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Original Article

Toward a Sustainable Urban Future: What Motivates Willingness to Pay for Plastic Waste Management through Biodegradation in Dhaka, Bangladesh

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Abstract

Background: *Current approaches to tackle plastic pollution have significant environmental drawbacks. Biodegradation offers an eco-friendly alternative. Although there is ample literature on the environmental impacts of plastic pollution, a gap exists in studies addressing perceptions and behavioural determinants of willingness to pay (WTP) for biodegradation to mitigate plastic pollution.*

Methods: *This study employs the Contingent Valuation Method (CVM) to estimate the willingness to pay (WTP) for a hypothetical programme focused on the "Biodegradation of plastic waste," and the binary logistic regression model to identify significant and dominant factors associated with the WTP.*

Results: *The WTP estimate, from a sample size of 455, is found to be Bangladeshi taka (BDT) 100 (approximately $0.83) per month. Furthermore, people would have been more willing to pay if they had understood biodegradation, had higher education, resided in smaller households, had confidence in biodegradation as a pollution reduction tool, and felt that improved biodegradation was necessary. The marginal effects indicate that awareness and perceptions of plastic pollution management are the most influential factors in WTP.*

Conclusion: *These findings underscore the significant influence of awareness on individuals' WTP. The estimated WTP derived from the CVM offers stakeholders valuable insights to foster a reduced plastic footprint.*

Keywords

biodegradation, contingent valuation, plastic pollution, willingness-to-pay, cognitive dissonance, sustainable, Dhaka, Bangladesh, UN SDG 11, sustainable cities and communities

INTRODUCTION

Plastic pollution poses a significant and growing threat to the world's ecosystem and its living organisms, requiring immediate action to prevent irreversible damage (Barnes et al., 2009). While plastic's durability makes it useful, this same quality causes it to persist in the environment, contaminating ecosystems, harming wildlife, and releasing toxic chemicals when disposed of through methods such as incineration or landfilling (Chen et al., 2020; Webb et al., 2012). Existing solutions, such as traditional recycling, are often insufficient, costly, solvent-dependent or unsuitable for mixed plastic waste (Lamtai et al., 2023; Stallkamp

et al., 2023). Despite public policy efforts like recycling targets (Parker, 2020; Wecker, 2018) and bans on single-use plastics (Wagner, 2017), these strategies have proven insufficient. In response to these persistent challenges, biodegradation, which uses biological processes to break down plastic, is increasingly gaining traction as a sustainable alternative. However, its widespread adoption requires more than just technological advancement; it also needs public support and investment.

To successfully implement large-scale biodegradation programs, governments and stakeholders must understand public perception and, more importantly, the public's willingness to pay (WTP) for these initiatives. WTP estimates, derived using the contingent valuation method (CVM), provide stakeholders with vital information on the feasibility of potential measures (Venkatachalam, 2004). The CVM assesses the monetary value of non-market environmental goods and services by asking people directly how much they would be willing to pay or accept for a particular improvement or for avoiding environmental damage, respectively. While CVM has been used globally to assess WTP for various environmental improvements (Dunn 2012; Hwang et al., 2021; Piromrat et al., 2019; Shang et al., 2012; Wang & Zhang 2009), and in Bangladesh for waste collection (Afroz et al., 2009) and water management (Islam et al., 2019; Sehreen et al., 2019), no study has examined WTP for biodegradation initiatives for plastic waste management. This lack of data represents a critical gap given Dhaka's escalating plastic waste crisis.

This study addresses this gap by focusing on the residents of Dhaka, Bangladesh, a city struggling with severe plastic waste issues. Our research is framed not only by economic principles but also by the psychological concept of cognitive dissonance. This theory, first coined by Festinger (1957), describes the psychological discomfort that arises when new information – such as the environmental damage caused by plastic – conflicts with an individual's existing plastic-using habits. For example, seeing wildlife harmed by plastic waste, learning how plastic pollution disrupts ecosystems, contaminates food chains, and threatens biodiversity and human well-being, can spark new awareness. For some, this heightened environmental awareness clashes with their existing consumption patterns, especially the widespread use of plastic products. The resulting dissonance becomes a powerful internal motivator for change. So, the researchers assume that the willingness to pay (WTP) is not purely driven by economic calculation (compensating variation, or CV, as commonly used in environmental theory and practice), but is also shaped by psychological processes, notably as described by the cognitive dissonance theory.

