

Role of public attitude, knowledge, and trust in shaping the acceptance of recycled wastewater for potable and non-potable uses

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ABSTRACT

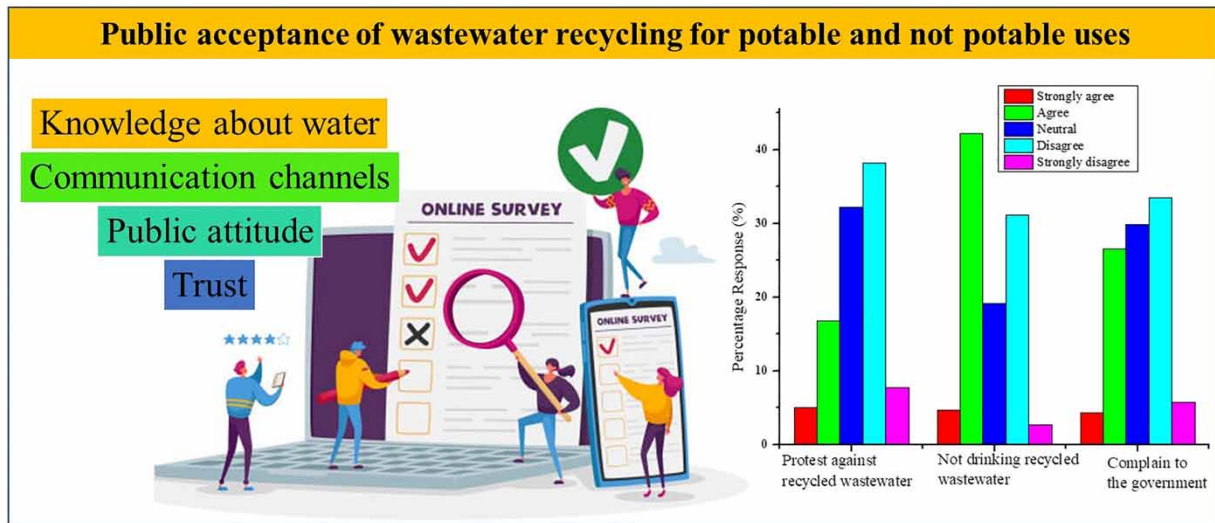
The acceptance of recycled wastewater plays a pivotal role in shaping the success of water management strategies. This study examines relation of public attitudes, knowledge, behaviors, and trust toward recycled wastewater systems, utilizing a survey of participants. The results reveal substantial knowledge deficits, with only 23.8% correctly defining recycled wastewater. In addition, 46.3% of respondents were knowledgeable about water scarcity, while 45.3% correctly identified the largest water uses. Attitudes were more reserved toward potable applications, with only 5% strongly agreeing to consume recycled water for drinking. Behavioral intentions favored non-potable uses, with 87% agreeing to use recycled wastewater for home gardening and flushing toilets, while 56% considered consuming food irrigated with recycled wastewater acceptable. Trust in water authorities emerged as a significant factor influencing acceptance. Lack of competence and not acting in public interest were identified as key factors eroding trust. The study also explored the influence of religion, revealing that non-contact applications were widely accepted across all religions, while direct-contact applications generated varied responses. The findings underscore the need for targeted educational campaigns, the cultivation of trust, and a nuanced approach considering cultural and religious diversity to promote wastewater recycling.

Key words: behaviors, knowledge, public acceptance, recycled wastewater, trust, water management

HIGHLIGHTS

- The study revealed the importance of awareness in enhancing public acceptance of recycled wastewater.
- The public is in support of non-potable use of recycled wastewater.
- Confidence in authorities is crucial for public acceptance of recycled wastewater.
- Religion affects public acceptance of recycled wastewater, especially for direct-contact applications.

GRAPHICAL ABSTRACT



1. INTRODUCTION

Sustainable management of water resources has emerged as a critical concern in the face of growing urbanization, population expansion, and the depletion of freshwater reserves. Within this context, the recycling and reuse of wastewater have garnered substantial attention as viable strategies to address water scarcity and enhance water security (Daigger *et al.* 2020; Chen *et al.* 2021). The successful implementation of wastewater recycling schemes, however, hinges on the acceptance and engagement of the public, a crucial determinant that shapes the dynamics of water management policies and practices (Morris *et al.* 2021).

Numerous studies have emphasized the significance of public acceptance in influencing the effectiveness of recycled wastewater projects (Asano *et al.* 1996; Duong & Saphores 2015; Chfadi *et al.* 2021). Public attitudes, knowledge, and behaviors toward recycled wastewater play a pivotal role in shaping the outcomes of such initiatives. A comprehensive understanding of these aspects is crucial for devising tailored strategies to promote the acceptance and adoption of recycled wastewater systems. The support of the public toward recycling of wastewater for non-potable uses is reported to be more than for recycling it for drinking purposes (Hurlimann & Dolnicar 2016). The resistance is not only to recycling wastewater for drinking but also for uses in which the exposure levels are higher. For example, recycling wastewater in swimming pools can be less acceptable to the public than using it for flushing toilets (Dolnicar & Schäfer 2009). The explanation of the difference in attitudes is drawn from the fear of health risk, which sometimes can even be perceived from non-potable uses such as irrigation. For example, Wu *et al.* (2015) reported health risk as a factor of recycling wastewater for irrigation. This indicates that public attitude toward potable and non-potable uses of recycled wastewater have evolved due to the context of recycling in which it is important to understand those factors that can reduce public resistance toward wastewater recycling. Goodwin *et al.* (2018) investigated how public attitude is influenced by framing the message to the public in different forms. The study concluded that information related to compliance of treated wastewater has a positive influence on the public attitudes toward recycling.

Another key factor to increase the positive attitude toward the acceptance of recycled wastewater is the realization of the water scarcity. Prins *et al.* (2022) reported that the studies that investigated the influence of knowledge on the public acceptance of water reuse are carried out in a framework where the participants were given a suite of water resources. However, public attitude can change if there is acceptance of water scarcity as a global challenge. For example, Prins *et al.* (2022) reported that majority of survey participants in South Africa accepted recycled wastewater as a viable drinking water source in drought situations. Therefore, it is necessary that the importance of information toward the acceptance of recycled wastewater should be investigated in the context of whether the participant perceives challenges of water scarcity. Previous literature highlights the intricate interplay between knowledge, attitudes, and behaviors regarding recycled wastewater (Baghapour *et al.* 2017; Abdelrahman *et al.* 2020; Msaki *et al.* 2022). Studies have emphasized that knowledge of the benefits, risks, and technical processes associated with recycled wastewater directly influences public acceptance (Mu'azu *et al.* 2020). Moreover, research underscores the critical role of education in enhancing public awareness and understanding of

wastewater recycling schemes (Wester *et al.* 2015). While the literature has addressed the importance of knowledge in shaping attitudes, research gaps remain in understanding the specific areas of knowledge deficit that hinder acceptance as well as the most effective educational strategies to bridge these gaps.

