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Determinants of Household Waste Management: Socio-economic Insights for cleaner Quetta, Pakistan

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Abstract
This study aims to find out key significant socio-economic factors influencing household waste management practices to ensure sustainable environment and further policy interventions in Quetta. Inefficient household solid waste management poses serious environmental and health challenges, resulting into blocked drainage system and outbreak of several diseases due to water contamination. A comprehensive understanding is mandatory for addressing the socio-economic dynamics that shape waste management practices; generation to disposal. For this purpose, trained enumerators collected data regarding socio-economic status and waste management practices from 321 households through semi-structured questionnaires. Multiple, binary logistic and ordinal regression models were used to assess factors driving waste generation, segregation and collection, respectively. Findings elucidate numerous socioeconomic determinants which could determine household waste practices. Household income, awareness, literacy level, gender roles, and waste volume significantly impacted the household's waste management practices. Community-driven polices, gender-sensitive approaches and education campaigns must be incorporated, and take initiative to align socio-economic realities and waste management strategies. It offers a framework for designing efficient, sustainable and environmental friendly waste management in Quetta in particular and Pakistan in general.

Keywords: Waste Generation, Waste Collection, Waste Segregation, Regression Models

Introduction

Household solid wastes (HSW) are discarded items (Bukari et al., 2017; Megersa, 2018; Omer, 2021), of community after using economic resources (Grishaeva et al., 2022; Nyumah et al., 2021). Households are the high resource utilizing units (water, gas, electricity) of the community, so are considered as major waste producing sources. Household solid waste management (HSWM) is comprised of waste collection, transportation, recycling treatment and disposal (Megersa, 2018; Omer, 2021). These practices directly affect the aesthetic and scenic beauty of the area as well as human health and environment. one of the primary source of municipal solid

waste producers is domestic sector of the community thus inclusion of households while designing waste management plan is compulsory (Bikash & Ichihashi, 2022; Mukui, 2013; Razali et al., 2019; Ridayati & Yunastiawan, 2021). Additionally foremost respondent in order to apply the concept of sustainable waste management in real manner are the households, that is why considering their diverse socio-economic factors are significant (Ridayati & Yunastiawan, 2021). Households are the main source of waste production. Inadequate waste education, training and awareness worsen the management of waste at all levels. Significance of waste management is depicted from the fact that within the environmental science framework, garbology (study of garbage and its disposal methods) is dealt as a separate discipline, mentioned in Oxford English Dictionary 2nd edition 1989 (Grishaeva et al., 2022). Due to this significance, provision of safe and healthy environment is the prime concern of any waste management system. Undoubtedly solid waste management is a multibillion dollar business, thus concerned stakeholders prefer to deal waste as a cash or valuable economic source rather than put it in an open space or burnt it out (Wendimagegn, 2019). Present study tries to findout the annex between socio-economic variables and household waste management practices so that the determinants at the groos root level of administration (Community level) could be successively identified and considered while planning and implementing any sustainable and integrated waste management policy.

Literature Review

There is a strong linkage between household waste management and socio-economic determinants found in the literature. For instance, in Ethiopia (Abegaz et al., (2021), Wendimagegn, (2019), Megersa, (2018)), Ghana (Adzawla et al., (2018)), Malaysia (Fadhullah et al., (2022)), Kenya (Mochache et al., (2020)), Uganda (Ssemugabo et al., (2020)), Libya (Moftah et al., 2016), Vietnam (Trang et al., 2017), Buea municipality (Sama & Mbwange, 2017), Indonesia (Handayani et al., 2018), Ecuador (Hidalgo et al., 2019), Chennai, India, (Deshpande et al., 2024), Sri Lanka (Soysa et al., 2022). (Fakunle & Ajani, 2021) argue that improper HSWM results into unpleasant odor, breeding ground for number of insects and animals, choking drainage system, and source of the outbreak of several diseases. Indiscriminate disposal of waste is the source of environmental and health risk. In developing countries, risk of mortality and morbidity coupled with pollution of all types; air, water, soil, may not be denied just due to poor waste management practices (Abegaz et al., 2021; Wegedie, 2018; Wendimagegn, 2019). Thus, human health, environment and ecosystem services are threatened by improper waste management. Waste caused diseases, contaminated surface and ground water, greenhouse gas emission, degraded ecosystem and loss of tourist attraction towards the area are some of the after effects of inefficient waste management (Abegaz et al., 2021; Wegedie, 2018). United Nation Environmental Program (UNEP) mentioned major acute disorders associated with improper waste management like; skin, respiratory, abdominal & intestinal, dental disorders, ear infection, neurological impairments, blood disorders e.g. malaria, chicken pox, infected wounds, congenital abnormalities, cardiovascular diseases and lung cancer (Abegaz et al., 2021). Keeping these facts under consideration, ensuring public health by proper management of household solid waste is gaining attention in residential areas of developing countries (Fakunle & Ajani, 2021). Although all the concerned stakeholder's involvement is the key element of integrated WM system but there are some other aspects too which may affect or ensure the successful implementation of any waste management plan that include socio-economic, socio-cultural, technical, legal, environmental and financial aspects of that area (Zakianis et al., 2018). Therefore, the main aim of this study is to highlight significant socio-economic factors which must be considered as an essential component of sustainable waste management plan for Quetta city (Fig. 1).