Here, the team relies on the fact that when individuals are presented with the opportunity to support biodegradation technologies through financial contributions, cognitive dissonance mechanisms influence their responses. Hence, in this study, the researchers hypothesize that environmental awareness and related perceptions outweigh demographic and socio-economic factors in eliciting value (WTP) for biodegradation of plastic waste. The team therefore incorporates demographic, socio-economic, and awareness-related determinants in this study.

This study estimates residents' willingness to pay for the biodegradation of plastic waste in Dhaka using the contingent valuation method. It further examines how demographic, socio-economic, and perceptual factors – including cognitive dissonance – shape payment decisions. The findings are expected to guide policymakers in designing sustainable plastic waste management strategies for Bangladesh.

METHODS

Study design, Population and the settings

The research utilized an online survey to collect data from residents of Dhaka megacity, specifically targeting inhabitants within both the northern and southern city corporation areas. The inclusion criteria for respondents were an age between 16 and 40 years. Due to the online format, we used open-ended WTP elicitation rather than a dichotomous choice, acknowledging potential challenges such as greater response variance.

For sample size calculation, the following equation has been taken into account:

$$n = pqz^2 / e^2$$

Where, n refers to the sample size, while p refers to the percentage estimate of willingness to pay for biodegradation of plastic, z refers to the value of the standard normal distribution considering α = 5%, and e refers to the permissible error (here, the team considers 5%) of the estimate, and p + q = 1. Thus, an estimate of p was required to determine the sample size for this study. During a pilot study for this survey, the researchers estimated that 70% of the respondents were willing to pay. Following the estimate, assuming p = 0.7, and putting other values in the above equation, the team found the sample size as follows,

$$n = pqz^2 / e^2 = \frac{.7\text{X}.3\text{X}1.96^2}{0.05^2} \approx 430.$$

The research team thus decided to collect data from a total sample size of n = 430 from the Dhaka megacity. To conduct the study, the team began with the philosophical assumption that there is an objective reality of willingness to pay for biodegradation of plastic pollution in Dhaka, Bangladesh, and that the team can measure it using systemic and scientific methods. This leads the team to consider the positivist paradigm to select the study design. Hence, the researchers set a quantitative method approach for this study, and we chose a cross-sectional study design for data collection. Using a cross-sectional study design, the team administered a sample survey to 455 respondents. Participation was voluntary, and all collected information was kept strictly confidential.

Study Tool, Variables, and Data Collection

Given the constraints of the COVID-19 pandemic, the team conducted a web-based survey. Due to COVID-19 restrictions, in-person and household-level data collection was not feasible. As an alternative, the researchers developed an online survey using Google Forms and disseminated via social media platforms such as Facebook and WhatsApp. The survey was circulated through the authors' personal and professional networks, using a snowball sampling approach that encouraged further sharing. Data collection took place between September 28, 2020, and January 27, 2021. All respondents were residents of Dhaka City, either from the North or South City Corporations.

The questionnaire was developed using the Contingent Valuation Method (CVM), which is widely used to estimate willingness to pay (WTP) for non-market environmental goods. Owing to the online format and its associated limitations, the researchers used an open-ended question format to elicit WTP rather than the conventional dichotomous-choice design as suggested by the NOAA panel. The draft instrument was reviewed by an expert with experience in doing CVM early and was subsequently piloted with 45 respondents. Based on pilot feedback, minor revisions were made, particularly to demographic and awareness-related items, to improve clarity and relevance.

The final instrument was structured into three sections: (1) demographic and socio-economic characteristics (e.g., age, gender, income, education); (2) attitudes and awareness related to plastic pollution and biodegradation; and (3) respondents' willingness to pay for plastic waste biodegradation solutions. However, the dependent variable was the self-reported willingness to pay (WTP), measured in Bangladeshi Taka (BDT) through an open-ended question. Independent variables included demographic attributes, socio-economic indicators, and environmental awareness. Awareness was assessed using binary indicators (1 = aware, 0 = not aware) across redefined themes including pollution severity, environmental health risks, and biodegradation benefits. These variables were selected based on existing theories and literature, and a hypothesis was formulated about their influence on willingness to pay (WTP) within the study settings.

A detailed list of all variables and their operational definitions is presented in Table 1.

