From Digital Consumption to Sustainable Disposal Electronic Waste Behaviour among Community in Malaysia

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ABSTRACT

The rapid growth in the use of electronic devices among youth has contributed to a significant increase in electronic waste (e-waste), posing serious environmental and public health challenges. In Malaysia, youth aged 15 to 40 years represent a major segment of technology users; however, their participation in formal e-waste management practices remains relatively low. This study, titled *E-Waste Management Among Youth in Malaysia*, aims to examine the factors influencing pro environmental behavior among Malaysian youth, with a specific focus on knowledge of formal e-waste management programs, recycling practices, and the convenience of recycling infrastructure and services. Guided by Social Cognitive Theory (SCT), the study adopts a quantitative, cross-sectional research design. Data are collected through a structured online questionnaire distributed to 384 respondents using a convenience sampling method. Pearson correlation analysis is employed to examine the relationships between the independent variables and pro environmental behavior as the dependent variable. The findings of this study are expected to provide valuable insights into how cognitive, behavioral, and environmental factors interact to influence youth participation in proper e-waste management. The results may assist policymakers, government agencies, non-governmental organizations, and businesses in developing targeted strategies, educational programs, and accessible recycling infrastructure to enhance youth engagement in formal e-waste recycling. Ultimately, this study supports Malaysia's environmental sustainability efforts, contributes to the advancement of a circular economy, and aligns with Sustainable Development Goal 12 on responsible consumption and production.

Keywords: E-waste, Environmental Knowledge, Recycling Practices, Infrastructure, e-waste

INTRODUCTION

The rapid advancement of technology and the widespread use of electronic devices have significantly increased the generation of electronic waste (e-waste) worldwide. E-waste refers to discarded electrical and electronic equipment such as smartphones, computers, televisions, and household appliances that have reached the end of their useful life (Forti et al., 2020). These products contain hazardous substances including lead, mercury, and cadmium, which pose serious risks to human health and the environment when improperly handled (Islam et al., 2020). At the same time, e-waste also contains valuable materials such as gold, copper, and rare earth elements, highlighting the importance of effective e-waste management for both environmental protection and resource recovery (Sulaiman & Hassan, 2021).

Globally, e-waste is the fastest-growing waste stream, with approximately 62 million tonnes generated in 2022 and projections exceeding 82 million tonnes by 2030 (Cucchiella et al., 2022). However, less than 25% of global e-waste is formally collected and recycled, resulting in significant environmental pollution and economic losses. In Malaysia, e-waste generation has increased rapidly due to rising consumption of electronic products,

particularly among youth who represent a major segment of digital device users (Rahman et al., 2024). Despite the presence of regulations such as the Environmental Quality (Scheduled Wastes) Regulations 2005, weak enforcement and the prevalence of informal recycling practices continue to hinder effective e-waste management (Goh & Sukri, 2025).

Youth play a crucial role in shaping sustainable waste management practices due to their high dependency on electronic devices and influence on consumption trends. Nevertheless, participation in formal e-waste recycling programs among Malaysian youth remains limited. Previous studies indicate that inadequate knowledge of ewaste management, weak recycling practices, and limited access to convenient recycling infrastructure significantly affect responsible disposal behavior (Yap & Sharaai, 2022). Without accessible infrastructures, even individuals with strong environmental awareness may fail to practice proper e-waste disposal.

Guided by Social Cognitive Theory (SCT), this study examines how knowledge of e-waste management programs, recycling practices, and the availability of infrastructures and services influence pro environmental behavior among youth in Malaysia. SCT emphasizes the interaction between personal cognition, behavioral patterns, and environmental factors in shaping individual actions (Bandura, 1986). By identifying these key determinants, this study aims to provide empirical insights to support policymakers, educators, and stakeholders in designing targeted interventions to improve e-waste recycling practices. Enhancing youth engagement in formal e-waste management is essential for reducing environmental risks, strengthening the circular economy, and supporting Sustainable Development Goal 12 on responsible consumption and production.