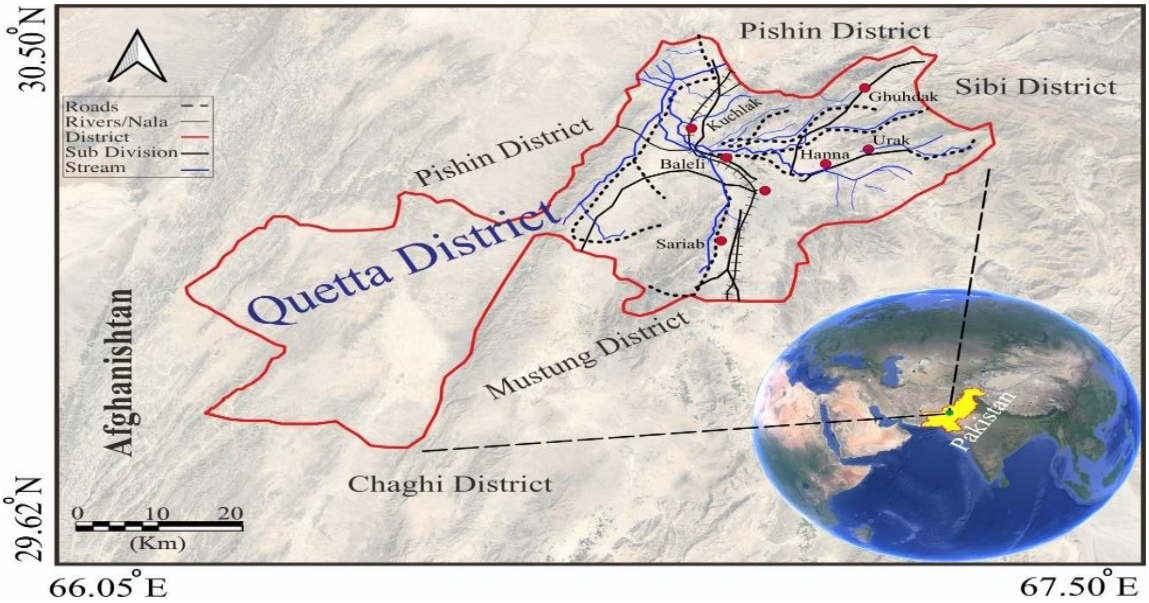

Figure 1**:** Location map of Quetta district

Material and Methods

Selection of the study area

The present study is exploratory in nature as it tries to explore socio-economic aspects of HWM from generation to disposal. Quetta city has been selected as study area being the provincial headquarter of Balochistan province. The city is the center of industrial, commercial, health and residential services hosting a population of 2.26 million with a growth rate of 4.67%, much higher than that of Pakistan (2.8%). The city produces 850 tons of organic and inorganic waste/day. Mean waste generation in Quetta is reported to 2.64 Kg/household/day and 0.33 Kg/capita/day. Similar figures are reported in National Study on Privatization of Solid Waste Management in Eight Selected Cities of Pakistan as 0.489 Kg/capita/day. Nearly 50% of generated waste is collected whereas remaining uncollected waste has root cause behind diverse public health risk in the form of clogging the drains, formation of stagnant ponds and providing breeding grounds for various diseases vectors like; malaria, dengue, cholera etc. Open dumping and burning is common disposal practice throughout the city premises (GoB, 2021). Keeping all this alarming situation and previous research studies in mind, present study tries to find out the socio-economic factors that need to be considered while designing and implementing any waste management plan, strategy and policy, so that environmental sustainability in terms of improved solid waste management system in Quetta city could be ensured.

