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Assessment of Knowledge among households towards solid waste management in GHMC

Md. Kaleemullah
Research Scholar,
Osmania University & Assistant Professor,
Bhavans Vivekananda College of Science,
Humanities and Commerce, Sainikpuri,
Hyderabad (Telangana, India)
E-mail: mkm7722@gmail.com

Prof. S V Satyanarayana
Retd. Senior Professor of Commerce,
Osmania University,
Hyderabad (Telangana, India)
E-mail: vajjalasura@yahoo.co.in

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ABSTRACT:

Background:

Rapid urbanization in the Greater Hyderabad Municipal Corporation (GHMC) has created significant solid waste management challenges, impacting environmental and public health. This study assesses household knowledge levels on solid waste management, focusing on socio-demographic factors such as age, income, and education.

Research Methodology:

A quantitative research design was used, surveying 404 households across six GHMC zones: LB Nagar, Charminar, Khairthabad, Secunderabad, Serilingampally, and Kukatpally. Data were collected through structured questionnaires and analyzed using one-way ANOVA to examine variations in knowledge levels based on age, income, and education.

Results:

Significant demographic variations in knowledge levels were found. Awareness of the government bin program varied by age ($F = 3.468$, $p = 0.016$) and income ($F = 4.216$, $p = 0.001$). Higher income and education levels were linked to better knowledge of waste management practices. Households with higher education levels showed greater awareness of the ban on plastic carry bags less than 75 microns thick ($F = 12.515$, $p < 0.000$). The highest awareness was about the prohibition of thin plastic bags (mean score = 3.550), while the tipper auto waste collection concept had the lowest awareness (mean score= 2.844).

Conclusions:

The study underscores the importance of socio-demographic factors in shaping environmental awareness and behaviour towards waste management. Tailored educational initiatives and policy interventions are crucial to bridge knowledge gaps and improve household participation in waste management, thereby contributing to sustainable urban development in Hyderabad.

Keywords: *Solid waste management, household knowledge, GHMC, socio-demographic factors, public awareness, sustainable urban development.*

INTRODUCTION:

In Effective domestic waste management has become a critical challenge in our rapidly urbanizing world. As cities grow and consumption patterns change, the volume of waste generated poses serious threats to public health and environmental sustainability. India, producing about 62 million tons of waste annually, with an average growth rate of 4% per year, faces significant issues. In 2020-21, the country generated 160,038.9 tons of solid waste daily, with Maharashtra, Uttar Pradesh, and Telangana being major contributors.

The introduction of new Solid Waste Management Rules by the Union Ministry of Environment, Forests, and Climate Change (MoEF&CC) in 2016 highlights the need for effective waste segregation at the source into categories such as biodegradable, non-biodegradable, combustible, sanitary, hazardous, and construction and demolition wastes. Despite these regulations, progress has been slow, with only 29% of waste being segregated at source in Telangana from April to June 2022.

Addressing solid waste management requires changing household behaviors and raising awareness about the impacts of improper disposal. Social marketing can play a crucial role in fostering behavioral change. In Telangana, the Information, Education, and Communication (IEC) strategy promotes waste separation through various communication tools, including public meetings, workshops, school activities, street plays, and handbills. This strategy aims to encourage the use of separate dustbins for wet and dry waste and to drive positive attitudes and behaviors among various stakeholders.

This study evaluates household behavior towards solid waste management practices, examining strategies, challenges, and outcomes to provide a blueprint for governments and policymakers seeking to use social marketing tools for positive community change and a more sustainable future.

REVIEW OF LITERATURE:

The important studies reviewed on the research topic are presented as follows:

Eshete, Desalegn, and Tigu (2023): This study reveals a significant knowledge-action gap in SWM in Gelemso Town, Ethiopia. High knowledge and positive attitudes exist, but implementation is lacking due to limited experience with waste sorting, inadequate removal methods, low awareness of the 3R concept, and insufficient infrastructure. The study offers a well-structured questionnaire to assess knowledge, attitudes, and practices, providing valuable insights for policymakers.

Nesterenko and Rosokhata (2023): This study focuses on marketing communication strategies within Ukraine's national waste management system. It emphasizes assessing the effectiveness of marketing initiatives aimed at attracting investors to the waste disposal sector, offering insights to optimize marketing efforts and enhance sustainability.

