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E-Waste: Awareness on Generation, Health, Environment Hazards and Management Practices among E-Devices Users in South India

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Abstract: ***Introduction:*** ***Management of E-waste is essential priority as India emerges as 5th largest E-waste producer globally. Primitive and hazardous management of E-waste poses potential hazardous consequences to both humankind and environment.*** ***Objectives:*** ***To describe the awareness towards generation, health, environmental hazards and management of E-waste among E-device users in South India.*** ***Methods:*** ***E-survey questionnaire assessing the awareness related to generation, health, environmental hazards and management practices of E-waste designed by using Google Docs was circulated among E-device users through social media network across India. Data was analyzed in Google docs and Chi-Square test was performed for significant associations.*** ***Results:*** ***Out of 533 responses, 471 (88.37%) were medical professional and 62 (11.63%) were non-medicos; 277 (51.97%) were female, 334 (62.66%) were graduates, 393 (73.73%) own multiple E-devices, Out of the total 471 medico respondents 347 (73.67%) own more than two E-devices; 440 (82.55%) are urban residents. Among respondents, 205 (38.47%) of them have poor awareness on E-waste. A total of 453 (85%) of the respondents were aware of health hazards due to E-waste and 37 (6.9%) knew that E-waste causes DNA Damage, 23 (4.31%) felt that it causes Lung Cancer, 39 (7.31%) about brain damage (neuro-developmental disorders) and 434 (81.42%) chose all the options. Also, 479 (89.9%) respondents were aware about the environmental hazards due to E-waste. Majority respondents, 422 (79.2%) were unaware of government policies for E-waste management in India Disposal of the E-device (36%) as E-waste handling practice is more common followed by re-use (33.80%) after repairs at service center. Only 55 (10.3%) respondents identified- Extended Producer Responsibility (EPR) and only 57 (10.7%) respondents had some measure or form of work-place policy for E-waste management.*** ***Conclusion:*** ***Poor awareness on E-waste generation, health, environmental hazards and sub-optimal handling practices was found among E-device users across South India.***

Keywords: E-waste, health-environment hazards, handling practices of E-waste

1. Background

E-waste it is defined as Waste Electrical and Electronic Equipment (WEEE), in whole or in part from their manufacturing, and repair process, which are intended for disposal. [1] Emerging technologies and new design features enable the current products obsolete with short life-span. This leads to huge increase of waste electric and electronic equipment (WEEE). Increased consumption and the production of WEEE can be a potential source of hazardous wastes which can affect both human health and environment.

These devices for instance, television and computer monitors normally contain hazardous materials such as lead, mercury, and cadmium, while nickel, beryllium, and zinc can often be found in circuit boards. [2] When these products are placed in landfills or incinerated, they pose health risks to the handlers due to the hazardous materials they contain. The improper disposal of electronic products leads to the possibility of damaging the environment. [3]E-waste when placed in landfills, leaks environmental toxins and is likely to result in elevated risks of cancer, developmental and neurological disorders. [3]Few scientists found alarming levels of dioxin compounds linked to cancer, developmental defects and other health problems in samples of breast milk, placenta, and hair. [4]

Developing countries with rapidly growing economies handle E-waste from developed countries, and from their own internal consumers. [5] Presently about 30% E-waste handled in India is from other nations. China processed around 70% of the world's E-waste in 2012 and remaining e-waste was handled by India and other countries in Eastern Asia and Africa, including Nigeria. [6]In countries like China, India, Pakistan, Vietnam and Philippines informal waste recycling procedures such as shredding, burning and dismantling the products (80-90%) in domestic environment such as residential outhouses or backyards lead to emissions from these recycling particles damaging human health and environment. [7]The major cause of the growing E-waste is the short life span of most electronic devices which is less than two years for computers and cell phones. [8] [9]In a 2012 report, the International Association of Electronic Recyclers projected that, with the current growth and obsolescence rates of the various categories of consumer electronics around 400 million units of E-waste would be scrapped away per year by 2020. [10] [11] E-waste has been linked to a variety of health problems in these countries, including cancer, neurological and respiratory disorders, and birth defects. [12]

