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Knowledge, Attitude, and Practice Regarding 3R (Reduce, Reuse and Recycle) and its Associated Factors among School Students in Bangladesh: A Cross-Sectional Study

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Abstract: Efficient waste management is crucial for maintaining a healthy environment, and young generations play a vital role in this process by practicing the 3R principle. Therefore, this study aimed to investigate the knowledge, attitudes, and practices (KAP) and its associated factors among secondary school students regarding the 3R. The two-stage random sampling method collected information from 400 students to investigate their KAP concerning 3R awareness. Statistical analyses such as descriptive statistics, Chi-square, and logistic regression were applied in this study. This study discovered that among students, 54.50% knew 3R, 58.50% showed a positive attitude towards it, and 51.12% practiced 3R principles. Urban students demonstrated higher knowledge, positive attitude, and better practice of 3R compared to rural students. Belonging to a joint family increased the likelihood of possessing 3R knowledge compared to nuclear families, but individuals from joint families were less likely to have a positive attitude towards 3R. Additionally, male students and those aged 13 years and above were more likely to have 3R knowledge than their counterparts. This study revealed different levels of understanding, positive attitudes, and actual implementation of 3R principles among the participants, with various factors influencing their KAP. It emphasizes raising awareness among young students or similar groups to promote sustainable waste management and environmental conservation efforts.

Keywords: *3R, Attitude, Environment, Knowledge, Practice, School Students*

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1. Introduction

Municipal solid waste (MSW) is a significant component of the waste generated by households, commercial activities, street-sweeping, and construction and demolition debris (Han et al. 2023; Chaturvedi S, Khare 2022). This waste includes materials like dust, tiles, paper, plastic, textiles, glass, metal, and wood, reflecting the diverse nature of human-generated waste (Oyewo et al. 2022). The management of MSW is crucial due to its potential to degrade the environment, harm human and animal health, and impact aesthetic beauty (Randhi UD, 2022; Zyder et al. 2022). Bangladesh faces significant challenges in managing MSW due to rapid urbanization and population growth, which have increased waste and strained limited waste management systems (Islam, 2021). Low public awareness of the 3R principles results in limited participation in waste reduction and recycling initiatives, further compounding the issue. Additionally, inadequate waste collection and segregation infrastructure often lead to improper disposal (Subedi et al., 2023). Much of the recycling in Bangladesh is handled by the informal sector, which operates with minimal support and lacks the organization necessary for more efficient recycling efforts (Amin, 2017). These inefficiencies contribute to environmental pollution, which poses serious public health risks (National 3R Strategy for Waste

Management, 2010). Furthermore, gaps in policy enforcement, combined with cultural attitudes that may not prioritize sustainable waste practices, create additional barriers to adopting the 3R approach across the country.

Several studies have examined the effectiveness of 3R programs and awareness-building efforts in various contexts. For instance, Zain et al. (2022) and Anua et al. (2022) focused on assessing the impact of 3R programs in primary schools in Malaysia, highlighting strategies to increase environmental awareness among young students. Research on 3R practices in Bangladesh has largely focused on specific groups and contexts. Kabir et al. (2023) explored farmers' perceptions and capacities regarding agro-waste management through the 3R principles, emphasizing sustainable practices in agricultural waste disposal. Mahmudul and Razy (2020) examined urban solid waste management in Rajshahi, studying how the 3R strategy is applied in city waste practices. More recently, Iqbal and bin Ahsan (2024) investigated environmental education and recycling practices among underprivileged children in Bangladesh to understand how marginalized communities engage with recycling. However, there has been no comprehensive study in Bangladesh to survey the knowledge, attitudes, and practices (KAP) concerning 3R principles among the general population, leaving a gap in understanding nationwide awareness and adoption of these sustainable practices.

