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Household Biomedical Waste in Urban Bangalore: Gaps in Awareness and Practices – A Situation analysis in an urban area in Bangalore

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Abstract

Background and Objectives: *The COVID-19 pandemic has increased domiciliary care, leading to a surge in household biomedical waste (HBMW). Inadequate management of HBMW poses risks to public health and the environment. This study aimed to assess awareness and practices related to HBMW management and COVID-19 waste disposal among households in urban Bangalore.*

Methods: *A descriptive cross-sectional study was conducted among 360 systematically selected households in the urban field practice area of a medical college in Bangalore. Data were collected using a pre-tested, semi-structured questionnaire. Descriptive statistics were applied, and associations between socio-demographic variables and HBMW practices were analyzed using Chi-square and Fisher's exact tests.*

Results: *Awareness of HBMW was low, with only 7.8% of households identifying biomedical waste correctly, and 15.3% practicing segregation at the source. Among households with COVID-19 cases (13.3%), 95.8% followed home isolation; however, only 63% disposed of masks appropriately. Socio-economic status and place of residence showed significant associations with HBMW awareness and practices ($p<0.001$).*

Conclusion: *The study highlights considerable gaps in HBMW awareness and management at the household level. Strengthening community awareness, enforcing proper segregation at the source, and improving municipal collection systems are essential to reduce risks of infection and environmental contamination.*

Keywords: *Household Biomedical Waste; Waste Management; Awareness and Practices; Urban Bangalore; COVID-19 Waste Disposal; Biomedical Waste Segregation*

INTRODUCTION

The burgeoning issue of biomedical waste (BMW) management has garnered significant attention globally, particularly in the wake of the COVID-19 pandemic. BMW defined as any waste generated during diagnosis, treatment, or immunization of human beings or in research activities pertaining thereto or in the production or testing of biological or in health camps. [1] Household Biomedical Waste (HBMW), includes used masks, gloves, expired medicines, and items contaminated with blood or body fluids generated at home.

Improper handling of the HBMW can cause, leaching of soil, increase in prevalence of Hepatitis B among the waste collectors due to which there's reluctance to take up this profession, etc [2]

There are 5 steps involved in the proper management of HBMW: Segregation (at point of generation), Collection (within 24hours), Transport (in authorized closed vehicle), Treatment and Final disposal (at Common Biomedical Waste Treatment Facility, CBWTF).

In India, there exists lack of strict legislations and policies, lack of awareness, absent collection system aided by lacunae in existing literature. This indicates the necessity of my study on management of HBMW in urban Bangalore and even among Covid positive households to help in strategy development for safe and effective management of HBMW.

OBJECTIVES:

1. To study the management of biomedical waste at household level in an urban field

practice area of a Medical College in Bangalore.
2. To assess the management of COVID-19 waste among home isolated COVID -19

MATERIALS AND METHODS

The study was approved by the Institutional Ethics Committee of M. S. Ramaiah Medical College (Approval No: MSRC/EC/SP-01/08-2021). A descriptive cross-sectional study was conducted among 360 households in the urban field practice area of a medical college in Bangalore over a period of one year.

The study population comprised households within the designated field practice area. Eligible respondents were residents aged 18 years and above who were present at home and consented to participate. Households producing mixed waste from commercial or industrial sources and those unavailable after three consecutive visits were excluded.

A systematic random sampling technique was employed. From eight randomly selected Census Enumeration Blocks (CEBs), 50 households were selected in each, yielding a total of 360 households. Sample size estimation was based on a previous study by Arun et al. [3], which reported that 63% of households segregated biomedical waste in accordance with the Biomedical Waste Management and Handling Rules (2016). At a 95% confidence level and 8% relative precision, the minimum required sample size was calculated as 353, which was rounded to 360 to account for non-response. The formula used was:

N=Z1−α/22×P×(1−P)d2N = \frac{Z^2_{1-\alpha/2} \times P \times (1-P)}{d^2}N=d2Z1−α/22×P×(1−P)

where $P = 0.63$, $q = 0.37$, $d = 0.08$, and $Z = 1.96$.