Public attitudes toward the use of recycled wastewater have also been extensively studied. Studies indicate that positive attitudes toward recycled wastewater are closely associated with perceptions of water scarcity, environmental consciousness, and trust in water authorities (Baghapour *et al.* 2017; Abdelrahman *et al.* 2020). However, there is limited research that delves into the underlying factors that drive preferences for non-potable versus potable applications of recycled wastewater. Furthermore, studies that explore the potential influence of cultural and religious considerations on these preferences remain scarce.

Behavioral aspects, including willingness to adopt recycled wastewater practices, have garnered attention due to their direct impact on system success. Previous research has examined factors that encourage the adoption of recycled water for non-potable applications, such as gardening and toilet flushing (Adewumi *et al.* 2014; Duong & Saphores 2015). Yet, a comprehensive assessment of the drivers behind behavioral choices, considering both non-potable and potable applications, remains necessary.

Trust in water authorities is another cornerstone of public acceptance. Previous research has identified the importance of trust in influencing public attitudes toward recycled wastewater (Gul *et al.* 2021). However, the specific dimensions of trust that contribute to public acceptance and the factors that erode this trust need further exploration.

Despite the extensive literature on public acceptance of recycled wastewater, several research gaps persist. First, there is limited insight into the precise domains of knowledge that contribute to public misunderstanding and skepticism regarding recycled wastewater schemes. Second, while the existing literature acknowledges the importance of cultural and religious considerations in shaping public attitudes, there is a dearth of studies that systematically investigate the impact of religious affiliations on attitudes toward direct-contact applications of recycled wastewater. Furthermore, the link between trust in water authorities and specific factors that bolster or undermine trust has not been extensively explored.

The objective of this study is to understand the factors influencing public acceptance of recycled wastewater. The factors focused in this study that influence public acceptance of recycled wastewater systems are knowledge, attitudes, behaviors, religious considerations, and trust. Quantitative survey-based data were collected in this study regarding these factors to investigate their influence on the public acceptance of recycled wastewater.

2. MATERIALS AND METHODS

2.1. Study location and participant selection

The eThekweni municipality, situated along South Africa's eastern coastline, holds the distinction of being the third largest municipality in the country, encompassing 103 wards within the KwaZulu-Natal province (MOSA 2022). This study focuses on residents in the suburbs of Durban, falling within the jurisdiction of the eThekweni Municipality. Figure 1 illustrates the geographical scope of the study area. A few wastewater reuse projects to demonstrate and evaluate technical feasibility are present in Durban, South Africa. The current projects include the construction of a 2000 m³/d reclamation plant as part of the Darvill Wastewater Treatment Works upgrade. In addition, a remix plant (6250 m³/d) combining wastewater reuse and desalination was constructed in South Durban, Bluff. That was the main reason the study focused on the residents in the suburbs of Durban so that the output of the study has practical management implications.

To ensure a diverse and representative sample, individuals from various racial and ethnic backgrounds were purposively selected. A total of 384 residents were sampled from the broader population of Durban using a stratified sampling technique, which takes into account the population's diversity. The sample size calculation followed Equation (1) (Nassiuma 2001):

$$n = \frac{Z_{0.95}^2 \times p(1-p) \times N}{(N-1) \times m^2 + Z_{0.95}^2 \times p(1-p)}, \quad (1)$$

where n is the required sample size; Z is the confidence level set to 95% (standard value of 1.96); P is the estimated prevalence of the outcome variable, 0.5 to get maximum sample size; N is the total number of the population; and m is the margin of error set to 5% (standard value of 0.05).

2.2. Survey instrument and data collection

Data collection was facilitated through a structured questionnaire. The initial section of the questionnaire focused on demographic information such as age, gender, education, and income. In addition, to quantify responses, Rensis Likert's technique

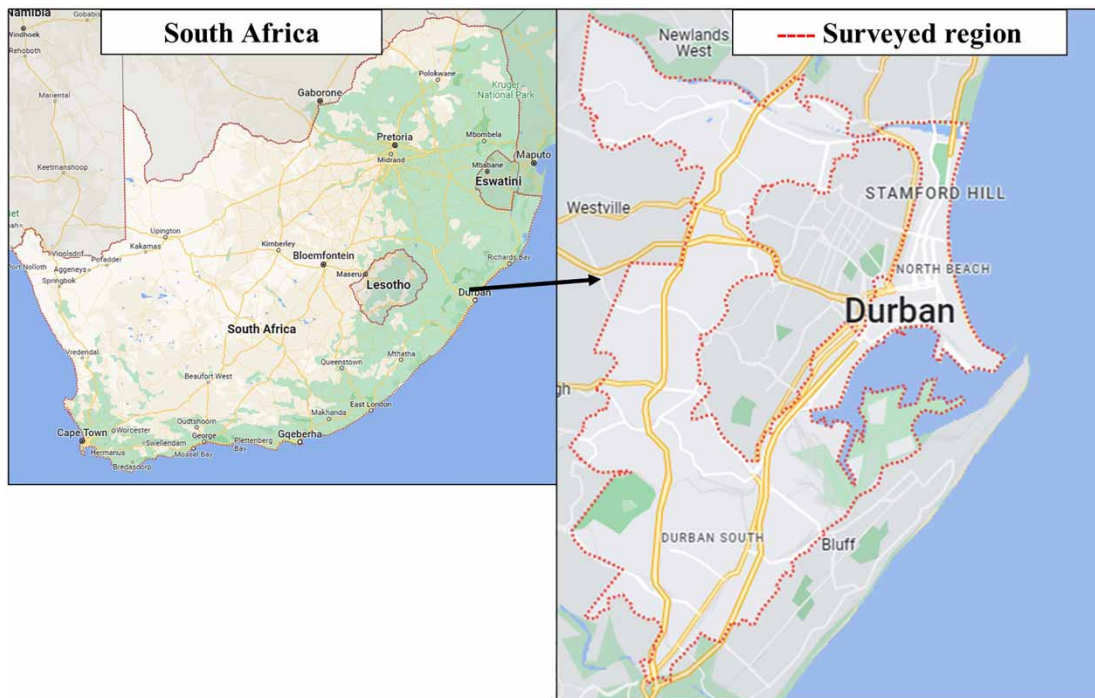


Figure 1 | Geographical location of the study area (Durban, South Africa) where the questionnaire survey was carried out.

was employed throughout the study, whereby participants were prompted to indicate their agreement or disagreement with statements using a five-point scale (strongly disagree = 1, strongly agree = 5) (Likert 2017). To gauge knowledge and marketing strategies, questions were designed to provide insights into respondents' perspectives.

