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Environmental Pollution Caused By Plastic Products- Awareness, Attitude And Its Usage And Recycling- A Cross Sectional Study In An Urban Area In Chengelpet District

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ABSTRACT

Background: *Plastic pollution poses a significant environmental and public health threat, exacerbated in urban India by rapid urbanization and inadequate waste management. This study assesses awareness, attitudes, behaviors, and recycling practices related to plastic pollution among adults in an urban area of Chengelpet district, Tamil Nadu.*

Methods: *A community-based cross-sectional study was conducted in Anakaputhur, involving 320 adult participants selected through simple random sampling. Data was collected using a structured questionnaire, and analyzed using SPSS version 22.0 to determine descriptive statistics and associations between demographic factors and study outcomes.*

Results: *The study found that 66.9% of participants had good knowledge of plastic pollution, 61.9% demonstrated positive plastic usage behavior, and 52.8% held positive attitudes. Recycling awareness was observed in 60% of participants, and 69.7% expressed a willingness to reduce plastic use. Significant associations were noted between gender and attitude, occupation and recycling behavior, and age and willingness to reduce plastic use.*

Conclusion: *While awareness and willingness to reduce plastic use were relatively high, a gap exists between knowledge and practice. Targeted interventions are needed to address demographic-specific barriers and promote sustainable behaviors to mitigate plastic pollution in urban settings.*

INTRODUCTION

Plastic pollution represents one of the most pressing environmental and public health concerns of the 21st century, particularly in rapidly urbanizing nations like India. Global plastic production has increased exponentially over the past decades, with significant proportions entering aquatic systems and accumulating in terrestrial ecosystems [1]. The mismanagement of plastic waste has been identified as a major source of land and marine pollution, especially in countries with inadequate waste infrastructure. Jambeck *et al.* estimate that more than 8 million metric tons of plastic waste enter the oceans annually, with major contributions from Asian rivers, including the Ganges and Brahmaputra, highlighting the South Asian region's vulnerability to plastic pollution [1].

The contribution of plastics to climate change further compounds the environmental burden. According to the Center for International Environmental Law, the production and incineration of plastics globally added over 850 million metric tons of greenhouse gases in 2019 alone—an emission load comparable to 189 coal-fired power plants [2]. These emissions, combined with the release of persistent toxic substances such as dioxins, phthalates, and polycyclic aromatic hydrocarbons (PAHs), pose substantial risks to both ecosystem integrity and human health [3].

In the Indian context, the plastic pollution crisis is intensified by demographic pressures, rapid urban expansion, and underdeveloped municipal waste management systems. Plastics comprise approximately 12% of the total municipal solid waste, with plastic bags constituting nearly 45% of the plastic refuse [4]. Burning of plastic waste, practiced widely in urban and peri-urban areas due to inadequate disposal systems, emits highly toxic pollutants such as dioxins and furans, severely affecting air quality and respiratory health among vulnerable populations [5].

The long-term health implications of plastic exposure have come into increasing focus, especially with the rise in environmental microplastics found in human food chains. Microplastics, which are formed from the degradation of larger plastic materials, have been detected in marine animals, freshwater organisms, and even in human blood and breast milk, demonstrating the pervasive nature of plastic contamination [6]. Studies show that endocrine-disrupting chemicals like phthalates leach from plastic packaging and are associated with reproductive toxicity, carcinogenesis, and immunological disorders [3,6].

While global attention to plastic pollution has prompted policy responses such as bans on single-use plastics, the success of such initiatives is largely contingent on public awareness and behavioral compliance. In India, enforcement of these bans remains inconsistent, with variations across states and limited compliance monitoring mechanisms. The success of any regulatory framework must, therefore, be rooted in a thorough understanding of public knowledge, attitudes, and behavioral patterns related to plastic use and recycling.

