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Effects of Socio-economic and Demographic Factors on Household Solid Waste Generation in Selected Urban Estates in Kisumu City, Kenya

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Abstract:
The study sought to establish the association between socio-economic and demographic factors and the amount of household solid waste (HSW) generated in selected urban estates in Kisumu city, Kenya. The study adopted a cross-sectional descriptive design. The study was conducted in Kisumu city and it targeted households in selected urban estates. Three estates representing three socio-economic groups; High Income (Milimani), Middle Income (Migosi), Low Income (Obunga) were selected through multi-stage simple random sampling. A stratified proportionate random sample of 368 households was selected from a study population of 8651 households. Household survey questionnaires and Direct Waste Weighing were the main instruments for data collection. Pearson moment product correlation coefficient was used to measure the strength and direction of association between household size, household monthly income, household monthly expenditure on food and age of the household head and the amount of HSW generated monthly in kilograms. The amount of HSW generated was 54Kgs/household/month, 36Kgs/household/month and 31.5Kgs/household/month for high, middle and low income socio-economic groups respectively. Results from the high income socio-economic group revealed that the amount of HSW generated monthly was strongly positively associated with household monthly income($r = 0.939$), household size($r = 0.921$),household monthly expenditure on food (r=0. 973) and age of the household head (r= 0.939).In the middle income, socio-economic group the amount of HSW generated monthly was strongly positively correlated with household monthly income ($r = 0.938$), household size (r=0.977), household monthly expenditure on food (r=0. 990) and age of the household head (r= 0.876). In the low income, socio-economic group the amount of HSW generated monthly was strongly positively correlated with household monthly income (r= 0.981), household size (r=0.957), household monthly expenditure on food (r=0. 931) and age of the household head (r= 0.920). The findings of this study revealed that the association between household size, household monthly income, household monthly expenditure on food and age of the household head and the amount of HSW generated monthly is strong and positive across high, middle and low income socio-economic groups thus socio-economic and demographic factors are important in understanding quantities of HSW.

1. Introduction

Urban solid waste generation due to economic development and rise in living standards raise serious problems in providing sustainable waste management in Cities (Florin*et al.,* 2015). Lifestyles due to population growth generate huge amounts of household solid waste (Ojewale, 2015). Thus, solid waste management is one of the most challenging issues in Urban Cities which are already facing serious environmental pollution. (Kumar *et al.,* 2009). In the modern world, quantification is the most important ingredient for any sound solid waste management system (Jonas *et al.,* 2014). Solid waste cannot be managed effectively and efficiently unless the origin and quantities are thoroughly understood (Kum *et al.,* 2005). Knowledge on solid waste quantity is essential for planning a solid waste management strategy for a given city or municipality (Aranda-uson *et al.,* 2013). The amount of solid waste generated in households is greater than the amount of waste generated in industries and health sectors (Emery *et al.,* 2003). Anomanyo (2004) observed that, apart from lack of funds, insufficient information on solid waste quantities is a major contributing factor to Ghana's waste management problems. Sustainable development of Cities requires an integral waste management strategy that takes into account all stages from generation to final disposal (Aranda-uson *et al.,* 2013). The accurate design of solid waste management strategies requires meticulous analysis of waste generation data (Iraia *et al.,* 2015).

Previous studies by authors such as Rushbook and Pugh (1999); Ikuporukpo (1993); Adedibu (1990); Abumere (1993) suggested that in order to have an effective waste management strategy, the need to carry out research on socio-economic characteristics of households was of paramount importance. However, most developing countries lack reliable historic waste data, therefore, for the problem of solid waste management to be solved, an accurate method for identifying relevant factors of influence the amount of household solid waste generated is required (Beigl *et al.,* 2003).A study identifying the relevant factors of influence (such as socio-economic and demographic factors) on the amount of household solid waste generated is therefore necessary for appropriate decision making in urban solid waste management. Solid waste characterization studies to document solid waste generation in cities of developing countries like Dar es salaam are rarely carried out owing to lack of funds and awareness among policy makers and waste management officials of its importance (Aisa, 2013). (Hristovski *et al.,* 2008) suggest that periodic short-term (1-2 weeks) studies could be a possible solution in the absence of comprehensive scientifically valid data needed to develop an efficient waste management system. Solid waste characterization studies aimed at establishing solid waste generation rates have mainly been carried out at disposal points and material recovery facilities, rather than at the source before recycling and scavenging activities occur. (Aisa, 2013).Solomon (2011) reported that a solid waste characterization study at the household level provides more detailed, accurate and crucial information on per capita solid waste generation.