A pilot test was conducted to assess the clarity of variables, response formats, and question comprehension. A random sample of 60 participants was chosen separate from the main group, and no significant issues were reported. Cronbach's alpha coefficient exceeded 0.75, validating the scale's reliability. The finalized questionnaire, following pilot testing, was administered online using Google Forms. Emails were sent to residents, resulting in 352 responses from the total sample, corresponding to a 91.6% response rate. Among these, 298 participants fully completed the required questions, while 54 responses were incomplete. The survey form settings limited the users to single, and instead of making the survey public, participation in the survey was asked via emails, which made it easier to reduce multiple responses from a single participant. The demographic data of the sample are shown in Table 1.

The authors engaged with community representatives through meetings held at the Remix demonstration wastewater reuse plant in Bluff, Durban. These gatherings, facilitated by the eThekweni Municipality's Department of Water and Sanitation, aimed to involve the public in wastewater reuse discussions. The study's objectives were presented, and participation was solicited. In addition, employees from various organizations and universities in Durban were invited via email, and university students were engaged through their online student groups.

2.3. Ethical considerations

Research involving human participants is contingent upon ethical considerations (Sekaran & Bougie 2016). Data collection respects the confidentiality and privacy of participants, safeguarding their self-esteem and dignity. Participants were informed about the study details, objectives, and approach during introductory sessions and data collection. An information letter, approved by the university, was shared, outlining the study's particulars. Risks associated with participation, anonymity maintenance, and data confidentiality were clarified prior to data collection. The online questionnaire was designed to prevent participants from viewing other respondents' answers, aligning with ethical protocols established by the university's ethical department.

Table 1 | Background demographic details of the participants in Durban, South Africa

Demographic characteristics		%
Gender	Male	44.60
	Female	52.34
	Prefer not to say	3.02
Age group	<25	9.73
	25–35	30.20
	36–45	36.58
	46–55	20.81
	>55	2.68
Education	Never have been to school	2.01
	Primary school	8.39
	High school	14.43
	Bachelor degree	41.61
	Postgraduate degree	33.22
Occupation	Unemployed	15.10
	Government	13.42
	Private company	24.16
	Self employed	34.90
	Other	6.38
Religion	Christianity	44.30
	Hinduism	13.42
	Islam	19.13
	Nazareth Baptist Church	0.34
	Traditional African Religion	20.47
	Other	0.34
	No response	1.34
	Atheist	0.34
Race	Buddhist	0.34
	White	7.05
	Black	63.42
	Indian	24.16
	Color	3.02
	Arab	0.67
	Asian	0.34
	Australian	0.34
Monthly income	No response	1.01
	<R5,000	11.74
	R5,000–R10,000	19.13
	R10,000–R15,000	39.45
Family members	>R15,000	29.19
	1–2	13
	2–5	67
	>5	20

3. RESULTS AND DISCUSSION

3.1. Knowledge about water sector and recycled wastewater

The queries presented to the participants for evaluating their comprehension of water and recycled wastewater, along with the corresponding replies, are summarized in [Table 2](#). Proficiency in knowledge serves as a primary factor influencing the acceptance of recycled wastewater. Analysis of the response rates revealed that a significant majority of participants provided inaccurate answers to most questions, underscoring the necessity to educate the residents about water-related topics. Notably, only 23.8% of participants accurately responded to the inquiry regarding the definition of recycled wastewater. A total of 64% of respondents equated conventional drinking water treatment and rainwater harvesting with recycled water. This

Table 2 | Overall response of the participants toward knowledge about water sector

Questions	Options	Response percentage	Correct option	Majority (>75%) correct?
What is your daily source of daily drinking water?	(a) Tap	87.58	Option (a)	Yes
	(b) Bottled water	5.37		
	(c) Stream/river	2.01		
	(d) Bore hole	5.03		
In your knowledge, which one of the below is recycled water?	(a) Water taken from streams/rivers and then purified to make it fit for potable uses	7.72	Option (b)	No
	(b) Wastewater from wastewater treatment works and then purified to make it fit for potable uses	23.83		
	(c) Stored rainwater and then purified to make it fit for potable uses	4.36		
	(d) All of the above	64.09		
What is the main source of drinking water which is coming in your taps?	(a) Boreholes	2.01	Option (b), (c) and (e)	Yes
	(b) Dam	47.32		
	(c) Rivers and streams	19.46		
	(d) Seawater desalination	3.36		
	(e) Treated water from reservoirs	27.85		
Which sector is the biggest user of water in Durban?	(a) Agricultural	45.30	Option (a)	No
	(b) Domestic use for people	15.10		
	(c) Industry	22.15		
	(d) No idea	17.45		
Does Durban have sufficient water?	(a) Sufficient water supply	24.50	Option (b)	No
	(b) Severe shortage	46.31		
	(c) No idea	29.19		
A drinking water treatment plant has a source of water. This water is treated in the treatment plant and supplied in our houses through water distribution pipes. In your knowledge, which of the following is/are sources of water to a drinking water treatment plant?	(a) Dams (fed by rivers)	55.03	Option (a)	No
	(b) Groundwater (water table below ground)	12.08		
	(c) Groundwater	1.68		
	(d) Industrial (effluents)	7.05		
	(e) Rivers	4.03		
	(f) No idea	20.13		

Note: The questions were related to knowledge about source of water, basic meaning of recycled water, and consumption of water in South Africa.

observation suggests a crucial need for water authorities to engage the public prior to executing any recycled wastewater initiatives.

