

Research Article

E-Waste awareness among Medical Undergraduates' in a Tertiary Care Teaching Hospital in Delhi, India: A Cross-Sectional Study

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A B S T R A C T

Background: Globally, around 44.7 million metric tonnes of e-waste was generated in 2016. India, being the second most populous country in world, generated 2 million metric tonnes of e-waste in 2016. About 5000 metric tonnes of e-waste is imported to India every year. This highlights the need to study awareness about e-waste among the consumers generating it. So, this study was planned with primary objective to assess the knowledge regarding e-waste among medical undergraduate students as they are also the consumers of electronic equipment which constitutes e-waste.

Methodology: The present study was a cross-sectional one, done among 300 medical undergraduate students of a tertiary care hospital and teaching institution in Delhi, India. A pre-tested, semi-structured, self-administered questionnaire was used to gather information from study participants. Descriptive statistical analysis was performed.

Result: More than two-thirds of the (77.3%, 232) study participants were aware about concept of e-waste. Out of these 232 students, only about half had adequate knowledge about equipment contributing to e-waste and constituents of e-waste. Most common reason for purchase of new electronics was desire for new technology.

Conclusion: A significant percentage of students (22.7%) have not even heard of concept of e-waste. Their practices related to e-waste handling were hazardous from both health and environmental aspect. This is an area of concern in this era of growing environmental deterioration. There is a need to study general public awareness also so that appropriate measures can be undertaken.

Keywords: E-Waste, Management, Medical Undergraduates, Hazardous

Introduction

Globally, around 44.7 million metric tonnes of e-waste was generated in 2016 which roughly accounts to 6.1kg e-waste per inhabitant.¹ There has been a continuous rising trend of e-waste generation since past few years and this is expected to increase further.¹ Among all the continents, Asia emerged as the leading generator in 2016,¹ partly owing to the highest number of inhabitants in this region. Also, 80% of the generated e-waste remains undocumented worldwide.¹ One-third of the world's population still remains uncovered from e-waste legislations.¹ Developing countries import significant quantity of e-waste even though the Basel convention restricts trans-boundary trade of it.²

The economy of India is presently the third largest in the world by Purchasing Power Parity (PPP).³ This growth has significant economic and social impact as the expeditiously increasing consumption and inusitation rates of electronic products are leading to higher generation of e-waste. India, being the second most populous country in world, generated 2 million metric tonnes of e-waste in 2016.¹ Although, India and China have their e-waste rules in place, covering Asia's 72% population by e-waste legislations, but both of them are having rapidly increasing amounts of e-waste which can be attributed to illegal imports and domestic generation.⁴ About 5000 metric tonnes of e-waste is imported to India every year.²

Delhi contributes to 9729.2 tonnes of e-waste and is the second largest e-waste generators in India.⁵ Major source of e-waste in India are household electronics and imports. Individual household e-waste contributes to 15% only, and rest contribution is by manufacturers.⁵

E-waste contains valuable as well as hazardous components.^{5,6} The main constituents found in e-waste are ferrous, non-ferrous material, plastic, glass etc.⁶ Hazardous components include heavy metals (lead, mercury, cadmium, chromium), chlorofluorocarbons (CFCs), polychlorinated biphenyls.⁷ Direct contact, inhalation of toxic fumes, accumulation of chemicals in environment leads to detrimental effects on health.⁷ Studies conducted globally proves this fact.^{8,9,10} Processing and recycling activities poses additional risk by production of by-products and injuries. It is hazardous to both health and environment.¹¹

Disposed electronics are a considerable category of secondary resource due to their suitability for reuse. This has led to unauthorized e-waste dismantling, recycling, resource recovery which has become a global concern. Large amount of e-waste is handled by the informal collectors who are unaware of proper disposal methods and thus expose themselves and the environment to the harmful effects of e-waste.

There are limited studies regarding India's public awareness

of the use of toxic chemicals in these products, government policies regarding their management and proper practices of disposal. An assessment of public awareness at the level of individual is vital to understand public behavior towards e-waste and to understand what is missing from the management strategies. So, this study was planned with primary objective to assess the knowledge regarding e-waste among medical undergraduate students as they are also the consumers of electronic equipment generating e-waste. Their awareness level could give a possible hint to the general public awareness. The secondary objective was to study the practices related to e-waste among the participants.

Materials and Methods

Study Design and Setting: The present study was a cross-sectional one, done in March 2016, among medical undergraduate students of a tertiary care hospital and teaching institution in Delhi, India. The students come from varied backgrounds and states.

Study Population: It comprised of undergraduate students and interns. Inclusion criterion was students using mobile phones, laptops or personal computers (PCs) and those students present at time of study. Exclusion criterion was students in 3rd professional (prof) part-I as data collection was done by a team of students of 3rd prof part 1. So to eliminate any bias, the students of this prof were excluded from the study.