A number of studies on Solid waste management (SWM) have been conducted in Kenya (Oyake-Ombis ,2012; Mukui 2013); Munala and Moirongo, 2011);Rotich *et al.,* 2006).However, none of these studies looked at the association between relevant household socio-economic and demographic factors and HSW generation which is key in planning for solid waste management. Munala and Moirongo (2011) focused their study on the need for integrated solid waste management in Kisumu while Opande (2010) studied HSW management in low income and unplanned settlements in Kisumu. These studies therefore did not provide relevant information on household socio-economic and demographic factors influencing HSW generation which is key in planning for solid waste management in urban areas. A study conducted at the point of HSW generation (households) and their corresponding household socio-economic and demographic characteristics is therefore necessary to provide accurate and detailed information on the effects of socio-economic and demographic factors on HSW generation. This study therefore sought to examine the effects of household monthly income, household size, household monthly expenditure on food, age of the household head on HSW generation in selected urban estates in Kisumu.

2. Literature Review

The management of HSW is one of the huge challenges of Urban areas of all sizes and is always in the top five of the most challenging problems of City managers (UNHABITAT, 2010). HSWG constitutes a growing problem and has gained increased research focus in recent years. The amount of SWG in the World is steadily increasing and every Government is currently focusing on methods to approach this challenge (UNHABITAT, 2010). A solid waste characterization study done in three municipalities in Dar es Salaam indicated that solid waste generation is highly dependent on the socio-economic status of the population (Jonas *et al.,* 2014). HSW generation studies normally differentiate households by size or income to account for differences in waste generation rates (Ojeda-benitez *et al,*2008).

Ojewale (2015) investigated the relationship between income, age composition of the household and household size as key determinants of HSWG and established that all these factors were key determinants of HSWG. However, he did not examine monthly expenditure on food and age of household head which this study examined. Studies by Afon(2007) and Nwachukwu (2009) investigated SWG in two different traditional Cities in Nigeria. The work of Afon (2007) focused on four residential attributes (education, occupation, income and household size) influencing HSWG. The findings indicated: there is a relationship between SWG and education and income status as well as household size and occupation of residents. On the other hand, Nwachukwu (2009), through use of secondary data examined the relationship between population increase and the quantity of SWG and established a linear relationship between quantity of SWG and population increase. The work of Afon(2007) did not examine monthly expenditure on food and age of the household head. Family size is an important determinant in HSW production (Ghorbani*et al.,* 2007).

Sankoh et al., (2012) revealed that the average age of the family size was negatively correlated to HSW generation. They however did not study the relationship between the age of the household head and the amount of HSW generated which this study investigated. They further established that the average family size and monthly income were the main influencing factors in HSW generation. Household size and income are the key determinants of HSW generation. (Monavari et al., 2012; Phillipe and Clout, 2009).Sing *et al.,* (2014) established that there was a significant positive relationship between household expenditure and HSW generation. Mahees *et al.,* (2011) further established that HSW generation was mainly influenced by weekly food consumption and family size. This study investigated the relationship between expenditure on food and HSW generation.

Irteza *et al*., (2013) studied 73 households across five socio-economic groups in Chittagong, Bangladesh and established that there was a positive relationship between the amount of HSW generated and household size and household monthly income. A study of approximately 160 households in Oyo, Nigeria also found a statistically significant correlation between household solid waste, household size and household income (Afon, 2007). The relationship between income and socio-economic status and the amount of household solid waste generated has not always returned consistent results (Irteza*et al*., 2013). A study of 47 households in Gaborone, Botswana found no direct relationship between household solid waste generation and income. Socio-demographic determinants may not always have similar relationships with the amount of HSW generated as shown in literature (Bolane and Ali (2004); Irteza *etal*., (2013). Bolane and Ali (2004); Irteza *et al*., (2013) therefore observed that these differences in findings suggest that one should exercise caution in making inferences about the impact of socio-economic factors in the amount of HSW generated by households located in different parts of the world or for households residing in different parts of the same city.