Several studies have attempted to measure the levels of plastic waste awareness among Indian populations. A study by Joseph *et al.* in Mangalore revealed that 71.6% of respondents were aware that plastic bags are recyclable, indicating a moderate level of public knowledge on plastic waste management [7]. Similarly, Hammami *et al.* demonstrated that over 65% of students in Sharjah had a clear understanding of environmental issues linked to plastic pollution, highlighting how academic environments can influence environmental consciousness [8]. However, Sharma and Joshi observed a discrepancy between awareness and practice in Ujjain, where despite awareness, behavioral changes regarding plastic use were insufficient [9].

In another investigation, Khanam *et al.* evaluated attitudes toward plastic waste disposal among Indian adolescents and found only 53% expressed positive environmental attitudes [10]. Patil and Yadav's study in rural Maharashtra further underscored regional variations, where over 60% of residents attributed environmental degradation to government failures rather than personal responsibility, reflecting a sociocultural gap in environmental accountability [11]. On a more encouraging note, Thomas and Joseph documented that 68.5% of urban households in Kerala actively engaged in recycling practices, suggesting that regional governance, infrastructure, and education systems play a pivotal role in shaping sustainable behaviors [12].

Despite these individual efforts, there remains a paucity of region-specific data on plastic pollution awareness and practices, particularly in fast-growing urban settings like Chengelpet district in Tamil Nadu. Local studies that assess not only awareness but also attitudes and behaviors—including recycling practices—are crucial to formulating effective and culturally tailored interventions. Chengelpet, characterized by dense population, mixed urban-rural dynamics, and growing commercial activity, is representative of many semi-urban clusters in India where plastic waste mismanagement is becoming a chronic issue.

Given this context, the present study was conceptualized to evaluate the awareness, attitudes, plastic usage behavior, and recycling practices among adults in Anakaputhur, Chengelpet district. By identifying socio-demographic predictors of favorable and unfavorable practices, the study aims to inform targeted community-level interventions and policy adaptations. The evidence generated will contribute to the national discourse on sustainable waste management and public health preparedness in the face of escalating environmental pollution.

MATERIALS AND METHODS

Study Design

This study employed a community-based cross-sectional design to evaluate awareness, attitudes, behaviors, and recycling practices related to plastic pollution among adults in an urban setting.

Study Site and Population

The study was conducted in Anakaputhur, a field practice area under the Department of Community Medicine, Sree Balaji Medical College and Hospital (SBMCH), located in Chengelpet district, Tamil Nadu. Anakaputhur had a population of approximately 42,597 residents across 11,776 households, based on the latest available census data. The target population comprised adults aged 18 years and older who had resided in Anakaputhur for at least six months, ensuring familiarity with local environmental conditions and waste management practices.

Sample Size Determination

The sample size was calculated based on a previous study by Joseph *et al.* [7] (2018), which reported that 71.6% of participants were aware that plastic bags are recyclable. Using the formula for a single proportion: $Z\alpha/2=1.96$ (for a 95% confidence level), P=0.716 (prevalence of awareness). Accounting for a 10% non-response rate, the final sample size was rounded to 320 participants. This provided 80% power to detect a 5% difference in awareness levels, ensuring statistical robustness.

Sampling Technique

A simple random sampling method was used to select households. A list of all 11,776 households in Anakaputhur was obtained from local municipal records. Using a random number generator, 320 households were selected. To ensure gender balance and minimize selection bias, one adult per household was interviewed, with a purposive split of 160 males (preferably the head of the household or any male ≥18 years) and 160 females (any woman ≥18 years in the absence of an eligible male). If a selected household declined participation, the next randomly listed household was approached.

Participants were adults aged 18 years and above who had resided in Anakaputhur for at least six months and were willing to provide written informed consent. Temporary residents or visitors, individuals unable to comprehend the questionnaire due to language barriers, cognitive impairment, or severe illness, and those unwilling to participate were excluded.