Sample Size This was calculated using the formula for proportions i.e. $4PQ/L^2$. We used the prevalence of knowledge about hazards of e-waste found in previous study as 22%. [12] After taking allowable error as 5% we got sample size of 275, which was rounded off to 300. So a total of 300 students were included.

Study Technique Data collection was done by a team of students of third professional part-I, who were trained by the investigators over a period of 7 days in techniques of interview and data collection. A convenient sampling technique was employed to select the study participants. The students were approached and eligibility was assessed according to above mentioned inclusion criterion. The eligible participants were then informed about the purpose of the study and nature of it. Written informed consent was obtained from each participant who were willing to participate. A semi-structured, self-administered, pre-tested questionnaire in English was used. A standard questionnaire could not be found, so the authors designed the questionnaire themselves after literature review. This was then peer-reviewed for content and based on their suggestions, necessary modifications were done. The questionnaire was then pilot tested among students of another college, different from our study area. Based on

pilot testing results, the questionnaire was further modified and finalised and then used for the present study. Data was gathered on socio-demographic information, knowledge regarding e-waste and practices related to e-waste.

Definitions Used in Study

1. Knowledge about equipment constituting e-waste- Participants were asked to write 5 electronic equipment constituting e-waste. If all 5 equipment were correctly written, participant was considered to have adequate knowledge, if 3-4 equipment were correctly written, participant was considered to have inadequate knowledge and if less than 3 equipment were written, participant was classified as having no knowledge.
2. Knowledge about constituents of e-waste- E-waste contains lead, iron, cadmium etc. Participants were asked to write 5 constituents of e-waste. If 5 constituents were correctly written, participant was considered to have adequate knowledge, if 3-4 constituents were correctly written, participant was considered to have inadequate knowledge and if less than 3 constituents were written, participant was classified as having no knowledge.
3. Knowledge about role in government policies as consumer- Participants were asked to write 2 roles as consumers. If both the rules were correctly written, student was classified as having adequate knowledge, if one role was written correctly, he/her was classified as having inadequate knowledge and if no role was written correctly, participant was classified as having no knowledge.

Statistical Analysis: Data was entered in MS excel and analysed using SPSS version 21.0. Quantitative data was presented in form of frequencies and percentages for categorical variables. Chi-square/Fischer exact test were employed wherever appropriate for qualitative data analysis. A p value of <0.05 was considered as significant.

Ethical Consideration: Permission for conducting the study was obtained from head of the institution. Written informed consent was obtained from each participant. Participants were ensured about confidentiality of data and they were assured that they are free to withdraw from study at any point of time. Privacy and confidentiality of data was assured.

Result

A total of 300 students were approached and all agreed to participate in study. So, the response rate was 100%. The age range of students was 17 to 25 years.

Maximum number of students (137, 45.7%) were in age group of 20-22 years. More than half were males (169, 56.3%). The students of 1st prof of MBBS constituted the highest number (101, 33.7%) of study participants (Table 1).

Table 1. Socio-demographic profile of the study participants (N=300)

Variable	Frequency	Percentage
Age groups (in completed years)		
17-19	110	36.7
20-22	137	45.7
23-25	53	17.6
Sex		
Female	131	43.7
Male	169	56.3
Year of MBBS		
1 st prof	101	33.7
2 nd prof	77	25.7
3 rd prof part-II	70	23.3
Interns	52	17.3

Table 2. Knowledge regarding E-waste among study participants

Variable	Frequency	Percentage
Aware of concept of e-waste (N=300)		
Yes	232	77.3
No	68	22.7
Knowledge about equipment constituting e-waste (n=232)		
Adequate	128	55.2
Inadequate	91	39.2
No knowledge	13	5.6
Knowledge about e-waste constituents (n=232)		
Adequate	139	59.9
Inadequate	75	32.3
No knowledge	18	7.8
Consider E-waste hazardous (n=232)		
Yes	228	98.3
No	4	1.7
Types of e-waste hazards known (n=228)		
Environmental	21	9.2
Health	26	11.4
Both	181	79.4
E-waste collectors heard of : (n=232)		
Only formal	23	9.9
Only informal	89	38.4
Both	42	18.1
None	78	33.6

Aware of government policies related to e-waste (n=232)		
Yes	29	12.5
No	203	87.5
Knowledge about role in government policies as consumer (n=29)		
Inadequate	6	20.7
No knowledge	23	79.3
Source of information about e-waste (n=232)*		
Internet	136	58.6
Parents	64	27.6
Educational institute	40	17.2
Others**	32	13.8

*Multiple responses present.