Recognizing the scarcity of water emerges as a pivotal motivator in fostering public interest to recycled wastewater. A mere 46.3% of respondents demonstrated awareness about water scarcity in Durban, while 24.5% erroneously believed in the sufficiency of water and 29.2% admitted to lacking knowledge about the city's water scarcity situation. Without a genuine understanding of water scarcity in a region, the adoption of alternative water sources like recycled wastewater might encounter resistance among citizens. Equally noteworthy, fewer than half of the participants (45.3%) correctly identified the largest water consumer in Durban. A smaller percentage (22%) mistakenly attributed this role to industries.

Water scarcity emerges as a key motivational factor in fostering public receptivity to recycled wastewater. The findings highlight that a substantial portion of participants lacked awareness about water scarcity in Durban. This lack of awareness could potentially impede the adoption of recycled wastewater as an alternative water source. Previous studies have also stressed the importance of creating a sense of urgency regarding water scarcity to enhance the acceptability of recycled wastewater (Garcia & Pargament 2015).

Inquiring about the water source in a Drinking Water Treatment Plant (DWTP), 55% of respondents correctly indicated 'dams' as the source, whereas 12% incorrectly thought of groundwater as the primary raw water source for a DWTP and

20% expressed uncertainty. The study's knowledge criterion was set at a 75% accuracy rate; however, none of the questions achieved this threshold. Despite 90% of participants possessing an education beyond high school – comprising 41.6% bachelor's degree holders, 33.2% postgraduates, and 14.4% high-school graduates – the failure to meet the 75% accuracy benchmark in knowledge inquiries indicates a pressing need for comprehensive public enlightenment regarding various facets of the water industry in Durban.

The study highlights the crucial role of knowledge and awareness in influencing public acceptance of recycled wastewater. The findings emphasize that participants exhibited a lack of accurate comprehension regarding water-related topics, indicating a need for improved education and public engagement. The data suggest that misconceptions about recycled wastewater, including its definition and differentiation from conventional drinking water treatment and rainwater harvesting, are prevalent among the surveyed participants. This lack of understanding could potentially hinder the successful implementation of recycled wastewater initiatives. Engaging the public prior to launching recycled wastewater projects becomes essential to prevent misconceptions and resistance. This point is supported by previous research that emphasizes the role of effective communication and community involvement in the success of water reuse programs (Smith *et al.* 2018).

Moreover, the study underscores the significance of accurate knowledge about water sources and consumption patterns in influencing public perceptions. The fact that less than half of the participants correctly identified the largest water consumer in Durban suggests a gap in understanding water usage patterns. This lack of awareness could be addressed through targeted awareness campaigns to inform citizens about water consumption patterns and associated challenges.

The study's finding that education level did not necessarily correlate with accurate knowledge about water-related topics suggests that simply having higher education does not guarantee comprehensive understanding about the wastewater reuse. This observation aligns with the literature, which highlights the need for tailored and accessible educational campaigns to bridge knowledge gaps and promote informed decision-making among diverse segments of the population (Msaki *et al.* 2022).

3.2. Public attitude and behavior toward potable and non-potable applications of recycled wastewater

The exploration of public sentiment concerning the utilization of recycled wastewater for non-potable purposes involved an inquiry into participants' willingness to adopt these applications. The survey presented four distinct non-potable applications: irrigating gardens, flushing toilets, washing dishes, and laundering clothes. Figure 2 illustrates the distribution of response

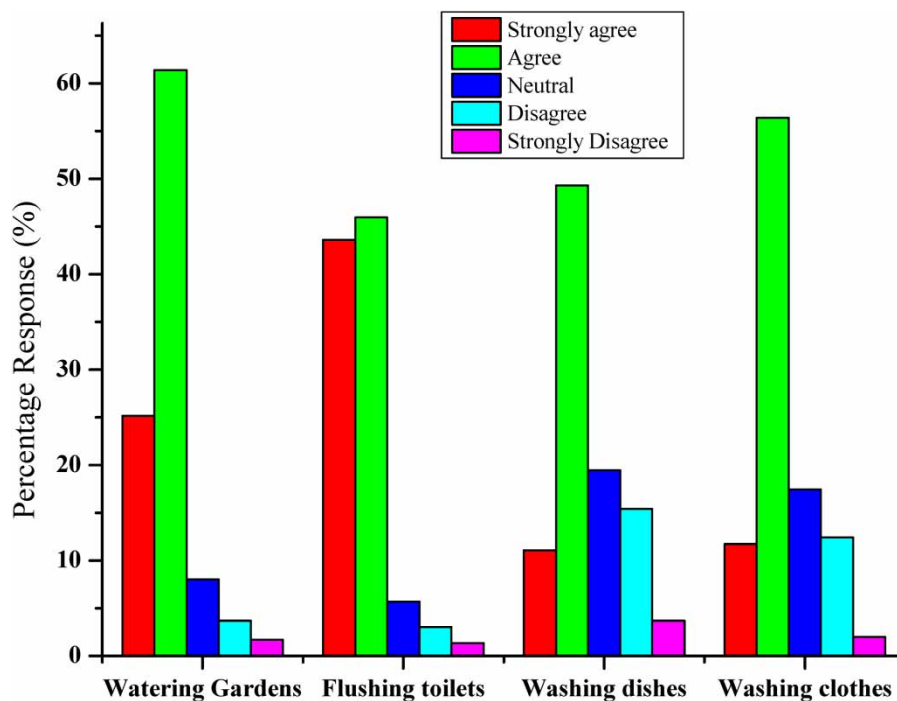


Figure 2 | Preferences of survey participants toward various non-potable applications of recycled wastewater.

percentages. Remarkably, all these non-potable applications garnered positive reception among the participants. Notably, 43.6% of respondents strongly endorsed and 46% agreed with employing recycled wastewater for flushing toilets (Figure 2). The application with the lowest preference was dishwashing, with 11% strongly in favor and 49% in agreement. When amalgamating the ‘strongly agree’ and ‘agree’ responses, it was evident that flushing toilets received the highest acceptance rate (90%), trailed by garden irrigation (86%), clothes laundering (68%), and dishwashing (60%).

