%	43.8%

Figure 1 indicates that the majority (92.6%) of the respondents used a broom to sweep an area where a CFL has broken as compared to only 2.4% who used a stiff paper.

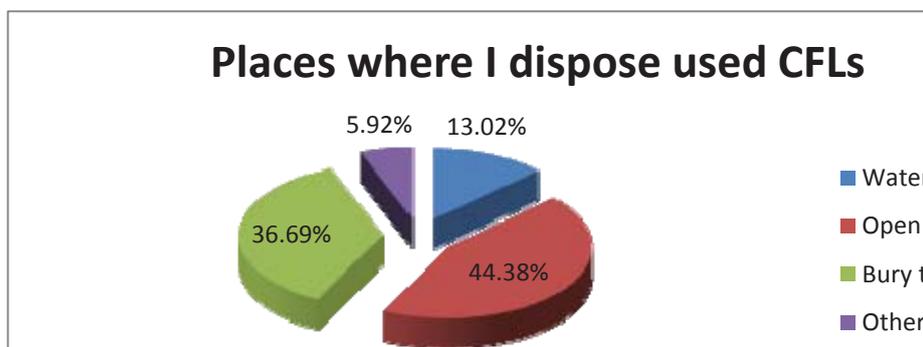


**Figure 1:** Things people used to sweep broken CFLs

A vacuum cleaner was used by 3.8% while 1.2% used a feather duster. Only 3.3% of the respondents used a disposable paper towel to wipe the area where CFL has broken compared to 68.1% of those who used a mop. Some (26.3%) used a cleaning towel/cloth while few (2.4%) used other wiping material.

*Disposal of used CFLs*

Table 2 indicates that only 34.9% of respondents always separated used CFLs from household waste compared to 65.1% who never separated them. More than half of the respondents (60.7%) never burned used CFLs with household waste as compared to 39.1% of those who always burned them. Only 23.7% always crushed or broke used CFLs before disposing them compared to 76.3% of those who never broke or crushed them. Fig 2 indicates that the majority of respondents (44.4%) disposed used CFLs in the open yard while 13% disposed them in a water stream. Those who dug a hole to bury used CFLs were 36% while 5.9% disposed them in a pit toilet.



**Figure 2:** Places where people disposed used CFLs

*Relationship between Age, Gender and Employment status with Practice*

Table 3 indicates that more than half (61.9%) of the males handled and disposed broken and used CFLs improperly as compared to 38.1% who handled and disposed broken and used CFLs properly. Less than half (49.3%) of the females had improper practice with regard to the handling and disposal of broken and used CFLs as compared to 50.7% who handled and disposed broken and used CFLs properly. The p value for the relationship between gender and practice is 0.028.

**Table 3:** Relationships between variables

<b>Gender</b>	<b>Practice</b>		<b>P value</b>
	Improper Practice	Proper Practice	
Male	61.9%	38.1%	0.028
Female	49.3%	50.7%	
<b>Age in Years</b>			0.001
15 – 35	60.4%	39.6%	0.001
36 – 60	43.3%	56.7%	
61+	26.3%	73.7%	
<b>Employment Status</b>			0.000
Employed	70.3%	29.7%	0.000
Unemployed	27.6%	72.4%	
Student	68%	32%	

Table 3 also indicates that more than half (60.4%) of respondents aged 15 and 35 had improper handling and disposal practices of broken and used CFLs as compared to 39.6% of those who had proper handling and disposal practices. Less than half (43.3%) of the respondents aged between 36 and 60 years had improper handling and disposal practices as compared to 56.7% of those who had proper handling and disposal practices. The majority (73.7%) of those aged 61 and above had proper handling and disposal practices as compared to only 26.3% of those with improper handling and disposal practices. The p value for the relationship between age and practice is 0.001.

Table 3 further indicates the relationship between employment status and practice. The majority of the employed respondents (70.3%) had improper practices as compared to 29.7% of those employed. Amongst the unemployed respondents, less than half (27.6%) had improper handling and disposal practices of broken and used CFLs as compared to 72.4% of those with proper handling and disposal practices. More than half (68%) of the students had improper practices of handling and disposing broken and used CFLs as compared to only 32% of those who had proper handling and disposal practices. The p value for the relationship between employment status and practice is 0.000.

