

Original Research Article

Household e-waste awareness, disposal practices and socioeconomic factors in a semi-urban community of Kerala: a cross-sectional study

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ABSTRACT

Background: Electronic waste (e-waste) is a growing environmental and public health concern. This study assessed e-waste awareness, generation patterns, disposal practices, and socioeconomic factors among households in a semi-urban community of Kerala.

Methods: A cross-sectional study was conducted among 105 households in Cheror ward, Thrissur district, Kerala. Data were collected through structured face-to-face interviews using a pre-tested questionnaire covering sociodemographic characteristics, e-waste generation, disposal practices, challenges, and awareness. Descriptive statistics, Pearson's Chi-square tests, and binary logistic regression were used to examine associations and socioeconomic factors associated with general e-waste awareness.

Results: General awareness of e-waste was reported by 84.76% of households, while 78.10% were aware of its negative effects and 74.29% of its health effects. Awareness of e-waste management policies and regulations was lower (31.43%), and 48.57% had received information or education on e-waste management. Selling e-waste to scrap dealers was the most common disposal practice (80.95%), followed by storing e-waste at home (50.48%). Education was significantly associated with receipt of e-waste management information ($\chi^2=8.497$, $df=2$, $p=0.014$). In adjusted logistic regression, households with monthly incomes of ₹20,000–50,000 had higher odds of general e-waste awareness than those earning below ₹20,000 (OR=3.37, 95% CI: 1.28–9.24, $p=0.015$).

Conclusions: The findings indicate a gap between general e-waste awareness and use of formal disposal options. Improved household-level information and accessible formal collection facilities may support better e-waste management in semi-urban communities.

Keywords: E-waste, Household disposal practices, Awareness, Kerala, Socioeconomic factors, Semi-urban community

INTRODUCTION

Electronic waste (e-waste) is one of the fastest-growing waste streams globally, driven by increasing consumption and rapid replacement of electrical and electronic devices. Global e-waste generation reached 53.6 million metric tons in 2019, while only 17.4% was formally collected and recycled.¹ Discarded electronic products contain valuable materials as well as hazardous substances, including lead, mercury, and cadmium. Improper handling and disposal of

e-waste can pose risks to environmental quality and human health.^{2,3}

India is among the major generators of e-waste, and effective collection, recycling, and monitoring remain important challenges. The e-waste (management) rules, 2022 strengthened the regulatory framework for e-waste management, including extended producer responsibility.^{3,4} Studies have also highlighted the need for more effective formal collection and recycling systems and improved implementation of e-waste management measures.^{5,6} In Kerala, increasing household use of

electrical and electronic products highlights the importance of understanding household-level awareness and disposal practices.

Previous studies have reported gaps between general awareness of e-waste and knowledge of appropriate disposal mechanisms, formal collection systems, and regulations.⁷⁻⁹ Research has also suggested that socioeconomic characteristics, access to information, convenience, and economic considerations may influence e-waste awareness and disposal behaviour.¹⁰⁻¹² Recent household-level research has further examined the role of environmental awareness and other factors in shaping e-waste recycling behaviour.¹³

However, household-level evidence from semi-urban communities of Kerala remains limited, particularly studies examining awareness, disposal practices, and socioeconomic factors together. Therefore, the present study assessed e-waste awareness, generation patterns, disposal practices, and challenges among households in Cheroor ward, Thrissur district, Kerala, and explored the association between selected socioeconomic characteristics and general e-waste awareness.

Awareness, behaviour, and structural barriers

Studies from different developing-country settings have reported gaps between awareness of e-waste and appropriate disposal practices. Meem et al reported limited awareness regarding the hazardous nature of e-waste, while Kariwala et al identified inadequate knowledge and continued use of informal disposal channels among households.^{8,14} A study conducted in Kochi, Kerala, also reported concerns regarding household awareness and e-waste disposal practices, highlighting the importance of appropriate collection and management systems.⁷

Awareness alone, however, may not always result in appropriate disposal behaviour. Attia et al reported that convenience and economic considerations can influence household e-waste disposal decisions. Similarly, Islam et al. highlighted the importance of information regarding collection systems and appropriate disposal options. Adhikari and Roy examined factors associated with informal e-waste disposal behaviour and demonstrated the relevance of socioeconomic and demographic characteristics in understanding disposal decisions.^{6,10,11}

More recent research has also examined factors influencing household e-waste recycling behaviour. Harafah et al reported that environmental awareness was associated with recycling intention and behaviour in their study of households in Surabaya, Indonesia.¹³ Although the setting and methodology differ from the present study, the findings support the importance of examining awareness together with actual e-waste management behaviour.