3. Methodology

3.1. Research Design

The research design is a plan that guides the researcher in planning and implementing the study in a way that is most likely to achieve the intended goals. (Burns and Groves, 2001). The research design was cross-sectional descriptive research and used both qualitative and quantitative tools of data collection and analysis. Medina (1997) observes that by combining the two techniques, social scientists balance the strengths and weaknesses of the two and will achieve a higher degree of reliability and validity, compared to the use of only one. The design by virtue of being cross-sectional gives a representation of the whole population with minimum bias. Data for this study was collected for a period of four weeks between 30th January 2016 to 28th February 2016. In this study, one month was taken to be 30 days, the period for which data on the HSW quantities was collected.

3.2. Study Area and Target Population

Kisumu is the third largest city in Kenya and it's on the shores of Lake Victoria, the second largest fresh water Lake in the World and covers an area of approximately 417 Km^2, 35.5% of which is under water. It is located in Kisumu county and serves as both as the county headquarters and the principal city in the region (NEMA, 2003). Kisumu city is lies between latitude $00^o02'N$; $00^o11'S$ and longitude $34^035'E$ and $34^055'E$ at an elevation of 1,131 meters above sea level. The city is occupied predominantly by low income households, with more than 50% of the population categorized as poor (KNBS, 2009). The city lacks a comprehensive response to solid waste management. Coupled with this, there is a poor attitude towards waste management and low capacity to offer waste services by Kisumu city management (Kisumu City Development Strategy, MCK, 2004).

The study targeted households in Kisumu city. Three estates representing three socio-economic groups (income levels) were selected through multi-stage simple random sampling according to socio-economic groups based on income levels borrowed from the Kenya National Bureau of Statistics (KNBS, 2009) classification which was also guided by literature from previous studies. Socio-economic status is commonly conceptualized as the social standing or class of an individual or group. It connotes one's position in the hierarchy, how the hierarchy is structured, and very often one's consequent life chances. In other words, socio-economic status indicates one's access to collectively desired resources, be they material goods, money, power, friendship networks, healthcare, leisure time and education opportunities. Invariably, socioeconomic status is measured as a combination of education, income and occupation (KNBS, 2009; Jonas *et al.,* 2014). The strata were; High Income Socio-economic group (HISG), Middle Income Socio-economic group (MISG), Low Income Socio-economic group (LISG). The three estates selected for the study were Milimani (HISG), Migosi (MISG) and Obunga (LISG).

3.3. Sampling Frame

The study utilized both multi-stage random sampling and stratified proportionate simple random sampling technique. Stratified proportionate simple random sampling is a modification of random sampling in which a population is divided into two or more relevant significant strata based on one or more attributes. (Saunders *et al*., 2007). The advantage of stratified sampling is said to be its ability to ensure inclusion of sub-groups which would otherwise be entirely omitted by other sampling methods (Jeptoo *et al.*, 2016).

The study used a mathematical approach given by fishers *et al.*, (1998) which stated that:

$N_f = n$ Fishers et al., (1998)

$1 + n/N$

Where;

n_f=the desired sample size when population is less than 10,000

n = the desired sample size when population is more than 10,000 (usually 384)

N= Estimated population size

n_f=384

1 + (384/8651)

n_f = 368

The sample size of the study was 368 households from a study population of 8651 households calculated using fishers *et al.*,(1998) formula. A stratified proportionate random sample of 368 households was selected. The number of households to be interviewed within each sampling unit (strata) were selected proportionally based on the number of households within each sampling unit /strata (socio-economic group). Households within each sampling unit/ strata (socio-economic group) were selected through simple random sampling.

Socio-economic group	Total no. of households (Study population)	No. of households selected
HISG (Milimani)	1302	55
MISG (Migosi)	4795	204
LISG (Obunga)	2554	109
TOTAL	8651 (Study Population)	368 (Sample Size)

Table 1: A sampling frame indicating the number of households studied under each strata

3.4. Data Collection Instruments

The study employed the use of structured household survey questionnaires and direct waste analysis to obtain primary data.