Table 4 indicates that in total more people in the village (53.6%) had improper handling and disposal practices of broken and used CFLs as compared to (46.4%) of those who had proper practices of handling and disposing CFLs.

**Table 4:** Practice for the whole population

Practice	Frequency	Percent
Improper Practice	187	53.6%
Proper Practice	157	46.4%
<b>Total</b>	<b>338</b>	<b>100%</b>

## Discussion

The results show that more women than men participated in the study and that more people were unemployed as compared to those employed. The high participation of women in the study could be associated with the high unemployment rate, affecting more women than men, in the municipality (Greater Tzaneen Municipality, 2014). The high participation rate by people in the 15 – 35 age groups can be associated with the finding that students were in the majority.

Most people in the village do not separate CFLs from other household waste which suggests that CFLs are disposed with ordinary household waste. Separation of waste is a challenge which requires coordinated efforts in order to educate and encourage citizens to practice (Rousta & Ekström, 2013; Akinro, 2014). The local municipality which governs the village has indicated that it has 89% backlog regarding refuse removal in rural areas (Greater Tzaneen Municipality, 2014). This suggests that the municipality is failing to implement refuse collection services in the village, leading to people burning refuse, disposing refuse into water streams, on any open spaces in the village while others dispose their refuse into pit toilets. Disposing refuse into pit latrines is a common practice in South Africa even in areas where municipalities collect refuse regularly (Bakare, Foxon, Brouckaert & Buckley, 2012; Brouckaert, Foxon & Wood, 2013). Ukpong and Udofia (2011) suggest that disposing waste through burning and dumping into water sources are common practices in areas where refuse collection by municipalities is a problem. Aucott, McLinden and Winka (2003) have found that only about 20% of used CFLs are recycled in the USA and are of the view that the rest are disposed with general refuse where they break and release mercury. The Minnesota Protection Control Agency (2007) advises that CFLs be recycled instead of being disposed in open spaces, water streams or buried in the ground.

The results of the study suggest a relationship between gender, age and employment status with handling and disposal practices of broken and used CFLs. The study results revealed that more females disposed CFLs properly as

compared to males. Disposal of household refuse is part of the domestic work of cleaning, which according to Asi, Busch and Nkengla (2013), is a role for women in most societies. This suggests that females would perform this domestic cleaning task better than males. The results of the study also indicated that the majority of young people who were also students were not disposing CFLs properly as compared to older people. This is in agreement with Hedge and Hunt (2010) who found that the majority of students disposed CFLs with general household waste as they did not believe that CFLs contain mercury. Siziba et al. (2014) found that public schools in one province of South Africa did not have policies on the handling of CFLs which suggests that broken and used CFLs are handled as general waste.

Most participants in the study used a broom to sweep an area where a CFL had broken instead of using a stiff paper and wiped with a mob instead of with a disposable paper towel. These sweeping and wiping practices break the mercury from broken CFL into droplets and spread them over the area increasing the risk of exposure to people in the household (United States Environmental Protection Agency, 2013). The results of the study suggest that people in the village generally dispose CFLs improperly and this is in agreement with the findings of Mauro, Jarbas, Gilmar and Mamerto (2011) that most people do not recycle CFLs and thus dispose them improperly.

### **Recommendations**

The study recommends that a coordinated education and community awareness campaigns on handling and disposal of CFLs which should include recycling be designed and implemented in the village. It further recommends that the local municipality be engaged to establish controlled disposal systems of CFLs containing waste such as drop off centres for used CFLs which should also provide some incentives for compliance

### **Conclusion**

The study investigated the practices of households regarding the handling and disposal of used and broken CFLs at a village in Limpopo Province of South Africa. Most females, young people and students participated in the study. Gender, age and employment status had an influence on the handling and disposal of broken and used CFLs. Refuse disposal service provision by the municipality was poor and participants disposed refuse in open spaces, rivers, and pit toilets while others burned it. The results suggest that the majority of households in the village handled and disposed broken and used CFLs improperly. Education, community awareness campaigns and establishment of safe containment facilities for CFLs are critical for improving proper practices on disposal of used and broken CFLs. Successful proper practice depends on the

commitment and engagement of the municipality to establish controlled disposal systems for CFLs containing waste and educating the households.

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