

Always on My Mind: Stakeholder Perspectives on (Micro)Plastic Pollution in Indonesia

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Badges for Good Research Practices:  Data.  Diversity Statement.  Materials.

Abstract

Research into the consequences of, and behavioural adaptation to (micro)plastic pollution is increasing, yet comparatively little focuses on non-WEIRD countries, despite them being disproportionately affected. This study examines self-assessed pro-environmental and health-protective behaviour in Kendari City, Indonesia. It utilises a mixed methods approach of a quantitative online questionnaire ($N = 585$) with Multiple Regression Analysis (MRA) and qualitative in-person interviews ($N = 72$) while considering psychological variables (subjective knowledge, experience, concern and attitude) and behaviour for different stakeholder groups (combined, civil society, and involved groups). The MRA ($p < .001$) showed a significant positive link between subjective knowledge and pro-environmental behaviour among combined stakeholders, civil society, and involved groups. The qualitative questionnaire supported this finding for the reduction of waste production. Experience of plastic pollution in local neighbourhoods and the broader environment, as well as exposure to microplastics through consumption, were associated with pro-environmental behaviours when all stakeholder groups were analysed together. For civil society stakeholders specifically, experience of plastic pollution in the environment and exposure to microplastics through consumption were also linked to increased



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pro-environmental behaviour. In contrast, observing plastic pollution in their own neighbourhoods was significantly associated with lower levels of pro-environmental behaviour. Psychological links to health-protective behaviour were more nuanced. Overall, our study could not fully establish a link between health-protective behaviour (willingness to consume seafood and seafood consumption) and psychological variables. The qualitative questionnaire found that involved groups (94%), but not civil society (20%), are aware of policies addressing marine litter in Indonesia. The policies are deemed ineffective by 48% of involved groups and 80% of civil society. The pro-environmental results indicate an opportunity to leverage knowledge to extend pro-environmental behaviours to combat plastic pollution, especially if building on existing behaviours focused on reducing plastic waste production.

Keywords

self-assessed, microplastics, pollution, waste management, seafood consumption

Non-Technical Summary

Background

Awareness of plastic pollution and its impacts is growing. There is awareness of microplastics (plastic particles smaller than 5 mm) and their contamination of seafood. This knowledge is particularly concerning for communities that rely heavily on seafood as a primary food and income source. Research is needed to understand if and how this increasing awareness links to behaviour.

Why was this study done?

We aimed to understand whether increased knowledge of plastic and microplastic pollution is psychologically associated with pro-environmental or health-protecting behaviours. We considered pro-environmental waste management practices and health-protecting behaviour regarding seafood consumption. We approached seafood consumption from the perspectives of willingness to consume and seafood consumption. We considered two different methods and different stakeholder groups. The stakeholder groups considered were: 1) all participants, 2) civil society and 3) those groups involved with plastic pollution research, prevention or the fisheries industry.

What did researchers do and find?

We conducted a mixed-methods study in Kendari City, Indonesia, utilising an online questionnaire with fixed Likert-scale responses and in-person interviews, which allowed open-ended responses. The questionnaire and interviews measured perceptions of plastics and microplastic pollution, including subjective knowledge, experience, concern and attitude, in relation to self-assessed behaviour concerning household waste treatment and seafood consumption. Higher subjective knowledge was linked to increased pro-environmental behaviour for all stakeholders, civil society and involved groups. Greater exposure to plastic