3.5. Structured Household Survey Questionnaires

This tool was used to gather information on specific household socio-economic and demographic data. In all cases, questionnaires were administered to obtain precise data on household size, household monthly income, household monthly expenditure on food and age of the household head. The following operational definitions were adopted for the study; household size was defined as the number of persons residing in a household or residence. household monthly income was defined as the measure of the monthly combined incomes of all people sharing a particular household of residence. Household monthly expenditure on food was defined as the amount of final consumption expenditure made by resident households to meet their monthly needs on food. Age of the household head was defined as the length of time the household head (person in charge of running the household and key decision maker) has lived.The questionnaires were categorized according to socioeconomic groups and answers were captured appropriately. The questionnaires were given numbers 1-368. This was done for household identity since there was need to match each household socio-economic and demographic data with its corresponding data on the amount of household solid waste generated

3.6. Direct Waste Analysis

Direct Waste Analysis (DWA) was used as a tool for the household solid waste characterization study to establish the amount of monthly household solid waste generated. DWA is a solid waste characterization tool which is used to determine the quantities and composition of solid waste generated and this is done through direct waste weighing and direct waste sorting respectively(Gomez*et al.,* (2008. The direct waste analysis technique has been used previously in several studies (Dieu et al., (2014); Aisa (2013); Mohammed *et al.,* (2012).

Direct waste weighing involved each selected household (residential) being provided with a labelled plastic bag to keep all their household solid waste generated for one week (7 days).This was done on a weekly basis for four weeks. The plastic bags were labelled using numbers 1 to 368. This was done to be able to match the household survey questionnaires data with the household direct waste analysis data. The household solid waste generated was weighed using a capacity portable weighing machine and weights recorded. This enabled the researcher to establish the amount of household solid waste generated in the selected urban estates in Kisumu City. The equipment and materials used were methodology driven. These equipment and materials were: Trash polythene bags, a portable twenty kilogramme (20 Kg) weighing machine, sorting shed, digital camera, personal protective equipment, large plastic canvas

3.7. Validity

Content validity was used to ensure that all the components of socio-economic and demographic factors that the researcher set out to investigate were included in the structured household survey questionnaire thus no component was neglected. To ensure that all the components relevant to the study were included in the data collection tools, two supervisors from the School of Environment and Earth Sciences with relevant skills in the field of study as well as the school post-graduate board assessed the content of the instruments and feedback was given. The feedback was incorporated in the final instrument before the actual study.The household socio-economic and demographic attributes investigated were; household size, household monthly income, household monthly expenditure on food and age of the household head.

3.8. Reliability

Reliability is the measure of the degree to which an instrument yields consistent results (Bless *et al.,* 2006). The test-retest reliability technique was used to establish the reliability of the research instruments. The test-retest was undertaken three times where data collection tools were administered randomly to 10% of selected households across all the socio-economic groups within the study area. The research instruments were found to be reliable since the results were very similar during each testing. The respondents that were sampled during the reconnaissance were noted to avoid re-sampling during the actual study.

3.9. Data Analyses

Pearson product-moment correlation coefficient was used to measure the strength and direction of association between household size, household monthly expenditure on food, household income and age of the household head and the amount of HSW generated monthly in Kilograms. Pearson product moment correlation was appropriate for this study because the sample data used was normally distributed.

4. Results and Discussion

4.1. Socio-economic and Demographic Data for Households

The data showing the household size, household monthly income, household monthly expenditure on food and age of the household head across three socio-economic groups, namely high income, middle income and low income are presented in Table 2

Socio-economic group/class			
Variable (Mean)	**HISG Milimani**	**MISG Migosi**	**LISG Obunga**
Household Size	5	5	5
Household Monthly Income (in Kshs)	57555	17333	15130
Household Monthly Expenditure on Food	17509	15102	8314
Age of the Household Head (in years)	42	36	35

Table 2: Socio-economic and demographic data for households. HISG stands for high income socio-economic group, MISG stands for middle income socio-economic group while LISG stands for low income socio-economic group

According to the household survey, the average household size from the sampled population was 5 in high, middle and low income socio-economic groups respectively. The average household monthly income was Kshs. 57555, Kshs. 17333 and Kshs. 15130 in high, middle and low income socio-economic groups respectively. The average household monthly expenditure on food was Kshs. 17509, Kshs. 15102and Kshs. 8314 in high, middle and low income socio-economic groups respectively. The average age of the household head in years was 42, 36 and 35 in high, middle and low income socio-economic groups respectively. The reason for considering household size and income in this study is the fact that they have been widely acknowledged as important factors influencing solid waste characteristics (Aisa, 2013). Solid waste generation is an inevitable consequence of production and consumption, hence the importance of Household expenditure on food in this study. The age of the household head is also considered as a key determinant of consumption.