Praveen Sultana (2023): Sultana's research evaluates the Swachha Badi program, which educates students about waste collection, segregation, and composting. It highlights the program's effectiveness in engaging students and the community in sustainable waste management practices.

Nik Masdek et al. (2023): This study investigates sustainable food waste management behavior among Malaysian urban households. It integrates the Theory of Planned Behaviour and the Norm Activation Model, identifying key predictors such as environmental awareness and personal norms. The study shows that intention partially mediates the relationship between these factors and behavior, with socio-demographic variables also moderating these associations.

ALFARAS (2023): This research examines the relationship between knowledge of SWM and implementation levels, finding a significant positive correlation. Increased knowledge leads to better practices, highlighting the importance of enhancing knowledge to improve strategies and outcomes.

Qu et al. (2023): The study explores college students' attitudes towards waste separation and recovery on campus, identifying significant factors influencing attitudes and behaviors. Favorable attitudes correlate with active participation, providing insights for effective strategies in educational settings.

Zainul Ikhwan et al. (2023): This study investigates the adoption of waste management innovations in schools on Penyengat Island, Tanjungpinang City. It highlights the importance of communication and community ownership, pointing out challenges like inadequate facilities and low public awareness. Enhanced stakeholder collaboration and communication strategies are recommended.

Owojori et al. (2022): This research reveals low levels of knowledge and awareness of SWM among students at a rural university, highlighting challenges like insufficient knowledge, inadequate facilities, and financial constraints. It emphasizes the need for educational improvements and better practices.

Sharmin Sultana et al. (2022): This study assesses waste management awareness and practices in the Mugda community using descriptive and inferential statistical analyses. It provides a framework for evaluating and addressing waste management challenges in urban contexts.

Premsudha et al. (2022): The study focuses on Hyderabad's Integrated Municipal Solid Waste Management system, detailing the process from waste generation to disposal. It highlights environmental and health impacts of improper management and the need for public awareness and participation. The study analyzes operations at the Hyderabad Integrated Municipal Solid Waste plant, emphasizing sustainable solutions.

Limon and Villarino (2021): This study analyzes household food waste management in the northern Philippines, offering insights into knowledge, attitudes, and practices. The factor analysis reveals complexities in managing food waste and factors influencing household practices.

Fadhullah et al. (2021): Using a cross-sectional survey, this study examines perceptions of

household waste segregation and socio-demographic correlations. It identifies relationships between perceptions and various factors, recommending further observational studies.

Usha Rani Vistharakula et al. (2021): This review examines the role of socio-economic factors in waste generation and the importance of effective practices for sustainable living. Conducted in Hyderabad, the study analyzes data from 60 households to draw conclusions about regional practices.

STATEMENT OF PROBLEM:

In recent years, Hyderabad has been grappling with an escalating solid waste management crisis. In 2020, the city was producing a staggering 5,500 to 6,000 metric tons of waste daily, as per data from the National Environmental Engineering Research Institute (NEERI). This alarming statistic makes Hyderabad the top producer of waste in terms of quantity, with each person generating approximately 0.57 kg of waste daily.

Domestic waste, constituting 37.18% of the total waste, surpasses other categories such as commercial waste. The segregation of waste at its source helps prevent the contamination of recyclable and organic materials with non-recyclable and hazardous waste. Waste segregation at the source is a crucial component of a circular economy, where resources are used efficiently, and waste is minimized through recycling and reusing materials. However, this vision will only become a reality when people's attitudes toward waste change. This situation underlines the urgency of addressing issues such as knowledge gaps of household regarding solid waste management in GHMC (Greater Hyderabad Municipal Corporation).

NEED FOR THE STUDY:

According to a study conducted by the National Environmental Engineering Research Institute (NEERI), Hyderabad stands out as the city generating the highest amount of waste, with an average of 0.57 kilograms of waste produced per person per day. One of the major sources of waste is domestic waste, which accounts 37.18 % so therefore household's role is crucial in managing domestic solid waste. Nevertheless, the Greater Hyderabad Municipal Corporation (GHMC) has initiated actions to address this problem, including the implementation of initiatives like the 'Zero Waste' program.But the success of these initiatives depends on the knowledge they have regarding waste management which foster positive attitudes, and cause behavioural change among household. Hence this study proposes the need for assessment of knowledge of households towards solid waste management in GHMC.