pollution in neighbourhoods and the wider environment, as well as observing microplastics in seafood, was associated with increased pro-environmental behaviour when all stakeholder groups were considered together. Among civil society stakeholders specifically, exposure to plastic pollution in the environment and observation of microplastics in seafood were also associated with increased pro-environmental behaviour, however, observing plastic pollution in their own neighbourhoods was linked to decreased pro-environmental behaviour. In the qualitative interviews, the pro-environmental behaviour was perceived as limited to reducing plastic waste production. The qualitative interviews enabled us to assess nuances in the results, revealing that not all qualitative participants recognised removing organic waste as sorting, which may have reduced sorting's role in participants' pro-environmental behaviour. The health-protective results between the two methods were contrasting. In the quantitative analysis, a decreased willingness to consume seafood is correlated with subjective knowledge among all stakeholders and observed microplastic contamination among civil society. In the qualitative interview, the majority of combined stakeholders (90%) did not consider their willingness to eat seafood to be associated with microplastic contamination. Regarding actual consumption, in the quantitative questionnaire, an increase in seafood consumption is correlated with increased subjective knowledge among civil society, as well as increased concerns about plastic and microplastics among combined stakeholder groups and microplastic concerns among the involved groups. In the qualitative interviews, the fishing industry considers its markets to be stable. It is noted that there was poor consistency (low Cronbach's alpha values) for consumption variables. For instance, the results indicated that subjective knowledge was significantly correlated with participants' willingness to consume seafood in the involved group, but not with their self-assessed seafood consumption. Additionally, concern about microplastics was strongly correlated with industry participants' self-assessed consumption, but not with their willingness to consume. A significant relationship exists between concerns about plastic and microplastics and self-assessed consumption among combined stakeholder groups. However, this was weak for both civil society and the involved participants. Moreover, the observation of microplastics in seafood also appeared to correlate significantly with perceived willingness to consume for civil society participants. Thus, the psychological factors linked to health-protective behaviour reveal nuanced relationships, especially across different stakeholder groups and data collection and analysis methodologies. No overall link was established between variables and health-protective behaviour.

What do these findings mean?

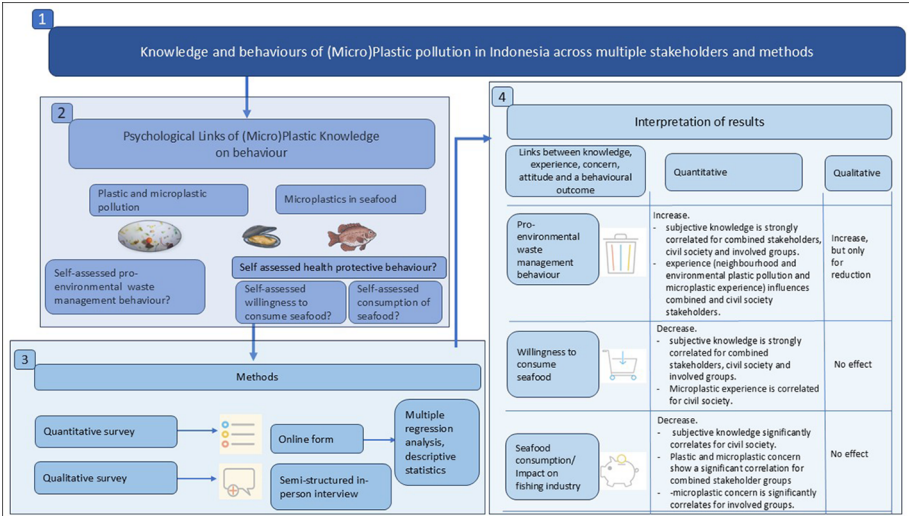
The results suggest that greater knowledge is associated with pro-environmental behaviour, though nuances exist regarding the type of pro-environmental behaviour. Thus, further increases in knowledge may encourage additional pro-environmental practices. However, infrastructure support, improved service delivery, and making waste management convenient, easy, and quick are necessary to help people manage their waste effectively. Overall, greater exposure to plastic pollution encourages individuals to adopt pro-environmental practices to address the issue; however, this pattern does not hold when civil society stakeholders encounter pollution within their own neighbourhoods. Overall awareness of plastic pollution

and microplastics in seafood is not directly linked to seafood consumption; therefore, it is not affecting the fishing industry.