Table 1. *Variables used for Contingent Valuation Method (CVM)*

Variables		Description
Demographics	Age	Age (in years) of the respondents
	Gender	Gender (1 =male; 2 = female; 3 = others) o f the respondents
	Household size	Number of household members (Persons)
Socio-Economic Status	Educational attainment	The highest level of education of the respondents
	Occupation	Occupation of the respondents
	Income	Monthly family net income (in Taka)
Awareness Indicators	Awareness of plastic Pollution	Whether the respondent is aware of the plastic pollution (1 = yes; 0= no)
	Excessive plastic pollutes the environment	Whether the respondent thinks that excessive plastic pollutes the environment (1 = yes; 0= no)
	Plastic recycling reduces white pollution	Whether the respondent thinks that plastic recycling helps to reduce white pollution (1 = yes; 0= no)
	Bangladesh is recycling plastic enough	Whether the respondent thinks that Bangladesh is recycling the plastics enough (1 = yes; 0= no)
	Familiarity with biodegradation	Whether the respondent is familiar with the word 'Bio-degradation' (1 = yes; 0= no)
	Biodegradation reduces plastic pollution	Whether the respondent thinks that Bio-degradation reduces plastic pollution (1 = yes; 0= no)
	Improved plastic biodegradation is required in Bangladesh	Whether the respondent thinks that improved biodegradation is required in Bangladesh (1 = yes; 0= no)
Dependent variable	Willingness to pay (WTP)	WTP for Plastic Waste Biodegradation Program per month (in Bangladeshi Taka)(1=yes; 0=no)

Statistical analysis

To assess the significant association between WTP and other selected covariates, the team first conducted a bivariate analysis using a x^2-test. They used significant covariates from the binary logistic regression analysis to identify the factors that significantly affect willingness to pay for a biodegradation program to reduce plastic pollution. In this model, WTP is represented as a binary dependent variable, where 1 denotes agreement and 0 denotes disagreement. The independent variables in the model include sociodemographic characteristics and indicators of plastic waste awareness. STATA (version 14.5) was used for the statistical analyses.

Ethical consideration

This research was funded by East West University through the EWUCRT Grant under Research Proposal No. Round-13, No-5. Ethical approval was obtained under Ethical Clearance No. EWUCRT-REC-10/2021. Informed consent was obtained from all subjects involved in the study.

RESULTS

A total of 455 respondents participated in the survey to assess willingness to pay (WTP) for a plastic pollution management program in Dhaka. As presented in Table 2, approximately 65% of respondents indicated a willingness to pay, and 35% did not. This finding highlight that a substantial proportion of the surveyed population recognizes the value of such an initiative and is willing to contribute financially towards its implementation. This high WTP response rate is notable, especially considering that the study employed

an open-ended question format rather than the more commonly used dichotomous choice questions in contingent valuation studies (Park & MacLachlan, 2008). Open-ended questions allow respondents to state their maximum WTP without being influenced by pre-defined bid prices.

Table 2. *WTP for Biodegradation to Reduce Plastic Pollution*

Willingness To Pay (WTP)	Cases (%)
Yes	294 (65)
No	161 (35)
Total	455 (100)

The WTP value elicitation first involved inquiring into respondents' WTP, and second, the amount of their WTP. The absence of WTP was further investigated to distinguish the "true" zeros from the protest responders through follow-up questions, occupations and household income (Mavrodi et al., 2021). The income and expenditure of the insolvents indicated that they could barely manage their daily lives; they simply did not have much to contribute. Conversely, the individuals in the 'protest zero' category were unwilling to pay due to their belief that it is solely the government's responsibility, doubts about the effectiveness of the proposed fund, or simply indifference towards plastic pollution.