LITERATURE REVIEW

Electronic waste, commonly referred to as e waste or Waste Electrical and Electronic Equipment, includes discarded electronic products containing plugs or batteries that pose significant risks to human health and the environment due to the presence of hazardous substances (Hsu et al., 2024). This category encompasses widely used devices such as mobile phones, computers, televisions, and household appliances that have reached the end of their functional lifespan. Rapid technological advancement, high consumption rates, and shortened product life cycles have contributed to electronic waste becoming the fastest growing waste stream globally. According to the Global E Waste Monitor (2024), approximately 62 million metric tonnes of electronic waste were generated worldwide in 2022, with projections indicating an increase to 82 million metric tonnes by 2030. Despite this growth, only 22.3 percent of electronic waste is formally collected and recycled, resulting in environmental contamination from toxic substances such as lead, mercury, and cadmium, while valuable materials including gold, copper, and rare earth elements remain unrecovered.

The dual nature of electronic waste as both an environmental hazard and a potential resource highlights the importance of sustainable management practices guided by the principles of reduce, reuse, and recycle (Hernández Uribe et al., 2025). However, existing literature consistently reports a lack of public awareness and engagement with responsible electronic waste management, particularly in developing countries (Hernández Uribe et al., 2025). In the Malaysian context, the rapid increase in electronic device usage has contributed to rising electronic waste generation, yet participation in formal recycling programmes remains limited. This gap underscores the need for stronger educational, behavioural, and policy driven initiatives to enhance public understanding and promote sustainable electronic waste management practices

Social Cognitive Theory (SCT)

Social Cognitive Theory (SCT), introduced by Bandura (1986), explains human behavior as a dynamic interaction between personal factors, behavioral patterns, and environmental influences. Unlike theories that focus solely on intention or attitude, SCT emphasizes reciprocal determinism, where individuals both influence and are influenced by their surrounding environment. This theory has been widely applied in environmental and sustainability research to explain behaviors such as recycling, waste segregation, and pro-environmental practices, particularly among youth populations.

According to SCT, personal cognition such as knowledge and awareness shapes an individual's understanding of environmental issues, while behavioral factors reflect habitual practices such as recycling behavior. Environmental factors, including the availability of infrastructures and institutional support, further determine

whether individuals are able to perform the desired behavior effectively (Bandura, 1986). In the context of ewaste management, SCT suggests that youth are more likely to engage in responsible disposal practices when they possess adequate knowledge, have established recycling practices, and are supported by accessible infrastructures and services.

Previous studies have successfully applied SCT to explain waste management and recycling behavior. For instance, Zulkifli et al. (2024) found that the interaction between environmental knowledge, habitual recycling practices, and infrastructural support significantly influenced sustainable waste behavior among Malaysian youth. Therefore, SCT provides a suitable theoretical foundation for this study in examining how knowledge of e-waste management, recycling practices, and infrastructures and services influence pro environmental behavior among youth in Malaysia.

Environmental Knowledge

Knowledge of e-waste management refers to an individual's understanding of what constitutes e-waste, its environmental and health impacts, and the appropriate methods for disposal and recycling. Knowledge is a critical cognitive factor that shapes environmental behavior, as individuals who are well-informed are more likely to engage in responsible waste practices (Yap & Sharaai, 2022).

Several studies have shown that insufficient knowledge remains a major barrier to effective e-waste management. Rahman et al. (2024) reported that although Malaysian youth demonstrate general environmental concern, many lack specific knowledge about e-waste categories, collection programs, and licensed recyclers. Without adequate knowledge, youths may underestimate the risks associated with improper e-waste disposal, leading to environmentally harmful practices.

From the SCT perspective, knowledge functions as a personal factor that influences behavior by shaping awareness and perceived responsibility. Therefore, greater knowledge of e-waste management is expected to positively influence pro environmental behavior among youth in Malaysia.

Recycling Practice

Recycling practice refer to the routine and repeated practices of separating and recycling waste materials. Practices play an important role in shaping sustainable behavior, as repeated actions reduce the cognitive effort required to perform environmentally responsible practices (Fang et al., 2021).

Previous studies indicate that individuals who regularly engage in household recycling are more likely to extend these practices to e-waste recycling (Ertz et al., 2023). Among youth, recycling practices are often influenced by early exposure, family practices, and educational institutions. In Malaysia, however, recycling practices among youth remain inconsistent due to limited reinforcement and weak recycling culture (Omar et al., 2025).

