Original Research

A Mixed Method Study on Pattern and Predictors of Macro-Plastic Pollution in an Urban Block of West Bengal

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Abstract

Background: Plastic pollution is one of the environmental concerns the impact of which have not been studied in our part of the country. An understanding of the distribution and determinants of plastic pollution would be imperative in combating it.

AIM: To quantitatively delineate the Knowledge, Practice, Risk Perception and Intention to carry action among households residing in Chetla, Kolkata & map the distribution of Macro Plastic Accumulation and qualitatively comprehend the risk perception among those causing and mitigating plastic pollution.

Materials and Methods: This cross-sectional, convergent parallel mixed method study was done among 148 Households & 38 participants for in depth interview in Chetla. A pretested questionnaire, observational checklist for spot mapping and an in-depth interview guide was used to collect data. Households were evaluated on 3 categories of knowledge, Risk perception and intention to carry action and bivariate correlation was done, in-depth interview of key-informants was done till data saturation.

Results: Bivariate correlation was done- The risk perception score and intention to carry action score showed weakly positive correlation which is significant. (Correlation coefficient- 0.254 and significance at two tail 0.002). The knowledge score and Intention to action score showed weakly positive correlation which is significant (0.217, 0.008). In-depth interview of key participants delineates that the extremely severe problem of plastic pollution has already reached disastrous potential and fast running out of control.

Conclusion: Since Knowledge, risk perception and intention to action show positive correlation, Education about plastic pollution through school, awareness campaigns, mass and social media is needed.

Key words: Mixed method study, Plastic pollution, Plastic

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Introduction

Plastic pollution is one the greatest challenges of our time. Micro-plastic has shown to be accumulated in most human tissues including Placenta indicating grave implications for fertility and child health [1]. Plastic associated chemical exposure has been known to cause problems in endocrine, child neurodevelopment, nutritional, circulatory, respiratory system as well as skin diseases and cancers [2]. Last couple of decades a large number of studies has shown the disastrous effect of plastic pollution on marine ecosystems without much emphasis on their effect on freshwater ecosystems and urban settings. Thus, an understanding of the prevailing knowledge and usage and disposal practices of plastic is of utmost importance. Risk is often portrayed as a function of hazard and exposure or in other words as being determined by the probability of an adverse event and the magnitude of this event's consequences [3]. The scientific capabilities for quantifying both probabilities and magnitude related to many risks are often relatively uncertain, which implies that quantification of risk is inherently uncertain [4]. An understanding of perceived risk of the given problem by the community is needed to be understood to move forward with mitigation.Hence it is important to study the of the quantitative burden and qualitatively exploreto paint a more wholesome picture and help us streamline our efforts.

Materials & Methods

The study was a community based observational, cross-sectional, mixed method study, convergent parallel in nature. The study was conducted in the Urban field practice area of All India Institute of Hygiene and Public Health.

For the quantitative arm households were the unit of study. Households permanently residing in the study area for at least a period of 1 year were included in the study and households refusing to give informed written consent along with Houses locked on the day of data collection or head of the household not present were excluded.

A Study conducted in Malaysia by Aminrad et al reported 74% of the study participants having good knowledge about plastic pollution[5]. Taking Z = 1.96 (AT 95% confidence level), margin of error = 5% and taking average Indian household size as- 4.8 [6] the required sample size becomes 65. Design effect 2 was applied and sample size became 130. Accounting for 10 % non- respondent rate the minimum sample size become 143. 10 cluster sampling was done, 15 households were selected from each cluster (Street), 148 households participated in the study. A list was made showing cumulative population of all streets. From the list of 27 streets 10 was selected by Probability Proportional to Size. After going to center of Selected Street, at first one direction was chosen randomly with the help of a currency note, then one house was chosen randomly with a currency note in that direction. If Head of the household was present and gave informed written consent, the household was taken as a study subject. if not, next households were visited continuously till 15 households had been covered. The same procedure was followed in all the 10 clusters.