Data were collected using a pre-tested, semi-structured questionnaire that included socio-demographic details, as well as awareness, attitudes, and practices related to household biomedical waste (HBMW) management, with special emphasis on COVID-19 waste disposal. Data entry was done in Microsoft Excel, and analysis was performed using IBM SPSS software. Descriptive statistics such as frequency and proportions were used to summarise awareness, attitudes, and practices. Associations between socio-demographic variables, comorbidities, and HBMW practices were assessed using Chi-square and Fisher's exact tests, with a *p*-value <0.05 considered statistically significant.

RESULTS

A total of 360 households were surveyed, exceeding the estimated minimum sample size of 353 to account for closed houses and potential non-response. Every third household was selected using systematic random sampling from eight randomly chosen Census Enumeration Blocks (CEBs) in Mathikere. The types of household biomedical waste (HBMW) generated are shown in Figure 1.

Socio-demographic characteristics

Among the 360 households, nuclear families predominated (285; 79.2%), and the majority were Hindu (307; 85.3%). Based on socio-economic classification, 154 households (42.8%) belonged to the upper-lower class. Regarding morbidity, diabetes mellitus was reported in 92 households (75.4%), hypertension in 77 (63.1%), and hypothyroidism in 28 (22.9%) households, with some individuals having multiple conditions.

Awareness and attitudes toward HBMW

Only 42.5% of respondents were aware of municipal collection systems, 28.9% about transportation, 6.4% about segregation, and 4.5% recognized COVID-19 waste as biomedical waste (Table 1). Attitudes, assessed using a Likert scale, are summarized in Table 2.

HBMW management practices

Of all surveyed households, only 27 (7.5%) practiced appropriate segregation and disposal of HBMW. Although 190 households (52.8%) reported handing over waste to municipal bins or vans, failure to segregate meant that only 7.5% could be classified as following appropriate management practices. Improper disposal methods included discarding into sewage/sullage (7; 1.9%), open dumping (161; 44.7%), and burning (2; 0.6%).

At the time of the survey, 177 households (49.2%) were actively generating HBMW. Among them, 27 (15.3%) segregated waste, while 118 (66.7%) disposed of it through municipal systems, 50 (28.2%) resorted to dumping, 7 (4%) to sewage disposal, and 2 (1.1%) to burning. These findings indicate that inappropriate management stemmed not only from disposal practices but also from the widespread absence of segregation at the source.

Determinants of awareness, attitude, and practice

Educational status was not significantly associated with segregation or transportation practices (p=1.0 and p=0.18, respectively), though it was significantly associated with knowledge of waste collection (p=0.007) (Table 3). Socio-economic status showed significant associations with attitudes toward segregation, door-to-door

collection, frequency of collection, and use of covered dustbins (all $p<0.001$ except for covered dustbins, $p=0.02$). However, socio-economic status did not significantly influence attitudes regarding COVID-19 waste segregation. In practice, socio-economic status was significantly associated with both segregation and disposal of HBMW, while place of residence showed a significant association only with disposal practices (Table 4).

COVID-19–related waste management

Among the surveyed households, 48 (13.3%) reported COVID-19 positive cases, of which 46 (95.8%) practiced home isolation. Mask disposal was reported universally; however, only 29 households (63%) adhered to appropriate disposal methods, which included cutting ear loops, storing masks in a paper bag for 72 hours, and then handing them over for municipal collection. Tissues were generated in 27 households (58.7%), of which 21 (77.8%) practiced appropriate disposal, while 6 (22.2%) resorted to dumping or burning. Only one household generated gloves; these were appropriately segregated, bagged, and handed over to municipal waste collectors (Table 5).

DISCUSSION

This study assessed awareness, attitudes, and practices related to household biomedical waste (HBMW) management among 360 households in urban Bangalore. A large proportion of households (79.2%) were nuclear families, a finding comparable to NFHS-5 data, which reported that 42.3% of Indian households were nuclear families [4]. Educational status of the heads of households in this study also mirrored NFHS-5 patterns, suggesting representativeness of the sample concerning socio-demographic characteristics.