There is no well-established system for separation, sorting, storage, collection, transportation, and disposal of E-waste. [13]So far, legislation on WEEE is mainly driven by certain European countries and the European Directive on WEEE. Most developing nations are lagging in the development of similar regulations and especially in their enforcement. [13] Switzerland has a decade-long experience of applying EPR

to manage its E-waste. [14] [15]The concept of Extended Producer Responsibility (EPR) is defined as the producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle. [15]The Swiss E-waste management system is an EPR-based system, where each stakeholder s responsibilities are clearly established. [16]According to a study by Hewlett-Packard (HP), the Global Digital Solidarity Fund (DSF) and other national federations lack legislative mechanisms to handle E-waste and have not yet recognized it as a hazardous waste stream. [17]

Few studies in India, state that solid waste management is becoming more complicated by the production of E-waste, mainly computer waste. [17]According to a report of Confederation of Indian Industries, the total E-waste produced is about 1, 46, 000 tons per year (CII, 2006). [18]As per the hazardous wastes (Management and Handling) rules, 2016 where electronic waste is included under List-I and List-II of Schedule III. [19]Responsibility of environmentally sound management of end of life products is listed on the manufacturer of the consumer goods according to the Implementation of E-waste rules India, 2011. [20]

In this study, we attempt to understand the awareness about E-waste generation, health and environmental hazards of E-waste and management practices among electronic device users across South India.

2. Objectives

This study aims to;

1. To describe the awareness on generation, health and environment hazards of the E-waste
2. To document management practices of E-waste among users of electronic devices in South India.

3. Methodology

A cross-sectional study was conducted among electronic device users in South India during February and March 2018. Non-probabilistic sampling technique is used to invite study participants through snowballing technique through social media platforms such as Facebook and Whatsapp. E-survey questionnaire was prepared using Google docs. The questionnaire included socio-demographic features, questions assessing the usage of various E-devices, ownership of multiple devices, household level E-waste management practices, and awareness about health and environmental hazards of E-waste and legislation for E-waste at workplaces. E-survey link is shared to through social media networks and recipients were requested to undertake the survey. A total of 533 respondents submitted the e-survey and the data was analyzed using MS-Excel sheet and SPSS 21 IBM software version. To assess the awareness on E-waste we devised a scoring system to rate the levels of awareness as poor, adequate or ideal using a set of 11 knowledge-based questions. The awareness questions (11) were given a score of 1 for ideal responses and 0 for non- ideal responses. A score of 9 and above is considered as ideal, a score of 6-9 as adequate and a score of 6 and below is considered as poor awareness on E-Waste.

4. Results

The responses from the study participants, who were electronic device users were analyzed as presented below:

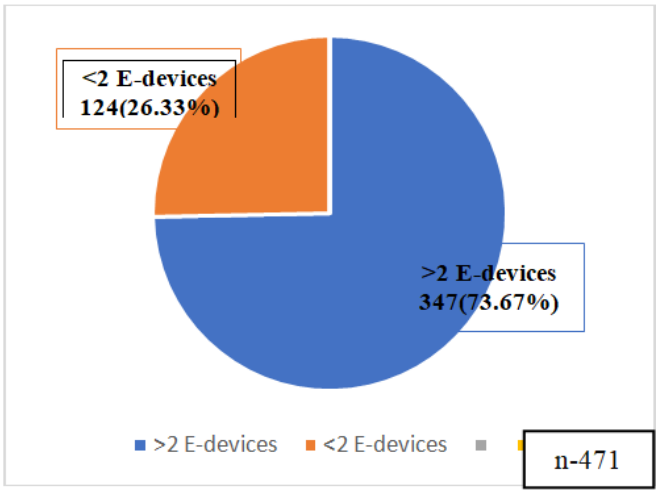
Table I: Socio-demographic characteristics of electronic device users across South India

CHARACTERISTIC	MEDICAL n (%)	NON-MEDICAL n (%)	TOTAL n (%)
GENDER			
Males	198 (77.34%)	58 (22.66%)	256 (48.03%)
Females	273 (98.55%)	4 (1.45%)	277 (51.97%)
AGE			
<25 Years	412 (88.98%)	51 (11.02%)	463 (87%)
25-35Years	20 (74.07%)	7 (25.93%)	27 (5%)
>35Years	39 (90.69%)	4 (9.31%)	43 (8%)
EDUCATION			
Plus two and below	112 (81.75%)	25 (18.25%)	137 (25.70%)
Diploma holders	-	18 (100%)	18 (3.38%)
Graduates	324 (97%)	10 (3%)	334 (62.66%)
Post-graduates	35 (79.54%)	9 (20.46%)	44 (8.26%)
RESIDENCE			
Urban	394 (80.54%)	46 (19.46%)	440 (82.55%)
Rural	77 (82.79%)	16 (17.21%)	93 (17.45%)

*N-Number of response *%-Percentage

In this study comprising 533 respondents, 256 (48.73%) were males of which198 (77.34%) were medicos and 58 (22.66%) were non-medicos and 277 (51.97%) were females of them273 (98.55%) were medicos and 4 (1.45%) were non-medicos.