**Others include friends, television, print media, radio etc.

None of the study participants, who were aware of government policies related to e-waste, had complete knowledge regarding their role as consumer as prescribed in government policies. When asked if the participants were willing to give their used electronics to e-waste collectors for free, majority (246, 82%) agreed (Table 2).

The most frequently used electronic was mobile phone for majority of the students (287, 95.7%). All the students (300, 100%) have purchased a new electronic in last 5 years. The most common reason for purchase was desire for new technology (170, 56.7%). About half of the study participants (155, 51.7%) have kept the older electronics at their home only while 18.4% (25) have thrown them away in trash (Table 3).

Table 3. Practices related to e-waste among study participants (N=300)

Variable	Frequency	Percentage
Most frequently used electronics*		
Mobile phone	287	95.7
Laptop/ Personal Computer (PC)	13	4.3
Mobile phone purchased/ replaced in last 5 years		
≤2	112	37.3
3-4	166	55.4
>4	22	7.3
PC/ laptop purchased/ replaced in last 5 years		
≤1	196	65.3
>1	104	34.7
Most common reasons for purchase of new electronics*		
Desire for new technology	170	56.7
Loss of function	80	26.6
Physical damage	39	13
Lost/ misplaced	11	3.7
Fate of older electronics*		
Kept at home	155	51.7
Trash	25	18.4
Given/ sold to personal contact	54	18.0
Sold to informal collector	48	16.0
Given to formal collector	18	6.0

*Electronics here refers to mobile phones, personal computers and laptops only.

Table 4. Association between socio-demographic variables and awareness about e-waste among study participants

Variable	Aware of e-waste (N=300)		Total	p-value
	Yes	No		
Age groups (in completed years)				
17-19	93 (84.5)	17 (15.5)	110 (100.0)	0.076
20-22	100 (73.0)	37 (27.0)	137 (100.0)	
23-25	39 (73.6)	14 (26.4)	53 (100.0)	
Sex				
Male	128 (75.7)	41 (24.3)	169 (100.0)	0.489
Female	104 (79.4)	27 (20.6)	131 (100.0)	
Educational qualification				
1 st prof	86 (62.8)	15 (37.2)	137 (100.0)	0.080
2 nd prof	58 (75.3)	19 (24.7)	77 (100.0)	
3 rd prof part-II	48 (68.6)	22 (31.4)	70 (100.0)	
Interns	40 (77.0)	12 (23.0)	52 (100.0)	

Variable	Aware of government policies regarding E-waste (n=232)		Total	p-value
	Yes	No		
Age groups (in completed years)				
17-19	13 (14.0)	80 (86.0)	93 (100.0)	0.590
20-22	10 (10.0)	90 (90.0)	100 (100.0)	
23-25	6 (15.4)	33 (84.6)	39 (100.0)	
Sex				
Male	14 (10.9)	114 (89.1)	128 (100.0)	0.425
Female	15 (14.4)	89 (85.6)	104 (100.0)	
Educational qualification				
1 st prof	15 (17.4)	71 (82.6)	86 (100.0)	0.142*
2 nd prof	3 (5.2)	55 (94.8)	58 (100.0)	
3 rd prof part-II	5 (10.4)	43 (89.6)	48 (100.0)	
Interns	6 (15.0)	34 (85.0)	40 (100.0)	

*-Fischer exact test.

Table 5. Association between awareness and practices related to e-waste among study participants (N=300)

Practices related to e-waste	Aware of e-waste		Total	p-value
	Yes	No		
Mobile purchased/ replaced in last 5 years				
≤2	97 (86.7)	15 (13.3)	112 (100.0)	0.003*
>2	135 (71.8)	53 (28.2)	188 (100.0)	
PC/ laptop purchased/ replaced in last 5 years				
≤1	145 (74.0)	51 (26.0)	196 (100.0)	0.061
>1	87 (83.6)	17 (16.4)	104 (100.0)	

*- Significant association.

None of the socio-demographic variable was found to be significantly associated with awareness about e-waste among study participants (p-value >0.05) (Table 4).

A higher percentage of participants who were aware of e-waste concept have purchased/replaced less than or equal to 2 mobile phones in last 5 years than those who were not aware of e-waste concept and the association was statistically significant (p value <0.05) (Table 5).

Discussion

Mobile phones and laptops have become a necessity in today's world. Cheap availability, multiple providers, rapid technology advancements all have led to a surge in number of mobile phone users in world and India also. This increased use ultimately translates into generation of equal amounts of E-waste. But sadly, the after-use management of these electronics is not given due importance. To add to this, solar E-waste generated due to solar equipment is also building up constantly. If ignored now, the problem may become catastrophic. So, present study was attempted to assess the awareness of students of a medical teaching

institution regarding e-waste which can aid in future public health policy implications.

