HOUSING CHARACTERISTICS AND MODE OF HOUSEHOLD SOLID WASTE DISPOSAL IN GHANA: AN EMPIRICAL ESTIMATION

Isaac DASMANİ *

ABSTRACT

Improper solid waste disposal practices have negative consequences on the environment and the health of residents. While several factors have been blamed for poor solid waste disposal practices in most developing countries, household socio-economic and housing characteristics have received less attention in the scholarly literature in terms of how they affect residents' waste disposal practices. This study, therefore, seeks to investigate whether the type of dwelling characteristics, coupled with household socio-economic features, influence the choice of a particular mode of solid waste disposal. Using data from the Ghana Living Standards Survey, we found that the major socio-economic characteristics that influence the household mode of solid waste disposal are; education, type of employment, residence (urban/rural) including housing characteristics, and income is found to be neutral in this case. More specifically, a multinomial logistic regression of the relative risk ratio shows that majority of those who contract private waste collectors either stay in a separate house or compound house (rooms). Similarly, 82.46% of those who dispose of their waste by burning stay in either a separate house or compound house (rooms), or huts/building (in the same compound). Education is found to be a strong variable in determining the mode of solid waste disposal by households. Self-employed persons tend to practice more burning of refuse, public dumping, and indiscriminate dumping. Policy implications are discussed in the paper.

Keywords: Housing characteristics; Mode of solid waste disposal; Households; Econometric analysis; Ghana.

JEL Codes: D13, Q53, R20.

1. INTRODUCTION

Over the past decades, solid waste generation around the globe has been increasing rapidly, with developing countries contributing significantly to this global waste phenomenon. For example, in 2012, the global generation of solid waste by the urban population was estimated at 1.3 billion tons,

* Department of Economics Studies, School of Economics, University of Cape Coast, Cape Coast, Ghana.   E-mail: sdadzie@ucc.edu.gh

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representing an increase of about 48% over the preceding 10 years, and this rate of generation is expected to increase to 2.2 billion tons by 2025 (Hoornweg & Bhada-Tata, 2012). In 2012, China's contribution to the global waste generation rate was approximately 170.8 million tons (National Bureau of Statistics of China, 2017), with a significant increase in the per capita waste generation from 0.50 per day in 1980 to 0.98 kg per day in 2006 (Zhang et al., 2010). This has been attributed to the rapidly increasing urbanization and population growth, coupled with the changing consumption pattern associated with urbanization and improved well-being (JICA & Pak-EPA, 2005).

In developing countries, solid waste disposal has become a social menace, which negatively affects many people and the environment. This situation is worsened by such factors as rapid urbanization, economic growth, disjointed policies, and weak governance and institutional issues (Marshall, 2013). Some researchers (see Batool et al., 2008; Visvanathan & Trankler, 2003) have asserted that people's enjoyment of improved living standards with higher consumption rates of packaged food increases per capita waste generation.

Effective solid waste management constitutes a major financial burden in developing countries, with most municipal authorities spending between 20-50% of their budget on solid waste management (World Bank, 2016). Thus, with huge quantities of municipal solid waste generated daily, municipal authorities require substantial revenue and administrative ability in order to effectively deal with the problem (Beukerering et al., 1999). Consequently, it is estimated that 30-60% of the waste remains uncollected and that more than half of the population in the developing world never receives waste collection services (World Bank, 2016). Uncollected and poorly disposed of wastes have been implicated in a number of potentially adverse environmental impacts, including flooding, emissions of gases and chemicals that pollute the air, water, and lands, such as vermin, dust, fumes, and odour which cause damage to valuable agricultural/recreational land (see El-Fadel et al., 1997; Lisk, 1991; Rabl et al., 2008).

In addition, poor solid waste management is responsible for morbidity and mortality situations in most developing countries, especially among the urban poor and the hard-to-reach areas (Marshall, 2013). For example, most of the waste remains uncollected and emits a foul smell into the atmosphere, particularly in low-income areas where the solid waste is often mixed with human excreta due to inadequate sanitation facilities (Boadi & Kuitunen, 2003). Improper solid waste management also leads to substantial negative environmental impacts (for example, pollution of air, soil, and water, and generation of greenhouse gases from landfills), and health and safety problems (such as diseases spread by insects and rodents attracted by garbage heaps, and diseases associated with different forms of pollution). The local authorities charged with the responsibility of providing solid waste management services have found it increasingly difficult to play this role. This difficulty has been aggravated by a lack of effective legislation, inadequate funds and services, and the inability of authorities to provide the services cost-efficiently.