Examining attitudes toward the potable uses of recycled water, the survey inquired about participants’ willingness to utilize such water for swimming and drinking. Intriguingly, participants exhibited some reluctance toward embracing the potable applications of recycled wastewater (Figure 3). For both questions, the percentage of respondents strongly agreeing was a mere 5%, while 44.6 and 33% concurred with employing recycled water for swimming and drinking, respectively. On the contrary, 28% expressed disagreement and 33% strongly disagreed with utilizing recycled wastewater for these purposes. This apparent hesitance toward potable applications, when compared to the acceptance of non-potable uses, underscores the need for a judicious allocation of recycled water applications.

Shifting focus to participants’ behaviors related to non-potable applications (as depicted in Figure 4), they were prompted about their willingness to consume crops irrigated with recycled wastewater and to acquire homes employing recycled wastewater for gardening and toilet flushing. Remarkably, the latter option gained significant traction, with 87% of participants endorsing it, whereas 56% expressed willingness to consume food grown with recycled wastewater irrigation. These findings imply that leveraging decentralized wastewater reuse technologies and providing recycled water for garden irrigation and toilet flushing could prove to be favorable strategies in Durban. Furthermore, these insights lend support to the viability of centralized recycling schemes supplemented by distribution networks for non-potable purposes.

Turning to the assessment of participant behavior regarding potable applications of recycled wastewater (as depicted in Figure 5), several questions were posed to gauge their attitudes. Overall, participants demonstrated disinclination toward actively protesting or filing complaints against recycling water initiatives. Specifically, 38% disagreed with the notion of protesting such schemes and 33.6% were against registering complaints with the government about wastewater recycling projects. Concurrently, there was agreement regarding the avoidance of consuming recycled wastewater for drinking, with 42.3% of participants favoring this stance. This nuanced perception among participants underlines the intricacies of their

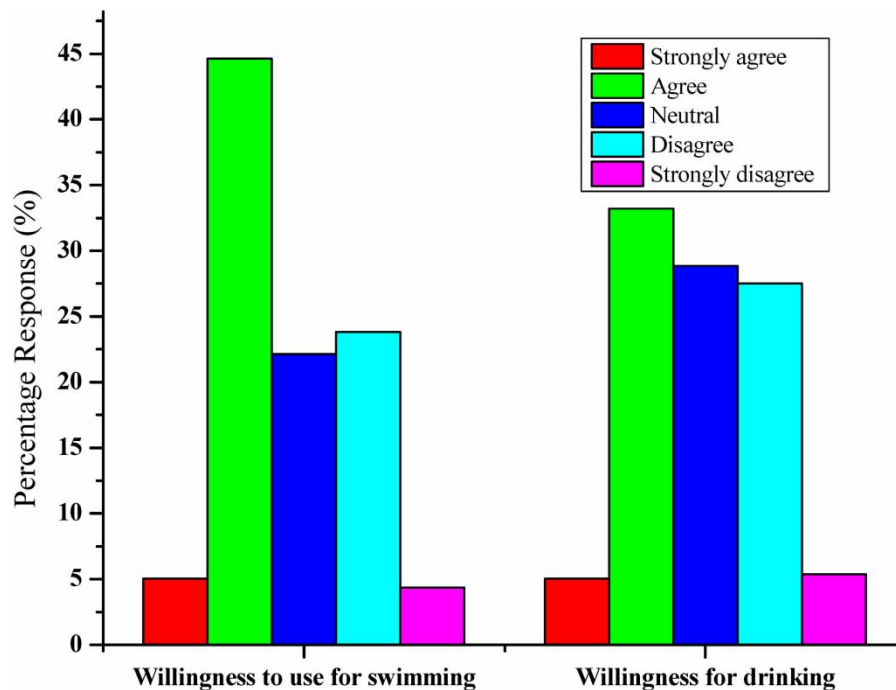


Figure 3 | Response of survey participants toward different potable applications regarding the acceptance of recycled wastewater.

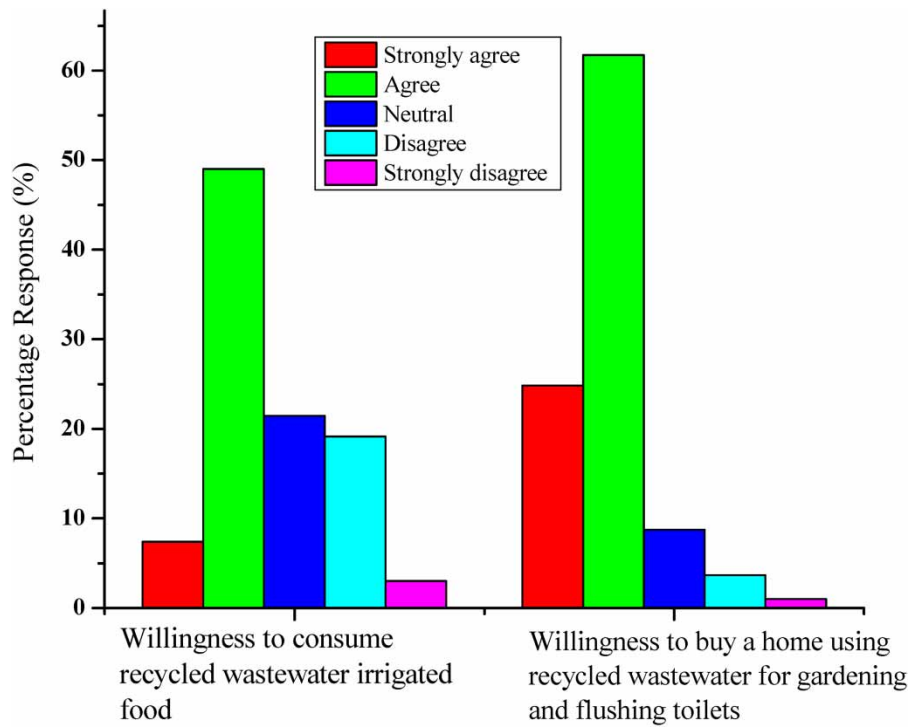


Figure 4 | Willingness level of survey participants to consume food irrigated with recycled wastewater or buy a home that has recycled wastewater connections for gardening and flushing.