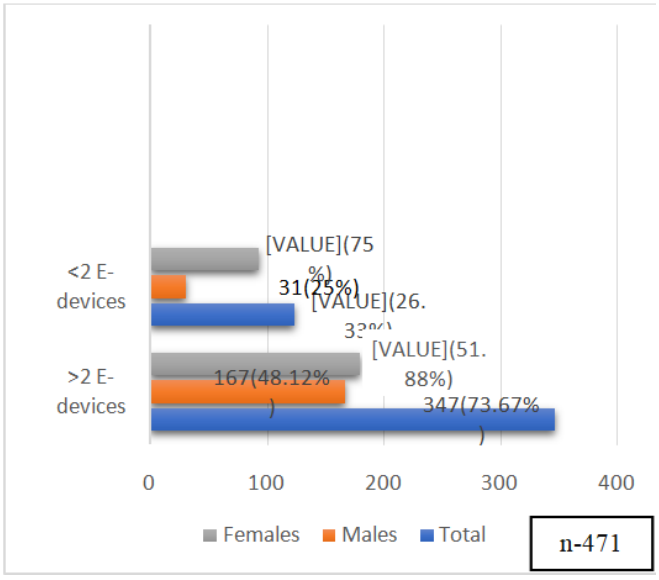
The number of electronic devices owned by medico study respondents were as shown below in Figure 1 and about 347 (73.67%) of them owned more than two electronic devices as compared to 124 (26.26%) owned less than two electronic devices. The male and female ownership of the devices among medical professionals is depicted in Figure 1.1



*N-Number of response *%-Percentage

Figure I: Cross-device ownership of electronic devices among medical E-device users across South India

Out of the total 471 medicos respondents 124 (26.33%) of them own less than 2 E-devices and 347 (73.67%) of them own more than 2 e-devices.

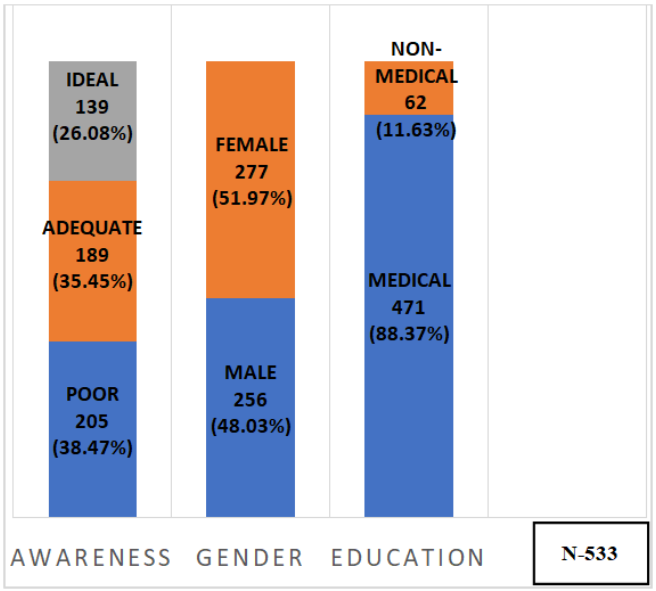


*N-Number of response *%-Percentage

Figure 1.1: Cross-device ownership of electronic devices among males and female medical professions E-device users across South India

Out of 471 medical professionals around 124 (26.33%) own less than 2 E-devices of which 31 (25%) of them were male and 93 (75%) of them were female respondents. Also 347 (73.67%) of them own more than 2 E-devices of which 180 (51.88%) were female and 167 (48.12%) were males.

The awareness on E-waste is assessed by knowledge-based questions and scoring was used to categorize levels of awareness as mentioned in methodology. The findings are depicted in Figure 2 as below.



*N-Number of response *%-Percentage

Figure II: Categories of awareness levels based on scoring among study participants and differentiation between male and female respondents and medical and non-medical professionals.

Of the total respondents, around 139 (26.08%) had ideal awareness on E-waste, 189 (35.45%) had adequate awareness on E-Waste and 205 (38.47%) had poor awareness on E-waste. No major difference in ideal awareness levels among both the genders whereas medical professionals had better awareness compared to non-medical respondents.