In Ghana, solid waste generation is growing steadily and the Ministry of Local Government and Rural Development (MLGRD, 2010), in a forecast in the National Environmental Sanitation Strategy and Action Plan (NESSAP) 2010–2015, reported a generation rate of 0.75 kg/person/day for all metropolitan cities in the country. Meanwhile, waste generation rates across Ghana, irrespective of the socioeconomic characteristics, range from 0.2 to 0.8 kg/person/day, which is similar to the generation rate for most cities in Sub-Saharan Africa (Friedrich & Trois, 2011; UNEP, 2013; Miezah et al., 2015). However, higher generation rates—about 1.39 kg/person/day—have been reported for Organisation for Economic Co-operation and Development (OECD) countries (OECD, 2010), reflecting the fear that increasing income levels in Ghana can worsen the waste generation problems. According to National Environmental Sanitation Strategy and Action Plan (NESSAP) (2010), the Tema Metropolitan Assembly, for instance, was able to collect only 263 tons out of 537 tons of waste generated per day. In the face of the increasing cost of waste collection, transportation, and disposal, together with the long-distance location of new disposal sites, the already poor collection performance is likely to further deteriorate.

Oduro-Kwarteng (2011) noted that three different modes of solid waste collection are practiced in Ghana: kerbside collection, house-to-house collection, and communal collection. These modes of solid waste are based on the income levels of the people, types of housing, and the required level of service. Kerbside and house-to-house collections are mostly rendered in middle- and high-income residential areas but the communal collection is rendered in low-income areas. In the kerbside collection system, waste is deposited at the kerbside on specific days within the week to be taken by the collection crew while in the house-to-house collection, the crew picks up the waste to be emptied from each property, with the bin returned after the waste is emptied into collection vehicles. In the communal collection, waste is deposited into containers placed at vantage points within the community and picked up by collection vehicles when they are full. One of the perceived factors responsible for ineffective solid waste collection, especially in low-income urban residential areas, is the poor housing characteristics, where collection trucks find it difficult to move around the areas to pick up waste containers (Mariwah, 2018; Marshall, 2013). Thus, irrespective of the waste collection in different income residential areas, it has been argued that huge disparities exist in the level of waste collection service (Oduro-Kwarteng, 2011; Tsiboe 2004).

Previous studies on household waste generation and management (disposal) largely focused on advanced countries rather than Sub-Saharan African countries (Foukaras & Toma, 2014; Skutmatz, 2008). Some of these studies (Bel & Gradus, 2016; Carattini, Baranzinic, & Lalive, 2018; Dijkgraaf & Gradus, 2014) looked at how sanitation laws and pricing of household waste disposal (unit-based pricing) affect the waste generation and disposal by households. Within this tranche of studies, other papers (Song, Wang & Li, 2016) have also examined the willingness of people to pay for improved

sanitation management and disposal technologies while Gyimah, Mariwah, Antwi, and Ansah-Mensah (2019) have examined household solid waste separation practices.

To the best of our knowledge, the studies conducted in some SSA countries (Kadafa, 2017; Ogwueleka, 2009; Sankoh et al., 2012) rarely look at how the type of dwelling characteristics influences the choice of a particular mode of waste disposal. While Kadafa (2017) looked at which mode of solid waste disposal is dominant among households in Abuja (the Federal Capital of Nigeria), Sankoh et al., (2012) concentrated on household solid waste generation and composition in Freetown, Sierra Leon. These two studies, even though they verified that socio-economic factors influence household waste generation; neglected the housing or dwelling type and waste generation and disposal. Ogwueleka (2009) focused on factors (institutional, economic, social, financial, and technical) that could help to achieve sustainable and effective management of municipal solid waste in Nigeria. One other study that partly focused on the subject matter of this current study was by Chuen-Khee and Othman (2010), who looked at how the status of house ownership influences the willingness-to-pay (WTP) for the service characteristics of various disposal technologies that are offered; they found that those owning a house were 1.48 times more likely WTP than those renting their residences. The authors added that this, generally, shows that the public is more wary of the disposal options if they are permanently staying in a residence. Renting a house would mean a temporary stay as one can move elsewhere if the place is receiving negative externalities from solid waste management-related issues. Chuen-Khee and Othman, however, did not look at the type of housing unit that one stays in and how that affects the mode of waste disposal such a person adopts. It is against this background that this study seeks to investigate whether the type of dwelling characteristics influences the choice of a particular mode of waste disposal. In the rest of the paper, we present some empirical literature, followed by data sources, methodology, results and discussion, and conclusion and policy recommendation.

2. EMPIRICAL LITERATURE

There are some empirical studies on household demand for waste disposal methods. The determinants of household waste disposal have been found to be partly influenced by socioeconomic and other factors such as sanitation laws, sociocultural practices, and distance to waste disposal sites (Adzawla et at, 2019). Some studies (Carattini et al., 2018; Dijkgraaf & Gradus, 2014; Skumatz, 2008) looked at the unit-based pricing (UBP) of residential solid waste collection and how that affects the amount of waste generation and disposal method adopted. Specifically, Bel and Gradus (2016) looked at the effects of UBP on household waste collection demand and indicated that introducing a separate waste collection and a fee for compostable waste is highly effective in waste management.