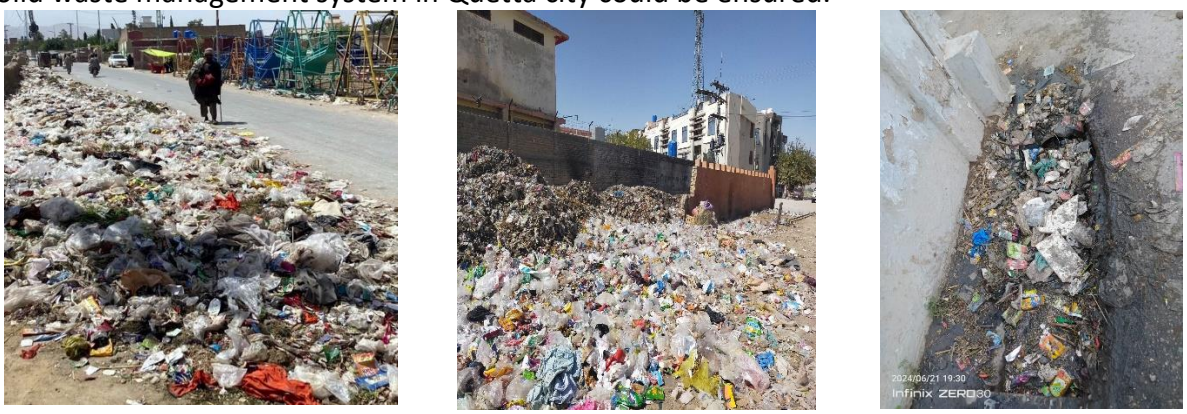

Figure 2: Open dumping of Waste resulting in clogging of drainage system and health hazard

Sampling design

To achieve the desired objective of the current study, primary data was used. According to census 2017, total households in Quetta city are reported as 276711. Taking this figure as population size, sample size of 321 households were calculated by using Arkin and Colton (1963) formula with 95% confidence level. Data collection tool included pre-designed questionnaire comprising of questions regarding numerous socio-economic factors and household waste management practices regarding waste generation, collection and segregation.

The questionnaire was filled up by household head during door to door field survey conducted by researcher along with the team of enumerators by using simple random sampling technique. Collected data then undergone statistical analysis through SPSS. To find out significantly determining socio-economic factors of household waste management, regression models were best suited. Based on the nature of dependent variable, the type of regression model varies. Dependent variables used in this study were; daily household waste generation, household waste collection frequency and waste segregation at household level.

The independent variables (factors) were numerous encompassing both direct and indirect influence on waste management practices at household level. These variables are shown in Table 1.

Table 1

Independent variables used in the regression models

Variables	Description	W.G*	W.C*	W.S*
Age	Age of the household head in years	Inc*	Inc	Inc
Gender	Gender of the household head	Inc	Inc	Inc
Literacy	Literacy of the household head	Inc	Inc	Inc
Income	Monthly household income in thousands	Inc	Inc	Inc
Children	Children aged 0-5 years	Inc	Exc*	Exc
Family structure	Joint and nucleated/separated family structure	Inc	Exc	Exc
Family size	No. of family members in each house	Inc	Exc	Inc
Knowledge	Knowledge regarding health risks related to poor waste management	Exc	Inc	Inc
Waste generation	Daily household waste generation in grams	Exc	Inc	Inc
Willingness to pay	Household's willingness to pay for improved household waste management	Exc	Inc	Exc

*W.G stands for Waste Generation

*W.C stands for Waste Collection

*W.S stands for Waste Segregation

*Inc stands for "Included"

*Exc stands for "Excluded

Econometric models specification for each dependent variables

Three distinct regression models were employed to find out significant socio-economic factors. For instance, multiple linear regression was selected for **waste generation** model.