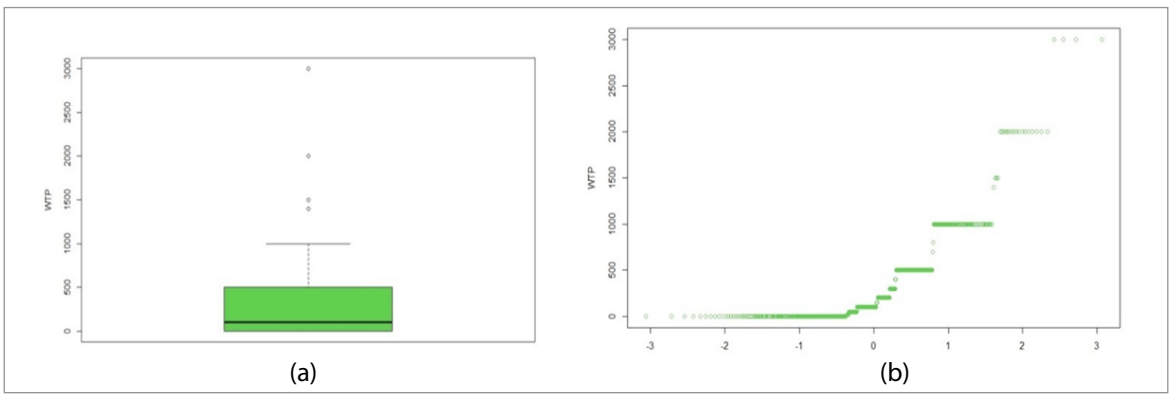

Figure 1. *Distribution of respondents' maximum WTP: (a) Boxplot; (b) Q-Q plot*

After removing responses from individuals who refused to pay, the WTP was calculated and is presented in Table 3. A notable finding from this table is the difference between the average (mean) WTP, approximately BDT 300 ($2.5), and the (median) WTP, roughly BDT 100 (≈ $0.83). This divergence is attributable to the distributional skewness of the respondents' WTP values in this study, as illustrated in Figure 1. Given this skewness, the team chose the median WTP as the most reliable estimate, given its superior statistical properties in such data.

Table 3. *Measurement of Maximum Affordable Amount WTP (excluding protest zeros)*

Variable	Arithmetic mean (in BDT)	5% trimmed mean (in BDT)	10% trimmed mean (in BDT)	Median (in BDT)
Maximum affordable amount (WTP)	393.67	320.25	293.76	100

After initial screening of the dependent variable, the researchers performed bivariate analyses to examine the distribution of the WTP across different categorical variables and identify candidate variables for

multivariate logistic regression (Table 4). Based on the p-value (<0.25) from x^2/ Fisher's exact test, a total of 06 covariates have been selected as the candidate variables for the logistic regression model as suggested by Hosmer et al. (2013). These are *Household Size, Educational Attainment, Bangladesh is recycling plastic enough, Familiarity with biodegradation, Biodegradation reduces plastic pollution, and Improved plastic biodegradation is required in Bangladesh*.

Table 4. *Results from Bivariate analysis*

Variables	WTP (%)		x^2/ Fisher's Exact Test (p-value)
	Yes	No	
Age			
16–20	37 (12.6)	21 (13.0)	0.82
21–25	212 (72.1)	116 (72.0)	
26–30	35 (12.0)	21 (13.0)	
31–35	8 (2.7)	3 (1.9)	
36–40	2 (0.7)	-	
Gender of the respondents			
Male	129 (43.9)	70 (43.5)	0.94
Female	165 (56.1)	91 (56.5)	
Household size			
≤5 members	248 (84.4)	124 (77)	0.05
>5 members	46 (15.6)	37 (23)	
Educational Attainment			
No formal education	-	3 (1.9)	0.01
High school degree	131(44.6)	84 (52.2)	
Bachelor and above	163 (55.4)	74 (46)	
Occupation			
Service (Govt. + non-govt.)	36 (12.2)	21 (13)	0.54
Business	8 (2.7)	7 (4.3)	
Housewife	3 (1)	-	
Student	241 (82)	128(79.5)	
Unemployed/Informal worker after graduation	6 (2)	5 (3.1)	
Monthly Family Income			
≤BDT 30000	33 (11.2)	25 (15.5)	0.42
BDT 30001–70000	172 (58.5)	90 (55.9)	
≥ BDT 70001	89 (30.3)	46 (28.6)	
Awareness of plastic Pollution			
Yes	288 (98)	157 (97.5)	0.748
No	6 (2)	4 (2.5)	
Excessive plastic pollutes the environment			
Yes	294 (100)	159 (98.8)	0.325
No	-	2 (1.2)	
Plastic recycling reduces white pollution			
Yes	278 (94.6)	149 (92.5)	0.393
No	16 (5.4)	12(7.5)	
Bangladesh is recycling plastic enough			
Yes	5 (1.7)	6 (3.7)	0.178
No	289 (98.3)	155 (96.3)	
Familiarity with biodegradation			
Yes	257 (87.4)	121(75.2)	0.001
No	37 (12.6)	40 (24.8)	