In addition, household income is deemed to have an effect on the type of waste generation and, subsequently, the mode of waste disposal. Some studies (Bandara et al., 2007; Foday, Yan, & Conteh, 2012; Ogwueleka, 2013) found an increase in income to be able to change the consumption patterns of

households, thereby resulting in a change in the composition and quantities of household waste and this affects the waste disposal method they adopt. On the contrary, Trang, Dong, Toan, Hanh, & Thu (2017) found that income has a significantly negative effect on the household waste generation of households. Another study by Mohd, Fadil, Normala, and Nur (2002) concluded that family size and eating habits have a positive correlation to household waste generation and disposal modes. A positive relationship was also found between household size and all categories of household solid waste (HSW) generation, except for glass and others (Trang et al, 2017). Thus, families with more members generate a larger organic waste per day by holding all other variables constant. According to Bandara et al. (2007), socioeconomic factors such as age, income, and education level also contribute significantly to variations in household solid waste generation. Trang et al. (2017) concluded that households with more members generate a larger quantity of household solid waste (HSW) per day, holding all other variables constant. Thus, families with more members generate a larger organic per day by holding all other variables constant.

Other factors such as distance to the disposal site, environmental knowledge and attitude of people, and willingness of people to pay for waste disposal are found to influence the household waste generation and mode of waste disposal. For example, Song et al. (2016) considered "enhancing residents' environmental awareness" as the most effective method for improving solid waste recycling in Macau. Also, Warunasinghe and Yapa (2016) indicated that awareness of the environmental hazards caused by improper waste management has greatly influenced the kind of waste disposal people adopt. Drawing from the forgoing literature, there is seldom a study on housing type (dwelling) and mode of household solid waste disposal, and this present study seeks to fill this gap using household survey data in Ghana:

3. MATERIALS AND METHODS

3.1. Estimation Model

According to McFadden's (1978) theoretical framework for a random utility structure, an individual has a set of alternative modes of refuse disposal from which to choose. It is assumed that each mode of refuse disposal has its attributes, though all have environmental consequences, which also influence the individual's choice over another alternative. The random utility model helps us to address how household heads make choices over alternative modes of refuse disposal taking into consideration both the explicit and implicit cost. The model is based on the notion that an individual derives utility by choosing a number of alternatives. The utilities are latent variables and the observable preference indicators manifest the underlying utilities. The theoretical specification of the multinomial logit model (MNL) has the following response probabilities:

$$p_{ij} = \frac{\exp(x_i b_j)}{1 + \sum_{j=1}^{j-1} \exp(x_i b_j)}$$

(1)

where p_{ij} is the probability of observing outcome j, b_j is a $K \times 1$ vector, x_i is a feature vector and $j = 1, 2, ... J - 1$. Equation (1) can only provide the direction of the effect of contextual background on choosing a particular mode of refuse disposal. The relative risk ratio (RRR) is also obtained by exponentiations of the multinomial logit coefficients. The RRR of a coefficient indicates how the risk of the household choosing indiscriminate waste dumping, compared to the risk of choosing private waste collection, changes with the variable in question. An RRR > 1 indicates that the risk of the outcome (say choice of public dumping of waste), relative to the risk of the outcome (say private waste collection), increases as the variable increases. In other words, the comparison outcome is more likely. An RRR < 1 indicates that the risk of the outcome falling in the comparison group, relative to the risk of the outcome falling in the referent group, decreases as the variable increases (Bruin, 2006).

3.2. Data Sources

The data for this study came from the Ghana Living Standards Survey round Six (GLSS-6). The GLSS-6 is a representative household survey that was conducted in 2012/13 to collect detailed information on topics, including demographic characteristics of the population, education, health, employment and time use, migration, housing conditions and household agriculture. The Survey describes a household as a person or group of related or unrelated persons who live together in the same housing unit, who acknowledge one adult male or female as the head of the household, who share the same housekeeping and cooking arrangements, and are considered as one unit.

Similarly, a dwelling[1] refers to a structure or group of structures (rooms or buildings), separate or contiguous, occupied by the members of the household. Age is recorded in years and months for persons aged five (5) years and below, and in completed years only for those six (6) years and older. Thus, the age is that of the last birthday.

If, for instance, a respondent's eighteenth birthday falls on the following day, age 17 is recorded as the answer. The highest educational level in the data means the highest level of formal schooling completed. If someone (respondent's parent) dropped out of school at a level, it means he/she has not completed that level and so it is not recorded as the highest. The data also recognized household membership to be all persons in the household, including children aged less than 3 months. For the purpose of this study, variables that were used are the gender of household head, age of household head, household size, residential stay (urban or rural) of household, educational level of household head,

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[1] The words 'dwelling' and 'housing' are use interchangeable in this study. This is so because, in the literature, different authors chose to use any of them, but refer to the same thing.

household income, employment nature of household head, housing characteristics of the household, and household expenditure on refuse (waste).