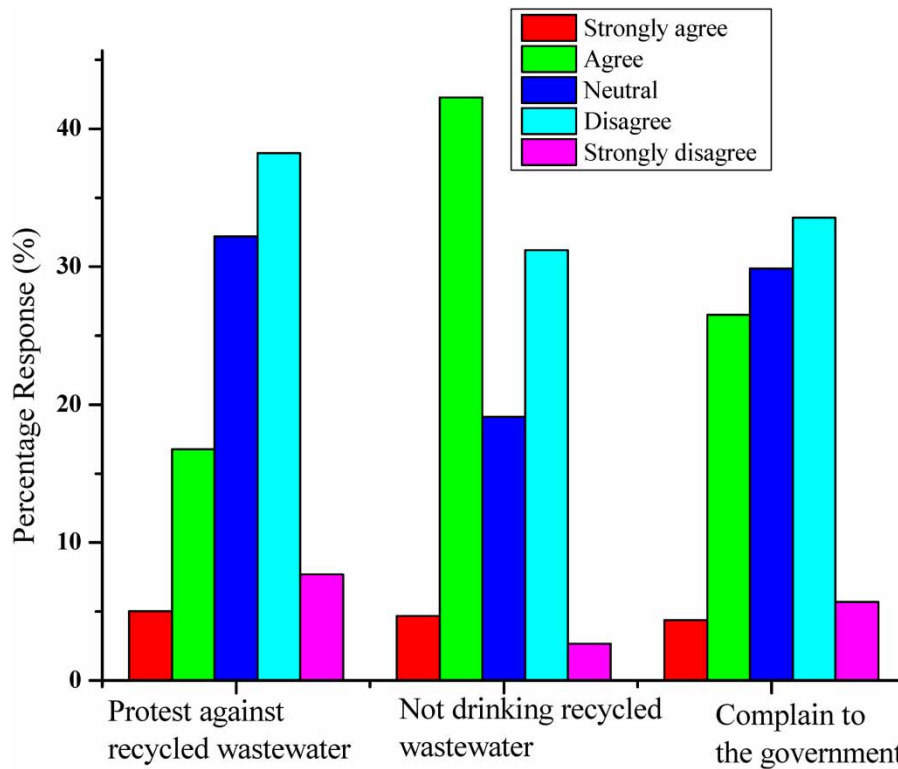


Figure 5 | Willingness level of survey participants to resist and take action against the usage of recycled wastewater in households.

views on wastewater recycling. When considering both ‘agree’ and ‘strongly agree’ responses, 22% indicated a readiness to protest such schemes. It is worth noting that such behavior could potentially result in financial and resource losses associated with wastewater recycling endeavors. In addition, such protests might attract a subset of citizens whose inclinations are less certain or who maintained a neutral stance during the survey. This category comprised 32% of respondents who indicated neutrality in their responses when queried about their intention to protest against recycling wastewater schemes.

3.3. Relationship of religion on usage of recycled wastewater

The discernment of recycled wastewater utilization preferences across different applications was correlated with religious affiliations, as illustrated in Figure 6. Notably, participants from all religious backgrounds exhibited strong inclination toward non-contact applications of recycled wastewater, such as irrigating gardens and flushing toilets. Across all religious groups, the percentage of participants endorsing the utilization of recycled wastewater for garden irrigation ranged from 85 to 91% (a combined response percentage of ‘strongly agree’ and ‘agree’). Similarly, for toilet flushing, this percentage spanned 88–97%, with Christianity at 88%, Hinduism at 88%, Islam at 97%, and traditional African religion at 92%. This uniformity in preference highlights a general acceptance of utilizing recycled wastewater for toilet flushing, transcending religious boundaries.

However, as the degree of contact with recycled wastewater applications escalated, the percentage of ‘strongly agree’ and ‘agree’ responses diminished. Participants’ favorability toward applications followed a hierarchy: toilet flushing > garden