SCT emphasizes that behavior is strengthened through repetition and reinforcement. Youths who have established recycling practices are more likely to manage e-waste responsibly, as recycling becomes a normalized and habitual behavior rather than a deliberate effort. Thus, recycling practices are expected to have a significant relationship with pro environmental behavior.

Infrastructures and Services

Infrastructures and services refer to the availability, accessibility, and convenience of e-waste collection points, recycling centers, and take-back programs. Environmental infrastructure is a crucial enabling factor, as even individuals with high awareness and positive attitudes may fail to recycle if infrastructures are inconvenient or unavailable (Presseau et al., 2022).

In Malaysia, limited access to certified e-waste recycling infrastructures remains a major challenge. Studies show that many youths are unaware of nearby collection points or find the recycling process inconvenient, discouraging participation in formal e-waste management systems (Lim et al., 2022). This infrastructural gap weakens the translation of knowledge and intention into actual behavior.

Within the SCT framework, infrastructures and services represent environmental factors that either enable or constrain behavior. Adequate infrastructures enhance perceived behavioral control and increase the likelihood of responsible e-waste management. Therefore, the availability of infrastructures and services is expected to significantly influence pro environmental behavior among youth. Based on the above discussion and guided by Social Cognitive Theory, the following hypotheses are proposed:

H1: There is a significant relationship between environmental knowledge and pro environmental behavior among community in Malaysia.

H2: There is a significant relationship between recycling practices and pro environmental behavior among community in Malaysia.

H3: There is a significant relationship between infrastructure and services and pro environmental behavior among community in Malaysia.

Figure 1 below portrays the research framework.

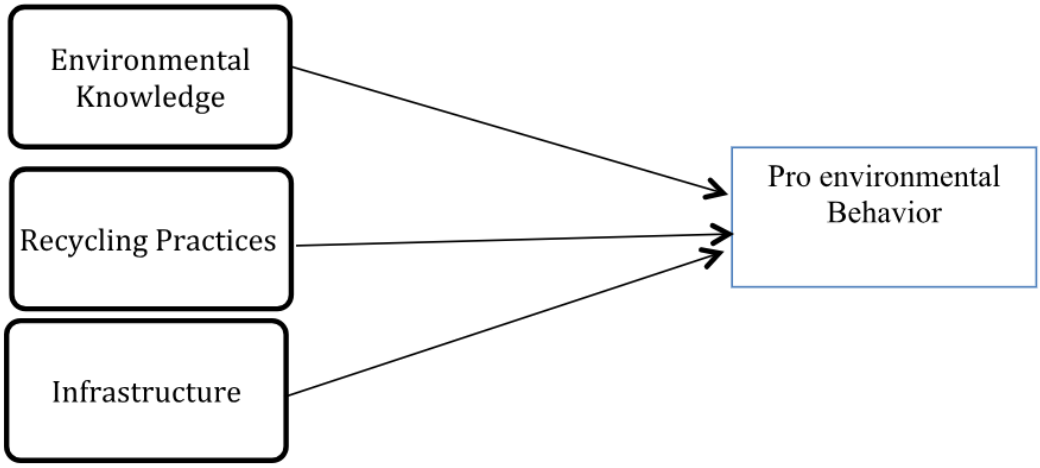

Figure 1 Research Framework

METHODOLOGY

A cross-sectional quantitative survey was conducted to examine the factors influencing e-waste management behaviour among Malaysian community. Quantitative research enables the systematic collection and analysis of numerical data to generate statistically valid findings and support generalisable conclusions. The cross-sectional approach allows the assessment of relationships between variables at a single point in time, making it suitable for behavioural and environmental studies.

The study population consisted of Malaysian community aged 18 to 40 years, in accordance with the Youth Societies and Youth Development Act 2007 (Amendment 2019). Youth were selected as the target group due to their high usage of electronic devices and significant contribution to electronic waste generation. A minimum sample size of 384 respondents was determined using the Krejcie and Morgan sample size determination table. To account for incomplete or invalid responses, the questionnaire was distributed to a larger pool of respondents, resulting in 407 valid responses. A purposive sampling technique was employed to ensure that only respondents who met the age criterion were included in the study.