Table 4. *continued*

Variables	WTP (%)		x^2/ Fisher's Exact Test (p-value)
	Yes	No	
Biodegradation reduces plastic pollution			
Yes	269 (91.5)	133 (82.6)	0.005
No	25 (8.5)	28 (17.4)	
Improved plastic biodegradation is required in Bangladesh			
Yes	277 (94.2)	142 (88.2)	0.023
No	17 (5.8)	19 (11.8)	

Table 5. *Regression Analysis using a Multivariate Binary Logistic Model*

Explanatory variables	Multivariate binary logistic regression model Explained variable: WTP (1); Non-WTP (0)			
	Odds ratio	95% CI	Marginal effect	Comparative significance
Household Size				
[≥6 membersa]	-	-	-	4th largest effect
[1–5 members]	1.69**	(1.02–2.78)	0.12	
Highest Educational attainment				
[upto HSCa]	-	-	-	5th largest effect
[Bachelor and above]	1.49**	(1.00 - 2.22)	0.09	
Familiarity with biodegradation				
[No[a]]	-	-	-	2nd largest effect
[Yes]	1.94**	(1.14–3.28)	0.16	
Biodegradation reduces plastic pollution				3rd largest effect
[No[a]]	-	-	-	
[Yes]	1.88**	(1.01–3.46)	0.15	
Improved plastic biodegradation is required in Bangladesh				Largest effect
[No[a]]	-	-	-	
[Yes]	2.08**	(1.02–4.23)	0.18	
Bangladesh is recycling enough				
[No[a]]	-	-	-	
[Yes]	0.48	(0.14–1.68)	-0.17	
-2log-likelihood	563.4			
McFadden's R2	0.05			
Area under the ROC curve	**0.64**			

**p-value <0.1, ** p-value <0.05, *** p-value <0.01*
[a] *Reference group*

The odds ratios (ORs) in Table 5 highlight several factors that affect a household's willingness to pay (WTP) for plastic biodegradation. Smaller households (OR = 1.69) and respondents with higher education (OR = 1.49) were more likely to be willing to pay. Additionally, familiarity with biodegradation significantly increased WTP by 1.94 times compared to those unfamiliar with it. Positive perceptions of biodegradation's ability to reduce plastic pollution (1.88 times more likely) and the need for improved plastic biodegradation in Bangladesh (2.08 times more likely) also strongly correlate with WTP, compared to negative perceptions. The area under the receiver operating characteristic (ROC) curve indicates the model's fair discrimination capacity and robustness.

However, Table 5 also highlights an interesting contrast through marginal effects. While the impacts of demographic and socio-economic factors are evident, awareness and positive perceptions about effective plastic pollution management have a greater impact on the WTP. This outcome aligns with the hypothesis that WTP is fundamentally motivated by an individual's perceived need for a good or service. Consequently, when a plastic-free environment is viewed as a basic necessity, individuals across different educational or socio-economic backgrounds would be inclined to contribute financially.

DISCUSSION

To track the sustainable urban trajectory towards a sustainable urban future in Dhaka, this article first estimated the willingness to pay (WTP) for biodegrading plastic pollution, followed by an examination of influential factors for that WTP. The cognitive dissonance theory suggests that inconsistency between environmental awareness and plastic consumption behavior generates dissonance and prompts individuals to engage in compensatory actions. On that basis, the research team identified a gap in how different factors affect WTP for biodegradation, as well as an estimate for environmental policy review in Bangladesh. To address the gap, the team hypothesized that environmental awareness and related perceptions outweigh demographic and socio-economic factors in value elicitation (WTP) for biodegradation. To meet the study's objectives, the researchers collected field data for four months in Dhaka using a sample survey with 455 respondents.

The results have both theoretical and practical implications. In the context of biodegradation of plastic waste, aligning with the hypothesis, in this study, the researchers have found that environmental awareness and perceptions outweigh socio-economic factors in the case of WTP decision-making. Here, WTP reflects not only individuals' valuation of a cleaner environment but also their desire to align their behaviors and stated preferences with their pro-environmental beliefs. These findings also provide important policy signals for government authorities. It also revealed that 65% of participants are willing to pay for plastic waste processing through biodegradation, a figure notably higher than in other studies using dichotomous-choice questions. While the responses in dichotomous-choice methods can be influenced by the preset bid amount potentially altering the response patterns (Bateman et al., 1995), in the open-ended format, participants set their WTP solely based on their subjective valuation and personal financial comfort without budget consciousness. Despite this, the high percentage of affirmative WTP responses suggests a strong positive sentiment towards plastic pollution management in Bangladesh. This finding is also corroborated by a recent study (Rahman et al., 2025), which showed that Bangladeshis have a positive attitude towards plastic pollution abatement.