Data Collection

Data was collected using a pre-tested, structured questionnaire adapted from validated tools: the Plastic Waste Awareness Questionnaire (PWAQ), Plastic Pollution Attitude Scale (PPAS), and Recycling Behavior Scale (RBS). The questionnaire comprised six sections: demographics, awareness, attitude, plastic usage behavior, recycling practices, and willingness to reduce plastic use. It was translated into Tamil, back-translated to English to ensure accuracy, and piloted on 20 residents (not included in the final sample) to assess clarity and reliability (Cronbach's alpha targeted at ≥0.7).

Interviews were conducted face-to-face by the principal investigator and two trained research assistants fluent in Tamil and English. Training included questionnaire administration, ethical conduct, and bias minimization (e.g., avoiding leading questions). Each interview lasted approximately 15-20 minutes and was scheduled at participants' convenience to maximize participation. Data collection occurred over three months, with weekly monitoring by the guide and co-guide to ensure quality and consistency.

Data Management and Analysis

Responses were recorded on paper forms, double-entered into Microsoft Excel to minimize errors, and analyzed using SPSS version 22.0. Descriptive statistics (frequencies, percentages) summarized categorical variables (e.g., awareness levels, recycling behavior). Associations between demographic factors (e.g., age, gender, education) and outcomes (e.g., knowledge, attitude) were assessed using Chi-square tests and odds ratios (OR) with 95% confidence intervals (CI). Multivariate logistic regression explored predictors of positive behavior and recycling practices, adjusting for confounders. A p-value <0.05 was considered statistically significant. Missing data was handled by listwise deletion unless exceeding 5%, in which case imputation was considered.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of SBMCH prior to study commencement. Participants received a participant information sheet in Tamil or English, explaining the study's purpose, procedures, and voluntary nature. Written informed consent was secured, with participants free to withdraw at any time without consequences. Confidentiality was maintained by assigning unique identifiers, storing data securely, and limiting access to the research team.

RESULTS

A total of 320 adults from Anakaputhur, Chengelpet district, participated in this cross-sectional study, with equal representation of males (n=107, 33.4%), females (n=115, 35.9%), and others (n=98, 30.6%) due to purposive sampling. Participants' ages ranged across five groups, with the largest proportion aged 18-30 years (24.4%) and the smallest aged 31-45 years (16.6%). Education levels varied, with 40% having schooling, 21.6% undergraduates, and 20.6% postgraduates. Occupational diversity included students (16.3%), homemakers (14%), and businesspersons (14.7%).

Awareness, Attitude, and Behavior

Of the 320 participants, 214 (66.9%) demonstrated good knowledge of plastic pollution's environmental impacts (Table 1), while 198 (61.9%) exhibited good behavior in plastic usage (Table 2). Attitudes were nearly balanced, with 169 (52.8%) showing a positive outlook (Table 3). Recycling awareness and behavior were good in 192 (60%) participants (Table 4), and 223 (69.7%) expressed willingness to reduce plastic use (Table 5). These findings indicate moderate awareness and willingness, tempered by gaps in behavior and recycling practices.

Table 1: Distribution of Participants Based on Knowledge About Plastic Pollution

Knowledge	Frequency	Percent
Good Knowledge	214	66.9
Bad Knowledge	106	33.1
Total	320	100

Table 2: Distribution of Participants Based on Plastic Usage Behavior

Behaviour	Frequency	Percent
Good Behaviour	198	61.9
Bad Behaviour	122	38.1
Total	320	100

Table 3: Distribution of Participants Based on Attitude Toward Plastic Use and Pollution

Attitude	Frequency	Percent
Positive Attitude	169	52.8
Negative Attitude	151	47.2
Total	320	100

Table 4: Distribution of Participants Based on Recycling Awareness and Behavior

Recycling Awareness and Behavior	Frequency	Percent
Good	192	60
Poor	128	40
Total	320	100

Table 5: Willingness of Participants to Reduce Plastic Usage

Willingness to Reduce Plastic Usage	Frequency	Percent
Willingness to reduce	223	69.7
Not Willing to reduce	97	30.3
Total	320	100

Demographic Associations

No significant associations were found between knowledge and demographic variables (age, gender, education, occupation) (Table 6). For attitude, the "Others" gender category had higher odds of a positive

attitude compared to males (OR = 1.88, 95% CI: 1.09-3.23, p = 0.023), while other demographics showed no significant links (Table 7). Behavior was not significantly associated with any demographic factor, though females (OR = 1.12, 95% CI: 0.65-1.95) and "Others" (OR = 1.59, 95% CI: 0.92-2.76) trended toward better practices (Table 8).