OBJECTIVE OF THE STUDY:

- To assess the Levels of knowledge of Households towards solid waste management in GHMC.
- To Investigate any relationships between household demographics and knowledge of solid

waste management practices.

Hypothesis:

H01: There is no significant difference between Levels of knowledge of households towards solid waste management based on age.

HO2 : There is no significant difference between Levels of knowledge of households towards solid waste management based on average monthly income

HO3 : There is no significant difference between Levels of knowledge of households towards solid waste management based on highest Education

RESEARCH METHODOLOGY:

A. Research Design: The study adopts both inferential and descriptive research approaches. Descriptive research helps in understanding the current state of knowledgetowards solid waste management among households in GHMC. Inferential research, on the other hand, helps in making predictions or inferences about the population based on the sample data collected.

B. Source of data for the Study:

Primary Data: Primary data was collected through a questionnaire survey conducted among 404 households across six zones within the GHMC area. The questionnaire, designed to assess knowledge towards solid waste management, included both closed and open-ended questions. It was adapted from similar studies by Gaëla Leroy (2019), with modifications to suit the GHMC context.

Secondary Data: Secondary data was sourced from journals, books, annual reports of various government pollution boards, and newspaper articles.

C. Sampling Frame: The sampling frame includes households residing in the six zones of GHMC. For this study, a household is defined as a group of individuals living together in a single dwelling unit, sharing common facilities for cooking, eating, and living. Households are considered primary generators of solid waste.

Zones: The zones included in the study are LB Nagar, Charminar, Khairthabad, Secunderabad, Serilingampaly, and Kukatpally.

D. Sample Size: Sample size is determined using following formula.

Population: The focus of our study is on the population within the jurisdiction of the Greater Hyderabad Municipal Corporation (GHMC). Total population of GHMC is 7.3 million as of 2024.

Parameters: To ensure the reliability of our findings, we have set the following parameters:

$$n = \left(\frac{1.96^2 \cdot 0.5^2}{(0.05)^2}\right)$$

$$n = \left(\frac{3.8416 \cdot 0.25}{0.0025}\right)$$

$$n = \left(\frac{0.9604}{0.0025}\right)$$

$$n \approx 384.16$$

Desired Confidence Level (CL): 95%

Margin of Error (E): 5% (expressed as a proportion)

Estimated Population Standard Deviation (σ): 0.5 (based on previous studies)

Formula and Calculation: Sample Size calculation.

Result: Based on our calculations, we would need a sample size of approximately 384 individuals from the GHMC population to achieve a confidence level of 95% with a margin of error of 5%. It is determined as 385

E. Sampling Method: Stratified random sampling with proportional allocation was applied to ensure each zone was represented according to its population size. The following table summarizes the population, proportion, and sample size for each zone:

Zone	Population	Proportion	Sample Size
LB Nagar	1,107,163	15.1%	61
Charminar	1,675,029	22.9%	92
Khairthabad	1,307,190	17.9%	72
Secunderabad	1,329,956	18.2%	73
Serilingampaly	794,577	10.9%	44
Kukatpally	1,108,946	15.2%	62
Total	**7,322,861**	**100%**	**404**

F. Data Collection:

i. Primary data is collected through questionnaire from households using emails, social media platforms and door-door data surveys.

ii. Secondary data is collected from journals, books, annual reports of various government pollution boards and newspaper articles.

G. Statistical Tools: The data collected was analysed using the following statistical tools:

-Descriptive Statistics: Simple percentages to summarize data.

-Inferential Statistics: Chi-square test, ANOVA

Pilot study:

In To ensure the trustworthiness of our survey instrument, we conducted a rigorous pilot test with 50 respondents. This crucial phase aimed to validate the reliability of the questionnaire and refine its content to align with our research objectives. Data collection and analysis involved both reliability analysis and confirmatory factor analysis to evaluate the robustness of the survey instrument.

The reliability coefficient, a key indicator in social science research, was found to be 0.8, well above the accepted threshold of 0.7. This high score demonstrates strong internal consistency among the survey items, confirming the questionnaire's reliability in measuring the intended constructs.

Additionally, given the initial complexity of the questionnaire, which contained 15 items, we undertook a detailed review process to streamline its content. By carefully evaluating each item, we reduced the questionnaire to 11 elements, optimizing the data collection process while maintaining

the study's integrity.

Reliability: The questionnaire has been checked for its validity and reliability through a pilot study.