E-waste management is also influenced by the availability of appropriate collection and recycling systems. Shittu et al discussed the challenges associated with increasing e-waste generation and uneven implementation of management systems. Li and Achal highlighted environmental and health concerns associated with inappropriate e-waste recycling practices. In the Indian context, Arya and Kumar discussed both the resource potential of e-waste and the environmental challenges associated with its management, emphasizing the need for effective recycling and regulatory systems. Islam and Ali also highlighted the importance of regulatory frameworks, extended producer responsibility, and improved management systems in addressing the growing e-waste problem.^{2,3,5,15}

Policy and institutional mechanisms are therefore important components of effective e-waste management. The Government of Kerala has issued guidelines promoting improved segregation, collection, recycling, and environmentally sustainable waste management through local self-government institutions.¹⁶ Sengupta et al further highlighted the role of informal waste collectors in waste recovery systems and their relationship with existing waste-management practices.¹⁷

Socioeconomic and educational influences

Educational attainment has frequently been examined as a factor associated with environmental awareness and e-waste management behaviour. Hamzah et al emphasized the importance of improving knowledge, attitudes, and practices related to e-waste recycling. However, educational attainment does not necessarily ensure adequate practical knowledge regarding available disposal systems. Studies by Kshetriya and Anchala and by Nazree et al reported gaps in practical knowledge and e-waste management practices even among relatively educated populations.^{9,12,18}

Access to information may also influence e-waste awareness and behaviour. Mor reported differences in awareness associated with access to information and communication channels.¹⁹ These findings suggest that formal education and access to information may represent related but distinct influences on household e-waste awareness.

Evidence from groups directly involved with e-waste handling also indicates that exposure to electronic waste does not necessarily ensure adequate knowledge of its hazards. Apprey et al reported insufficient awareness of e-waste-related hazards among workers involved in e-waste-related activities.²⁰ Jain et al examined health risks associated with e-waste and highlighted the potential consequences of inappropriate e-waste management.²¹ Halim and Suharyanti reviewed trends in e-waste research and emphasized the continuing environmental and human health concerns associated with increasing e-waste generation, particularly in developing countries.²²

Overall, the existing literature suggests that socioeconomic characteristics, education, information access, and the availability of appropriate disposal systems may all be relevant to household e-waste awareness and management practices. These findings provide a basis for examining socioeconomic factors alongside awareness and disposal practices in the present study.

Research gap and study rationale

Existing studies have provided important information on e-waste awareness, disposal behaviour, health concerns, and management systems. However, findings vary across settings, and household practices may be influenced by local socioeconomic conditions and the availability of disposal facilities.⁶⁻¹¹

Evidence specifically focusing on household e-waste management in semi-urban communities of Kerala appears comparatively limited. In particular, there is scope for studies that examine general awareness, awareness of management-related information and regulations, disposal practices, reported challenges, and selected socioeconomic characteristics within the same household-level survey.

The present study therefore examined these aspects among households in Cheror ward, Thrissur district, Kerala. The study also explored associations between selected socioeconomic characteristics and general e-waste awareness using chi-square tests and binary logistic regression.

METHODS

Study design and area

This was a cross-sectional, descriptive study using quantitative methods to assess household e-waste awareness, generation patterns, and disposal practices in Cheror ward, Thrissur district, Kerala. Cheror ward, which falls under the jurisdiction of the Thrissur Municipal Corporation, was selected as the study area. The area represents a semi-urban setting with a mixed socioeconomic population and increasing household use of electrical and electronic products.

Study period

The study was conducted from January 2025 to January 2026.

Sampling strategy and sample size

A purposive convenience sampling strategy was used to recruit 105 households from Cheror ward. Efforts were made to include households from different income groups (<₹20,000, ₹20,000–50,000, and >₹50,000 per month) and educational groups (graduate, non-graduate, and professional degree holders). One adult member from each

household, preferably the person involved in household waste-management decisions, participated in the survey. Households were excluded if no adult member was available during two scheduled visit attempts.

The final sample consisted of 105 households. As a non-probability sample from a single ward, the study was considered exploratory, and the findings were not intended to provide population-level estimates for Kerala.

Inclusion and exclusion criteria

Households residing in Cheror ward with at least one adult member available to participate were eligible for inclusion. One adult member from each household, preferably the person involved in household waste-management decisions, participated in the survey. Households were excluded if no adult member was available during two scheduled visit attempts or if the household was unwilling to participate.