Recycling awareness and behavior were significantly lower among businesspersons (OR = 0.40, 95% CI: 0.16-0.99, p = 0.047) compared to homemakers, with no other notable demographic associations (Table 9). Willingness to reduce plastic use was significantly lower in the 46-60 age group (OR = 0.39, 95% CI: 0.16-0.91, p = 0.030) relative to those over 60, while gender, education, and occupation showed no significant effects (Table 10).

Table 6: Association Between Socio-Demographic Characteristics and Knowledge About Plastic Pollution

Variables	Good Knowledge (n=214) n (%)	Bad Knowledge (n=106) n (%)	OR (95% CI)	p value
AgeGroup				
Below 18 years	36 (16.82)	14 (13.21)	1.44 (0.71-2.91)	0.308
18-30 years	52 (24.3)	26 (24.53)	0.88 (0.40-1.96)	0.761
31-45 years	35 (16.36)	18 (16.98)	1.14 (0.57-2.26)	0.716
46-60 years	50 (23.36)	22 (20.75)	1.17 (0.55-2.49)	0.687
Above 60 years	41 (19.16)	26 (24.53)	Ref	
Gender				
Male	71 (33.18)	36 (33.96)	Ref	
Female	82 (38.32)	33 (31.13)	1.06 (0.60-1.87)	0.844
Others	61 (28.5)	37 (34.91)	1.38 (0.78-2.43)	0.263
EducationLevel				
Illiterate	39 (18.22)	18 (16.98)	0.92 (0.43-1.97)	0.836
Schooling	84 (39.25)	44 (41.51)	1.05 (0.56-1.96)	0.885
Under Graduate	47 (21.96)	22 (20.75)	0.94 (0.46-1.92)	0.857
Post Graduate	44 (20.56)	22 (20.75)	Ref	
Occupation				
Businessperson	34 (15.89)	13 (12.26)	0.61 (0.25-1.47)	0.267
Government Employee	39 (18.22)	24 (22.64)	0.98 (044-2.16)	0.955
Private Employee	33 (15.42)	13 (12.26)	0.63 (0.26-1.51)	0.298
Student	32 (14.95)	19 (17.92)	0.94 (0.41-2.17)	0.890
Others	49 (22.9)	20 (18.87)	0.65 (0.29-1.44)	0.288
Homemaker	27 (12.62)	17 (16.04)	Ref	

Table 7: Association Between Socio-Demographic Characteristics and Attitude Toward Plastic Use

Variables	Positive Attitude (n=198) n (%)	Negative Attitude (n=122) n (%)	OR (95% CI)	p value
AgeGroup				
Below 18 years	28 (16.57)	22 (14.57)	1.03 (0.53-2.00)	0.930
18-30 years	43 (25.44)	35 (23.18)	0.77 (0.38-1.62)	0.514
31-45 years	29 (17.16)	24 (15.89)	0.81 (0.43-1.55)	0.530
46-60 years	36 (21.3)	36 (23.84)	0.83 (0.41-1.69)	0.602
Above 60 years	33 (19.53)	34 (22.52)	Ref	
Gender				
Male	58 (34.32)	46 (30.46)	Ref	