Table 1-Reliability Statistics

Reliability Statistics	
Cronbach's Alpha	N of Items
.927	11

(Source: Author's complied data)

The Cronbach's Alpha coefficient of 0.927, as obtained from the reliability statistics presented in Table 1.1, indicates a high level of internal consistency among the items in the questionnaire. This coefficient value suggests that the items within the questionnaire are highly correlated with each other, indicating reliability in measuring the construct of interest.

Scope Of The Study:

The scope of this study is cantered within the jurisdiction of the Greater Hyderabad Municipal Corporation (GHMC). In this context, solid waste exclusively refers waste generated by residential households. The research endeavours to engage residents and households across diverse localities within GHMC. This study aims to shed light on the effectiveness of solid waste management awareness initiatives after 2016 within GHMC, offering insights that can inform future waste management strategies and contribute to more sustainable waste practices in the region.

Period Of Study:

Secondary data was collected from 2016 to 2022 i.e., six calendar years timeline. While field (primary data) was collected from respondents between November 2023 to March 2024 (5 months).

RESULTS AND DISCUSSION:

Levels of Knowledge of Households towards Solid Waste Management in GHMC

The Levels of Knowledge Scale, adapted from Leroy (2019) and modified for the GHMC context, includes 11 items assessing public awareness of waste management. The data reveals a range of knowledge levels among respondents. This analysis underscores both strengths and gaps in public knowledge, providing essential insights for developing targeted educational and policy interventions in solid waste management.

I. One-way ANOVA for levels of knowledge Based on Age factor

Analyses of variance has been performed to check the significance of levels of knowledge among households towards solid waste management in GHMC based on various age group. it helps to identify specific knowledge gaps, facilitates targeted educational efforts, and supports the

development of effective waste management policies tailored to the needs and behaviours of different generations within the GHMC.

Table 2- Respondents knowledge towards solid waste management based on Age

Variables	Age	Mean	P – Value
The government has implemented a program to provide households with two different colored bins for the collection of dry waste and wet waste.	< 20 Yr	3.2	0.016
	21 Yr - 40 Yr	3.2	
	41 Yr - 60 Yr	3.1	
	> 60 Yr	3.6	
aware of the concept of tipper auto for waste collection	< 20 Yr	2.5	0.002
	21 Yr - 40 Yr	3.0	
	41 Yr - 60 Yr	2.8	
	> 60 Yr	3.1	
Burning waste causes health risks such as bronchitis and asthma.	< 20 Yr	3.34	0.197
	21 Yr - 40 Yr	3.51	
	41 Yr - 60 Yr	3.11	
	> 60 Yr	3.38	
Illegal dumping of solid waste causes bad smells and loss of aesthetics in this area.	< 20 Yr	3.39	0.827
	21 Yr - 40 Yr	3.35	
	41 Yr - 60 Yr	3.30	
	> 60 Yr	3.45	
It is my responsibility to ensure that I dispose of solid waste in the designated areas for later collection by the authorities.	< 20 Yr	3.40	0.001
	21 Yr - 40 Yr	3.69	
	41 Yr - 60 Yr	3.25	
	> 60 Yr	3.79	
Flooding in our town is due to solid waste blocking drains and gullies.	< 20 Yr	3.50	0.369
	21 Yr - 40 Yr	3.49	
	41 Yr - 60 Yr	3.29	
	> 60 Yr	3.60	
The manufacturing, importing, stocking, distributing, selling, and using of plastic carry bags with less than 75 microns thickness are prohibited in Telangana, effective from 30th September 2021.	< 20 Yr	3.35	0.003
	21 Yr - 40 Yr	3.68	
	41 Yr - 60 Yr	3.45	
	> 60 Yr	3.92	

Direct dumping of untreated waste into ponds and lakes results in accumulation of toxic substances in the food chain through the plant and animal that feed on it.	< 20 Yr	3.21	0.022
	21 Yr - 40 Yr	3.28	
	41 Yr - 60 Yr	3.18	
	> 60 Yr	3.61	
The green bin is for wet waste and the blue bin is for dry waste.	< 20 Yr	2.81	0.215
	21 Yr - 40 Yr	3.08	
	41 Yr - 60 Yr	2.87	
	> 60 Yr	3.13	
Vending machines for disposing plastic bottles and receiving cash incentives are available.	< 20 Yr	3.31	0.203
	21 Yr - 40 Yr	3.51	
	41 Yr - 60 Yr	3.11	
	> 60 Yr	3.38	
Using a twin-bin waste segregation approach emerges as an optimal solution within the context of promoting a circular economy (where things are used, reused, and made into new things again and again).	< 20 Yr	3.15	0.266
	21 Yr - 40 Yr	3.32	
	41 Yr - 60 Yr	3.30	
	> 60 Yr	3.45	