Studies on willingness to pay (WTP) for plastic pollution mitigation in countries other than Bangladesh show varied results and influencing factors. A study in Indonesia found that participants were willing to pay about 15 pounds ($20.22), which was ~2% of their average monthly salary, for initiatives to mitigate marine plastic pollution (Tyllianakis & Ferrini, 2021). Personal convictions and beliefs turned out to be the key determinants there. A separate study in Surakarta found a WTP of 2,214 Indonesian Rupiah ($0.13) for biodegradable plastic, noting that females and individuals with higher knowledge and awareness were more inclined to pay (Jati et al., 2025). A Malaysian study estimated a WTP of Malaysian Ringgit 0.43 ($0.10) for biodegradable plastic bags, which was positively influenced by education level and participants' young age (Mohamed Noor et al., 2024). A 2023 study in Mexico revealed that 33% of participants preferred biodegradable plastic, with a greater preference among women and those with higher education (Rentería et al., 2024). A study in the USA found a WTP of $1.32 for biodegradable plastic relative to conventional options, which increased by $0.50 with additional information provided to participants (Yang et al., 2025). It is important to note that while some comparative studies focus on preferences for biodegradable plastic items, this research focuses on biodegradation for plastic waste remediation as a sustainable approach to tackling plastic pollution.

Plastics are commonly recognized biodegradable when they are designed to break down into smaller substances by living organisms. While the adoption of engineered biodegradable plastics should facilitate waste management, this study's objective is to manage plastic waste regardless of its type – whether it is a material originally engineered for biodegradation or a traditional one whose environmental fate was not considered while production. The focus on post-consumer plastic waste remediation stems from the learning capacity of microbial enzyme pools to evolve and break down plastic polymer. Traditional plastics, such as polyethylene terephthalate (PET) and polyethylene (PE), are new to nature, yet microorganisms are evolving to utilize them as a carbon and energy sources (Azizi et al., 2024; Heris 2024; Swarna et al., 2024). Moreover, there is concern that the so-called "biodegradable" plastics (with shorter lifespans than PET/PE, etc.) still generate microplastic fragments, with performance that is likely no different from traditional microplastics in natural environmental conditions (Kubowicz & Booth, 2017). So, what matters is complete mineralization. This ambiguity underscores the persistent need for advanced post-consumer biodegradation methods that ensure the complete and controlled mineralization of all plastic waste into benign end products.

A limitation of this study's approach was the inability to remind respondents of their personal budget flexibility and constraints while they stated their WTP amount, in the context of COVID-19, as suggested by the NOAA panel to minimize the warm glow effect. This study was also confined to a certain age group (16-40) in the city Dhaka who had access to the internet and were mostly students. The researchers suggest that the study be replicated using a large-scale, representative survey, following the full guidelines of the NOAA panel.

CONCLUSION

This study finds that 65% of Dhaka residents are willing to pay for plastic biodegradation initiatives, with a median WTP of 100 (BDT) (~$0.83). More importantly, WTP is driven by environmental awareness and perceptions rather than socio-economic status, which aligns with cognitive dissonance theory. These insights can guide policymakers in designing interventions that address both economic and psychological drivers of pro-environmental behavior.

Authors' Contribution

SKS: Methodology, Data curation, Writing–Original Draft Preparation, Formal Analysis, Investigation; **MAM:** Methodology, Data curation, Formal Analysis, Investigation; **MMM:** Conceptualization, Funding acquisition, Writing–Reviewing and Editing, Project Administration and Supervision, Validation; **MTA:** Conceptualization, Writing–Reviewing and Editing, Project Administration, Validation; **J:** Conceptualization, Funding acquisition, Writing–Reviewing and Editing.

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Ethical Approval

Ethical approval was obtained from the East West University under Ethical Clearance No. EWUCRT-REC-10/2021. Informed consent was obtained from all subjects involved in the study.

Competing interest

The authors declare no conflicts of interest.

Data Availability

Data will be made available by the corresponding author on request.

Declaration of Artificial Intelligence Use

The authors confirm that this manuscript was prepared, analyzed, and written solely by human effort, without the assistance of generative AI or AI-based technologies.

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