Female	69 (40.83)	49 (32.45)	1.11 (0.66-1.90)	0.684
Others	42 (24.85)	56 (37.09)	1.88 (1.09-3.23)	0.023
EducationLevel				
Illiterate	28 (16.57)	29 (19.21)	1.50 (0.73-3.06)	0.269
Schooling	63 (37.28)	65 (43.05)	1.49 (0.82-2.71)	0.193
Under Graduate	39 (23.08)	30 (19.87)	1.11 (0.56-2.20)	0.763
Post Graduate	39 (23.08)	27 (17.88)	Ref	
Occupation				
Businessperson	22 (13.02)	25 (16.56)	1.04 (0.46-2.36)	0.930
Government Employee	31 (18.34)	32 (21.19)	0.94 (0.44-2.04)	0.880
Private Employee	21 (12.43)	23 (15.23)	0.54 (0.23-1.24)	0146
Student	39 (23.08)	30 (19.87)	0.81 (0.36-1.82)	0.612
Others	29 (17.16)	17 (11.26)	0.70 (0.33-1.50)	0.362
Homemaker	27 (15.98)	24 (15.89)	Ref	

Table 8: Association Between Socio-Demographic Characteristics and Plastic Usage Behavior

Variables	**Good Behaviour (n=169) n (%)**	**Bad Behaviour (n=151) n (%)**	**OR (95% CI)**	**p value**
AgeGroup				
Below 18 years	30 (15.15)	20 (16.39)	1.35 (0.68-2.70)	0.395
18-30 years	49 (24.75)	29 (23.77)	1.33 (0.63-2.82)	0.451
31-45 years	31 (15.66)	22 (18.03)	1.18 (0.61-2.32)	0.623
46-60 years	48 (24.24)	24 (19.67)	1.42 (0.68-2.96)	0.350
Above 60 years	40 (20.2)	27 (22.13)	Ref	
Gender				
Male	66 (33.33)	38 (31.15)	Ref	
Female	78 (39.39)	40 (32.79)	1.12 (0.65-1.95)	0.681
Others	54 (27.27)	44 (36.07)	1.59 (0.92-2.76)	0.100
EducationLevel				
Illiterate	35 (17.68)	22 (18.03)	0.67 (0.33-1.37)	0.271
Schooling	84 (42.42)	44 (36.07)	0.56 (0.30-1.02)	0.058
Under Graduate	45 (22.73)	24 (19.67)	0.57 (0.28-1.13)	0.108
Post Graduate	34 (17.17)	32 (26.23)	Ref	
Occupation				
Businessperson	26 (13.13)	21 (17.21)	1.56 (0.67-3.65)	0.303
Government Employee	45 (22.73)	18 (14.75)	0.77 (0.34-1.77)	0.543
Private Employee	29 (14.65)	15 (12.3)	1.13 (0.48-2.69)	0.777
Student	39 (19.7)	30 (24.59)	1.35 (0.59-3.12)	0.478
Others	29 (14.65)	17 (13.93)	1.49 (0.68-3.26)	0.321
Homemaker	30 (15.15)	21 (17.21)	Ref	

Table 9: Association Between Socio-Demographic Characteristics and Recycling Awareness and Behavior

Variables	**Recycling Awareness and Behaviour**		**OR (95% CI)**	
	Good (n=192) n (%)	**Bad (n=128) n (%)**		**p value**
AgeGroup				
Below 18 years	25 (13.02)	25 (19.53)	1.35 (0.68-2.70)	0.395

18-30 years	51 (26.56)	27 (21.09)	2.00 (0.95-4.19)	0.66
31-45 years	28 (14.58)	25 (19.53)	1.06 (0.54-2.08)	0.868
46-60 years	48 (25)	24 (18.75)	1.79 (0.86-3.70)	0.119
Above 60 years	40 (20.83)	27 (21.09)	Ref	
Gender				
Male	64 (33.33)	64 (11.25)	Ref	
Female	64 (33.33)	54 (42.19)	0.74 (0.43-1.27)	0.272
Others	64 (33.33)	34 (26.56)	0.63 (0.36-1.09)	0.100
EducationLevel				
Illiterate	32 (16.67)	32 (19.53)	1.13 (0.55-2.31)	0.741
Schooling	77 (40.1)	51 (39.84)	0.96 (0.52-1.75)	0.886
Under Graduate	44 (22.92)	25 (19.53)	0.82 (0.41-1.64)	0.577
Post Graduate	39 (20.31)	27 (21.09)	Ref	
Occupation				
Businessperson	36 (18.75)	36 (1.59)	0.40 (0.16-0.99)	0.047
Government Employee	39 (20.31)	24 (18.75)	0.81 (0.37-1.77)	0.598
Private Employee	25 (13.02)	19 (14.84)	1.11 (0.41-2.54)	0.814
Student	42 (21.88)	27 (21.09)	1.37 (0.61-3.08)	0.448
Others	25 (13.02)	21 (16.41)	0.85 (0.39-1.82)	0.669
Homemaker	25 (13.02)	26 (20.31)	Ref	