II. One-way ANOVA for levels of knowledge Based on Income factor

Analyses of variance have been performed to check the significance of levels of knowledge about solid waste management among households in the Greater Hyderabad Municipal Corporation (GHMC) based on various income groups. This analysis helps to identify specific knowledge gaps, facilitates targeted educational efforts, and supports the development of effective waste management policies tailored to the needs and behaviours of different income levels within the GHMC.

Table 3 – Respondents knowledge towards solid waste management based on Income

Variable	Income	Mean	P Value
The government has implemented a program to provide households with two different colored bins for the collection of dry waste and wet waste.	Below 10,000	3.4	**0.001**
	10,000 - 20,000	3.3	
	20,001 - 30,000	2.9	
	30,001 - 40,000	3.0	
	40,001 - 50,000	2.9	
	Above - 50,001	3.4	
aware of the concept of tipper auto for waste collection	Below 10,000	3.1	

	10,000 - 20,000	2.7	**0**
	20,001 - 30,000	2.6	
	30,001 - 40,000	2.2	
	40,001 - 50,000	2.4	
	Above - 50,001	3.0	
Burning waste causes health risks such as bronchitis and asthma.	Below 10,000	3.46	0.173
	10,000 - 20,000	3.47	
	20,001 - 30,000	2.76	
	30,001 - 40,000	3.19	
	40,001 - 50,000	3.20	
	Above - 50,001	3.37	
Illegal dumping of solid waste causes bad smells and loss of aesthetics in this area.	Below 10,000	2.28	**0**
	10,000 - 20,000	3.79	
	20,001 - 30,000	2.79	
	30,001 - 40,000	3.31	
	40,001 - 50,000	2.95	
	Above - 50,001	3.69	
It is my responsibility to ensure that I dispose of solid waste in the designated areas for later collection by the authorities.	Below 10,000	4.00	**0**
	10,000 - 20,000	3.76	
	20,001 - 30,000	3.07	
	30,001 - 40,000	3.28	
	40,001 - 50,000	3.00	
	Above - 50,001	3.54	
Flooding in our town is due to solid waste blocking drains and gullies.	Below 10,000	4.82	**0**
	10,000 - 20,000	3.53	
	20,001 - 30,000	2.93	
	30,001 - 40,000	3.34	
	40,001 - 50,000	3.20	
	Above - 50,001	3.32	
The manufacturing, importing, stocking, distributing, selling, and using of plastic carry bags with less than 75 microns thickness are prohibited in Telangana, effective from 30th September 2021.	Below 10,000	4.00	**0**
	10,000 - 20,000	3.59	
	20,001 - 30,000	3.66	
	30,001 - 40,000	3.09	

	40,001 - 50,000	3.00	
	Above - 50,001	3.68	
Direct dumping of untreated waste into ponds and lakes results in accumulation of toxic substances in the food chain through the plant and animal that feed on it.	Below 10,000	3.46	**0.001**
	10,000 - 20,000	3.32	
	20,001 - 30,000	2.97	
	30,001 - 40,000	3.03	
	40,001 - 50,000	2.92	
	Above - 50,001	3.47	
The green bin is for wet waste and the blue bin is for dry waste.	Below 10,000	3.15	**0.002**
	10,000 - 20,000	3.17	
	20,001 - 30,000	2.62	
	30,001 - 40,000	2.69	
	40,001 - 50,000	2.42	
	Above - 50,001	3.08	
Vending machines for disposing plastic bottles and receiving cash incentives are available.	Below 10,000	3.46	0.17
	10,000 - 20,000	3.44	
	20,001 - 30,000	2.76	
	30,001 - 40,000	3.13	
	40,001 - 50,000	3.20	
	Above - 50,001	3.37	
Using a twin-bin waste segregation approach emerges as an optimal solution within the context of promoting a circular economy (where things are used, reused, and made into new things again and again).	Below 10,000	2.28	**0**
	10,000 - 20,000	3.45	
	20,001 - 30,000	2.79	
	30,001 - 40,000	2.94	
	40,001 - 50,000	2.95	
	Above - 50,001	3.69	

III. One-way ANOVA for levels of knowledge Based on Education factor

Analyses of variance have been conducted to evaluate the significance of differences in knowledge levels about solid waste management among households in the Greater Hyderabad Municipal Corporation (GHMC) based on various education levels. This analysis helps to identify specific knowledge gaps, facilitate targeted educational efforts, and support the development of effective waste management policies tailored to the needs and behaviours of different education levels within the GHMC.