A pre-designed pilot-tested Structured Questionnaire was administered to the Head of Households for a face-to-face interview. The questionnaire contained four domains, one on knowledge, Practices, Risk perception & Intention to carry individual action. Knowledge was assessed in 3 sections - effect of plastic as an environmental hazard, as a Human health Hazard and knowledge of prevalent disposal practices. For each right answer 1 point was awarded and for wrong answer or Lack of knowledge no points was awarded. Prevalent local practice regarding plastic usage and disposal was assessed through 10 questions. Risk perception was assessed in the following 7 domains of Severity of the problem, Timing, efficacy of segregation of waste and recycling in combating plastic pollution, Self – efficacy, intention to carry out segregation and recycling, Control and Voluntariness. The questions were pitched in a 5-pointLikhert scale and was scored 0-4 and tabulated. Intention to carry out individual action to combat plastic pollution was assessed with 7 items. Segregation of waste was operationally defined as disposing wet and dry waste products in different designated places [7]. Recycling is operationally defined as re-use of plastic waste for any constructive or storage purpose except as a means of disposal of other waste [8]. Data Analysis was done By Microsoft Excel-2016 & SPSS version 16. Descriptive statistics

were shown by frequency tables. Predictors were seen by test of significance at 95% confidence interval. Test of normality was done with scores and bivariate correlation was done to check for correlation

Multiple transect walks was done in the study area to delineate the distribution of macro-plastic pollution in form of a Spot map. Any plastic with more than 5 mm thickness was considered macroplastic. An accumulation of more than 5 macro plastic particles was considered for spot mapping.

In-depth interview was carried out for 38 participants who were key stake-holders (for e.g. – municipal corporation worker, kabadiwalas, Food and vegetable vendors that use single use plastic) in the causation and mitigation of plastic pollution. Participants were chosen by purposive sampling and data was collected until saturation. An in-depth interview guide, a tape recorder and field notes were used as instruments. Informed written consent was taken and anonymity was assured after explaining the study. Through in-depth interview knowledge, risk perception of the participants was explored.

Results

Among 148 families 97 (65.5%) families were nuclear while 51 (34.5%) were joint families. 125 (84.5%) families followed Hinduism, 21 (14.5%) Families followed Islam.100 (67.6%) families belongs to general category, 33 (22.3%) families belong to Schedule caste while 15(10.1%) families belong to Other Backward Classes (OBC). According to Modified BG Prasad scale 2020 [9].Socio-economic status was tabulated. 17(11%) belongs to upper-class, 40 (27 %) belongs to upper Middle, 45 (30%) belongs to middle, 42 (28%) belongs to lower-Middle and 4 (3%) bellows to lower socio-economic class.

Knowledge score was a summation of scores on knowledge of plastic as an environmental hazard, plastic as a health hazard and knowledge of plastic disposal practices. The scores were non-parametric in their distribution. The median score for knowledge on environment was 6 with a variance of 1.31. The median score for knowledge on Health was 4 with a variance of 2.25. The median score for knowledge on Plastic Disposal Practices was 4 with a variance of 2.43. The summation was taken as Knowledge score which had a median of 14, standard deviation of 2.82, with a range of 15, the maximum and minimum score being 19 and 4 respectively.

Household practices of plastic usage and disposal was also gaged. 135 (91.21%) of the family had a female member with responsibility if household disposal while only 13(9.79%) had a male member doing the same. The frequency of household waste disposal was also tabulated and it was found out that 106 (71.6%) families disposed their plastic waste daily, 17 (11.5%) on every alternate day, 19 (12.8%) once in 3 days and 6 (4.1%) families disposed them once a week.

Table 1: Distribution of the Households according to their practices

	ALWAYS	OFTEN	SOMETIMES	NEVER
Buying plastic water bottles for drinking	11, 7.4%	8, 5.4%	100, 67.6%	29 ,19.6%
Plastic bag Re-usage	34, 23%	30, 20.3%	69, 46.6%	15, 10.1%
Plastic bag Storage for future use	19,12.8%	25, 16.9%	58, 39.2%	45, 30.4%
Usage of Plastic cutlery	28,18.9%	18,12.2%	83,56.1%	19, 12.8%
Carrying reusable bags to Market	50, 33.8%	29, 19.6%	63, 42.6%	6, 4.1%

Out of 148 families 33 (22.3%) practices recycling of some of their plastic waste, while 48 (32.4%) families segregated their wet and dry waste products.