Questionnaire development and pre-testing

Data were collected using a structured, pre-tested questionnaire developed for the study. The questionnaire consisted of four modules: socio-demographic characteristics, including household size, monthly income, and highest educational attainment; e-waste generation patterns; e-waste disposal practices and challenges; and awareness regarding e-waste, its environmental and health effects, and e-waste management regulations.

The questionnaire was prepared in English and was pilot-tested among 10 households that were not included in the final study sample. Based on the pilot testing, necessary modifications were made to improve the clarity and understanding of the questions. During the main data collection, the researchers conducted face-to-face interviews and read the questions to the participants, who provided their responses.

Variables and measures

The primary outcome for the logistic regression analysis was general e-waste awareness, which was classified as a binary variable (aware versus not aware). The independent variables included educational attainment, monthly household income, and household size.

For the Chi-square analyses, receipt of e-waste management information or education, awareness of e-waste management policies or regulations, and awareness of health issues related to e-waste were considered categorical outcomes. The selected socioeconomic variables were considered potential factors associated with household e-waste awareness. The logistic regression analysis was treated as an exploratory assessment of socioeconomic factors associated with e-waste awareness rather than as a causal model.

Statistical analysis

Data were analysed using descriptive and inferential statistical methods. Frequencies and percentages were used to summarize the socio-demographic characteristics, e-waste generation patterns, disposal practices, challenges, and awareness indicators. The Pearson Chi-square test was used to examine associations between selected socio-economic characteristics and e-waste awareness.

A binary logistic regression analysis was performed to examine factors associated with general e-waste awareness. Odds ratios (ORs) with 95% confidence intervals (CIs) and p values were reported. Model fit was assessed using the Nagelkerke R^2 , Akaike information criterion (AIC), and likelihood-ratio test. Statistical significance was considered at $p < 0.05$.²³

Ethical considerations

Verbal informed consent was obtained from all participants before data collection. Participants were informed about the purpose of the study, and participation was voluntary. The information collected from the participants was kept confidential and used solely for the purpose of the study.

RESULTS

Socio-demographic characteristics

Among the 105 surveyed households, 63 (60.00%) had fewer than four members, while 42 (40.00%) had four or more members. The largest income group was ₹20,000–50,000 per month (45, 42.86%), followed by households with an income below ₹20,000 (38, 36.19%) and above ₹50,000 (22, 20.95%). Regarding educational attainment, 47 (44.76%) households were classified as graduate, 31 (29.52%) as professional degree holders, and 27 (25.71%) as non-graduates (Table 1).

Table 1: Socio-demographic profile of surveyed households (n=105).

Variables	Frequency	Percentage (%)
Household size		
Below 4 members	63	60.00
4 members and above	42	40.00
Monthly income (₹)		
Below 20,000	38	36.19
20,000–50,000	45	42.86
Above 50,000	22	20.95
Education level		
Graduate	47	44.76
Not graduate	27	25.71
Professional degree	31	29.52

The highest education level per household is recorded

E-waste generation

Mobile phones, fans, and bulbs were reported by all surveyed households. Batteries were the most commonly reported type of e-waste (75, 71.43%), followed by bulbs (62, 59.05%) and chargers (61, 58.10%). Mobile phones were reported by 46 households (43.81%), while headphones were reported by 25 (23.81%). Televisions and laptops/computers were the least frequently reported items, each reported by 5 households (4.76%) (Table 2).

Table 2: Types of e-waste reported by surveyed households.

E-waste type	Frequency	% of households
Battery	75	71.43
Bulb	62	59.05
Charger	61	58.10
Mobile phone	46	43.81
Headphone	25	23.81
Fan	11	10.48
Television	5	4.76
Laptop/computer	5	4.76

Responses are not mutually exclusive; households could report more than one e-waste type

Disposal practices and challenges

Selling e-waste to scrap dealers was the most commonly reported disposal practice, reported by 85 households (80.95%), followed by storing e-waste at home, reported by 53 households (50.48%). Vendor buy-back or exchange schemes were reported by 36 households (34.29%), while 19 households (18.10%) reported disposing of e-waste along with regular household waste. The most frequently reported challenges were lack of awareness about appropriate e-waste disposal methods (72 households, 68.57%) and lack of collection services (63 households, 60.00%). Other reported challenges included the absence of dedicated drop-off points nearby (41 households, 39.05%) and lack of information about e-waste regulations (38 households, 36.19%) (Table 3).