Table 4 -Respondents knowledge towards solid waste management based on Education

Variable	Education	Mean	P-value
The government has implemented a program to provide households with two different colored bins for the collection of dry waste and wet waste.	No Formal Education	2.9	0
	Primary School (up to class 5) Secondary School (up to class 10)	3.1	
	Higher Secondary education (classes 11 and 12)	2.9	
	Diploma or vocational education	3.4	
	Undergraduate degree	3.6	
	Postgraduate degree	3.3	
	Doctorate or specialized professional degree	2.9	
aware of the concept of tipper auto for waste collection	No Formal Education	2.5	0
	Primary School (up to class 5) Secondary School (up to class 10)	3.8	
	Higher Secondary education (classes 11 and 12)	2.2	
	Diploma or vocational education	2.3	
	Undergraduate degree	3.0	
	Postgraduate degree	2.8	
	Doctorate or specialized professional degree	2.7	
Burning waste causes health risks such as bronchitis and asthma.	No Formal Education	3.4	0.115
	Primary School (up to class 5) Secondary School (up to class 10)	2.6	
	Higher Secondary education (classes 11 and 12)	3.1	
	Diploma or vocational education	3.6	
	Undergraduate degree	3.3	
	Postgraduate degree	3.2	
	Doctorate or specialized professional degree	3.0	
Illegal dumping of solid waste	No Formal Education	2.0	**0**

causes bad smells and loss of aesthetics in this area.	Primary School (up to class 5) Secondary School (up to class 10)	4.8	
	Higher Secondary education (classes 11 and 12)	3.6	
	Diploma or vocational education	3.4	
	Undergraduate degree	3.7	
	Postgraduate degree	3.1	
	Doctorate or specialized professional degree	3.0	
It is my responsibility to ensure that I dispose of solid waste in the designated areas for later collection by the authorities.	No Formal Education	3.7	**0**
	Primary School (up to class 5) Secondary School (up to class 10)	3.8	
	Higher Secondary education (classes 11 and 12)	3.0	
	Diploma or vocational education	3.3	
	Undergraduate degree	3.8	
	Postgraduate degree	3.1	
	Doctorate or specialized professional degree	2.7	
Flooding in our town is due to solid waste blocking drains and gullies.	No Formal Education	4.7	**0**
	Primary School (up to class 5) Secondary School (up to class 10)	2.7	
	Higher Secondary education (classes 11 and 12)	3.1	
	Diploma or vocational education	3.4	
	Undergraduate degree	3.6	
	Postgraduate degree	3.0	
	Doctorate or specialized professional degree	2.7	
	Total	3.4	
The manufacturing, importing, stocking, distributing, selling, and using of plastic carry bags with less than 75 microns thickness are	No Formal Education	3.9	**0**
	Primary School (up to class 5) Secondary School (up to class 10)	3.8	
	Higher Secondary education (classes 11	2.9	

prohibited in Telangana, effective from 30th September 2021.	and 12)		
	Diploma or vocational education	3.2	
	Undergraduate degree	3.9	
	Postgraduate degree	3.4	
	Doctorate or specialized professional degree	2.7	
	Total	3.5	
Direct dumping of untreated waste into ponds and lakes results in accumulation of toxic substances in the food chain through the plant and animal that feed on it.	No Formal Education	2.9	**0**
	Primary School (up to class 5) Secondary School (up to class 10)	3.1	
	Higher Secondary education (classes 11 and 12)	2.8	
	Diploma or vocational education	3.4	
	Undergraduate degree	3.6	
	Postgraduate degree	3.3	
	Doctorate or specialized professional degree	2.9	
The green bin is for wet waste and the blue bin is for dry waste.	No Formal Education	2.5	**0.001**
	Primary School (up to class 5) Secondary School (up to class 10)	3.8	
	Higher Secondary education (classes 11 and 12)	2.6	
	Diploma or vocational education	2.8	
	Undergraduate degree	3.1	
	Postgraduate degree	2.8	
	Doctorate or specialized professional degree	2.7	
Vending machines for disposing plastic bottles and receiving cash incentives are available.	No Formal Education	3.4	0.117
	Primary School (up to class 5) Secondary School (up to class 10)	2.6	
	Higher Secondary education (classes 11 and 12)	3.1	
	Diploma or vocational education	3.6	
	Undergraduate degree	3.3	