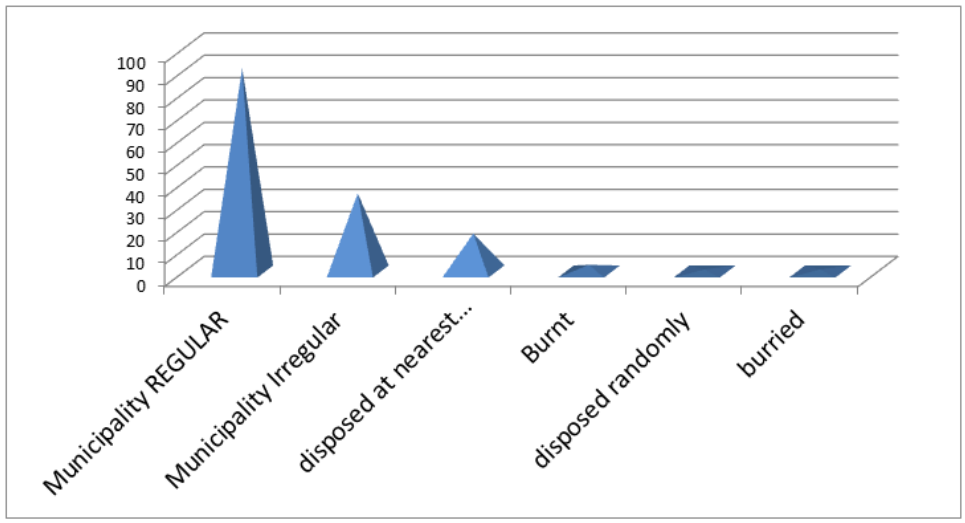

Figure 1: Bar Diagram Showing Distribution of Households According to Method of Waste Disposal

TABLE 2: SHOWING DISTRIBUTION OF HOUSEHOLDS ACCORDING TO THEIR RISK PERCEPTION OF SEVERITY OF PLASTIC POLLUTION AND EFFICACY OF ITS CONTROL METHODS (N=148)

	Certainly not (0)	Probably not (1)	Perhaps yes-Perhaps not (2)	Probably yes (3)	Certainly yes (4)	Do Not Know (0)
TIMING	2, 1.4%	7, 4.7%	17, 11.5%	91, 61.5%	30, 20.3%	1, 0.7%
EFFICACY SEGREGATION	0	12, 8.1%	27, 18.2%	79, 53,4%	24, 16.2%	6, 4.1%
EFFICACY RECYCLING	0	9, 6.1%	8, 5.4 %	87, 58.8%	29, 19.6%	15, 10.1%
SELF EFFICACY SEGREGATION	1, 0.7%	11.7.4%	26 ,17.6%	85, 57.4%	19, 12.8%	6, 4.1%
SELF EFFICACY RECYCLING	4, 2.7%	18, 12.2%	22, 14.9%	74, 50%	13, 8.8%	17,11.5%
INTENTION TO CARRY SEGREGATION	2,1.4%	11 ,7.4%	11, 7.4%	83, 56.1 %	33, 22.3 %	8, 5.4%
INTENTION TO CARRY RECYCLING	1, 0.7%	12, 8.1%	8, 5.4%	86, 58.1%	28, 18.9 %	13, 8.8%
CONTROL	5, 3.4%	10, 6.8%	9, 6.1%	103, 69.6%	21, 14.2%	0