Data were collected using a structured questionnaire distributed online via Google Forms. The survey link was shared through social media platforms such as WhatsApp, Instagram, Facebook, TikTok, and Telegram to reach a broad range of youth respondents. The questionnaire consisted of items measuring four key constructs. Knowledge about formal e-waste management programmes assessed respondents' understanding of the environmental impact of e-waste, types of e-waste that can be recycled, negative consequences of informal disposal, and familiarity with the 3R principles (Reduce, Reuse, Recycle). E-waste recycling practices measured the frequency and consistency of behaviours such as separating e-waste from regular waste, seeking disposal

information, giving away old devices, and considering environmental impact during disposal. Convenience of e-waste recycling infrastructures and services captured respondents' perceptions of accessibility, transport availability, and ease of sending e-waste to formal collection points. Finally, e-waste management behaviour evaluated actual practices, including reviewing the usability of devices, proper disposal, and using correct recycling methods. All items were measured using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), and were adapted from validated instruments in prior research to ensure content reliability.

The collected data were analysed using IBM SPSS Statistics Version 27. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarise respondents' demographic profiles and overall response patterns. Prior to inferential analysis, reliability and normality tests were conducted. Reliability was assessed using Cronbach's alpha, with values exceeding 0.70 indicating acceptable internal consistency for all constructs. Normality was evaluated using skewness and kurtosis values, with values within the acceptable range of −2 to +2, confirming that the data were suitable for parametric testing

Pearson correlation analysis was employed to examine the relationships between the independent variables knowledge of e-waste management programmes, e-waste recycling practices, and convenience of recycling infrastructures and services and the dependent variable, e-waste management behaviour. Statistical significance was assessed at the 0.01 level (two-tailed). The results of reliability and normality tests confirmed that the data were suitable for hypothesis testing and inferential analysis.

Table 1: Measurement of variables, normality test, and reliability test results

VARIABLES/ CONSTRUCT	Skewness	Kurtosis	Reliability Test	Normality Test
Environmental knowledge	-.601	-.166	0.732	0.941
E-waste recycling practices	-.191	-.663	0.707	0.960
Recycling facilities and service	-.800	.217	0.750	0.929
Pro environmental Behavior	-.718	.076	0.746	0.932

FINDINGS

Demographic Profiles

A total of 407 respondents participated in this study. Male respondents slightly outnumbered females, with 224 males (55.0%) and 183 females (45.0%). The majority of respondents were aged 21–30 years (n = 176, 43.2%), followed by those aged 31–40 years (n = 146, 35.9%), 18–20 years old (n = 54, 13.3%), and 41–50 years old (n = 31, 7.6%). In terms of education level, most respondents held a Bachelor's degree (n = 277, 68.1%), followed by a Diploma (n = 72, 17.7%), STPM (n = 29, 7.1%), Master's degree (n = 25, 6.1%), and Other (n = 4, 1.0%). Regarding their current living area, the respondents were relatively distributed across Semi-Urban (n = 152, 37.3%), Urban (n = 143, 35.1%), and Rural (n = 112, 27.5%). Concerning occupation, the majority of respondents were Private Sector Employees (n = 214, 52.6%), followed by Public Servants (n = 164, 40.3%), and Self Employed (n = 29, 7.1%).

Hypothesis Testing

The hypothesis testing results confirmed that all proposed hypotheses were supported. Knowledge of electronic waste management programs showed a moderate, positive relationship with e-waste management ($r = 0.647$, $p = 0.000$), supporting H1. Electronic waste recycling practices demonstrated a moderate and significant relationship with e-waste management ($r = 0.649$, $p = 0.000$), supporting H2. The convenience of electronic waste recycling infrastructures and services also showed a moderate, positive relationship with e-waste management ($r = 0.645$, $p = 0.000$), providing support for H3.

Overall, the correlation results suggest that all three variables are significantly associated with e-waste management among youth in Malaysia. Pearson correlation analysis revealed that knowledge, recycling

practices, and convenience of recycling infrastructures were positively and significantly correlated with e-waste management at the 0.01 significance level (2-tailed). Among the three variables, electronic waste recycling practices demonstrated the strongest correlation with e-waste management (r = 0.649), followed by knowledge of electronic waste management programs (r = 0.647) and convenience of recycling infrastructures and services (r = 0.645). These findings indicate that higher levels of knowledge, better recycling practices, and greater convenience are associated with improved e-waste management among youth in Malaysia.