Conducting a study on KAP regarding 3R among school students in Bangladesh is crucial as it helps understand the level of awareness and engagement in proper waste management practices. Children's formative years are essential for developing values, attitudes, and behaviors, making it imperative to instill awareness about environmental issues like waste management early on (Kara et al., 2015; Ardoin & Bowers, 2020). Moreover, investigating KAP related to 3R among students is vital as they are the nation's future leaders and need to be equipped with the necessary knowledge and skills to address environmental challenges effectively. Awareness about environmental problems, including proper waste management practices like 3R, is essential for students to actively contribute to sustainable practices and environmental conservation efforts (Tartiu, 2011). Therefore, this study aims to evaluate the knowledge, attitude, and practice of school students in Natore district, Bangladesh, regarding the principles of the 3R. This study also aimed to identify the factors that influence students' KAP related to the 3R.

2. Materials and methods

2.1. Study design, target area and population

The cross-sectional study focused on Natore district, which belongs to the Rajshahi division in the northern region of Bangladesh. The study's target population was secondary-level students in Natore district (Figure 1).

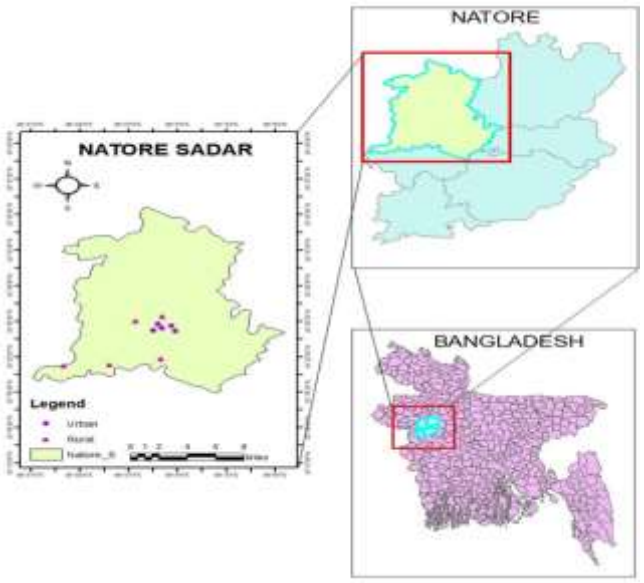

Figure 1: Target area of the study

2.2. Sampling techniques

The required sample size for this study was estimated using the formula given by (Cochran, 1963).

$$n = \frac{z^2 p(1-p)}{d^2}$$

This formula provided that 384 samples were required for this study. However, a total of 400 samples were considered in this study. In this study, a multi-stage random sampling method was used. First, one Upazila was randomly selected from the seven Upazilas in Natore district. Next, the urban area (the municipality) was included, and five rural areas (Unions) were randomly selected from the seven Unions. In the urban area, five schools were randomly selected from eight secondary schools, and in each selected rural area, one school was also randomly selected. Finally, 207 students were randomly selected from the rural schools and 193 from the urban schools, making a total of 400 students for this study. All required information was collected from the schools during September and October 2023.

2.3. Data collection and analysis

Initially developed in English, the questionnaire was translated into Bangla for better understanding and reviewed by environmental experts for accuracy and relevance. A seven-day pilot survey was conducted in August 2023 with 50 students from different schools in Natore district to test the clarity and relevance of the questionnaire items. Based on participant feedback, unclear questions were rephrased, redundant items were removed, and the order was revised for better survey flow. This resulted in a final version with 26 items covering general information, family background, and KAP assessment on the 3R principle. The revised questionnaire

demonstrated high internal consistency (Cronbach's alpha = 0.80). Since the study involved human participants but not clinical or experimental procedures, formal ethical approval was not required; however, written consent was obtained from all participants, ensuring voluntary participation, confidentiality, and the right to withdraw at any time. The KAP questionnaire included 10 items assessing knowledge, 7 assessing attitude, and 9 assessing practice, with mean scores of 14.08, 7.68, and 11.65, respectively, used to classify individuals into two groups. Knowledge was coded as 1 if the mean score was below 14.08 and 0 otherwise, attitude as 1 if below 7.68 and 0 otherwise, and practice as 1 if above 11.65 and 0 otherwise. Independent variables included gender, age group, residence, parent's education and occupation, and family type. Descriptive statistics, Chi-square tests, and logistic regression were used to assess KAP levels, associations, and influencing factors, with a significance level of $p<0.05$, and SPSS version 22.0 was used for data analysis.