Awareness of HBMW

Awareness of HBMW was notably low; only 7.8% of households recognized that materials contaminated with blood or body fluids, or expired medicines, constituted biomedical waste. This finding is consistent with a study in South Africa, where respondents demonstrated poor awareness of healthcare waste generated at home [5]. In the present study, respondents identified masks (67.2%), sanitary napkins (64.4%), expired drugs (6.9%), band-aids (2.5%), and glucometer strips (1.7%) as forms of HBMW. By contrast, Narayan et al. reported that 81.3% of households recognized baby diapers and 70.7% recognized sanitary pads as hazardous healthcare waste, though awareness of items such as pregnancy test strips, condoms, and expired medicines remained low [6].

HBMW Management Practices

Only 15.3% of households practiced segregation of HBMW from general solid waste, and just 7.5% practiced appropriate management that included both segregation and proper disposal. Most households (66.7%) disposed of waste through municipal systems without segregation, while others resorted to dumping (28.2%), sewage disposal (4%), or burning (1.1%). These findings are concerning, given that improper disposal increases risks of environmental contamination and disease transmission. Similar practices have been reported elsewhere; for instance, in Ghana, 80% of expired medicines and 89% of sharps were disposed of along with general waste [7]. Households generating expired medicines demonstrated particularly poor practices. In this study, only 12.5% segregated expired medicines from general waste, compared to 63% in an earlier study from Bangalore [8]. Place of residence significantly influenced disposal practices ($p<0.001$), consistent with findings from coastal Karnataka [6]. Educational status was significantly associated with knowledge of collection ($p=0.007$), though not with segregation or transport. Comparable results from an Indian study suggested that healthcare professionals such as nurses and doctors had better biomedical waste management practices, likely due to training and access to resources [9].

Socio-demographic determinants

Socio-economic status and place of residence were significant determinants of both segregation and disposal practices, aligning with findings from Tehran where education, employment, gender, and age were correlated with knowledge and practices regarding medical solid waste management [10].

COVID-19–related waste management

The pandemic further emphasised the importance of HBMW management. In this study, nearly all participants agreed on the need to segregate COVID-19 waste, and 49.2% were aware that such waste is infectious. However, practices lagged behind attitudes. Among COVID-positive households, mask disposal was universal, yet only 63% followed recommended guidelines. Similarly, while most households disposed of tissues through municipal systems, some continued to dump or burn them. These findings mirror those of Sravanthi et al., who reported only modest improvements in HBMW segregation during the pandemic [11]. The most commonly generated wastes—masks, tissues, and gloves—were consistent with global observations, such as those reported by Filho et al. [12].

STRENGTHS OF THE STUDY

- Community-based design conducted in an urban slum setting, addressing an underexplored dimension of biomedical waste management.
- Use of a validated study instrument, ensuring reliability of responses.
- Application of an appropriate sampling strategy that minimized selection bias and enhanced representativeness.

LIMITATIONS OF THE STUDY

- Self-reported practices regarding COVID-19 waste management may have been influenced by recall bias.
- The study design did not allow quantification of the volume of household biomedical waste generated.
- Perspectives of waste management stakeholders, such as municipal workers, contractors, and Pourakarmikas, were not explored, which could have provided a more comprehensive understanding of systemic challenges.

CONCLUSION:

This community-based study revealed substantial deficiencies in household biomedical waste (HBMW) awareness and management in urban Bangalore. Although more than half of households disposed of waste through municipal systems, only a small fraction practiced appropriate segregation at the source. COVID-19 waste disposal, particularly for masks, was also suboptimal despite clear guidelines.

The findings underscore the urgent need for structured awareness campaigns targeting households, training programs for waste handlers, and policy-level interventions to strengthen segregation, collection, and disposal infrastructure. Addressing these gaps is crucial for minimizing health hazards, preventing environmental contamination, and ensuring sustainable biomedical waste management in urban communities.