In present study, more than half of the study participants were males. The age range was 17-25 years. The findings were comparable to the findings of another study conducted among medical students.¹³ More than three-fourth students were aware or had heard of concept of e-waste. Out of these students, only about half of them knew correctly the equipment constituting e-waste and constituents of e-waste. This is higher than the level of awareness among higher secondary and high school students as found out by Vivek et al.¹⁴ E-waste is considered hazardous by almost all of the students who had heard of it. This was in contrast to the knowledge of general public.^{12,15} Low knowledge regarding equipment constituting e-waste will automatically lead to improper management and disposal. Such equipment should come with a hazard symbol or mention of e-waste label for consumers so that they can be disposed of accordingly in accordance with guidelines.

Almost one-third of the students had never heard about

any e-waste collector. Only 9.9% had heard of formal e-waste collectors which was similar to the findings of study conducted among general public.¹⁵ With purchase of a new electronic, an information booklet is provided by the manufacturer which usually mentions the method of disposal of that electronic item. But due to lack of awareness, very few people read and comply with those instructions. There is need for further research into this arena to look for better strategies for consumer awareness regarding not only about use but also disposal of the electronic equipment.

Adding to this, a mere 12.5% of students out of 232 were aware of government policies regarding e-waste in India. Rest were unaware of it. Even who were aware of government policies, more than three-fourth of them were completely clueless about their roles as defined in those policies. This highlights the glaring deficiencies in awareness about e-waste and its management among students. It can then be rightly predicted that general public would be having a lower awareness level which was evident from findings of another study.¹⁵ This makes the problem even much larger.

In present study, only 17.2% students out of 232 students, who were aware about e-waste, had acquired this knowledge from their educational institutions. Educational institutions can play a major role in sensitising students to the issue of e-waste, its hazards and its management. Inclusion of e-waste in educational curriculum at school and college level can make a big difference. Awareness campaigns highlighting this issue can be planned and executed. World environment day which is celebrated on 5th June can be used as an opportunity to run such campaigns. E-day which is celebrated in New Zealand to create awareness about e-waste can be a good example to learn from.

All the participants in present study had purchased a mobile phone/ laptop/ PC in last 5 years. This was similar to another study in which 99.4% students were using their handsets for less than 5 years.¹³ The most common reason for purchase of new electronic equipment was desire for new technology, a finding similar to other study by Mittal A et al among medical undergraduates and study by Shah A et al among general public.^{13,15}

A higher percentage of students in present study had kept older electronics at home (51.7%) as compared to another studies.^{13,15} But this was comparable to another study done in Nigeria among households.¹² About one-fifth students had thrown away their older electronics in trash which was also higher as compared to previous study.¹³ But this was much lower compared to study by Okoye et al.¹² This is a dangerous practice as e-waste thrown away in trash is likely to be handled by rag pickers which includes children

also. They might suffer injuries due to the toxic elements present in these equipments. Also, it leads to environmental pollution due to leaching of chemicals into water, soil and air if the hazardous materials present in them come in contact with the environment.

Although the percentage of students who know about any system of collection of e-waste was higher, the students who were actually giving their old electronics to any such system is much lower. The reason for such wide gap between knowledge and practice could be attributed to the lack of knowledge about the government policies and their role as consumers. A qualitative research is required to identify the other possible reasons associated with these practices.

Strengths

This study is amongst the few studies conducted in North India among medical undergraduate students to assess their awareness about e-waste. Students from varied age group and different professional years of MBBS were included. Scientific method of sample size calculation was used.

Limitations

The study can't be generalised to general population as it was conducted among medical students. Selection bias could be present as we used a non-probability sampling technique.

Conclusion

The knowledge of students regarding e-waste and government policies was not satisfactory. A significant percentage of students have not even heard of concept of e-waste. Their practices related to e-waste handling were hazardous from both health and environmental aspect. This is an area of concern in this era of growing environmental deterioration. The students are amongst the important e-waste generators as the desire for new technology and e-learning methods compel them to rely highly on electronic equipment like computers and mobile phones.

Recommendation

There is a need to study general public awareness also so that appropriate awareness programmes can be planned for consumers and public health policies can be formulated in regard to e-waste. Qualitative studies are also required to understand the behavioural patterns associated with use and purchase of electronic equipment. Manufacturers should inform their customers regarding safe disposal practices of electronic equipment. Policies and rules should be translated into Acts and they should be strictly implemented. Violation of consumers' responsibility should be strictly looked upon and appropriate legal actions should be taken. Consumers should be made aware about e-waste, its hazards and their role in its management.

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