4.2. Amount of HSW Generated in Kilograms by Socio-economic Group

The amount of HSW generated by households and individuals in high, middle and low income socio-economic groups in Kisumu city are presented in Table 3.

Socio-economic Group	Number of hh* studied	Amount of HSW generated (Kg/hh/month	Amount of HSW generated (Kg/cap**/month)	Amount of HSW generated Kg/cap/day
HISG	55	54	10.8	0.36
MISG	204	36	7.2	0.24
LISG	109	31.5	6.3	0.21
TOTAL	368	121.5	24.3	0.81

Table 3: The Amount of HSW generated by households and individuals
**hh= household*
***= capita*

The average amount of HSW generated per household per month was 54, 36 and 31.5 kg/hh/month in HISG, MISG and LISG respectively (table 3). Results from table 3 further established that the average amount of HSW generated per person per month was 10.8, 7.2 and 6.3 kg/cap/month in HISG, MISG and LISG respectively and 0.36, 0.24 0.21 Kg/cap/day in HISG, MISG and LISG respectively. From these study findings, it is clear that the amount of HSW generated varies across socio-economic groups with the amount of household solid waste generated increasing with improving socio-economic status. Socio-economic status is measured as a combination of income, education and occupation and it indicates one's access collectively to desired resources. The relationship between socio-economic groups and the amount of HSW generated has been discussed by various authors (Aisa, 2013; Bandara *et al.,* 2007; Mohammed *et al.,* 2012). Results from table 3 agree with a study by Jonas *et al.,* (2014) who established that the overall amount of HSW generated per capita increased with improving socio-economic status with high income socio-economic group generating the most. Kaseva and Mbulingwe (2005) established that the average amount of HSW generated by households in Dar es Salaam was 0.42 kg/cap/day. Dauda and Osita (2003) established that in Maiduguri, the amount of HSW generated was 0.25 kg/cap/day. The average amount of HSW generated in Nigerian households is 0.49kg/cap/day Solomon (2009). From the discussion above, it is evident that previous studies have not been keen on investigating the amount of HSW generation across different socio-economic group which this study (table 3) has done.

4.3. Relationship between the Amount of HSW Generated Monthly and Socio-economic and Demographic Variables

The correlation coefficient results showing the strength and direction of association between socio-economic and demographic variables (household size, household monthly income, household monthly expenditure on food and age of the household head) and the amount of HSW generated monthly in high, middle and low income estates in Kisumu city are presented in Table 4.

Correlation coefficient, r				
Socio-economic group	**Household monthly income**	**Household size**	**Household expenditure on food**	**Age of the household head**
HISG	r = 0.939	r = 0.921	r = 0.978	r = 0.939
MISG	r = 0.938	r = 0.977	r = 0.990	r = 0.876
LISG	r = 0.981	r = 0.957	r = 0.931	r = 0.920

Table 4: Pearson Product-Moment Correlation coefficient between the amount of household solid waste generated in Kilograms and socio-economic and demographic variables
Significance (2-tailed), p<0.05

Results from table 4reveal that the amount of HSW generated monthly in households in urban estates in Kisumu is strongly and positively associated with household monthly income, household size, household monthly expenditure on food and age of the household head. Previous research has found that the average waste generation rate is dependent on socio-economic groups with higher income socio-economic groups generating more waste (Abu Qdais *et al.,* 1997). A study conducted by Buenrostro *et al.,* (2001) in Morelia observed that socio-economic characteristics had a positive correlation with the amount of HSW generated. There is a clear relationship between demographics and HSW generation (Quinn and Nivison-Smith, 2006).A study by Abel, (2007)showed that social status are important factors in influencing solid waste generation in Ogbomoso, Oyo state, Nigeria. Sridhar *et al.,* (1985) revealed that solid waste quantities vary with socio-economic groups with high and middle income groups generating more than low income groups.