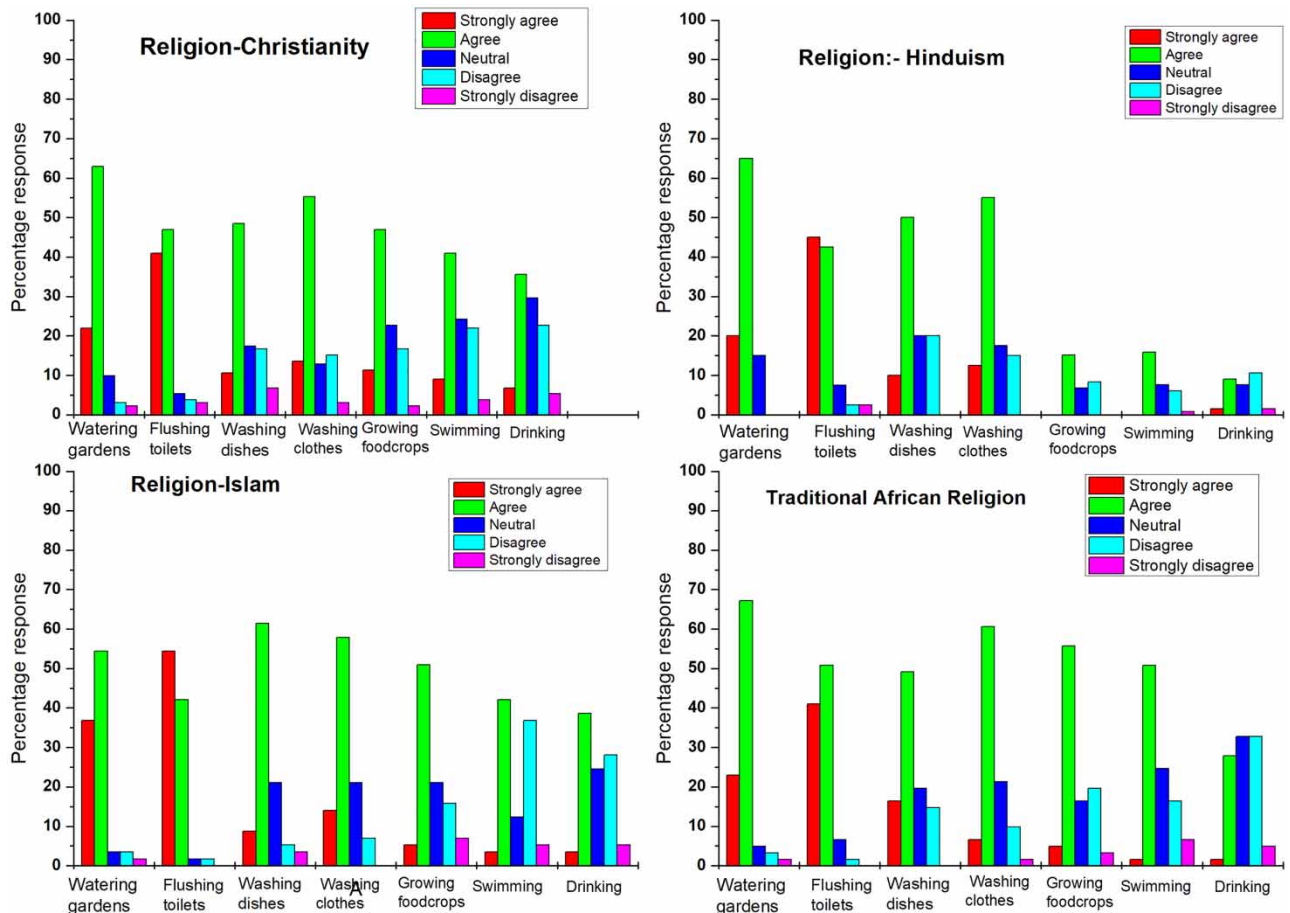


Figure 6 | Willingness level among survey participants to use recycled wastewater for various applications in households.

irrigation > clothes laundering > dishwashing > cultivating food crops > swimming > drinking. It is worth noting that preferences varied for specific applications within distinct religious groups. For instance, the agreement percentages for using recycled wastewater in swimming and drinking were approximately 42–50% among Christians, 42–46% among Muslims, and 42–46% among adherents of traditional African religion. Collectively, the data underscore that direct-contact applications of recycled wastewater garner less acceptance across all religious communities. This divergence in consideration levels for direct-contact applications suggests the necessity for tailored engagement initiatives based on specific religious communities when contemplating the implementation of recycled wastewater for applications like swimming and drinking.

The consideration of religion as a potential determinant in the acceptance of recycled wastewater originated from the Muslim community, which may view the use of recycled wastewater as conflicting with their religious principles of cleanliness. Initial studies on the role of religion in the acceptance of recycled wastewater were conducted by Wilson & Pfaff (2008) in Durban, South Africa, where a significant population follows the Islamic faith. There are conflicting reports on whether wastewater reuse aligns with Islamic law. For instance, Faruqui *et al.* (2001) reported that wastewater reuse is not acceptable among Muslim communities, while the Council of leading Islamic scholars in Saudi Arabia declared that recycled wastewater can be used for drinking and other Islamic rituals as long as there are no associated health risks (Wilson & Pfaff 2008). The crux of the religious barrier to wastewater recycling lies in the Islamic ruling that considers urine and feces as impure, requiring their removal before engaging in religious rituals. The Council of Muslim theologians asserts that the Muslim community will be sensitive to recycled wastewater, and religious considerations become critical if there are even slight variations in water quality. Thus, religious factors should be considered and weighted in recycled wastewater projects, especially given the sensitivity of the Muslim community to variations in water quality. The study's results indicated similar acceptance rates across different religious groups, suggesting awareness within the Muslim community in Durban about recycled wastewater. In response to the protest against the eThekweni municipality's 2012 recycling plans, the Water Research Commission in South Africa addressed the concerns through engagement with religious scholars, as reported by Tayob *et al.* (2015), concluding that there is no fundamental religious reason to reject recycled water in Islam. However, the engagement of various community stakeholders remains crucial during project implementation. The survey results of our study indicated comparable acceptance levels across all religions, contributing valuable insights into the acceptance levels of religions not previously investigated.

3.4. Trust factor in public acceptability of recycled wastewater

Establishing trust in water authorities constitutes a pivotal determinant for fostering the acceptance of recycled wastewater projects, as highlighted by previous research (Gul *et al.* 2021). To gauge the extent of trust in water authorities within the Durban context and explore plausible explanations for its deficiency, participants were presented with four trust-related statements and four potential factors, as depicted in Table 3. Responses were recorded on a five-point scale, ranging from 'strongly

Table 3 | Correlation between concerns arising out of lack of trust in local municipality and the associated possible factors

	Trust concern 1	Trust concern 2	Trust concern 3	Trust concern 4	Factor 1	Factor 2	Factor 3	Factor 4
Trust concern 1	1.00							
Trust concern 2	0.61	1.00						
Trust concern 3	0.55	0.62	1.00					
Trust concern 4	0.55	0.62	0.75	1.00				
Factor 1	0.57	0.59	0.62	0.67	1.00			
Factor 2	0.34	0.37	0.46	0.52	0.49	1.00		
Factor 3	– 0.32	– 0.32	– 0.41	– 0.44	–0.47	–0.47	1.00	
Factor 4	0.54	0.59	0.60	0.70	0.64	0.54	–0.51	1.00

Notes: The details of the various trust concerns and factor tested in this study are mentioned at the end of the table. All correlations are significant with $p < 0.05$. Correlations of interest are shown in bold.

Trust concern 1: I have confidence that my local municipality will deliver satisfactory services. Trust concern 2: I think that the local municipality has good intentions in managing Durban's water supply. Trust concern 3: I can depend on the local water authority to provide a good quality water supply. Trust concern 4: I have complete trust in the water authority to provide me with good quality water supply. Factor 1: I agree that the local municipality is competent enough to manage our water supply. Factor 2: The local municipality provides the Durban community with the necessary information they want to know about their water supply. Factor 3: The local municipality does not listen to concerns raised by people like me. Factor 4: I agree that the local municipality acts in the public interest when it comes to water quality.

agree' to 'strongly disagree'. Employing regression coefficient analysis, the relationship between trust statements and underlying factors was examined, with the results documented in Table 3. The statistical significance of the regression analysis, as determined through *t*-test analysis, demonstrated a robust outcome with a significance level of $p < 0.05$.

Two primary factors, Factor 1 and Factor 4, exhibited positive regression coefficients exceeding 0.5 in connection with all four trust statements. This pattern indicates that participants' mistrust could stem from perceived shortcomings in the competence of local municipalities to manage water supply and a perceived failure to act in alignment with public interests. Factor 2, encompassing the provision of necessary water-related information, displayed a significant correlation (Pearson coefficient of 0.52) with trust statement 4, which pertained to trust in the municipality's ability to deliver high-quality water. This highlights the importance of transparent communication from local municipalities to update citizens about water quality, a practice that holds the potential to elevate trust levels.