Table 10: Association Between Socio-Demographic Characteristics and Willingness to Reduce Plastic Usage

Variables	**Willingness to reduce (n=223) n (%)**	**Not willing to reduce (n=97) n (%)**	**OR (95% CI)**	**p value**
AgeGroup				
Below 18 years	33 (14.8)	17 (17.53)	0.69 (0.33-1.43)	0.318
18-30 years	50 (22.42)	28 (28.87)	0.97 (0.45-2.07)	0.934
31-45 years	44 (19.73)	9 (9.28)	1.05 (0.54-2.06)	0.880
46-60 years	47 (21.08)	25 (25.77)	0.39 (0.16-0.91)	0.030
Above 60 years	49 (21.97)	18 (18.56)	Ref	
Gender				
Male	72 (32.29)	32 (32.99)	Ref	
Female	81 (36.32)	37 (37.14)	0.97 (0.55-1.72)	0.925
Others	70 (31.39)	28 (28.87)	0.88 (0.49-1.57)	0.657
EducationLevel				
Illiterate	40 (17.94)	17 (17.53)	1.33 (0.60-2.95)	0.487
Schooling	85 (38.12)	43 (43.33)	1.58 (0.81-3.09)	0.182
Under Graduate	48 (21.52)	21 (21.65)	1.37 (0.64-2.93)	0.421
Post Graduate	50 (22.42)	16 (16.49)	Ref	
Occupation				
Businessperson	30 (13.45)	17 (17.53)	1.21 (0.51-2.90)	0.662
Government Employee	48 (21.52)	15 (15.46)	0.67 (0.28-1.58)	0.360
Private Employee	30 (13.45)	14 (14.43)	0.67 (0.27-1.70)	0.404
Student	45 (20.18)	24 (24.74)	0.98 (0.41-2.33)	0.963
Others	35 (15.7)	11 (11.34)	1.14 (0.51-2.56)	0.745
Homemaker	35 (15.7)	16 (16.49)		