3. Results

In this study, 400 secondary school students participated, with slightly more males (52.3%) than females (47.7%). Most participants were 13 years or older (77.0%), and approximately equal numbers lived in urban and rural areas. Most fathers (82.8%) and mothers (79.5%) had attained secondary education or higher. A significant portion of fathers were involved in business (51.3%), and most participants lived in nuclear families (76.3%) (Table 1).

Table 1: Socio-economic and demographic characteristics of respondents

Study Variables	Frequency	Percentages
Gender		
Male	209	52.3
Female	191	47.7
Age Group		
< 13 years	92	23.0
≥ 13 years	308	77.0
Residence		
Urban areas	193	48.2
Rural areas	207	51.8
Education Level of Father		
Illiterate and Primary	69	17.2
Secondary and above	331	82.8
Education Level of Mother		
Illiterate and Primary	82	20.5
Secondary and above	318	79.5
Occupation of Father		
Service	93	23.3
Business	205	51.3
Others	102	25.4
Occupation of Mother		
Housewife	350	87.5
Others	50	12.5
Type of family		
Nuclear	305	76.3
Joint	95	23.7

Figure 2: KAP regarding 3R among secondary school student's in Natore district

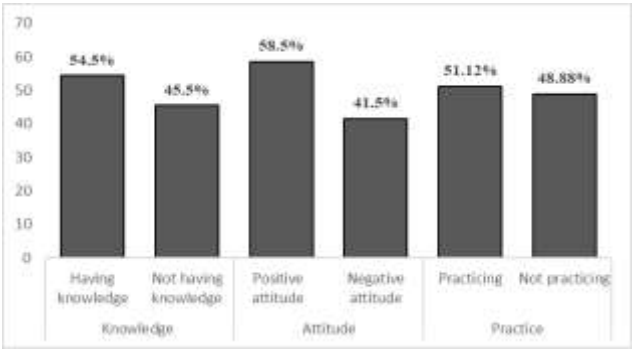

Figure 2 shows that 54.50% of secondary school students knew about the 3R concept, 58.50% exhibited a positive attitude towards it, and 51.12% practiced 3R principles.

Table 2: Association between respondents' socio-economic characteristics and their KAP regarding 3R

Variables	Group	Knowledge about 3R		Attitude towards 3R		Practicing 3R	
		Having knowledge, N (%)	χ^2 – value	Positive attitude, N (%)	χ^2 – value	Practicing, N (%)	χ^2 – value
Gender	Male	146 (69.9)	41.62**	119 (56.9)	0.44	115 (55.0)	2.84
	Female	72 (37.7)		115 (60.2)		89 (46.6)	
Age group	< 13 years	36 (39.1)	11.38**	51 (55.4)	0.46	42 (45.7)	1.37
	≥ 13 years	182 (59.1)		183 (59.4)		162 (52.6)	
Residence	Urban areas	146 (75.6)	47.26**	129 (66.8)	10.68**	128 (66.3)	35.03**
	Rural areas	72 (34.8)		105 (50.7)		76 (36.7)	
Education Level of Father	Illiterate and Primary	38 (55.1)	0.01	46 (66.7)	2.29	38 (55.1)	0.55

	Secondary and above	180 (54.4)		188 (56.8)		166 (50.2)	
Education Level of Mother	Illiterate and Primary	38 (46.3)	2.77	47 (57.3)	0.06	44 (53.7)	0.29
	Secondary and above	180 (56.6)		187 (58.8)		160 (50.3)	
Occupation of Father	Service	54 (58.1)	5.98	56 (60.2)	0.23	51 (54.8)	0.72
	Business	100 (48.8)		120 (58.5)		102 (49.8)	
	Others	64 (62.7)		58 (56.9)		51 (50.0)	
Occupation of Mother	Housewife	187 (53.4)	1.30	209 (59.7)	1.70	179 (51.1)	0.02
	Others	31 (62.0)		25 (50.0)		25 (50.0)	
Type of family	Nuclear	155 (50.8)	7.01**	167 (54.8)	7.42**	149 (48.9)	2.37
	Joint	63 (66.3)		67 (70.5)		55 (57.9)	