Highlights

- Knowledge is strongly associated with pro-environmental behaviour across stakeholders
- Waste reduction is the most widely practised pro-environmental behaviour.
- Plastic pollution exposure is associated with increased pro-environmental behaviour.
- Local pollution observation is linked to reduced pro-environmental behaviour.
- Microplastic awareness is not yet associated with changes to Indonesia’s fisheries sector.

Graphical Abstract



Plastic waste production, its leakage into the environment, and the resulting impacts are heavily driven by socio-economic factors that vary across communities and countries. The evident surge in visible plastic pollution, which causes adverse environmental and societal effects (Borrelle et al., 2020), is matched by a substantial increase in awareness (Heidbreder et al., 2019). Additionally, though there is increased scientific awareness of microplastics (< 5 mm in size, [GESAMP, 2016]), their contamination of seafood and potential associated health risks (Pironti et al., 2021), assessment of microplastic perceptions in the general population is in its infancy. However, this is a growing

area of literature with recent studies (Henderson & Green, 2020; Janzik et al., 2024) showing potential increases in awareness of microplastics (Fian et al., 2024). Studies on microplastics and perceptions within European populations, from sources to solutions, have been conducted for experts (Grünzner et al., 2023) and stakeholders along the food chain (Fian et al., 2024). Both studies revealed a range in knowledge levels and high levels of concern. Existing mitigation strategies often aim to leverage interventions through increasing awareness and knowledge of both plastic and microplastic pollution. Although behavioural approaches in tackling the issue of plastics are growing, they are still underrepresented in the plastics discourse (Pahl & Grünzner, 2023), particularly in differentiating between different behaviours. A further gap in existing literature is that Western, Educated, Industrialised, Rich, and Democratic (WEIRD) countries dominate behavioural science studies (Jones et al., 2017), limiting the generalizability of findings beyond these populations (Simmons & Fielding, 2019; Vlasceanu et al., 2024).

Our research is conducted in Kendari City, Indonesia. Indonesia is the second-highest plastic-emitting country (Jambeck et al., 2015). As the primary source of protein (14%), seafood plays a central role in the country's dietary landscape, aligning with geographical and cultural expectations (Partelow et al., 2023). The site was selected as a high-emitting country and as a prime example of an urban population that relies heavily on seafood as a primary source of protein, where fisheries play a vital role in the economy, and the population includes involved groups such as fishermen/fisherwomen (fishers), the fish processing industry, government and academics, as well as civil society. The current research examines the psychological links between variables (subjective knowledge, experiences, (micro)plastic concern, and attitude) and behaviours. Two specific self-assessed behaviours are considered: pro-environmental behaviour and health-protective behaviour, in the relative forms of waste management and seafood consumption.

By examining combined and distinct stakeholder groups (civil society and involved groups), we gain a better understanding of perceptions and nuanced responses to self-assessed behaviour and how these may differ between interest groups. The mixed-method approach combining quantitative questionnaires and qualitative interviews allows us to, on the one hand, gain a more representative picture of drivers of behaviour in Kendari as well as deeper insights into differences between groups and their perceptions about (micro)plastics in their local environment, which would not be possible within the constraints of single-method approaches.

Rationale for Pro-Environmental and Health-Protective Behaviour in the Local Context

The present study focuses on pro-environmental behaviour and health-protective behaviour. Pro-environmental behaviours are studied as they directly affect the planning, implementation and effectiveness of ground-up mitigation strategies for managing plastic

pollution in a local context. Understanding a population's past behaviours can help develop future mitigation strategies in the local context. Pro-environmental waste management behaviour includes, but is not limited to, reducing waste production, waste sorting, and recycling. Health-protective behaviour considers seafood consumption in the context of microplastic contamination. If increased knowledge of microplastic contamination leads to reduced seafood consumption, such a reduction could have socio-economic impacts.