In order to know the factors contributing to solid waste generation (in grams) at the household level in Quetta city. Prior to run the multiple regression, correlation matrix (in the appendix) was developed to ascertain the association between explanatory and exploratory variables and to sense the presence of any multicollinearity.

Equation 1 shows multiple regression model for waste generation as follows;

$Yi = X + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots \ldots \ldots \ldots \ldots \beta_7 X_7 + \epsilon$ (Equation 1)

The description of variables is given in Table 1.

In order to evaluate the impact of socio-economic variables on waste collection, we have adopted the "**Cumulative Logit Model**" originally proposed by Walker & Duncan (1967) and was later called the "**Proportional Odds Model**" by McCullagh (1980) in the current study. The selection of this model is based on the assumption that our waste collection response variable is ordinal in nature (1=once in a week to 4=Twice a day).

The dependence of Y on X for the proportional odds model has the following representation:

$P(Y \leq y_j|x) = \frac{\exp(X_j - x'\beta)}{1+\exp(X_j - x'\beta)}$ j=1, 2…k (Equation 2)

Or equivalently can be re-expressed in Logit form as:

$log\left[\frac{P(Y \leq y_j|x)}{P(Y > y_j|x)}\right] = X_j - x'\beta$ j=1, 2…k (Equation 3)

Here X_j are the unknown intercept parameters, satisfying the condition $X_1 \leq X_2 \leq \ldots\ldots \leq X_k$ and β'_k is a vector of unknown regression coefficients corresponding to x'independent variables.

For waste segregation, we have employed binary logistic model as the response variable (waste segregation) is binary in nature (Segregate=1; otherwise 0); the model is expressed as follows;

$P\ (Y = 1|x) = \frac{\exp(\mathrm{X}+x'\beta)}{1+\exp(\mathrm{X}+x'\beta)}$ (Equation 4)

Where X, β and x' are terms expressed earlier and variables described in Table 1.

Results and Discussion

Socio-economic determinants of household waste management

Household waste management encompasses a variety of critical activities designed to handle and dispose of waste materials efficiently and responsibly. It encircles all the activities starting from generation at the source to its final disposal. Here, household waste management considered under three significant activities with households are directly linked with; waste generation, waste collection and waste segregation. All the mentioned activities are interlinked processes that form the foundation of effective waste management system. Amount of generated waste directly influence the methods and frequency of its collection. Efficient collection system rely on proper segregation at the point of generation or source. Segregation facilitates the recycling or proper disposal which in turns reduces the burden on collection system and minimize the environmental impact. Therefore all these activities must work in harmony to create a sustainable and efficient waste management system.

Socio-economic determinants of household waste generation

The results indicate that multiple regression model significantly improve our ability to reliably predict the variation in exogenous variable; household waste generation, by the set of numerous control variables; age, gender, education etc. Moreover, almost fifty percent (47.8%) of the variation is caused by the control variables, which is fairly enough to predict any change in household waste generation. (R^2 = 0.478; adjusted R^2 = 0.466; F= 41.168; sig=0.000).

Table 2
Socio-economic determinants of household waste generation

Socio-economic determinants	Regression coefficients		T	p-value
	B	S.E.		
(Constant)	1065.11	197.18	5.40***	0.000
Age	-0.27	3.83	-0.07	0.943
Gender	178.58	72.88	2.45**	0.015
Education	-12.72	90.25	-0.14	0.888
Family structure	320.170	113.37	2.82***	0.005
Family Size	98.88	18.88	5.24***	0.000
Monthly Household Income	1.78	0.91	1.964**	0.050
Children (0-5 years)	54.48	28.95	1.88*	0.061

Dependent Variable: Household waste generation
R^2 = 0.478, **adjusted R^2** = 0.466 **F**= 41.168
***, **, * represents significant at 1%, 5%, and 10% respectively

Overall seven factors were considered for the waste generation model, among them, five appeared to be significant for predicting waste generation in the study area. The significant factors includes; gender, family structure, size of the family, monthly income and number of children below 5 years of age.