Table 3: Summary of Hypothesis Testing

Hypothesis	Pearson correlation (r)	Sig. (2-tailed)	Result
H1: There is a significant relationship between environmental knowledge and pro environmental behavior among community in Malaysia.	0.647	0.000	supported
H2: There is a significant relationship between electronic waste recycling practices and pro environmental behavior among community in Malaysia.	0.649	0.000	supported
H3: There is a significant relationship between the convenience of electronic waste recycling infrastructures and services and pro environmental behavior among community in Malaysia.	0.645	0.000	supported

DISCUSSION

Environmental knowledge about the formal e-waste management programme The analysis demonstrates that knowledge of electronic waste management programmes has a moderate and significant positive relationship with e-waste management behaviour ($r = 0.647$, $p < 0.01$). This finding indicates that community who are more knowledgeable about the environmental impacts of e-waste, formal disposal methods, and recycling programmes are more likely to manage their electronic waste responsibly. This result is consistent with previous studies conducted in Malaysia and other developing countries, which found that awareness and understanding of formal recycling systems significantly influence pro-environmental behaviour (Munir & Daud, 2024). From the perspective of SCT, knowledge enhances self-efficacy, enabling individuals to feel confident in performing appropriate disposal actions. When community understand where and how to dispose of e-waste, the likelihood of engaging in correct disposal practices increases.

E-waste recycling practices In addition, the findings reveal that e-waste recycling practices exhibit the strongest correlation with e-waste management behaviour ($r = 0.649$, $p < 0.01$). This suggests that habitual recycling behaviour plays a critical role in determining how effectively community manage their electronic waste. Community who consistently separate e-waste, seek information on proper disposal, or reuse electronic devices tend to demonstrate better overall ewaste management practices. This result aligns with earlier research showing that repeated recycling behaviour strengthens environmental responsibility and leads to more sustainable waste management outcomes (Guarnieri et al., 2022). Within the SCT framework, this finding reflects the importance of observational learning and behavioural reinforcement, where repeated exposure to recycling activities and positive social cues fosters longterm habit formation. The strong influence of recycling practices suggests that behavioural interventions, such as campus recycling initiatives and community-based programmes, may be particularly effective in improving e-waste management among community.

Convenience of e-waste recycling infrastructures and services Furthermore, the study finds that the convenience of e-waste recycling infrastructures and services is positively and significantly related to e-waste management behaviour ($r = 0.645$, $p < 0.01$). This indicates that community are more likely to manage their e-waste responsibly when recycling infrastructures are accessible, easy to use, and supported by adequate transportation or collection services. This finding supports previous research highlighting that physical infrastructure and service accessibility are key enablers of sustainable waste behaviour (Rahman & Aziz, 2023). According to SCT, environmental facilitators play a crucial role in translating intention into action. Even when individuals possess

sufficient knowledge and positive attitudes, a lack of convenient infrastructures can hinder actual recycling behaviour. Therefore, accessible and well-maintained e-waste infrastructures serve as external cues that reinforce and sustain responsible disposal practices.

Theoretical Implications

The findings of this study contribute meaningfully to the theoretical understanding of environmental behavior, particularly by supporting the application of Social Cognitive Theory (SCT) in the context of digital waste management. First, the study reinforces the SCT concept of self-efficacy, showing that specific knowledge serves as a precursor to action. This aligns with recent work by Yaacob et al. (2025), which suggests that when community possess a solid understanding of how and where to recycle, their confidence in performing these behaviors increases. In this sense, "knowledge" is not simply awareness it functions as a practical tool that enhances the self-efficacy necessary to navigate complex recycling systems.

Second, the results deepen our understanding of observational learning and habit formation. The strong association between recycling practices and management behavior indicates that sustainable actions are socially reinforced routines rather than isolated decisions. Nordin et al. (2025) emphasize that community participating in communal recycling events demonstrate more consistent disposal practices, underscoring the importance of environmental cues and peer modeling in transforming occasional actions into habitual behaviors. Similarly, Sulaiman et al. (2025) note that practices develop through repeated exposure to these cues, suggesting that theoretical models should incorporate the "automaticity" of recycling behavior fostered by supportive environments.