On the contrary, Factor 3, representing the municipality's responsiveness to citizen concerns, exhibited a negative correlation with all trust statements (as detailed in Table 3). This observation underscores the significance of promptly addressing citizens' apprehensions regarding water supply. Any deficiencies in this area could have adverse consequences, eroding trust among citizens and potentially impeding the successful execution of wastewater recycling initiatives.

In sum, the study reinforces the critical role of trust in water authorities in driving the acceptance of recycled wastewater schemes. Findings indicate that enhancing trust involves addressing concerns about water management competence, aligning actions with public interests, providing transparent water quality information, and promptly responding to citizen concerns. These insights, resonating with prior literature, underscore the need for proactive measures in ensuring successful implementation of recycled wastewater projects.

3.5. Approaches for promotion of recycled wastewater

In order to enhance public receptivity toward recycled water, the development of effective strategies is imperative. One approach with potential to drive acceptance of recycled wastewater for potable purposes is offering discounted water supply connections. This incentive holds the promise of motivating the public to embrace recycled water. Survey participants considered a discounted water bill as a pivotal condition for endorsing recycled wastewater (as indicated in Table 4). Notably, 44% of participants favored the idea of a discounted water bill, while 45% remained open to the possibility ('maybe' option).

Table 4 | Preferences of the participants toward marketing strategy of recycled wastewater, which local authorities can adopt in future

Parameter	Response (%)
Acceptance of recycled wastewater with a discounted water bill, as a condition	44 (Yes); 45 (Maybe); 11 (No)
Other benefit preferences to motivate acceptance of recycled wastewater	
Discount on income tax	16.40
Shopping card rewards	19.80
Cashback	17.10
Discount on other municipality services	46.60
Alternate preferences in the absence of above benefits	
Accept with transparency and good customer care	60.70
Bottled water	31.20
Protest and complete rejection	6
No preference	2
Media choice for transparency and good customer care	
Facebook	47.7
WhatsApp	44
Instagram	2.3
Twitter	4.7
Snapchat	1.3

Additional preferences for benefits were also solicited from participants, revealing that 46.6% viewed discounts on municipality services as a viable alternative to reduced water bills (Table 4). These results highlight the potential of offering discounted water supply connections as an incentive to drive the acceptance of recycled wastewater for potable purposes. This approach aligns with behavioral economics, where providing tangible benefits can influence decision-making (Thaler & Sunstein 2009). The findings suggest that a discounted water bill is a key factor influencing participants' endorsement of recycled wastewater. Investigating further into marketing approaches, participants were questioned about their response if no tangible benefits were attached to the recycled wastewater scheme. A significant 61% of participants highlighted transparency in services and effective customer care from water authorities as prerequisites for accepting recycled wastewater without direct incentives. This reveals the importance of intangible factors in driving acceptance when direct incentives are not provided. The emphasis on transparency in services and effective customer care as prerequisites for accepting recycled wastewater highlights the significance of trust and communication in building public confidence in water reuse programs.

Tariffs are used as a tool in managing drinking water demand. Marketers use tariffs to change the behavior of consumers. The consumer decides whether to use less or pay more as tariffs increase. According to the study conducted by Adewumi *et al.* (2014), if the tariff for wastewater reuse is lower than the tariff for drinking water, 71% were willing to accept recycled wastewater. This is also based on the 'nudge theory' proposed by Thaler & Sunstein (2009) that suggested the implementation of policies can be successful if there are incentives, which can change the behavior of an individual. A discounted water bill may be considered an incentive influencing participants' endorsement of recycled wastewater.

To achieve transparency and superior customer care favored by participants, a range of media platforms could be harnessed. The study revealed that participants identified social media as effective channels for both information dissemination and customer services. Specifically, 48% of participants favored Facebook and 44% expressed preference for WhatsApp. In contrast, platforms such as Twitter, Instagram, and Snapchat garnered preference from less than 5% of participants. This underscores the need for local municipalities to transition toward contemporary media platforms when sharing water-related information and catering to customer needs. The participants' platform preferences were congruent with the accessibility and widespread adoption of Facebook and WhatsApp, suggesting that aligning with these platforms could yield optimal results.

The Internet, social media, and television are the main sources of information (Abdelrahman *et al.* 2020). The most dominant method of informing the community about recycled wastewater reuse is social media (Buyukkamaci & Alkan 2013). Akpan *et al.* (2020) studied that most respondents (85.4%) get information regarding environmental issues from the Internet sources. Online sources (Internet 61%) followed by social media (38%) were found as the leading information sources (Chfadi *et al.* 2021).

3.6. Future aspects

The findings from this study suggested the possible aspects for exploration in the domain of recycled wastewater acceptance and utilization. First, future research could focus into the design and implementation of targeted educational interventions aimed at bridging the identified knowledge gap among public about wastewater recycling. In addition, the efficacy of educational campaigns in enhancing public understanding of wastewater treatment processes and safety measures would be instrumental in fostering confidence and acceptance of recycled wastewater. Future investigations should also focus into assessing how factors such as climate change awareness and sustainable water management practices influence public attitude toward recycling of wastewater. This could provide insights about the factors that can shape positive attitudes toward recycled wastewater, guiding the development of effective attitude-shaping initiatives. Further studies should also focus on the dynamics of trust-building in the context of recycled wastewater initiatives. Understanding the specific elements and communication strategies that contribute to trust formation in municipal water services could guide policymakers and project managers in fostering community trust, thereby facilitating the successful implementation of recycled wastewater projects.

4. CONCLUSION

The findings of this study focused on key aspects regarding the public's knowledge, attitudes, and behaviors toward recycled wastewater and its applications. Despite higher participant education among survey participants, knowledge deficiency about wastewater reuse may persist, suggesting that knowledge about wastewater reuse is important that may create a sense of confidence in public that the wastewater has been treated enough to produce potable water. The positive attitude can influence

the acceptance of recycled wastewater. The survey results indicated that the feeling of water scarcity can have a positive effect on the attitude toward the importance of recycled wastewater and improve its public acceptance. Religious affiliations are important to consider and tailored engagement strategies that consider religious beliefs should be adopted in planning recycled water projects. The study indicated that trust in municipal services also influence acceptance of recycled wastewater. The survey results indicate that trust can be fostered through transparent communication, addressing competence concerns, and prompt response to citizen inquiries. The survey results also indicate more preference of contemporary media platforms like Facebook and WhatsApp for information dissemination and customer services in scenarios using recycled wastewater as a source of water.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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