Pro-Environmental Behaviour and Indonesia

Parameters influencing behaviour differ across the literature when dealing with behaviour and mitigating plastic pollution. Deng et al. (2020) suggest that attitudes and knowledge about microplastics can predict microplastic mitigation behaviours. Felipe-Rodriguez et al. (2022) expanded on this work, suggesting that information campaigns may benefit from combining facts about specific sources of microplastics with practical guidance on pro-environmental behaviour for mitigating microplastic sources. Garcia-Vazquez and Garcia-Ael (2021) found that knowledge of microplastics is central to the psychological framework of (micro)plastic pollution, directly connected with the willingness to adopt more pro-environmental behaviour, with risk perception and perceived control identified as less important. In Indonesia, Arifani and Haryanto (2018) observed that environmental knowledge positively impacted the intention to purchase a reusable shopping bag. However, though knowledge is a key term in past research, multiple predictors should be considered. For example, Hasan et al. (2015) found that among students in Malaysia, perceived behavioural control showed the strongest relationship with behaviour when reducing plastic consumption, compared to other variables.

This research provides a first step toward understanding the past and current behaviour of the Kendari City population in managing their waste, as well as the psychological factors behind this behaviour. Research-informed interventions have been identified as beneficial for governments and municipalities at local, national, or international levels to reduce plastic pollution (Pahl & Grünzner, 2023). Policies can influence people's behaviour, but practical implementation and the removal of barriers are crucial for achieving desired outcomes (Deng et al., 2020; Kollmuss & Agyeman, 2002). In Indonesia, the absence of robust waste management services and infrastructure may be a significant barrier, especially when compounded by further identified barriers, including socio-economic constraints, convenience, and effort.

Health-Protective Behaviour and Plastic Pollution in Indonesia

Prior research on marine pollutants in Indonesia has demonstrated an increased awareness, linked to a decreased willingness to consume seafood among housewives (Fercudani, 2015). Research on the health impacts of microplastics in seafood is still in its infancy. However, there is interest, especially from the governments of countries de-

pendent on fishing sectors, in determining whether a similar health-protective behaviour occurs with microplastics.

Seafood consumption behaviour is potentially crucial for communities that rely on seafood as a primary source of protein and income. Additionally, the fisheries sector is a valuable contributor to the Indonesian economy (Kementerian Kelautan dan Perikanan, 2013). In Southeast Sulawesi, the province where Kendari City sits, fisheries are the primary coastal income source and account for 149,200 tons (~2%) of the national captured fisheries production (Sholeh, 2018). As an essential source of protein and income, any changes in consumption due to emerging information regarding microplastic contamination are of concern and unknown.

Although emerging concerns about health and microplastics, especially associated chemicals, are growing, no established human health effects linked to microplastics have been identified (Naidoo et al., 2020). The emerging concerns are based on the detection of microplastics in seafood (Bakir et al., 2020), particularly in the edible parts, such as meat and muscle (Abbasi et al., 2018), as well as in seafood containing intestinal tracts (Van Cauwenberghe & Janssen, 2014). Additional concerns arise from the negative impacts on biota (Maes et al., 2020), the presence of contaminants within microplastics (Rodrigues et al., 2019), and the known effects of these contaminants on health. An expanded summary of this information is available in Supplementary Information (see SI 3 in Preston-Whyte et al., 2026). Though nanoplastics (1–1,000 nanometers; GESAMP et al., 2019) have been found to enter the bloodstream and traverse tissues (Leslie et al., 2022), for ease of communication in this study, only the term microplastics has been used.

What Are the Drivers of Behaviour in the Context of Plastics and Microplastics?