Family size is the most significant determinant of household waste generation (t= 5.24; sig= 0.000) depicting that waste generation on the average will increased by nearly 100 grams on the addition of a one extra family member in the house. In simpler words, households consisting of larger family size, generates more waste compared to lower family size, finding resonates with the finding of (Adzawla et al., 2018; Hidalgo et al., 2019; Moftah et al., 2016; Trang et al., 2017; Wegedie, 2018; Wendimagegn, 2019). It may be because larger families naturally consume more food, utilities and various products, which leads to greater waste generation. This generated waste is not only higher in quantity but diverse in composition/nature too; from food waste to packaging or personal care waste. Another ascertained fact is, this huge amount and diverse composition of household waste make its management a serious challenge for the household. Thus household does not pay serious attention to its sustainable management; recycling or composting.

Family structure significantly determine household waste generation (t= 2.824; sig=0.005) depicting that waste generation in households following joint family structure is tend to be 320 grams greater compared to those in nucleated or separated houses. Major reason of this finding is joint families typically consists of more family members than nucleated families, as described earlier, leading to higher consumption of goods and services, and consequently generates more waste. Joint families often includes members of multiple generation, from infants to elderly, each with different consuming behavior and needs. This waste diversity may leads to higher waste generation in joint families. Another economic reason is that joint families might have more collective purchasing power leading to bulk buying and more waste generation.

Gender of household head is statistically significant (t=2.451; sig=0.015) depicting that household waste generation in male headed households is around 179 grams more than female headed houses. There are numerous possible reasons of this finding, like usually male headed houses holds a larger family size, thus it significantly contributes to higher waste generation as compared to female headed houses. Another reason may be difference in monthly income. Usually earning of the male HH head is more than female due to multiple source of income as compared to females. Higher income successively change the consumption behavior of goods

and services resulting in greater amount of waste generation. One major reason is cultural and social setup of the study area. Women has to play primary role of managing household resources. Additionally, women tend to be more environmentally conscious, practicing diligent waste management practices, thus due to efficient utilizing and conserving the resources female headed HH generate less waste.

Monthly household income significantly determine household waste generation (t= 1.964; sig= 0.050) depicting that nearly 2 grams increase in household waste generation is resulted on an addition of 1 thousand monthly household income. In other words, household waste generation increase with increasing household income. This positive relation between two variables is supported by previous literature (Deshpande et al., 2024; Handayani et al., 2018; Hidalgo et al., 2019; Moftah et al., 2016; Soysa et al., 2022; Wegedie, 2018). There are various possible reasons behind this finding, like; higher consumption of variety of goods and services, greater affordability of disposable or single use items, frequent upgrading or replacing household items (electronics, appliances, clothing, furniture), purchasing of food or other items beyond their need. All these practices leads to higher household waste generation.

Number of Children (0-5 years) is also considered significant determinant of household waste generation (t= 1.882; sig= 0.06) depicting that household waste generation will increase nearly 50 grams on addition of additional child in a family. It means higher no. of children will increase the household waste generation. Because large no. of children means more food, clothing, toys and consumables are needed. All these items generate greater amount of food waste, packing waste and overall general household waste. Usage of disposable items like, diapers, baby wipes, and single-use feeding products significantly contributes to household waste.

Socio-economic determinants of household waste collection

Model fitting information and goodness of fit value was the first thing to consider while interpreting the ordinal regression analysis. Significant model fitting value, (chi square= 62.814, sig=0.000) shows that there is a significant improvement in predicting the household waste collection when predictors (age, gender, education, income etc.) are added in the model, and the model adequately describes the data. Goodness of fit test insignificant value (chi square= 1002.696, sig= 0.148) means that there is no significant difference in the observed and fitted model. In addition, McFadden pseudo R-square value (0.094) indicates that there has been 9.4% improvement in the prediction of household waste collection based on the set of predictors in comparison of the null model.

As the above discussion clarified that ordinal regression model for predicting household waste collection is statistically significant, therefore one can relies on the parameters estimates of the model. Parameter estimate assess the impact of individual predictor (age, gender, education, monthly household income, household waste generation on daily basis, waste related knowledge and WTP for household waste management) on household waste collection. Among these seven predictor variables, six were identified as statistically significant variables that includes age, education, monthly household income, and household waste generation on daily basis, waste related knowledge and WTP for household waste management. Detailed description is reported in Table 3.