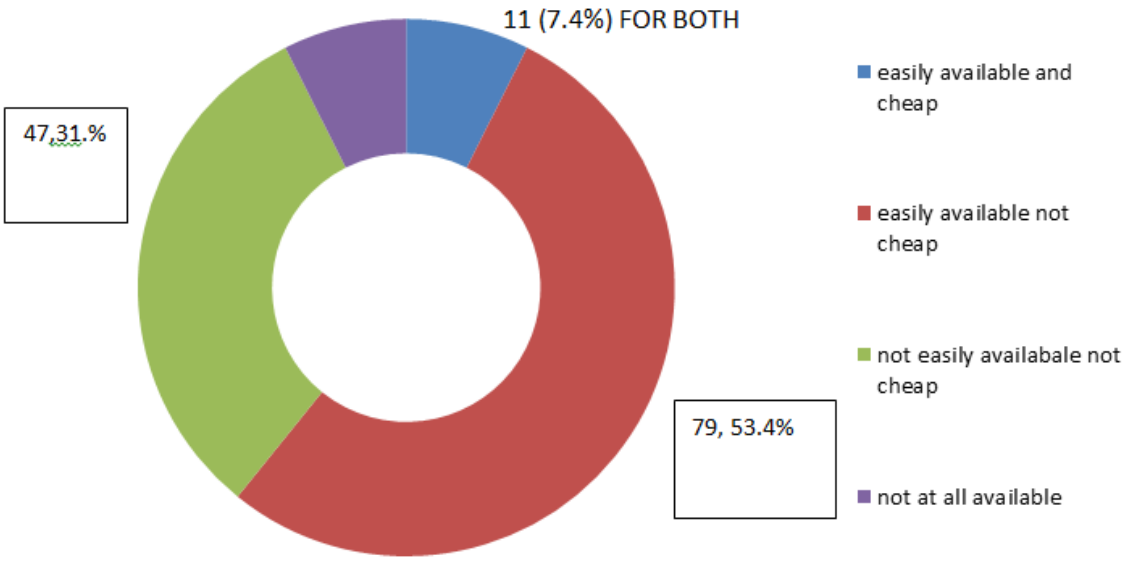

FIGURE 2: DONUT PIE CHART SHOWING DIVISION OF HOUSEHOLDS ACCORDING TO PERCEPTION OF HOW EASILY AVAILABLE ECO-FRIENDLY ALTERNATIVE TO SINGLE USE PLASTIC POLLUTION IS TODAY

Risk Perception score was Non parametric in distribution, with median being 26, Standard deviation being 5.13, interquartile range of 5 and a range of 30 with minimum being 5 and maximum being 35.

TABLE 3: SHOWING INTENTION FOR ACTION

ITEM	YES	NO
STOP USING SINGLE USE PLASTIC PRODUCTS	131 (88.5%)	17(11.5%)
STOP USING GLITTERS	115(77.7%)	33(22.3%)
STOP USING PLASTIC STRAW	116(78.4%)	31(20.9%)
JOIN CLEAN YOUR NEIGHBOURHOOD	99 (66.9%)	49(33.1%)
RAISE AWARENESS	103 (69.6%)	45((30.4%)
STOP USING SINGLE USE PLASTIC BAG	104(70.3%)	44(29.7%)
ONLY USE REUSABLE BAG	134(90.5%)	14(9.5%)

ANALYTICAL STATISTICS

The risk perception was scored and minimum score is 5 while the maximum being 35and the median is 26.00 and IQR of 5. Forty Two (28.4%) households had low risk perception, 63 (42.6%) had moderate risk perception and 43 households (29.1%) had high perception of risk regarding plastic pollution. When the risk perception score categories was cross tabulated with socioeconomic scale categories (Modified BG Prasad scale 2020) a significant association was noticed (p value 0.004 and Fischer exact test statistic 0.013).

Bivariate correlation was done- the knowledge score and perception score showed weakly positive correlation which is not significant. (Correlation co-efficient -0.159, significance at 2 tail – 0.054). The risk perception score and intention to carry action score showed weakly positive correlation which is significant. (Correlation coefficient- 0.254 and significance at two tail 0.002). The knowledge

score and Intention to action score showed weakly positive correlation which is significant (correlation coefficient – 0.217 and significance at 2 tail 0.008).

OBSERVATIONAL NOTES FROM SPOT MAPPING

1. ROADSIDE ACCUMULATION - Most roadside accumulation of plastic waste is due to disposal of food packet material or water bottles beside some vendor shops. For e.g. – A large number of plastic cups are disposed by tea stalls; wrappers of food products are thrown in roadside beside the shop from which they have been bought.