4.4. Household size and the Amount of HSW Generated Monthly

The association between household size and the amount of household solid waste generated across high, middle and low income socio-economic groups was determined. In high, middle and low income socio-economic groups in urban estates in Kisumu city, the results show that the amount of HSW generated monthly is strongly and positively associated with household size (r = 0.921), (r = 0.977) and (r = 0.957) significant at 95% confidence level respectively. Increase in the number of family/household members leads to an increase in resource consumption and utilization, hence the amount of household commodities purchased from food stuff to non-food stuff will increase leading to an increase in the amount of household solid waste generated. Results from table 4 agree with studies from Sing *et al.,* (2014) who found a strong positive relationship (r= 0.376) between household size and the amount of HSW generated. Sankoh *et al.,* (2012) found a strong positive relationship (r= 0.9914) in Freetown Sierra Leone. Results from Monavari *et al.,* (2012); (Mohd *et al,* 2010) and Dangi (2009) also found a strong positive relationship between household size and the amount of HSW generated. Similarly, a study by Aisa (2013) found a weak positive correlation between household size and the amount of HSW generated in Mkunguni (middle income) and Midizini (low income) households respectively. However, Ojeda-Benitez *et al.,* (2008); Qu, *et al.,* (2009) established that as household size increases, the amount of household solid waste generated has been found to decrease. Some studies (Jenkins 1993; Jenkins *et al.,* 2003; Hong 1999; Hong and Adams, 1999) established that household size and the amount of HSW generated had a negative relationship. They assumed that this may be due to factors such as tendency to conserve on packaging for consumer items such as food and beverages which are purchased in larger quantities for larger family sizes which was supported by a study by (Nick and Julien, 2013). The reason for differences in these results could be attributed by some household activities such as reduction and re-use of waste which could have been absent in households in Kisumu. Studies on the association between household size and the amount of HSW generated have sometimes returned conflicting results. This can be attributed to differences in some of the household activities such as waste re-use and minimization, knowledge, attitudes and perceptions towards household solid waste management. Similarly, there are informal businesses being undertaken in residential areas such as small shops and groceries whose solid waste fractions are independent of household size yet they end up in the HSW stream. Previous studies have mainly been conducted at disposal facilities. Similarly, previous studies have sampled very small sections of the population without giving a clear scientific method on how they arrived on the sample size, for example, (Aisa, 2013) only sampled 75 households out of a study population 4659.Aisa (2013) noted that from a statistical point of view, the accuracy of determining these parameters increases with an increase in the number of samples analyzed. This study therefore ensured that household data on the amount of HSW generated monthly was collected at the household level and at individual households before the waste samples are interfered with through activities like solid waste scavenging and recovery.

4.5. Household Monthly Income and the Amount of HSW Generated Monthly

The association between household monthly income and the amount of household solid waste generated monthly across high, middle and low income socio-economic groups was determined. In high, middle and low income socio-economic groups in urban estates in Kisumu city, the results show that the amount of HSW generated monthly is strongly and positively associated with household monthly income (r = 0.939), (r = 0.938) and (r = 0.981) significant at 95% confidence level respectively. This can be attributed to the fact that an increase in income and living standards increases consumption of goods and services as well as more expenditure and the amount of household solid waste generated. As the household income increases, household expenditure goes up due to the increase in the amount of disposable income leading to the increase in the amount of HSW generated in households. The higher the Household income the higher the purchasing power which will enable households to buy more goods and commodities hence an increase in the amount of household solid waste generated is expected. An increasing trend on in income levels is therefore expected to have a positive effect on the amount of HSW generated. Results from table 4 agree with a study by Mohamed *et al*., (2012) which established

that there was a strong positive correlation between monthly income and the amount of HSW generated (r= 0.87). This showed that as families earned more per month, they have the tendency to generate larger quantities of household solid waste each day. This positive correlation was also found in the research conducted by Sujauddin *et al*., (2008). Sankoh *et al.,* (2012) found a strong positive relationship(r= 0.921) in Freetown Sierra Leone. Individuals with higher income have a high purchasing power therefore they consume more than lower income individuals (Grover and Singh, 2014) making household monthly income is one of the most significant factors affecting the quantity of solid wastes from household consumption(Richardson and Harvileck, 1978; Sudhir *et al.*, 1997).Unlike previous studies, table 4 has presented correlation results for individual socio-economic groups that is HISG, MISG and LISG hence increased accuracy in the data.