Table 3

Socio-economic determinants of household waste collection

Socio-economic determinants	Estimate	Std. error	Wald	P-value
Waste generation	.302	.143	4.469	.035
Age	-.030	.014	4.748	.029
Income	.014	.003	22.320	.000

Literacy=0	-.782	.293	7.145	.008
Literacy=1	0[a]	.	.	.
Gender=0	-.234	.255	.844	.358
Gender=1	0[a]	.	.	.
Waste related knowledge=0	-1.015	.310	10.694	.001
Waste related knowledge=1	0[a]	.	.	.
WTP=0	-.812	.267	9.272	.002
WTP=1	0[a]	.	.	.

Model fitting Chi-square value = 62.814 (p-value < 0.000)
Goodness-of-fit Chi-square value = 1002.696 (p-value = 0.148)
McFadden Pseudo R-square = 0.094 (9.4%)

Results of the fitted model indicate that Monthly household income is the most significant determinant among all the other significant predictors (sig=0.000, B=.014). This indicates that households with higher monthly household income followed frequent waste collection practices (once or twice a day) as compared to the lower earning households. Finding is in line with (Abegaz et al., 2021; Adzawla et al., 2018; Handayani et al., 2018; Mochache et al., 2020). There are several contributing factors for this trend, like access to municipal services either public or private waste collection services, increased purchasing power and affordability of waste management containers and services, and access to greater knowledge and information regarding environmental sustainability, cleanliness and hygiene issues which leaded to conscious household waste collection and disposal.

Waste management knowledge also plays a significant role in describing household waste collection practices. The results (sig=.001, B=-1.015) show that households without specific knowledge of waste management practices tend to have lower waste collection frequency as compared to environmentally knowledgeable households. This finding is aligned with the findings of (Handayani et al., 2018; Lema et al., 2019; Megersa, 2018; Ssemugabo et al., 2020; Wendimagegn, 2019). This disparity could be due to lack of environmental awareness, limited or no access to education and environmental information and consciousness, lack of participation in community initiatives and programs regarding frequent waste collection schedules etc.

Willingness to pay for household waste management is another significant determinant of frequent waste collection practices (sig=0.002, B=-0.812). It is evident that households who are unwilling to pay for household waste management generally did not prefer frequent household waste collection as compared to those who are willing to pay for such services. Wendimagegn, (2019) and (Megersa, 2018) also found the similar results in their research. Such behavior of the respondents could be linked with financial constraints, differing perception of the importance of frequent waste collection, or a lack of awareness about the benefits of regular waste collection. Willingness to pay for waste management services often correlates with a higher preference for frequent collection, as these households likely recognize the value in maintaining cleanliness, reducing health risks, and improving the overall quality of life. On the other hand, households unwilling to pay may not prioritize these benefits, or they might seek alternative waste management solutions that are less costly, even if they are less convenient or effective.

Education or literacy is another significant socio-economic factor that describes any change in household waste collection practices (sig=0.008, B=-0.782). The results show that households headed by illiterate individuals tend to follow less frequent waste collection practices compared to those headed by literate individuals. Several researcher (Abegaz et al., 2021; Adzawla et al., 2018; Handayani et al., 2018; Megersa, 2018; Mochache et al., 2020; Sama & Mbwange, 2017) also found the similar finding. This disparity attributed to several factors like; better access to

knowledge and awareness of environmental and health benefits of proper waste collection, better access to resources and services, productive attitude and perception towards frequent household waste collection and better financial sources (literacy is often correlated with higher income levels) leads to frequent waste collection.

Age is also a significant factor of household waste collection. The results (sig=0.029, B=-0.030) indicate that older respondents did not prefer frequent waste collection practices, however, the younger generation was much more aware and conscious about proper waste collection. This can be explained by several factors; like access to environmental education and awareness in recent curriculum, better access to information through digital plate forms and social media and much more conscious behavior of youth towards long-term environmental impacts. Contrary to this, Adzawla et al., (2018) reported that older generation is much more conscious about waste collection and fine disposal compared to younger ones.