Table II: Awareness on health and environmental hazards of E-waste among study participants

Variable	Medicos n (%)	Non-medicos n (%)
Health Hazards Yes No	408 (90.06%) 63 (78.75%)	45 (9.94%) 17 (21.25%)
(A) Lung cancer	17 (73.91%)	6 (26.09%)
(B) DNA damage	29 (78.37%)	8 (21.63%)
(C) Brain damage (Neuro-developmental disorders) -Yes	33 (84.61%)	6 (15.39%)
(D) All of the above	392 (90.32%)	42 (9.68%)
Environmental Hazards Yes No	432 (90.18%) 39 (72.22%)	47 (9.82%) 15 (27.78%)
Total		**n-533**

*N-Number of response *%-Percentage

A total of 453 (85%) of the study participants were aware of health hazards due to E-waste and only 37 (6.9%) knew that E-waste causes DNA damage, 23 (4.31%) felt that it causes lung cancer, 39 (7.31%) were aware that E-waste cause brain damage (neuro-developmental disorders) and 434 (81.42%)

chose all the options.479 (89.9%) were aware about the environmental hazards due to E-waste.

Table III: Levels of awareness among males and females respondents of the study

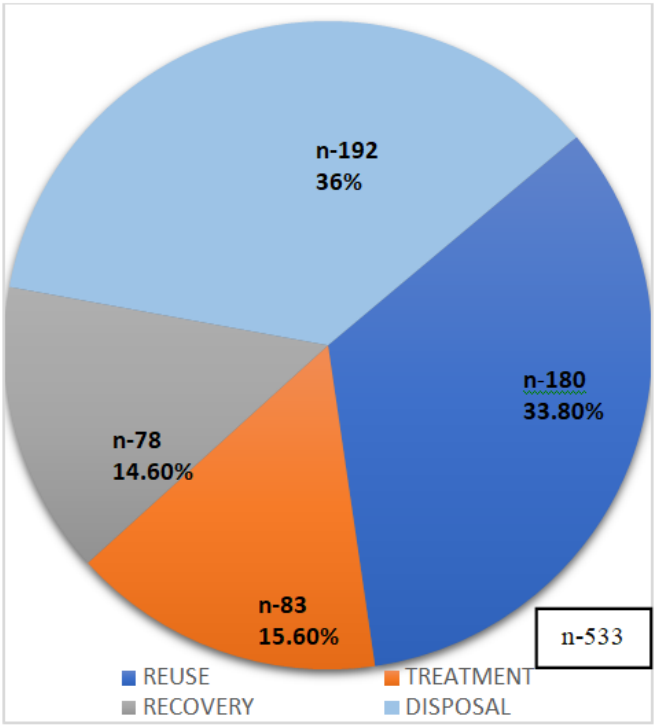
Level of Awareness	Male	Female
Poor	113	92
Adequate	91	98
Ideal	52	87

X2=10.39 at df (degree of freedom) =2, which is more than the expected Chi-Square value and hence the difference is found to be significant at p value of < 0.05.

Table IV: Levels of awareness among medical and non-medical professionals among study participants

Level of Awareness	Medical	Non-Medical
Poor	187	18
Adequate	165	24
Ideal	119	20

X2=2.85 at df (degree of freedom) =2, which is less than the expected Chi -Square value and hence the difference is found to be non- significant.



*N-Number of response *%-Percentage

Figure III: Management practices of E-waste among study participants

Disposal of the E-device (36%) and buying new product/device as E-waste management practice is more common followed by re-use (33.80%) of the E-device after repairs at service center.

Table VI: Awareness about EPR, government/workplace policies on E-waste among study participants.

Variable	Awareness-Yes N (%)	Awareness-No N (%)	Total
EPR	55 (10.3%)	478 (89.7%)	533
Govt. Policy/Law	111 (20.8%)	422 (79.2%)	533
Work-place Policy	57 (10.7%)	476 (89.3%)	533

*N-Number of response *%-Percentage
*EPR: Extended Producer Responsibility (EPR)

Awareness on policies/law related to E-waste is (approximately 20%) among the respondents.