Awareness indicators

Most households (89, 84.76%) reported general awareness of e-waste. Awareness of the negative environmental effects of e-waste was reported by 82 households (78.10%), while 78 households (74.29%) were aware of its potential health effects. However, awareness of e-waste management policies or regulations was lower, with only 33 households (31.43%) reporting such awareness. In addition, 51 households (48.57%) reported having received information or education related to e-waste management. These findings indicate a difference between general awareness of e-waste and awareness of its management policies and practices (Table 4).

Table 3: E-waste disposal practices and challenges faced by households (n=105).

Variables	Frequency	% of households
Disposal methods		
Informal disposal	85	80.95
Store at home	53	50.48
Vendor buy-back/exchange scheme	36	34.29
Dispose with regular household waste	19	18.10
Challenges in disposal		
Lack of awareness about disposal methods	72	68.57
Lack of collection services	63	60.00
No dedicated drop-off points nearby	41	39.05
Lack of information on regulations	38	36.19

Multiple responses permitted for both disposal methods and challenges; percentages may exceed 100%

Table 4: E-waste awareness indicators among surveyed households (n=105).

Awareness indicator	Yes (N)	No (N)	% aware
General awareness of e-waste as a category	89	16	84.76
Aware of negative effects of e-waste	82	23	78.10
Aware of health issues from improper disposal	78	27	74.29
Received e-waste management information/education	51	54	48.57
Aware of e-waste management policies/regulations	33	72	31.43

Cancer (60.95%) and respiratory diseases (53.33%) were the most commonly identified health risks; awareness of lead and mercury poisoning was minimal (<10%)

Association between socioeconomic factors and awareness

The association between selected socioeconomic characteristics and e-waste awareness indicators was

examined using the Pearson chi-square test. Educational attainment was significantly associated with receipt of information or education on e-waste management ($\chi^2=8.497$, $df=2$, $p=0.014$). No statistically significant association was observed for the other selected associations at the 5% significance level (Table 5).

Binary logistic regression

A binary logistic regression analysis was performed to examine the association of selected socioeconomic factors with general e-waste awareness. A univariable model was first used to examine the association between educational attainment and general e-waste awareness, followed by a multivariable model including educational attainment, monthly household income, and household size (Table 6).

In the univariable model, non-graduate households had lower odds of reporting general e-waste awareness than graduate households (OR=0.322, 95% CI: 0.118–0.849, $p=0.024$). The association for households with a professional degree was not statistically significant (OR=1.607, 95% CI: 0.581–4.776, $p=0.372$).

A multivariable binary logistic regression model was then fitted including educational attainment, monthly household income, and household size (Table 7).

In the multivariable model, the association between educational attainment and general e-waste awareness was attenuated after adjustment for monthly household income and household size. Non-graduate households had lower odds of reporting general e-waste awareness than graduate households, although the association was not statistically significant (OR=0.39, 95% CI: 0.13–1.10, $p=0.076$). Households with a monthly income of ₹20,000–50,000 had higher odds of reporting general e-waste awareness compared with those earning below ₹20,000 (OR=3.37, 95% CI: 1.28–9.24, $p=0.015$). The association for households earning above ₹50,000 was in the same direction but did not reach statistical significance at the 5% level (OR=4.09, 95% CI: 1.04–18.83, $p=0.052$). Household size was not significantly associated with general e-waste awareness (OR=1.05, 95% CI: 0.42–2.63, $p=0.922$). The overall model was statistically significant according to the likelihood-ratio test ($p=0.011$), although the Nagelkerke R^2 of 0.112 indicated modest explanatory power.

Table 5: Summary of Chi-square test results.

Association tested	Independent variable	χ^2 value	df	P value
Education versus e-waste management information received	Education	8.497	2	0.014*
Education versus awareness of e-waste policies	Education	2.277	2	0.320
Income versus awareness of health issues from e-waste	Monthly income	0.131	2	0.936

* $P<0.05$ (statistically significant at 5% level); H_0 =null hypothesis of no association

Table 6: Univariable binary logistic regression – effect of education on e-waste awareness.

Education category	β	SE	OR	95% CI lower	95% CI upper	P value
Graduate (reference)	–	–	1.000	–	–	–
Not graduate	–1.132	0.501	0.322	0.118	0.849	0.024*
Professional degree	0.475	0.532	1.607	0.581	4.776	0.372

OR=odds ratio; SE=standard error; CI=confidence interval; * $p < 0.05$. Dependent variable: e-waste awareness (1=yes, 0=no). Reference category: graduate; n=105

Table 7: Multivariable binary logistic regression – predictors of e-waste awareness.