	Postgraduate degree	3.2	
	Doctorate or specialized professional degree	3.0	
Using a twin-bin waste segregation approach emerges as an optimal solution within the context of promoting a circular economy (where things are used, reused, and made into new things again and again).	No Formal Education	2.0	**0**
	Primary School (up to class 5) Secondary School (up to class 10)	4.8	
	Higher Secondary education (classes 11 and 12)	3.	
	Diploma or vocational education	3.1	
	Undergraduate degree	3.7	
	Postgraduate degree	3.1	
	Doctorate or specialized professional degree	3.0	

FINDINGS:

I. Awareness of Government Programs:

Awareness of Government's Two-bin Program and Tipper-Auto Concept:

- The study reveals significant differences in awareness levels regarding the government's two-bin program and the tipper-auto concept across age, income, and education groups.
- Respondents above 60 years demonstrated the highest awareness of the two-bin program (mean = 3.63, p = 0.016), likely due to longer exposure to civic initiatives.
- Younger adults aged 21-40 years were more aware of the tipper-auto concept (mean = 3.04, p = 0.002), reflecting a greater familiarity with modern waste collection methods.
- Income-wise, the highest awareness of the two-bin program was found in respondents earning above 50,001 (mean = 3.48, p = 0.001), indicating that higher income groups have better access to information and resources.
- In contrast, the lowest income group (Below 10,000) showed the highest awareness of the tipper-auto concept (mean = 3.15, p = 0.000), suggesting effective grassroots communication strategies.
- Education also played a crucial role, with undergraduate degree holders showing the highest awareness of the two-bin program (mean = 3.61, p = 0.000), and those with primary and secondary education being most aware of the tipper-auto concept (mean = 3.88, p = 0.000).

II. Health Risks:

Awareness of Health Risks of Burning Waste:

• Awareness of the health risks associated with burning waste, such as bronchitis and asthma, was generally high across all demographic groups. There were no significant differences in awareness levels across age groups (p = 0.197), indicating a widespread understanding of these health risks.

• Similarly, income groups showed uniform awareness (p = 0.173), reflecting the effectiveness of public health campaigns. Educationally, diploma or vocational education holders exhibited the highest awareness (mean = 3.66, p = 0.115), suggesting that practical education significantly impacts health risk awareness.

III. Environmental Impacts:

Awareness of Illegal Dumping Impacts, Flooding Due to Waste, and Environmental Impact of Direct Dumping:

• Awareness of the environmental impacts of illegal dumping, flooding due to waste, and direct dumping of untreated waste into water bodies was high across most demographic groups.

• Age-wise, respondents above 60 years had higher awareness levels regarding the impact of direct dumping (mean = 3.61, p = 0.022) and flooding (mean = 3.60, p = 0.369).

• Income-wise, the lowest income group (Below 10,000) exhibited significant awareness of flooding impacts (mean = 4.82, p = 0.000) and illegal dumping (mean = 2.28, p = 0.000), likely due to direct exposure to these issues.

• Educationally, primary and secondary school-educated respondents showed the highest awareness of illegal dumping impacts (mean = 4.82, p = 0.000), flooding due to waste (mean = 4.79, p = 0.000), and environmental impacts of direct dumping (mean = 3.88, p = 0.000).

IV. Personal Responsibility:

Responsibility for Proper Waste Disposal:

• The sense of personal responsibility for proper waste disposal varied across demographic groups. Older respondents (above 60 years) felt a stronger sense of responsibility (mean = 3.79, p = 0.001), likely due to a greater sense of community duty.

• The lowest income group (Below 10,000) exhibited the highest sense of responsibility (mean = 4.00, p = 0.000), suggesting that direct impact on living conditions may drive a stronger sense of personal duty.