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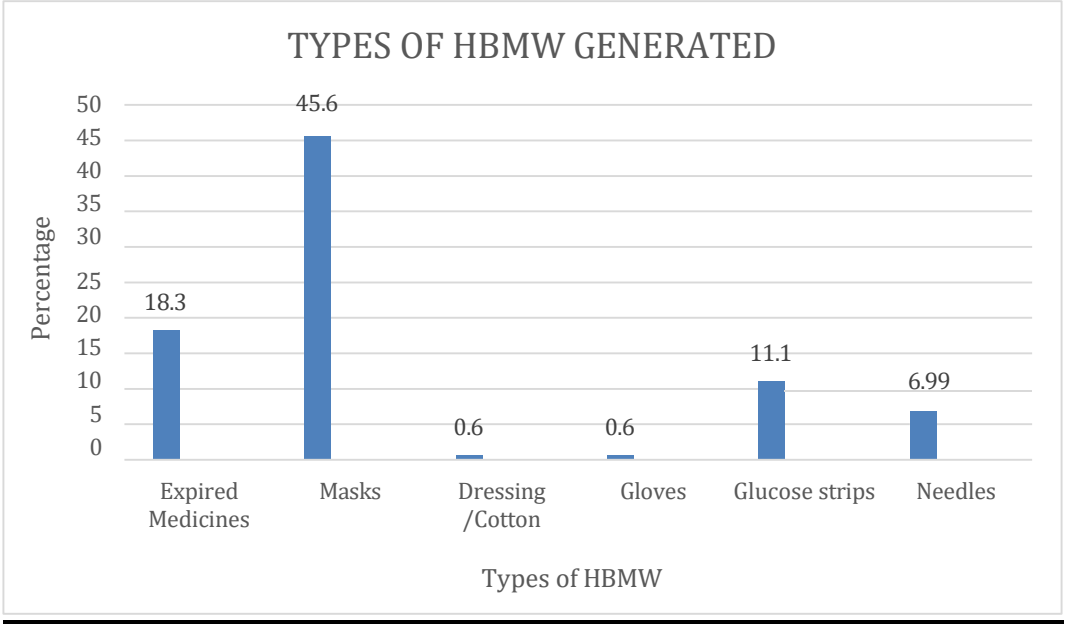
Figure : 1 : Distribution of types of HBMW generated at time of visit(N=360)



TABLES

Table 1: Assessment of awareness regarding HBMW (N= 360)

Awareness regarding biomedical waste		Frequency	Percentage (%)
Aware of what constitutes Household Biomedical waste	Yes	28	7.8
	No	332	92.2
Types of HBMW generated	Masks	242	67.2
	Drugs	25	6.9
	Sanitary napkins	232	64.4
	Band aid	9	2.5
	Glucometer strips	6	1.7
Aware that HBMW has the potential to transmit disease	Yes	40	11.1
	No	82	22.8
	Don't Know	238	66.1
Diseases transmitted through Biomedical waste	Viral diseases	30	75
	Bacterial infections	8	20
	Needle prick injuries	1	2.5
	Water borne diseases	1	2.5

Table 2: Assessment of attitude on HBMW among the study population (N=360)

Questions	Strongly agree n(%)	Agree n(%)	Neutral n(%)
Segregation of HBMW	170(47.2)	190(52.8)	0
HBMW to be collected from doorstep	200(55.6)	157(43.6)	3(0.8)
Frequency of collection of HBMW to be twice weekly	190(52.8)	170(47.2)	0
Dustbins to be covered	266(73.9)	94(26.1)	0
Segregation of COVID-19 waste	249(69.2)	111(30.8)	0

Table 3: Association between socio-demographic factors and knowledge on HBMW management

Knowledge on	Place of residence: Chi-square(P-value)	Socio-economic status: Chi-square(P-value)
Segregation	6.1(0.01)	32.7(<0.001)

Collection of HBMW	41.4 (<0.001)	70.8 (<0.001)
Transportation of HBMW	12.6(<0.001)	23.2 (<0.001)

Table 4: Association between socio demographic factors and practice on HBMW Management

Socio-demographic factors	Practice of segregation: Chi-square(P-value)	Practice of disposal: Chi-square(P-value)
Socio-economic status	26(0.001)	31.9 (<0.001)
Place of residence	6.1(0.01)	15.9(<0.001)
Educational status	- (1.00)	- (0.35)

Table 5. Management of COVID-19 waste among home isolated COVID -19 positives (N=46)

Out of the 48 (13.3%) households with COVID-19 positive cases, 95.8% (46) practiced home isolation.

Biomedical waste among Home isolated COVID 19 positives	Generated n(%)	Segregated n(%)	Appropriately managed n(%)	Inappropriately managed n(%)
Used Masks	46(100)	33(71.7)	29(63)	17(37)
Tissues	27(58.7)	21(77.8)	21(77.8)	6(22.2)
Gloves	1(2.2)	1(100)	1(100)	0(0)