   Marketplaces have a substantial collection of single use plastic with food waste.
2. ACCUMULATION IN WATERBODIES AND DRAINS – There is a tendencyto dispose waste in or by a water body leading to plastics in and around it.In monsoons heavy rains also disperse the collection of plastic wastes and carry them to drains and water bodies in which they accumulate as litter.Plastic wastes block drainages during monsoon aggravating the problem of water logging.
3. LACK OF SEGREGATION – Segregation of waste is not practiced even in designated solid waste disposal zones (VATs).

QUALITATIVE ANALYSIS

38 persons were interviewed. The average age of those interviewed is 38.78yrs with a range of 47 the minimum and maximum being 19 and 66 respectively. These people were from various walks of life who are all stake holders in causation and mitigation of plastic pollution. They are divided according to their occupation as follows –

6 municipal waste collectors

6 fast food stall owners

5 homemakers

5 local shop owners

4 local health care workers

4 kabadiwalas

4 vegetable vendors

3 meat vendors

1 traffic police

(All quotes are said in the native language of Bangla & Hindi and translated to English for wider reach and understanding)

- All unanimously agreed that plastic pollution is harmful for both man and environment. A 36-year-old home maker said *"yes it gathers in a place over time and is not destroyed, burning also produces toxic fumes smelling which may cause cancer, it is harmful both for us and animals as well as aesthetically displeasing"*

- Risk perception of Those involved were gaged under 7 criteria
- Voluntariness- Most people were of the opinion that plastic usage can only be given up if there is an availability of other eco-friendly and cheap materials. Eco-friendly alternative to plastic is rare and even when present are a few times costlier than their plastic counter-part for e.g. jute bags. A47-year-old Poultry vendor interjected *"Inwhat else will I give meat, people don't want their market bags to be stained with blood, paper bags get wet and don't hold it well, unless I get an alternative as cheap and versatile as plastic, I can't stop using them"*. A 64-year-old local pan shop owner said *"If big companies are packaging their products in plastic what can common people do about it."*
- Control- Most people said that the problem is still in control but fast running out of control while some were of the opinion that it is already at catastrophic level. One 29-year-old municipal waste collector said that *"plastics are everywhere and such integral part of life, thus disposal is a natural outcome of it, thus the problems will only increase and that is inevitable."* A 58-year-old shopkeeper said "*when there was a government ban on single use plastic bags, people started carrying their own bags for grocery but now again that habit is gone*."
- Time – Many were of the opinion that plastic pollution will reach hazardous level soon but not in their lifetime, while many other stated that it has already reached hazardous level. One 54-year-old home-maker *said "it may not be of significance in my lifetime, but the next generations will suffer because of it."* While 34-year-old healthcare worker interjected *"we have all heard of sea animals suffering hugely for plastic pollution. There is a garbage patch in our ocean, if it is not a concern now, do we have to wait for it to start killing humans and then do something?"*.
- Severity – Almost all unanimously agreed that it was a serious problem. A 22-year-old newlywed home-maker said "increasing *global temperatures and plastic everywhere are the two great environmental concerns of our generation."*
- Methods to tackle Plastic pollution and its effectiveness and problems – major two methods available at consumer level are segregation of solid waste and recycling of plastic waste. The municipal workers have taught segregation of plastic waste and some families practice it. A 49-year-old home maker said *"the municipality workers have given us 2 buckets to store dry and wet waste separately and they collect it in that manner."* A 26-year-old municipality waste collector said *"I don't know what recycling is, but we do collect dry and wet waste separately."*
- Novelty – People have grown used to plastics around them, the threat being less novel is less perceived. a 34-year-old healthcare worker *said "plastics are everywhere, people have grown used to it."*
- Tangibility – the threat from plastic pollution is of long-termconsequence, through a cascading effect which many people may not recognize to be as a cause of plastic pollution at all. As the felt threat is not acute and less tangible the risk perceived is considerably less. A 28-year-old Kabadiwala interjected *"more than half of the waste I and my family work with is plastic, look am still alive."*