Previous work has designed frameworks to help us understand factors related to behaviour, utilising empirical data to confirm the relevance of factors such as knowledge, beliefs and self-efficacy. Engagement in behaviour aimed at protecting the environment or one's health can be captured through psychological theories such as the Theory of Planned Behaviour (TPB; Ajzen, 1985), Protection Motivation Theory (Rogers, 1983) and Value-Belief-Norm Theory (Stern, 2000; Stern et al., 1999). These combine knowledge, personal experiences, attitudes, beliefs, perceptions of threat, and other factors not directly captured by the present study, such as perceived behavioural control, values, and norms. Empirical studies have confirmed that factors such as concern (Oturai et al., 2022), experience (Owens, 2018), attitudes (Oztekin et al., 2017) and socio-cultural factors (Fian et al., 2025) were related to behavioural outcomes and support for policy in the context of plastics and microplastics. Notably, most of these studies were conducted with WEIRD samples focusing on outcomes such as recycling, consumer behaviour and policy support (see Heidbreder et al., 2019 for a review). One exception is a study by Simmons and Fielding (2019) in a coastal community in Sulawesi, Indonesia, which found that

the intention to prevent waste from entering the ocean was positively related both to attitudes toward waste disposal and to positive views of reef health, underscoring the importance of focusing on local context and behaviour.

What Psychological Factors Are Related to Behavioural Outcomes in the Context of (Micro)Plastics?

Studies on the perception of plastics, particularly microplastics, are limited and predominantly focused on outcomes such as risk perception and concern (Fian et al., 2025). Socio-demographic factors (i.e., gender, education, income, age, household size, and stakeholder category) are related to risk perception of (micro)plastics (Felipe-Rodrigues et al., 2024; Fian et al., 2025; Kramm et al., 2022) as well as pro-environmental behaviour (Soares et al., 2021). Older participants and women report higher risk perception for microplastics (Kramm et al., 2022) and more pro-environmental behaviours (Soares et al., 2021) in WEIRD contexts. Importantly, in quantitative studies, these associations are primarily small (e.g., Fian et al., 2025).

Subjective knowledge encompasses perceived factual knowledge (van der Linden, 2015), referring to the extent to which participants are aware of (micro)plastic pollution, thus enabling a consideration of cognitive factors. Other studies, e.g., Kramm et al. (2022), defined self-assessed knowledge as the participants' assessment of their knowledge through a rating system, specifically focusing on the emergence of microplastics, their distribution, impact, and what to do about them. They found that there was a positive association between knowledge (of microplastics) and risk perception. There may be a difference in knowledge level between plastics and microplastics pollution specifically (e.g., Dowarah et al., 2022); however, research shows that the public is transferring knowledge from macro- to micro- to close their uncertainties (Janzik et al., 2024). We hypothesise that increased subjective knowledge should be linked to both increased pro-environmental and health-protective behaviours.

Experience is considered direct personal experience, focusing on observed plastic pollution in specific environments with a time-frequency component. Here, we have included three forms of experience. These are plastic pollutants observed in the environment, plastic pollution observed closer to home (in the participants' neighbourhood) and observations of microplastic contamination in seafood. Personal experience reflects the experiential components (Fian et al., 2025). Personal experience is linked to increased risk perception through emotional reactions (Loewenstein et al., 2001), and thus potentially plays a crucial role in influencing behaviour. Here, we expect participants who have directly observed microplastic contamination in seafood to exhibit a health-protective response.

Concern is defined as the level of worry among the participants. Concern is considered for plastics and microplastics pollution separately. Concern is highly related to risk perception and worry to the extent that some researchers use these terms interchange-

ably (Kramm et al., 2022). Concern allows for the inclusion of the study's affective component. Through studying climate change, van der Linden (2015) developed the Climate Change Risk Perception Model (CCRPM), attributing 70% of the variance in risk perception to cognitive, experiential and socio-cultural factors. Personal concern is a valuable indicator (Smith & Leiserowitz, 2014) for knowledge and behaviour. While concern or risk perception is inherently subjective (Slovic, 1987), research indicates that concern has been a catalyst for adopting mitigating environmental behaviours (Jones et al., 2017). Although published after the data here was collected, Fian et al. (2025) successfully introduced the use of the CCRPM to gain insight into the public's perceptions of microplastics and policy regulations. The original CCRPM utilised sociodemographic, knowledge, affect, personal experience, social norms and values (van der Linden, 2015).