4. METHODOLOGY

4.1 Descriptive Statistics and Distribution of Variables

The descriptive statistics and distribution of variables are shown in Table 1. The data shows that the households are male-headed dominated, with seven out of ten households (72%) headed by males. More than half of the households (56%) lived in rural areas, with about half (50.7%) household heads having no formal education. The employment status of the household head shows that the majority of them (78.3%) are self-employed, with 43% engaged in agricultural self-employment and 25% in non-agriculture self-employed businesses; 14% were private employees while 7% were employed in public sector.

The study also found that more than half (56.12%) of the households live in compound houses (rooms), with as few as 2.11% staying in either a tent or improved home (kiosk) or living quarters attached to an office/store or uncompleted building or in other forms of settlements. Public dumping of refuse is found to be popular among 48% of households, with 13.1% contracting private waste collectors to manage their waste, while 19% dump waste indiscriminately.

Table 1. Descriptive Statistics and Distribution of Variables

Variable	Measurement	Response	Percentage	Obs.
Gender	The gender type of the household head	Female	28.20	4,729
		Male	71.80	12,043
Residential	The geographical location of the household (rural/urban)	Urban	44.39	7,445
		Rural	55.61	9,327
Education	The educational level of the household head (completed such level)	None	50.72	8,507
		Basic	13.71	2,300
		Junior high	16.78	2,814
		Senior high	8.49	1,424
		Voc/Tech.	4.64	779
		Tertiary	5.65	948
Employment type	The kind of employment that the household head engaged in	Public	7.28	1,221
		Private	13.92	2,334
		Non-AG S/E	25.21	4,229
		AG S/E	43.05	7,220
		Unemployed	2.93	492
		Retired	1.01	169
		Other	6.60	1,107
Housing / Dwelling	The housing type that the household leaves in	Separate house	13.71	2,299
		Semi-detached house	7.72	1,294
		Flat/apartment	3.15	528
		Compound house (rooms)	56.12	9,409
		Huts/Building (same)	15.61	2,617
		Huts/building (different)	1.57	264
		Tent	0.05	9
		Improved home (kiosk, etc.)	0.58	97
		Living quarters attached office	0.20	34
		Uncompleted	0.57	96
		Other	0.71	119
Waste disposal	The mode of waste disposal that the household adopts	Private collection	13.12	2,199
		Burning by household	19.88	3,334
		Public dumping	47.89	8,030
		Indiscriminate dumping	19.11	3,204

Obs. = observations, AG S/E=agriculture self-employed, Non-AG S/E=non-agriculture self-employed
Source: Authors' computation based on GLSS-6

Table 2 depicts the employment status of the household heads and the choice of mode of refuse disposal. The results show that non-aggregate self-employed household heads (32.93%) tend to engage the services of waste management companies to collect their refuse, followed by private employees (30.77%), with the retired having the least percentage (2.65%). Most self-employed household heads (50.84%) dispose of refuse by burning refuse, by the use of public dump (41.63%), or by dumping refuse indiscriminately (72.48%).

Table 2. Mode of Refuse Disposal and Employment Status of Household Head

Employment Status of Household Head	Mode of Refuse Disposal				
	Private Collection	Burned by household	Public Dump	Dumped indiscriminate	Total
Public Employee	298	244	590	89	**1,221**
	14.60%	7.77%	7.93%	2.93%	**7.80%**
Private Employee	628	396	1,163	146	**2,333**
	30.77%	12.61%	15.62%	4.81%	**14.90%**
Non-ag Self-employed	672	744	2,351	461	**4,228**
	32.93%	23.69%	31.58%	15.19%	**27.00%**
Ag Self-employed	323	1,597	3,099	2,199	**7,218**
	15.83%	50.84%	41.63%	72.48%	**46.09%**
Unemployed	66	135	156	134	**491**
	3.23%	4.30%	2.10%	4.42%	**3.14%**
Retired	54	25	85	5	**169**
	2.65%	0.80%	1.14%	0.16%	**1.08%**
Total	**2,041**	**3,141**	**3,141**	**3,034**	**15,660**
	100%	**100%**	**100%**	**100%**	**100%**

Source: Authors computation based on the GLSS-6,

Table 3 shows the mode of refuse disposal and the type of dwelling. The majority (62%) of those who contract private waste collectors stay in the compound house (rooms). Similarly, 63.5% of those who resort to public dumping of waste are from the compound house (rooms). This high proportion of those using the various modes of waste disposal coming from compound houses is partly due to the nature of the data, as more than half (57%) of the respondents were those living in the compound house (rooms). Similarly, the majority (82.46%) of household heads who dispose of their waste by burning stay in either a separate house or compound house (rooms), or huts/building (same compound), with the rest either staying in the semi-detached house or flat/apartment or huts/building (different compound) or tent or improved home (kiosk, container, etc.) or living quarters attached to office/store or uncompleted building.