Household waste generation on daily basis was significant determinant of waste collection practices (sig=0.035, B=0.302). Households that generate greater amounts of waste tend to follow more frequent waste collection practices. This behavior was influenced by several factors; firstly, larger amount of waste quickly become unmanageable, leading to issues such as unpleasant odor, pest infestation and numerous health hazards. To mitigate this problem, households with larger amount of waste production are more likely to opt frequent waste collection. In addition, households may not have sufficient space to store large amounts of waste for extended period of time, thus frequent and regular collection helps to manage the waste volume and prevent overflow.

Socio-economic determinants of household waste segregation

In order to assess the socio-economic determinants of household waste segregation practices, a binary logistic regression model is used due to dichotomous nature of the response variable in this study. The set of socio-economic explanatory variables such as age, gender, literacy, monthly household income, family size, household waste generation on daily basis and waste related knowledge are used in the model.

The first thing to consider was goodness of fit model. Omnibus test statistics (55.870, $p < 0.05$ at 95% C.I) indicates the existence of relationship between explained and explanatory variables. In addition, there is no significant difference between the observed and predicted data (Hosmer and Lemeshow test statistic = 7.635 $p > 0.05$ at 95% C.I), that confirms reliability of Binary Logistic Regression estimates. Furthermore, Nagelkerke's R^2 value indicates that about 21.2 % of the variation in the household's waste segregation (response variable) is due to predictors variables (socio-economic factors) included in the model. Next thing to consider was classification table which exhibited that how well the model was able to predict the waste segregation practices once the socio-economic variables were added in the study. Overall percentage showed that model predicted 62.8% HH waste segregation practices when socio-economic predictors were considered for the model, also called percentage accuracy in classification. First row of classification table showed specificity or true negative rate, predicted the percentage of HH that had not chosen waste segregation practices. The specificity of this model was 64.5%, means nearly 65% HH would never observe waste segregation practices in their households. Second row of classification table showed sensitivity or true positive rate, predicts the percentage of HH who opted to choose the waste segregation practices. The sensitivity of this model was 61% depicted the correct prediction for HH preferring waste segregation practices.

Table 4

Socio-economic determinants of household waste segregation

Variables included	B	S.E.	Wald	df	p-value	Exp(B)
Age	-0.001	0.014	0.005	1	0.941	0.999
Gender(1)	0.774	0.259	8.910	1	0.003	2.168
Literacy	0.738	0.322	5.268	1	0.022	2.092
Family Size	0.042	0.046	0.838	1	0.360	1.043
Monthly Household Income	-0.019	0.005	12.187	1	0.000	0.982
Do you know which diseases spread from waste	0.894	0.350	6.535	1	0.011	2.446
Waste in KG	0.413	0.179	5.331	1	0.021	1.512
Constant	-2.103	0.797	6.961	1	0.008	0.122

Dependent Variable: Household Waste Segregation (Binary)

Out of seven predictor variables, five are found as significant determinants of household waste segregation practices. These included gender, literacy, monthly household income, waste related knowledge and daily household waste generation. Detailed description of each of these variable is below:

Monthly household income is statistically a significant (probability of Wald statistic is 0.000 and B = - 0.019) determinant of household waste segregation depicting negative relation with waste segregation which indicates that higher income people do not opt for segregation. The odds ratio is 0.982 which implies that with additional increase of 1000 in income, the likelihood of waste segregation decrease by 2%. This in turn implies that low income households are more likely to segregate their waste because they find metal, glass, plastic (recyclable waste) as an extra source of income by selling them to vendors.

Gender of the household head is also another significant (probability of Wald statistic is 0.003 and B = - 0.774) determinant of HH waste segregation (see Table 4). The associated odds ratio implies that female headed households are two times more likely to segregate their household waste compared to male headed households. There are numerous reasons of this finding, like; traditional gender role, females are more often responsible for managing household chores including waste management. Thus, they are more proactive and aware about waste segregation practices. Women exhibit stronger pro-environmental attitude and behavior compared to men. This might translate to more diligent waste segregation practices in female headed households. Access to resources, time and prioritization, community engagements, social norms and peer influence are other influencing factors regarding gender based waste segregation practices.