4.6. Household Monthly Expenditure on Food and the Amount of HSW Generated Monthly

The association between household monthly expenditure on food and the amount of HSW generated monthly across high, middle and low income socio-economic groups was determined. In high, middle and low income socio-economic groups in urban estates in Kisumu city, the results show that the amount of HSW generated monthly is strongly and positively associated with household monthly expenditure on food (r = 0.978), (r = 0.990) and (r = 0.931) significant at 95% confidence level respectively. Food is a commodity that is consumed on a daily basis. Households with bigger family sizes and more children are normally expected to consume more food. Daily food consumption leads to HSW generation hence when the household expenditure increases or is high, it is expected that the amount of HSW waste generated will also increase. Previous studies have shown that food waste make up the largest fraction of HSW stream (Aisa, 2013; Jonas *et al.,* 2014; Mohammed *et al.,*2012; Yemadje*et al.,* 2015). Data on the association between household expenditure on food and the amount of HSW generated monthly is non-existent. This raises serious concerns bearing in mind that previous studies have established that food waste make up the largest fraction of HSW stream. Ferra (2009) reported that in 2005, households accounted for 75% of MSW in Korea, Germany, United Kingdom, Mexico, Belgium, Netherlands, Denmark and Spain and this can be attributed to uncontrollable spending, consumption, increased population and attitude towards shopping which is directly linked to expenditure. Sing *et al.,* (2014)revealed that expenditure on food accounted for the highest (26.9%) in households in Iskandar, Malaysia. Singh *et al.,* (2014) found a significant positive relationship between the amount of HSW generated and household expenditure. Thanh *et al.,* (2010) found a significant positive relationship between the amount of HSW generated and household expenditure. Results from table 4 on the association between household expenditure on food and the amount of HSW generated therefore bridges an important gap in knowledge by providing key which data despite its relevance has been ignored by previous researchers.

4.7. Age of the Household Head and the Amount of HSW Generated Monthly

The association between age of the household head and the amount of household solid waste generated monthly across high, middle and low income socio-economic groups was determined. In high, middle and low income socio-economic groups in urban estates in Kisumu city, the results show that the amount of HSW generated monthly is strongly and positively associated with age of the household head (r = 0.939), (r = 0.876) and (r = 0.920) significant at 95% confidence level respectively. Households with older heads are expected to have children and even live with relatives hence more people living within the household. Similarly, as age of the household head increases, one is expected to have progressed career wise or in better paying jobs as compared to households with younger heads who have just started their careers, hence there is increase in disposable income leading to increase in household expenditure and consumption, hence an increase in the amount of HSW generated. Koushki and Al-Kaleefil (1998) established that families with older heads generated larger quantities of solid waste each day which agree with the results of this study. This can be attributed to the fact that as the age of the household head increases, the amount of disposable income increases hence higher consumption and waste generation. Results from a study by Omole and Alakinde (2013) however did not agree with results from this study since they found a negative relationship between age of the household head and the amount of HSW generated (r= -0.035).Omole and Alakinde, (2013) explained that this could be attributed to the fact that as the age of the household head increases there was tendency to re-use some household stuff and also these households tended to purchase in bulk hence decrease in waste generation. Derksen and Gartel (1993) found that as the age of the household head increases, there is a decrease in the amount of HSW generated. The inconsistencies in results arise from the fact that there could be differences in household solid waste practices such asknowledge and awareness on recycling and re-use (Quinn and Nivison-Smith, 2006). Results from table 4 on the association between age of the household head and the amount of HSW generated monthly provide useful and detailed information since data has been presented for three socio-economic groups unlike previous studies where the data is lumped together.

5. Conclusions

This study aimed at assessing the effects of socio-economic and demographic variables on the amount of HSW generated monthly. This study has revealed that the association between of household size, household monthly income, household monthly expenditure on food and age of the household head and the amount of HSW generated monthly is strong and positive across high, middle and low income socio-economic groups. It is clear from this study that household socio-economic and demographic factors influence the amount of HSW generated monthly. Understanding such a relationship has demonstrated the importance of HSW quantification which is important for proper solid waste management in urban estates. Knowledge of the factors influencing the amount of HSW generated will help decision and policy makers in planning for solid waste management.

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