Variables	OR	95% CI lower	95% CI upper	P value
Education				
Graduate (ref)	1.000	–	–	–
Not graduate	0.39	0.13	1.10	0.076
Professional degree	1.10	0.35	3.56	0.864
Monthly income				
Below 20,000 (ref)	1.000	–	–	–
20,000–50,000	3.37	1.28	9.24	0.015*
Above 50,000	4.09	1.04	18.83	0.052
Family size				
Large (ref)	1.000	–	–	–
Small	1.05	0.42	2.63	0.922

Model fit: Nagelkerke $R^2=0.112$ -AIC=134.48-overall model $p=0.011$ *

The education–awareness association was attenuated after adjustment for monthly household income and household size, with the OR for non-graduate households changing from 0.322 in the univariable model to 0.39 in the multivariable model.

DISCUSSION

General awareness and disposal practices

The present study found a relatively high level of general awareness of e-waste (84.76%), with most households also reporting awareness of its environmental (78.10%) and health effects (74.29%). However, awareness of e-waste management policies or regulations was considerably lower (31.43%), and less than half of the households (48.57%) reported receiving information or education on e-waste management. This suggests that general familiarity with e-waste does not necessarily translate into knowledge of specific management procedures. Similar differences between general awareness and practical knowledge of e-waste management have been reported in Indian studies. A household study in Kochi reported awareness and disposal practices among household users, while a study among users of electronic equipment in Lucknow examined knowledge, attitudes and practices related to e-waste management.^{7,8}

Disposal practices and access to facilities

Selling e-waste to scrap dealers was the most commonly reported disposal practice in the present study (80.95%), while 50.48% of households reported storing e-waste at home. Vendor buy-back or exchange schemes were

reported by 34.29% of households. These findings suggest that households may rely on available disposal channels when dedicated collection options are limited. Previous research has also highlighted the importance of accessibility and collection infrastructure in shaping e-waste disposal practices.^{6,7,11} Studies of household e-waste management have reported reliance on available disposal channels and difficulties in accessing formal collection options, suggesting that awareness alone may not ensure appropriate disposal behaviour.^{6,7,11}

Information and socioeconomic factors

Educational attainment was significantly associated with receiving information or education on e-waste management ($\chi^2=8.497$, $df=2$, $p=0.014$). In the multivariable analysis, households with a monthly income of ₹20,000–50,000 had higher odds of reporting general e-waste awareness than households with an income below ₹20,000 (OR=3.37, 95% CI: 1.28–9.24, $p=0.015$). The association for households with income above ₹50,000 did not reach statistical significance at the 5% level ($p=0.052$). These findings suggest that socioeconomic characteristics may be associated with e-waste information exposure and general awareness, although the small sample and cross-sectional design limit the strength of these conclusions.

Implications

The findings highlight the need for interventions that address both information gaps and access to appropriate collection facilities. Awareness activities should provide practical information on where and how households can dispose of e-waste, rather than focusing only on the

environmental and health hazards of e-waste. Locally accessible collection points, clear information on authorized disposal channels, and periodic community-level awareness programmes may help households make more informed disposal choices.

Limitations

This study has several limitations. First, the study was conducted among 105 households in a single ward of Thrissur district using purposive convenience sampling; therefore, the findings cannot be generalized to the wider population of Kerala. Second, the cross-sectional design provides information at one point in time and does not allow causal relationships to be established. Third, information on e-waste generation, disposal practices, and awareness was self-reported and may therefore be affected by recall or social desirability bias. Finally, the logistic regression analysis was based on a relatively small number of households classified as not generally aware, and the regression findings should therefore be interpreted as exploratory. The analysis focused on general e-waste awareness rather than directly modelling disposal behaviour.

CONCLUSION

The study found a relatively high level of general awareness of e-waste among households in the selected semi-urban community of Kerala. However, awareness of e-waste management policies and regulations was considerably lower, and disposal practices showed substantial reliance on scrap dealers and household storage. Lack of awareness about appropriate disposal methods and limited collection services were commonly reported challenges. Educational attainment was significantly associated with receiving information or education on e-waste management, while household income showed an association with general e-waste awareness in the multivariable analysis. Overall, the findings suggest a need for practical, community-level information on e-waste management together with accessible collection facilities.

Recommendations

The findings have implications for community-level e-waste management. Awareness programmes should move beyond general information about the hazards of e-waste and provide households with clear, practical information on available disposal and collection options. Establishing accessible collection points and providing predictable collection schedules may reduce prolonged household storage and dependence on available informal channels.

Community-based awareness activities could be targeted towards households with lower exposure to e-waste management information. Coordination between local authorities, authorized collection agencies, retailers, and existing scrap-dealer networks may also help improve the

transition towards safer and more organized e-waste management.

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