Waste management knowledge which is a significant determinant and positively associated with HH waste segregation (sig=0.011, B = 0.894). The value of Exp (B) is 2.446 which implies that adequately knowledgeable and aware households are indeed more likely to segregate their waste effectively. In other words with increasing knowledge of waste management and its adverse impacts, households positively implement waste segregation practices as explained by (Handayani et al., 2018; Lema et al., 2019; Megersa, 2018; Ssemugabo et al., 2020; Wendimagegn, 2019). Odd ratio figure (2.446) indicates that knowledgeable households segregate their household waste 2.4 times more than the households with poor knowledge of waste management and its adverse impacts on human health and environment. Awareness of the health risks associated to household waste, environmental consciousness, realizing the importance of recycling and reuse, better access to information and resources, perceived responsibility of waste segregation due to sound base of knowledge and awareness and better

understanding of waste segregation methods are some key reasons why knowledge of waste management has positive relationship with HH waste segregation practices.

Household waste generation on daily basis is another significant determinant of HH waste segregation. The value of the coefficient indicates positive relationship between amount of waste generated in households and their waste segregation practices. The associated odds ratio indicates that with additional increase of 1kg HH waste generation, the likelihood of waste segregation increases about 1.5 times. In fact higher volumes of household waste lead to increased disposal cost for both households and municipalities. Efficient waste segregation practices can reduce this cost by minimizing the amount of waste sent to landfills and maximizing the amount of recyclable materials. Thus, the households that generate more waste have more potential recyclables, making segregation practices more appealing. With increasing volume of household waste, the environmental impact becomes more apparent. This heightened awareness may also motivate households to adopt better waste segregation practices to mitigate adverse environmental impacts.

Literacy is another significant determinant of HH waste segregation (sig=0.022, B = 0.738). The results indicate the positive relationship between education/literacy and household waste segregation practices. Educated households segregate their waste more efficiently than uneducated ones. Similar finding revealed by (Abegaz et al., 2021; Deshpande et al., 2024; Handayani et al., 2018; Megersa, 2018; Mochache et al., 2020; Sama & Mbwange, 2017). The value of Exp (B) is 2.092 which indicate that literate individuals segregate their household waste 2 times more than illiterate individuals. There are several reasons for this finding such as better access to information about environmental issues like pollution, resource depletion and climate change, sound understanding of waste segregation (in terms of differentiate between recyclables, compostable and general waste) and its importance, access to educational resources like books, magazines, articles, online platforms providing information on effective waste management practices. Moreover educated households often have higher economic stability, enabling them to invest in tools and systems for efficient waste segregation, such as separate bins and composting units etc.

Conclusion

Main objective of the present study was to highlight the linkage between waste management system and socio-economic setup of the sampled respondents. For this purpose, three most important activities of waste management system with which households were directly linked were selected; waste generation, collection and segregation. Regression analysis clarified that monthly household income was significant variable in all the three waste management activities. In addition, income may define household's willingness to pay for improved waste management services. Thus, the monthly income influence waste management practices both directly and indirectly. Environmental education, waste related knowledge and awareness are also the significant determinants of waste collection and segregation practices in the study area. Family size and structure, gender and no. of children affect waste volumes in the area however this generation of waste then further determines the waste collection and segregation practices. Awareness raising campaigns about not only proper management but waste reduction, recycling, proper segregation and sustainable disposal is dire need of the present time. Environmental education in the form of curriculum, courses or community trainings may assist in developing a sound base of awareness and knowledge about improved solid waste management system.

Recommendations

Following are some recommendation based on study findings:

- Integrate environmental education into formal and informal systems; like school curricula, vocational training, and community awareness programs.
- Implement income-sensitive waste management policies; like tiered or subsidized payment models should be developed. Low income households may be offered subsidies or incentivized participation in recycling programs.
- Strengthen community based waste segregation programs; provision of color-coded bins, regular training sessions, and local monitoring can enhance segregation practices.
- Develop incentive-based schemes; such as discounts on utility bills, reward points, or tax rebates can be introduced for households that demonstrate good waste segregation and participation in community programs.
- Waste management policies and services should account for variables like family size, structure, and number of children, as they impact waste volumes and practices.

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