Table 2 examined the association between respondents' socio-economic characteristics and Knowledge, Attitude, and Practice (KAP) regarding the 3R (Reduce, Reuse, Recycle) principles. Significant associations were found between several characteristics and knowledge on 3R: a higher proportion of males demonstrated knowledge compared to females (p = 0.001), individuals aged 13 years and above exhibited higher knowledge than those below 13 years (p = 0.001), urban respondents had more knowledge compared to rural respondents (p = 0.001), and individuals from nuclear families showed higher knowledge compared to those from joint families (p = 0.001). Residence and type of family were also significantly associated with attitude toward 3R, with urban respondents displaying a more positive attitude than rural respondents (p = 0.001), and individuals from nuclear families demonstrating a more positive attitude than those from joint families (p = 0.001).

Table 3: Effect of socio-economic factors on respondents KAP regarding 3R

Variables	B	S.E.	p-value	OR	95% C.I. for OR	
					Lower	Upper
Effect of socio-economic factors on respondent's knowledge regarding 3R						
Gender						
Male vs Female	1.01	0.25	0.001	2.73	1.69	4.43
Age group						
≥ 13 years vs <13 Years	0.94	0.28	0.001	2.55	1.48	4.38
Residence						
Urban areas vs Rural areas	1.37	0.24	0.001	3.93	2.44	6.31
Type of Family						
Joint vs Nuclear	0.71	0.27	0.010	2.03	1.87	3.47
Effect of socio-economic factors on respondent's attitude towards 3R						
Residence						
Urban areas vs Rural areas	0.65	0.21	0.002	1.91	1.27	2.87
Type of Family						
Nuclear vs Joint	0.71	0.26	0.012	0.53	0.32	0.87
Effect of socio-economic factors on respondent's practice of 3R						
Residence						
Urban areas vs Rural areas	1.22	0.21	0.001	3.39	2.25	5.12

Table 3 presented that male exhibited higher likelihood of knowing about 3R compared to females, while older

individuals were also more likely to possess this knowledge than younger ones. Living in urban areas significantly increased the probability of knowing about 3R compared to rural areas, and being part of a joint family enhanced the chances of having this knowledge compared to being in a nuclear family. Additionally, urban residents displayed a greater likelihood of having a positive attitude toward 3R compared to rural residents. At the same time, individuals from joint families were less likely to have a positive attitude compared to those from nuclear families. Moreover, people living in urban areas were more inclined to practice 3R compared to rural residents.

4. Discussion

A total of 400 secondary school students were selected for this study to investigate the knowledge, attitude, and practice regarding 3R. This study revealed that 54.50% of secondary school students knew the 3R concept. Conversely, a recent by Zain et al. (2022) in Malaysia focused on primary school students, indicating that 38.1% possessed knowledge regarding 3R. Additionally, Desa et al. (2011) discovered that 63.8% of college students in Malaysia were knowledgeable about solid waste management. Overall, while there were variations in the levels of awareness among different educational levels, it's evident that a substantial portion of students across various educational stages are familiar with concepts related to waste management and the 3R approach. This highlighted the importance of integrating environmental education into curricula at all levels to promote sustainable practices from an early age. It was found that among secondary school students, 58.50% of the sample exhibited a positive attitude towards the 3R concept. It was also found that among secondary school students, 51.12% of the respondents practiced 3R principles, which was higher than the Malaysian primary school students (32.3%) (Zain et al. (2022). Educational systems and cultural factors might contribute to 3R-related knowledge, attitudes, and practices. Countries with environmental education in schools typically have students more engaged in 3R practices. Cultural values like sustainability and communal resource use also promote 3R behaviors, while societies reliant on single-use items may have lower 3R awareness.