Table 3. Cross Tabulation of Mode of Refuse Disposal and Type of Dwelling

Type of Dwelling	Mode of Refuse Disposal				
	Private Collection	Burned by household	Public Dump	Dumped indiscriminate	**Total**
Separate house	350	503	1,173	273	**2,299**
	15.93%	15.11%	14.66%	8.75%	**13.81%**
Semi-detached house	170	307	624	193	**1,294**
	7.74%	9.22%	7.80%	6.18%	**7.77%**
Flat/Apartment	187	104	209	28	**528**
	8.51%	3.12%	2.61%	0.90%	**3.17%**
Compound house (rooms)	1,362	1,440	5,083	1,524	**9,409**
	61.99%	43.26%	63.54%	48.83%	**56.52%**
Huts/building (same compound)	69	802	756	990	**2,617**
	3.14%	24.09%	9.45%	31.72%	**15.72%**
Huts/building (different compound)	5	75	96	88	**264**
	0.23%	2.25%	1.20%	2.82%	**1.59%**
Tent	1	2	3	3	**9**
	0.05%	0.06%	0.04%	0.10%	**0.05%**
Improvised home (kiosk, container etc)	35	26	28	8	**97**
	1.59%	0.78%	0.35%	0.26%	**0.58%**
Living quarters attached to office/shop	5	12	13	4	**34**
	0.23%	0.36%	0.16%	0.13%	**0.20%**
Uncompleted building	13	58	15	10	**96**
	0.59	1.74%	0.19%	0.32%	**0.58%**
Total	**2,197**	**3,329**	**8,000**	**3,121**	**16,647**
	100%	**100%**	**100%**	**100%**	**100%**

Source: Authors' computation based on GLSS-6

A cross-tabulation of the mode of refuse disposal and the educational level of the household head is found in Table 4. The table shows that the majority (93%) of the household heads who had no formal education resort to public waste dumping sites or burn the waste or dump the waste indiscriminately, with the remaining 7% contracting private waste collectors to manage their waste. As more people become educated or as the educational level of persons improves, they resort to contracting private waste collectors than any of the means of waste disposal. For example, the proportion of households with basic that resort to private waste collection methods is 13%, as against almost 37% in the case of those with tertiary level of education. Similarly, as educational level improves (from BECE to tertiary), the rate at which people dump refuse indiscriminately reduces; as high as 29% of the household heads who are uneducated dump refuse indiscriminately while only about 4% of those with tertiary education dump refuse indiscriminately. Within each educational category, public dumping is what the majority of the people adopt, as against indiscriminate dumping, which is the least adopted. However, indiscriminate dumping of waste is the second method used aside from the public dumping mode by non-educated persons.

Table 4. Cross Tabulation of Mode of Refuse Disposal and the Educational Level of the Household Head

Mode of Refuse Disposal	Educational Level of Head						
	None	Basic	Junior High	Senior High	Voc./Tec/ Teacher	Tertiary	Total
Private Collection	583	303	390	379	198	346	**2,199**
	6.85%	13.17%	13.87%	26.62%	25.42%	36.50%	**13.12%**
Burned by household	1,833	407	506	255	131	202	**3,334**
	21.55%	17.70%	18.00%	17.91%	16.82%	21.31%	**19.88%**
Public Dump	3,633	1,346	1,647	652	394	358	**8,030**
	42.72%	58.52%	58.59%	45.79%	50.58%	37.76%	**47.87%**
Dumped indiscriminate	2,456	244	268	138	56	42	**3,204**
	28.88%	10.61%	9.53%	9.69%	7.19%	4.43%	**19.11%**
Total	**8,505**	**2,300**	**2,811**	**1,424**	**779**	**948**	**16,767**
	100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Pearson chi2 = 0.002   Pr = 0.000
Source: Authors' computation based on GLSS-6

4.2 Econometric Results

Econometric results are shown in Tables 5 and 6. In Table 5, the results report the multinomial logistic regression to indicate the relationship and direction between the variables of interest and the mode of waste disposal adopted by households. Gender, as one of the variables, shows that female-headed household is inversely related to disposing of household waste by private arrangements, compared to public dumping of waste. This same inverse relationship is observed between being female and burning waste, compared to dumping at public dumpsites. The size of household membership is negatively related to the means of private waste disposal. This is so partly because larger households may generate a larger amount of waste per day and using private waste collectors could be more costly than resorting to public dumpsites. However, having more household members could also lead to indiscriminate dumping of waste, as shown by the positive relationship between household size and indiscriminate dumping of waste.

Table 5 further reveals that having a Basic or Junior High education reduces the probability of practicing the private waste collection method, as shown by the negative relationship between Basic or Junior High and private waste collection mode. However, as one gets more educated (by, say, moving from Basic to High school (Junior or Senior High) and subsequently to tertiary), the probability of privately engaged waste disposal means increases and the probability of indiscriminate dumping of waste reduces. Thus, education determines the kind of mode of waste disposal one adopts. Similarly, household income is found to be positively related to private waste collection mode and negatively to both burning and indiscriminate dumping of waste. This means that, when household income increases, the likelihood of the household engaging private waste collectors to manage its waste increases. This finding is in line with that of Fodey *et al.* (2012) and Ogwueleke (2013). Again, being a private employee increases the chances of using private waste collectors, but this is not statistically significant.