Practical Implications

From a policy perspective, this study highlights that improving waste management practices requires structural and infrastructural interventions rather than relying solely on awareness campaigns. Goh and Sukri (2025) identify fragmented regulatory frameworks and the scarcity of certified recycling centers as major barriers to effective e-waste management in Malaysia. Moreover, Rahman et al. (2024) report that annual e-waste generation has surpassed 364,000 tonnes, largely driven by increased digital consumption, emphasizing the need for urgent government action. Policymakers, such as the Department of Environment (DOE), should therefore prioritize the establishment of accessible drop-off points in areas with high community populations. As Zulkifli et al. (2024) note, rapid urbanization in states like Selangor has intensified waste volumes, making physical infrastructure a crucial enabler of pro-environmental behavior; without convenient access, even individuals with high environmental awareness may struggle to adopt sustainable practices.

For educational institutions and NGOs, the findings suggest a shift from passive information campaigns to active, habit-building interventions. Hernández-Uribe et al. (2025) highlight that engagement remains low despite growing e-waste volumes, indicating that current educational approaches are insufficient to address the health risks posed by toxic e-waste components. Experiential learning strategies, such as service-learning programs where students lead recycling awareness initiatives, have been shown to reinforce environmental responsibility effectively (Sulaiman et al., 2025). Furthermore, Norziana et al. (2025) found that higher education students demonstrate better recycling practices when knowledge is combined with positive attitudes, underscoring the value of "active" recycling programs such as gamified collection drives that provide repeated opportunities for community to practice sustainable behaviors.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

This study has certain demographic limitations, focusing primarily on youth aged 18 to 40 in urban areas. The exclusion of younger adolescents (under 18) and rural populations limits understanding of the broader spectrum of digital-native behaviors. Zulkifli et al. (2024) emphasize that digital waste practices extend across all community age groups, not just young adults. Additionally, the findings may not fully generalize to rural settings, where recycling infrastructure is often more limited. Nordin et al. (2025) demonstrate that e-waste recycling behaviors vary by region, as observed in their study of Negeri Sembilan, suggesting that future research should include rural and semi-rural populations to capture regional disparities in access and behavior.

Methodologically, this study employed a cross-sectional survey design, which captures data at a single point in time rather than tracking behavioral changes longitudinally. While this approach identifies correlations between variables, Khan et al. (2023) note that it restricts the ability to infer causality regarding how behavioral intentions develop into lasting practices. Additionally, although the sample size was adequate for statistical analysis, Ahmad et al. (2023) caution that self-reported survey data may be prone to response bias, with participants potentially overstating their pro-environmental behaviors. Future studies should adopt longitudinal research designs to examine the persistence of recycling practices over time, particularly following targeted policy or educational interventions.

CONCLUSION

This study examined the factors influencing e-waste management behaviour among Malaysian community by focusing on environmental knowledge management programmes, e-waste recycling practices, and the convenience of recycling infrastructures and services. The findings demonstrate that all three factors are positively and significantly associated with e-waste management behaviour, with recycling habits showing the strongest relationship. These results indicate that community who are knowledgeable, habitually engage in recycling, and have access to convenient recycling infrastructures are more likely to manage their electronic waste responsibly.

Overall, the study highlights that effective e-waste management among community requires an integrated approach that combines education, behavioural reinforcement, and supportive infrastructure. The findings contribute to the existing literature by providing empirical evidence from the Malaysian context and by reinforcing the applicability of Social Cognitive Theory in explaining pro-environmental behaviour. From a practical perspective, the results suggest that policymakers, educational institutions, and waste management stakeholders should prioritise awareness programmes, encourage consistent recycling practices, and improve the accessibility of formal e-waste recycling infrastructures to strengthen sustainable e-waste management among community.

Ethics Statement

This study was conducted in accordance with ethical research principles. Participation was voluntary, and informed consent was obtained from all respondents prior to data collection. Respondents were informed of the purpose of the study, and confidentiality and anonymity of responses were assured. No personal identifiers were collected, and the data were used solely for academic and research purposes.

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Author Contributions

Conceptualisation, methodology, data collection, and formal analysis were carried out by the authors. Writing original draft preparation was completed by the authors, while writing review and editing were performed collaboratively. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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