This study found that gender, age group, residence, and type of family were significantly associated with KAP of 3R of secondary school students in Bangladesh regarding 3R. Males exhibited a higher likelihood of knowing about 3R compared to females. This finding aligns with similar results reported by Geetha and Rajalakshmi (2020), who also observed a higher level of 3R awareness among males than females. Males may have more exposure to environmental education programs or initiatives (Busser, Hyams, & Carruthers, 1996; Coyle, 2005), leading to a higher likelihood of knowing about 3R. This study also found older individuals (aged 13 years and above) were also more likely to possess this knowledge than younger ones. With age, individuals are exposed to more information and education on environmental issues (Aminrad et al. 2010), increasing their awareness and knowledge of 3R principles. Older individuals often have a greater sense of responsibility towards the environment and future generations, motivating them to acquire knowledge about sustainable practices like 3R. Students from urban areas displayed a greater likelihood of having knowledge of 3R compared to students from rural areas. This finding aligns with previous studies by Babaei et al. (2015) and Moniz et al. (2016), which also reported greater 3R awareness among urban students. Urban areas often have better access to educational materials, environmental initiatives and campaigns related to 3R (Aprillia et al. 2022), enhancing students' knowledge. Again, being part of a joint family enhanced the chances of having this knowledge compared to being in a nuclear family. This is because living in a joint family allows for shared experiences about 3R, and the communal nature of joint families provides a support system for learning and implementing 3R, contributing to enhanced knowledge levels.

This study also found that residence and type of family had a significant association with attitude toward 3R. Students from urban areas were more likely to have a positive attitude toward 3R than students from rural areas. Several factors might influence the positive attitudes towards 3R among urban students. Urban areas typically have better access to waste management facilities and resources, educational initiatives in urban settings often focus on environmental awareness, the socio-economic status of urban residents may contribute to a greater emphasis on environmental conservation, and urban communities may have a stronger emphasis on sustainability and environmental responsibility (Aprillia et al. 2022; Ameir, 2022) shaping students' attitudes towards 3R positively. Again, individuals from joint families were less likely to have a positive attitude than those from nuclear families found in this study. Joint families may have diverse opinions and decision-making processes, while nuclear families may have more autonomy in decision-making, which positively influences attitudes towards 3R.

Moreover, students' residence was found to have a significant association with the practice of 3R. Students living in urban areas were more inclined to practice 3R than rural residents. This difference could be attributed to better access to resources and facilities for waste management in urban settings. Socio-economic factors in urban areas may play a role in shaping attitudes toward environmental conservation and waste management; urban areas often have more educational initiatives and programs focused on environmental awareness (Aprillia et al., 2022; Ameir, 2022), which could contribute to the higher practice of 3R among urban students compared to rural students.

Based on the findings of this study regarding the significant associations between residence, type of family, gender, age group, and KAP towards 3R among secondary school students in Bangladesh, it is recommended that

targeted educational programs and initiatives be implemented. These programs should enhance awareness and knowledge of 3R principles, particularly among females, younger students, and those from rural areas. Strategies could include integrating environmental education into the curriculum, organizing awareness campaigns adapted to different demographics, and ensuring equitable access to educational materials and resources across urban and rural settings. Additionally, fostering community engagement and promoting collaborative efforts within joint families could further strengthen attitudes and practices towards 3R, contributing to sustainable waste management practices at both individual and community levels.

5. Conclusion

The findings revealed that over half of the students know 3R, have a positive attitude towards it and actively practice its principles. Gender, age, family type, and residence significantly influence KAP levels. The study highlights the need for targeted interventions, including environmental education in curricula, awareness campaigns, and equitable access to resources, particularly for females, younger students, and those in rural areas. However, certain limitations, such as reliance on self-reported data and a restricted geographical focus, call for broader studies across Bangladesh. Future research could expand to primary school students and employ advanced analytical models like structural equation modeling to deepen understanding. The study's implications emphasize the role of schools, educators, and community leaders in fostering sustainability. A coordinated effort among policymakers and stakeholders is essential to instilling sustainable waste management practices and ensuring long-term environmental awareness.

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