Also, an unemployed person has an increase in the chances of burning waste or indiscriminate dumping waste. Again, being a retired person reduces the likelihood of engaging private waste collectors, as shown by the negative association between retirement and private waste collection, which is significant at the 10% level.

Table 5 further indicates that a household living in a hut/building, whether in the same compound or a different compound, reduces the probability of managing its waste by private means. However, living in huts/building increases the probability of burning waste or dumping waste indiscriminately. On the contrary, staying in any of the housing types apart from huts/building increases the probability of engaging private waste collectors. Also, household expenditure on refuse is found to be positively related to private waste collections but negatively related to the burning of waste and indiscriminate dumping of waste. Expenditure on refuse is found to be highly statistically significant (at a 1% level) in determining the mode of waste disposal.

Table 5. Multinomial Logit Regression Results

Variable	Private Collection	Burned by Household	Dumped Indiscriminately
Female	-0.209**	-0.267***	-0.434***
	(-2.86)	(-4.77)	(-7.09)
Age of the Household Head	0.00367	0.00160	-0.00327*
	(1.44)	(0.93)	(1.88)
Household size	-0.139***	0.0276	0.0120
	(-5.26)	(1.31)	(0.54)
Household size squared	0.00959***	0.00210	0.00269*
	(4.78)	(1.32)	(1.69)
Urban	0.569***	-0.650***	-1.227***
	(7.08)	(-11.79)	(-18.03)
Basic	-0.197*	-0.321***	-0.903***
	(-1.97)	(-4.34)	(-10.62)
Junior High	-0.250**	-0.367***	-1.048***
	(-2.73)	(-5.61)	(-13.29)
Senior High	0.369***	0.0360	-0.502***
	(3.55)	(0.39)	(-4.48)
Voc/Tec/Teacher	0.298*	-0.0926	-0.757***
	(2.32)	(-0.76)	(-4.45)
Tertiary	0.495***	0.426***	-0.761***
	(3.76)	(3.54)	(-3.77)
Household income	0.104***	-0.0257*	-0.00175
	(6.41)	(2.10)	(-1.50)
Private Employee	0.118	-0.0298	-0.267
	(1.03)	(-0.27)	(-1.59)
Non-ag Self-employed	-0.196*	-0.00178	-0.0802
	(-1.70)	(-0.02)	(-0.52)
Ag Self-employed	-0.313*	-0.112	0.412**
	(-2.43)	(-1.06)	(2.76)
Unemployed	0.187	0.746***	1.165***
	(0.94)	(4.73)	(5.98)
Retired	-0.596*	-0.147	-0.480
	(-2.08)	(-0.58)	(0.98)

Table 5. Continues

Variable	Private Collection	Burned by Household	Dumped Indiscriminately
Semi-detached house	0.271*	0.157*	0.120
	(2.01)	(1.69)	(1.03)
Flat/Apartment	0.633***	0.435**	0.347
	(4.04)	(3.08)	(1.53)
Compound house (rooms)	0.0902	-0.279***	0.336***
	(0.96)	(-4.24)	(4.17)
Huts/building (same compound)	-0.286*	0.686***	1.116***
	(-1.75)	(8.64)	(12.31)
Huts/building (different compound)	-0.814	0.363*	0.740***
	(-1.56)	(2.12)	(4.26)
Tent	1.189	0.754	1.721*
	(0.96)	(0.74)	(1.77)
Improvised home (kiosk, container etc)	1.009**	1.392***	1.350**
	(3.24)	(4.74)	(2.95)
Living quarters attached to office/shop	0.198	0.868*	0.786
	(0.30)	(2.10)	(1.31)
Uncompleted building	1.247**	2.808***	2.379***
	(2.75)	(8.54)	(5.30)
Expenditure on refuse	0.890***	-0.914***	-2.524***
	(21.61)	(-7.29)	(-5.75)
Constant	-1.937***	-0.603***	-0.738***
	(-9.71)	(-3.91)	(-3.81)
Observations (N)	15450		
Log likelihood	-2072.4881		
Pseudo R^2	0.0342		
Prob>chi^2	0.0000		

Source: Authors' estimation,   Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Note: private collection is when household contracts a company for waste collection/disposal; burned by household means that the household gathers their solid waste and burn it by themselves; indiscriminate dump means household throws the solid waste anywhere around.

Table 6 reports the RRR of the multinomial logistic regression for the study. The results indicate that being in a female-headed household decreases the odds of resorting to private refuse collection versus public refuse dumping as a means of waste disposal by about 19% and decreases the odds of burning refuse versus public dumping by about 23% and dumping indiscriminately versus public dumping by about 35%. On the age of household head, a one-year increase in age leads to increases in the odds of contracting private refuse collectors rather than resorting to the public refuse dump by about 0.4% and the odds of household burning refuse instead of public dumping increases by about 0.2%. This is consistent with the findings of Adzawla et al (2019) and Awunyo-Vitor et al. (2013) who found out that, in Ghana, age is positively related to improved waste disposal practices. In reverse, the odds of household dumping refuse indiscriminately instead of public dumping reduce by about 1%. It is only the odds of indiscriminate dumping that are significant, even at a 10% level.