Discussion

Plastic and associated chemicals have been found to cause a myriad of health problems. Phthalates , the most known plasticizer are associated with spontaneous pregnancy loss, decreased anogenital distance in boys, insulin resistance in children and adults, with additional associations between certain phthalates and decreased birth weight, T2D in adults, precocious puberty in girls, reduced sperm quality, endometriosis, adverse cognitive development and intelligence quotient (IQ) loss, adverse fine motor and psychomotor development and elevated blood pressure in children and asthma in children and adults[2]. Inhalation, ingestion, and dermal exposure of microplastics cause genotoxicity, cell division and viability, cytotoxicity, oxidative stress induction, metabolism disruption, DNA damage, inflammation, and immunological responses in humans [9]. Plastics being ubiquitous in distribution have profound effect on human health and if not curbed at source may turn out to be the greatest challenge in modern times. Through this mixed method study in convergent parallel design, we tried to triangulate the pattern

and predictors of plastic pollution in an urban population. Though most have the knowledge that plastic is harmful for the environment, many do not perceive it as a direct health hazard which causes them to depersonalize the problem and hence not work on it. Since Knowledge, risk perception and intention to action show positive correlation, Education about plastic pollution through school, mass awareness campaigns, mass & social media is of utmost importance to combat plastic pollution. At household level women are the overwhelming majority that tackle household waste they must be the target population for education to implement behavioral change. Legislature on extent of plastic use and complete ban on single use plastic products along with enough awareness to enforce such laws may go a long way in combating the menace. Educating Kabadiwala and bringing them under an organized sector so that solid waste management can be taught to them and done in an organized manner to decrease plastic particles from ending up everywhere. Responsibility must shift from the consumer to the producers to find alternative packaging product

Ethical Clearance: India Institute of Hygiene & Public Health, Institutional ethics committee, on 22/1/2023,

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No conflict of interest

References

1. Zurub RE, Cariaco Y, Wade MG, Bainbridge SA. Microplastics exposure: implications for human fertility, pregnancy and child health. Front Endocrinol (Lausanne). 2024 Jan 4;14:1330396. doi: 10.3389/fendo.2023.1330396. PMID: 38239985; PMCID: PMC10794604.
2. Symeonides C, Aromataris E, Mulders Y, Dizon J, Stern C, Barker TH, Whitehorn A, Pollock D, Marin T, Dunlop S. An Umbrella Review of Meta-Analyses Evaluating Associations between Human Health and Exposure to Major Classes of Plastic-Associated Chemicals. Ann Glob Health. 2024 Aug 19;90(1):52. doi: 10.5334/aogh.4459. PMID: 39183960; PMCID: PMC11342836.
3. Syberg K, Hansen SF (2016) Environmental risk assessment of chemicals and nanomaterials — the best foundation for regulatory decision-making? Sci Total Environ 541:784–794
4. Beck U; Risk society: towards a new modernity. Sage, London (1986)
5. Aminrad Z, Zakariya SZ, Hadi AS, Sakari M. Relationship between awareness, knowledge and attitudes towards environmental education among secondary school students in Malaysia. World Applied Sciences Journal. 2013;22(9):1326-33.
6. Banerjee AN, Banik N, Dalmia A. Demand for household sanitation in India using NFHS-3 data. Empirical Economics. 2017 Aug;53(1):307-27.
7. Arena U, Mastellone ML, Perugini F. Life cycle assessment of a plastic packaging recycling system. The international journal of life cycle assessment. 2003 Mar;8(2):92-8.
8. Wichai-utcha N, Chavalparit O. 3Rs Policy and plastic waste management in Thailand. Journal of Material Cycles and Waste Management. 2019 Jan 22;21(1):10-22.9$.
9. Mathiyalagen P, Davis P, Sarasveni M. Updated BG Prasad Socio-Economic Classification: The 2020 Update. Indian J Pediatr. 2021 Jan;88(1):76-77. doi: 10.1007/s12098-020-03362-4. Epub 2020 Jun 5. PMID: 32504455.
10. Kumar R, Manna C, Padha S, Verma A, Sharma P, Dhar A, Ghosh A, Bhattacharya P. Micro(nano) plastics pollution and human health: How plastics can induce carcinogenesis to humans? Chemosphere. 2022 Jul;298:134267. doi: 10.1016/j.chemosphere.2022.134267. Epub 2022 Mar 14. PMID: 35301996.