5. Discussion

In our study around 73.3% respondents own more than two electronic devices, which is quite similar to a study in Ahmadabad where ownership of dual E-devices was 89.7%. [21]Cross-device ownership refers to the fact that individuals own and use multiple digital devices from which they can access content, play games, watch TV and more. Verito found that 32% of the U.S. online universe owns at least two devices. [22]Again in US, on average, the typical digital consumer now owns 3.64 of them with the 25-44 age group emerging as the clear leaders for multi-device ownership with men having slight lead against women users. [23]

This is reflective of universal trends of multiple device ownership and is another significant contributor to the increasing burden of E-waste in the communities leading to health and environmental hazards. Consumers need to be educated about harms involved in exposure to multiple devices and awareness needs to be present to minimize the exposure towards various radio-active frequencies emitted through various E-devices.

In our study 61.4% of the respondents possessed adequate to ideal levels of awareness about E-waste as in other studies conducted in Delhi (36%) [24], Andhra Pradesh (34%) [25] and around 64% in Turkey. [26]As can be seen, awareness among population of Indian states is very minimal compared to the ubiquity of E-device penetration and this highlights huge gap in awareness. Thus E-waste is a potential area for awareness campaign drives to be undertaken across the country.

Awareness on the health hazards (68%) caused due to E-waste, comparable to 63% in a Malaysian study [27], Nigeria (28%) [28], another Ahmadabad (53%) [29] studies and around 49% [30]in other developing countries. This high awareness levels could be owed due to majority participants being medical professionals unlike in other studies. Being science stream students/professionals they might possess higher levels of awareness about health and environmental hazards of E-waste compared to non-medical professionals. Associated Chamber of Commerce and Trade (ASSOCHAM) in India in 2015 reported that 76% of the workers at informal E-waste sector, were suffering from respiratory ailments. [31]Also case report by Jayapradha

Annamalai in 2015 informed about the occupational health hazards associated with informal recycling procedures/practices of e-waste in India. [32]

The WHO/International Agency for Research on Cancer (IARC) has classified radio-frequency electro-magnetic fields as "possibly carcinogenic to humans" and associates it with wireless phone use. The Working Group concluded that though evidence building is happening on real-time basis, it is still strong enough to label it as 2B classification-carcinogenic to human.

Handling practices of E-waste is major area of importance in the current scenario with huge burden of E-waste being generated. Disposal of the E-devices either re-selling or just discarding unused but still lying in the domestic environments such as cup-boards, study tables etc is an area to be addressed too. An important finding of the Swati Kawatra [33] study echoes our own findings wherein it was found that 12-26 per cent people replace their major electronic goods within the first three years of purchase. E-waste generation is heightened due to these practices of discarding and buying new products, with additional manufacturing of E-devices stretching the E-waste burden to burst at seams very soon in the near future. Though our study did not include E-waste handlers as study respondents, Sapna Mishra et al identified poor awareness among majority (>75%) of E-waste handlers and stressed upon the importance of awareness campaigns and provision of protective gear for E-waste handlers who are already from marginalized and poorer socio-economic strata. [34]

Awareness campaigns should also focus on work done by organizations such as Earth Day Network who urges people to drop off their electronic waste and deposit them at E-waste recycling facilities where they will be recycled safely. [35]The paper by Anwesha Borthakur, especially explains the complexities in India's E-waste management system owing to multifaceted socio-economic, education, cultural and other associated factors influencing consumers' disposal behaviour and awareness on the same. [36]

In our study, 478 (89.7%) of the study participants were unaware about the Extended Producer Responsibility (ERP).E-waste (Management) Rules, 2016, [37] enacted since October 1, 2017, strengthened the Extended Producer Responsibility (EPR), a global best practice to ensure the take-back of the end-of-life products. To strengthen EPR further, 'Producer Responsibility Organization' (PRO) has been introduced, an authorized body financed collectively or individually by producers, to share the responsibility for collection and channeling of E-waste generated from the 'end-of-life' products to ensure environmentally sound management of such E-waste in the country. The rule has provisioned the targets for the producers, which was missing in the first version of the Rule (2012). Now, manufacturers are mandated to take back their sold products with recommended mechanisms. [37]

India is 5th largest E-waste generator globally, and receives about 50, 000 tons every year from developed countries. In order to address the issue, an E-waste management policy (2011) was launched by the government of India (GOI). Among the study respondents more than 80% were unaware on E-waste policies which is similar to a study done in Ahmedabad-89%. [38]India does have a policy on E-waste management but, more than 95% of E-wastes is treated in unorganized settings located in urban slums. [39]This is suggestive of poor enforcement of existing policies by the concerned authorities.

6. Conclusions

Awareness regarding health and environment hazards of E-waste though found to be adequate to ideal levels, the ideal management practices of E-waste were found to be lacking from E-device users, a majority of the medical professionals in this study.

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