Also, increasing the household size by one person increases the odds of household burning their refuse (solid waste) rather than public dumping by about 3% and increases the odds of indiscriminate dumping versus public refuse dumping by about 1.2%. However, an increase in household size reduces

the odds of private waste collection instead of public waste dumping by about 13%, which is significant at a 1% level. This finding suggests that households with more members may generate a larger quantity of HSW per day (Trang *et al.*, 2017) and for that matter may have to spend more on waste management, thereby avoiding any form of payment. For example, a study by Adzawla et al (2019:56) came to a similar conclusion when they stated that "household size has a negative significant effect on open and public waste disposal. This means that households with larger household sizes had a higher probability of burying or burning their domestic solid wastes other than dumping them at public dumping sites or the open places". When the household size, as a variable in this study, was squared, the odds of households resorting to private waste collection versus public dumping reversed from a reduction to an increase of about 1%, which is significant at 1%.

Household staying in urban setting increases the odds of household contracting private waste collectors rather than resorting to public refuse dumpsites by about 77%, reduces the odds of burning solid waste versus public dumping by about 48%, and reduces the odds of dumping indiscriminately instead of using the public dumping site by about 71%. This finding is partially so because, in urban settings, regulations on sanitation may be enforced and most people are well to do than their counterparts in rural areas. Hence, apart from the sanitation rules that regulate the disposal of waste in urban areas, urban households can also afford to use private waste collectors than resort to public waste dumping sites or burning or indiscriminate refuse.

On the educational status of household heads and mode of waste disposal, Table 6 further indicates that a basic education reduces the odds of households contracting private waste collectors instead of using the public dumping site by 18% and resorting to burning waste versus public dumping by 27% and about 60% reduction in the odds of dumping indiscriminately rather than using public dumping sites. A household head being a Senior High School (SSS) graduate increases the odds of the household using private waste collectors to manage its waste versus resorting to a public dumpsite by about 45% and being a tertiary graduate increases the chances of a household head using private waste collection rather than using the public dumping site by about 64%. All the educational levels are significant at a 1% level in influencing the odds of dumping indiscriminately instead of resorting to the public dumping site. Thus, the education of a person helps in determining the waste disposal mode that he/she adopts. This finding is so, partly because an educated person may be much aware of the dangers of bad sanitation habits and the sanitation laws that exist.

Table 6. Multinomial Logit Regression for Relative Risk Ratios

Variable	Private Collection	Burned by Household	Dumped Indiscriminately
Female	0.812**	0.766***	0.648***
	(-2.86)	(-4.77)	(-7.09)
Age of the household head	1.004	1.002	0.997*
	(1.44)	(0.93)	(1.88)
Household size	0.870***	1.028	1.012
	(-5.26)	(1.31)	(0.54)
Household size squared	1.01***	1.002	1.003*
	(4.78)	(1.32)	(1.69)
Urban	1.767***	0.522***	0.293***
	(7.08)	(-11.79)	(-18.03)
Basic	0.821*	0.726***	0.405***
	(-1.97)	(-4.34)	(-10.62)
Junior High	0.778**	0.693***	1.351***
	(-2.73)	(-5.61)	(-13.29)
Senior High	1.450***	1.037	0.605***
	(3.55)	(0.39)	(-4.48)
Voc./Tec/Teacher	1.348**	0.912	0469***
	(2.32)	(-0.76)	(-4.45)
Tertiary	1.642***	1.531***	0.467***
	(3.76)	(3.54)	(-3.77)
Household income	1.000	1.000*	1.000
	(-0.84)	(2.10)	(-1.50)
Employee private	1.125	1.030	0.766
	(1.03)	(-0.27)	(-1.59)
Non-ag self-employed	0.822*	0.998	1.084
	(-1.70)	(-0.02)	(-0.52)
Ag self-employed	0.731*	0.894	1.511**
	(-2.43)	(-1.06)	(2.76)
Unemployed	1.205	2.108***	3.206***
	(0.94)	(4.73)	(5.98)
Retired	0.550*	0.864	0.619
	(-2.08)	(-0.58)	(0.98)
Semi-detached house	1.311*	1.170*	1.127
	(2.01)	(1.69)	(1.03)
Flat/Apartment	1.883***	1.545**	1.415
	(4.04)	(3.08)	(1.53)
Compound house (rooms)	1.094	0.757***	1.399***
	(0.96)	(-4.24)	(4.17)
Huts/Building (same compound)	0.752*	1.985***	3.052***
	(-1.75)	(8.64)	(12.31)
Huts/Building (different compound)	0.443	1.438*	2.096***
	(-1.56)	(2.12)	(4.26)
Tent	3.284	2.125	5.589*
	(0.96)	(0.74)	(1.77)
Improvised home (kiosk, container etc.)	2.743**	4.023***	2.859**
	(3.24)	(4.74)	(2.95)
Living quarters attached to office/shop	1.219	2.382*	2.195
	(0.30)	(2.10)	(1.31)
Uncompleted building	3.480**	16.580***	10.792***
	(2.75)	(8.54)	(5.30)