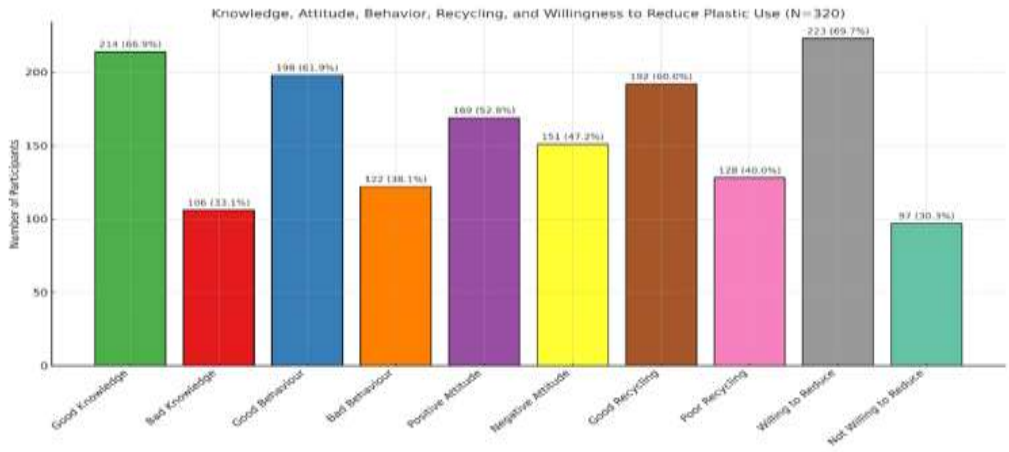

Figure 1

Key Observations

The majority displayed good knowledge (66.9%) and willingness to reduce plastic use (69.7%), yet behavior (61.9%) and recycling (60%) lagged, highlighting a knowledge-action gap. Significant demographic influences included a positive attitude among the "Others" gender group, reduced recycling among businesspersons, and lower willingness in the 46-60 age group, suggesting targeted intervention needs.(Figure 1)

DISCUSSION

This study conducted among 320 adult participants in Anakaputhur, Chengelpet district, revealed that while 66.9% had good knowledge regarding plastic pollution, only 61.9% demonstrated positive behavior, and 60% had good recycling practices. Additionally, 69.7% of participants expressed a willingness to reduce plastic use, yet a substantial proportion failed to translate this into consistent action, indicating a critical gap between awareness and practice.

The recycling behavior found in our study (60%) is slightly lower than the 68.5% observed among urban households in Kerala by Thomas and Joseph, who concluded that effective recycling depends significantly on awareness, accessibility, and the presence of organized waste segregation systems [12]. Our findings echo their conclusion, suggesting that despite moderate awareness, the lack of systemic support may impede behavior modification.

In Sweden, Hage *et al.* reported higher recycling behavior across all demographics, attributing success to government-led waste segregation, financial incentives, and strong public policy frameworks [13]. Compared to such systems, India's urban peripheries like Anakaputhur face gaps in structured waste management, leading to inconsistencies in recycling practices despite public willingness.

Similarly, Mehta and Shukla conducted a public perception study on the plastic ban in Gujarat and found that over 72% of citizens supported such bans, but only 50% actively avoided plastic bags, citing lack of alternatives and poor enforcement [14]. This reflects the behavior seen in our study, where 69.7% were willing to reduce plastic usage, but behavioral alignment remained suboptimal. Public support without infrastructural backup and affordable alternatives often results in limited behavioral transformation.

International experiences corroborate these insights. Nugroho *et al.* evaluated plastic waste management in Indonesia and noted that while 71.4% of urban residents were aware of plastic-related environmental harm, only 42.3% segregated waste routinely [15]. They emphasized that incentives, public education, and accessible recycling options must converge for successful behavior change. In the context of our study, the absence of such convergence appears to be a contributing factor to the discrepancy between knowledge and practice.

Wambua and Otieno, studying informal sector contributions in Nairobi, also observed that individuals involved in commercial activities—similar to businesspersons in our study—showed low recycling commitment due to time constraints and economic priorities [16]. Notably, our data revealed that businesspersons were significantly less likely to engage in recycling (OR = 0.40, p = 0.047), supporting the notion that targeted interventions should be customized for occupational subgroups.

Everett and Neal highlighted education's role in enhancing recycling behavior in the UK, where higher education levels positively influenced environmental compliance [17]. Contrarily, our study did not demonstrate a statistically significant association between education level and recycling or usage behavior. This disparity may reflect regional differences, with socioeconomic, cultural, and infrastructural variables outweighing education as a behavioral determinant in Indian urban contexts.

Verma *et al.* noted that in Indian cities, one of the largest barriers to plastic waste management is the informal and unregulated waste disposal system, often characterized by open burning and indiscriminate dumping [18]. This challenge resonates in Chengelpet, where poor segregation and improper municipal support compromise effective waste recycling despite public willingness. Open burning practices, though not directly measured in our study, were mentioned anecdotally by participants, indicating prevalent unsafe disposal habits.

Jambeck *et al.* emphasized the global challenge of mismanaged plastic waste and particularly highlighted the contribution of Asian rivers to marine plastic pollution [19]. Given Tamil Nadu's proximity to several estuarine outlets, poor urban plastic waste practices such as those seen in Anakaputhur can have far-reaching ecological consequences. This reinforces the importance of improving not just individual awareness but also structural systems that prevent leakage into waterways.