• Education-wise, those with primary and secondary education showed the highest sense of responsibility (mean = 3.88, p = 0.000), highlighting the role of early education in promoting civic responsibility.

V. Waste Management Practices:

Awareness of Color-coded Bin System, Vending Machines for Plastic Bottles, and Twin-bin Segregation Approach:

Awareness of various waste management practices, including the color-coded bin system, vending machines for plastic bottles, and the twin-bin segregation approach, showed significant differences across demographic groups.

- Age-wise, respondents above 60 years were more aware of the color-coded bin system (mean = 3.13, p = 0.215) and the twin-bin approach (mean = 3.45, p = 0.266), indicating a better understanding of waste segregation benefits. Younger adults aged 21-40 years were more aware of vending machines for plastic bottles (mean = 3.51, p = 0.203), reflecting familiarity with modern recycling initiatives.
- Income-wise, the highest income group (Above 50,001) showed greater awareness of the color-coded bin system (mean = 3.08, p = 0.002) and the twin-bin approach (mean = 3.69, p = 0.000). Conversely, the lowest income group (Below 10,000) demonstrated the highest awareness of vending machines (mean = 3.46, p = 0.170).
- Education-wise, primary and secondary school-educated respondents had the highest awareness of the color-coded bin system (mean = 3.88, p = 0.001), vending machines (mean = 3.66, p = 0.117), and the twin-bin approach (mean = 4.82, p = 0.000), emphasizing the importance of early education in promoting effective waste management practices.

DISCUSSION ON HOUSEHOLD WASTE MANAGEMENT PRACTICES:

The analysis of household waste management practices in the Greater Hyderabad Municipal Corporation (GHMC) area, based on demographic factors such as age, income, and education, provides critical insights into the effectiveness of current waste management strategies and the areas needing improvement. This discussion synthesizes the findings from the interpretation file with data from various studies to offer a comprehensive evaluation.

The analysis of household waste management practices in the Greater Hyderabad Municipal Corporation (GHMC) area, considering demographic factors such as age, income, and education, provides critical insights into the effectiveness of current strategies and areas needing improvement. Age-related differences show that younger individuals are more aware of waste segregation programs (F = 3.468, p = .016), likely due to better exposure to environmental education (Gopi, 2022; Nguyen & Tran, 2022), while all age groups uniformly perceive health risks from burning waste (F = 1.566, p = .197) (Laor et al., 2018). Income levels significantly influence knowledge and practices, with higher-income households being more aware and responsible in waste disposal (F = 4.216, p = .001; F = 4.907, p < .000; F = 6.765, p < .000) (Lema et al., 2019; Shetty et al., 2019; Ramachandra et al., 2018). Education impacts waste management knowledge, with higher education levels correlating with better understanding and participation (F = 5.647, p < .000) (Gu et al., 2015), although perceptions of health risks from burning waste do not vary significantly (F = 1.719, p = .115) (Adogu et al., 2015). Significant attitudinal and behavioral variations indicate the need for

targeted interventions (Interpretations File). Policymakers should develop demographic-specific educational campaigns, improve access to resources, and foster community engagement to enhance waste management practices (Lema et al., 2019; Gopi, 2022; Shetty et al., 2019; Nguyen & Tran, 2022).

The findings underscore the necessity of demographic-specific strategies to enhance waste management practices. Policymakers should consider the following recommendations:

1. **Targeted Educational Campaigns:** Develop educational programs tailored to address the specific knowledge gaps identified among different age, income, and education groups. These programs should utilize diverse communication channels to effectively reach all demographics (Lema et al., 2019; Gopi, 2022).
2. **Improving Access to Resources:** Enhance access to waste management facilities and services, particularly in low-income communities. Providing subsidies or incentives for waste management practices, such as recycling and composting, can encourage broader participation (Shetty et al., 2019).
3. **Community Engagement:** Foster active community involvement in waste management initiatives to improve compliance and foster a sense of responsibility. Programs that engage local communities and stakeholders can create more sustainable waste management practices (Nguyen & Tran, 2022).

CONCLUSION:

The critical discussion of household waste management practices in GHMC highlights significant demographic variations in knowledge, attitudes, and practices. Addressing these variations through targeted educational campaigns, improved access to resources, and active community engagement is essential for fostering sustainable waste management practices. These insights provide a valuable framework for developing effective waste management policies that cater to the diverse needs of different populations, ultimately promoting a healthier and more sustainable urban environment.

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