Table 6. Continues

Variable	Private Collection	Burned by Household	Dumped Indiscriminately
Expenditure on refuse	2.435***	0.401***	0.080***
	(21.61)	(-7.29)	(-5.75)
Constant	0.144***	0.547***	0.478***
	(-9.71)	(-3.91)	(-3.81)
Observations		**15450**	
Log likelihood		**-3188.8238**	
Pseudo R^2		**0.0457**	
Prob>chi^2		**0.0000**	

Source: Authors' estimation, Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

In Table 6, it is further revealed that income is much more neutral in influencing the mode of waste disposal. An increase in household income neither increases nor decreases the odds of private waste collection versus public waste dumping, burning waste versus public dumping, and indiscriminate waste dumping versus public waste dumping sites. However, it is only the odds of burning waste versus public waste dumping sites that are significant at a 10% level.

The employment type of household head and the mode of waste disposal the household adopts are further shown in Table 6. Being an employee of a private entity increases the odds of private waste collection versus resorting to public dumping sites by about 13% and being non-agricultural self-employed or ag-self-employed reduces the odds of household waste collection privately versus public dumping mode by 18% and 27% respectively. Being an unemployed household head leads to an increase in the odds of the household contracting private waste collection instead of the public dump by about 21%. The odds of burning waste by household instead of resorting to the public dump is more than doubled (2.108) for a household where the head is unemployed and more than tripled in the case of the odds of dumping indiscriminately versus public dumping. The household head being a retired person reduces the odds of the household engaging in private waste disposal versus public waste dumping by 45%, burning waste versus public dumping by about 14%, and household dumping waste indiscriminate versus dumping waste at public dumpsite by 38%.

On the main interest of this study (i.e. housing characteristics and mode of solid waste disposal), Table 6 further revealed that the odds of a household privately collecting its solid waste instead of using a public waste dumping site increases by about 31% if the household stays in Semi-detached house and about 88% if the household lives in Flat/Apartment.

Again, the likelihood of a household burning its waste generated instead of dumping it at public dumpsites more than doubles if the household lives in either a tent or living quarters attached to an office/shop and more than quadrupled when the household stays in an improved house (kiosk, container, etc.) and it is more than 16 folds when the household stays in an uncompleted building. However, living in a compound house (rooms) reduces the odds of households burning the waste generated versus resorting to dumping it at public dumpsites by about 24%. Similarly, the odds of a household resorting

to the private collection of waste rather than using public dumpsites reduces by about 25% when the home is a hut/building in the same compound and bout 56% when the household stays in Huts/building in a different compound.

5. CONCLUSION

This study investigated whether the type of dwelling characteristic influences the choice of a particular solid waste disposal mode by households in Ghana. Multinomial logistic regression of relative risk ratio was estimated on four categories of household solid waste disposal (private waste collection, public waste dumping, indiscriminate dumping and household burning of waste). Majority (78%) of those who contract private waste collectors either stay in a separate house or compound house (rooms). Similarly, 82.46% of those who dispose their waste by burning stay in either a separate house or compound house (rooms) or huts/building (same compound).

Education is found to be a strong variable in determining the mode of solid waste disposal by households. Highly educated household heads make use of private waste collectors to dispose their waste than any of the means of waste disposal. Living in a semi-detached house or flat/apartment increases the chances of households choosing private waste collection means, burning waste and indiscriminately dumping waste rather than resorting to public dumping sites. Also, aggregate self-employed persons tend to practice more of burning of refuse, public dumping and indiscriminate dumping. The odds of a household dumping solid waste indiscriminately instead of using public refuse dumping sites increases irrespective of the housing type the household stays in. While household income was found to be neutral in affecting the odds of choosing one mode versus the other, household expenditure on refuse, on the other hand, was found to have increased the odds of household engaging private waste collectors to manage their waste generated rather than using public dumping sites. Also, an increase in household expenditure reduces the odds of burning waste (by about 60%) and dumping waste indiscriminately (by about 92%).

Government in collaboration with waste management companies should look at programmes that aim at reducing, recycling and composting household solid waste in the country. Warunasinghe and Yapa (2016) showed that 96% of respondents in their study are willing to participate in any program, which aimed at reducing, recycling and composting domestic garbage. The government should establish waste collecting centres, encourage home composting, and provide standard waste bins and waste collecting vehicles to communities. Waste management and collection could be geared more towards self-employed persons, as they appear to generate more waste and resort to public dumping as well as indiscriminate dumping. Again, public education as well as formal education should be intensified to help make people environmentally concerned, as this will make people adopt good sanitation practices.

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