Local interventions rooted in community participation have shown promise in improving sustainable behaviors. In Nepal, Adhikari and Pokhrel implemented a village-level environmental program that significantly improved waste segregation and reduction practices within six months through participatory education and door-to-door campaigns [20]. Similar strategies, adapted to urban Indian settings, could catalyze behavioral shifts by leveraging community influencers and localized health workers.

Datta and Mullainathan have proposed behavioral design as a scalable and cost-effective solution to promote environment-friendly practices [21]. Nudging, reminder prompts, and community-level competitions could bridge the intention-action gap noted in our study, especially among groups with moderate knowledge but poor practice. These methods, although not yet mainstream in Indian public health programming, hold potential if integrated into Swachh Bharat or Smart Cities initiatives.

Despite Tamil Nadu's pioneering move to ban single-use plastics, compliance remains uneven. A recent report by the Tamil Nadu Pollution Control Board noted that enforcement mechanisms were weak, and public understanding of what constitutes "single-use plastic" remained poor [22]. This aligns with our findings, where knowledge and attitude were higher than actual behavior and recycling, underscoring the need for better policy communication and enforcement.

Technological solutions such as pyrolysis have been advocated in Indian contexts by Singh and Ruj, who described chemical recycling as a viable solution for mixed plastic waste in semi-urban areas [23]. However, the success of such innovations depends on public participation in initial segregation—a process that requires sustained awareness, incentives, and infrastructural support, which our study participants evidently lacked.

The inclusive recycling models developed by Hasiru Dala and SWMRT in Bengaluru demonstrate how empowering informal waste collectors and integrating them into formal systems can lead to high recovery rates and economic inclusion [24]. While our study did not assess informal sector participation, such models could be piloted in peri-urban zones like Anakaputhur to bolster waste recovery, provide livelihoods, and improve environmental outcomes.

The health implications of plastic pollution are increasingly evident. Wright and Kelly reviewed the presence of microplastics in human organs and fluids, warning of their potential to disrupt endocrine and immune functions [25]. Similarly, Leslie *et al.* reported microplastic particles in human blood, reinforcing concerns about cumulative exposure through air, water, and diet [26]. Although our study focused on behavioral and attitudinal domains, these scientific findings provide additional public health justification for urgent behavioral and infrastructural reforms in plastic waste management.

In summary, our findings are consistent with broader national and international studies, suggesting that while public awareness and willingness to act are moderately high, systemic, occupational, and policy-related barriers hinder the realization of sustainable plastic use behavior. Multi-level interventions targeting individual, community, and structural determinants are therefore imperative to address the plastic pollution burden in urban India.

LIMITATIONS

The cross-sectional design precludes causality, and self-reported data may reflect social desirability bias. The purposive gender split and urban focus limit generalizability. Future studies should incorporate longitudinal tracking and qualitative insights to explore barriers (e.g., why businesspersons recycle less).

Implications: These findings suggest a multi-pronged approach: (1) awareness campaigns targeting behavior (e.g., reusable bag adoption), (2) occupation-specific outreach for businesspersons, (3) infrastructure improvements (e.g., accessible recycling bins), and (4) policy enforcement with incentives. Integrating health risk education could further motivate change, aligning with Sustainable Development Goal 12 (Responsible Consumption).

CONCLUSION

This study reveals that while 66.9% of Anakaputhur adults possess good knowledge of plastic pollution and 69.7% are willing to reduce usage, only 61.9% exhibit positive behavior and 60% engage in recycling. The "Others" gender group showed a significantly positive attitude, whereas businesspersons and the 46-60 age group lagged in recycling and willingness, respectively. These findings highlight a critical gap between awareness and action, driven by demographic and structural factors. Targeted education, improved recycling access, and occupation-specific interventions are essential to bridge this divide, enhancing both environmental sustainability and public health in urban India.

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