Attitude refers to the attitudes towards recycling, which may influence the participants' intention to engage in pro-environmental practices (Simmons & Fielding, 2019). Attitude allows for the inclusion of evaluative or affective aspects. Research suggests that attitude is an important determinant of behaviour as it considers one's degree of favourability towards a behaviour (Ajzen & Fishbein, 1977).

This study extends previous research by focusing on the relationship between socio-demographics, subjective knowledge, experience, concern, attitude (also known as belief), and two specific reported behaviour outcomes in the local context of Kendari City, Indonesia.

The Importance of the Inclusion of Different Stakeholder Groups

This study examines differences in behaviour among various stakeholder groups. In this study, stakeholder groups are categorised into combined stakeholders, civil society, and involved groups. The combined stakeholders considered all individuals who responded to the study. Civil society considers participants who fall outside the involved stakeholder group; they are members of the wider society who share a common interest in answering our study. Involved stakeholder groups comprise all participants within groups involved with plastic pollution research, prevention, or the fisheries industry, including academia/researchers, NGOs, fishers, the fish processing industry, and the government. By considering behaviours across stakeholder groups, we can understand the differences in knowledge and behaviour between groups. First, we expect differences in psychological links, such as subjective knowledge, experience, and concern, from involved groups compared with those who do not work with plastic pollution, microplastic contamination of seafood, or the fishing industry. Specifically, we expect researchers to have greater knowledge or more observations of microplastic contamination than other groups. However, Fian et al. (2025) demonstrated that in Austria, the involved groups broadly shared the concerns of wider society regarding microplastics in food. Second, by measuring different stakeholder groups, we may be able to observe differences in self-reported and

objective behaviour. For example, if people's willingness to consume seafood decreases, does the fishing industry observe a reduction in seafood consumption?

Current Research

In the current work, we employ a mixed-methods design to examine self-assessed behaviour and the psychological factors associated with plastic pollution and microplastic contamination in seafood in Kendari City, Indonesia. Furthermore, we consider these factors not only among civil society but also among individuals personally involved in plastic pollution and fisheries. In particular, we explore whether different psychological variables contribute to self-assessed behaviour regarding: (1) waste management, and (2) seafood consumption. Furthermore, we considered stakeholders' awareness of existing policies to combat plastic pollution, their views on their effectiveness, current challenges and potential future areas of mitigation focus.

Method

The purpose of the quantitative questionnaire and qualitative interviews was the same, and they were developed in parallel. Developed to complement each other, the quantitative questionnaire provides generalisations across Kendari City, with the qualitative interviews giving depth to our understanding. The initial research proposal aimed to examine public awareness of the impact of microplastic contamination of seafood and its effects on the fisheries sector in Kendari City, Indonesia. The main proposal, along with the development of a quantitative questionnaire and qualitative interviews, evolved to include pro-environmental behaviour.

Following a convergent parallel design (Edmonds & Kennedy, 2017), participants were recruited concurrently from Kendari City, Indonesia, for both the quantitative questionnaire and qualitative interviews, which aimed to gauge the population's response. The target sample was the adult population of Kendari City, including stakeholders covering civil society, academics, NGOs, fishers (subsistence and commercial), the fish processing industry, and the government, with additional questions for fishers/fish processing industry and government stakeholders. The questionnaire and interviews were conducted between October and December 2021. Both the questionnaire and interviews were conducted in Bahasa Indonesian, and there was no overlap in participants. SI 3 (Preston-Whyte et al., 2026) provides a detailed rationale for selecting Kendari City, Southeast Sulawesi, Indonesia, as the study site, along with details on the microplastic studies conducted here.

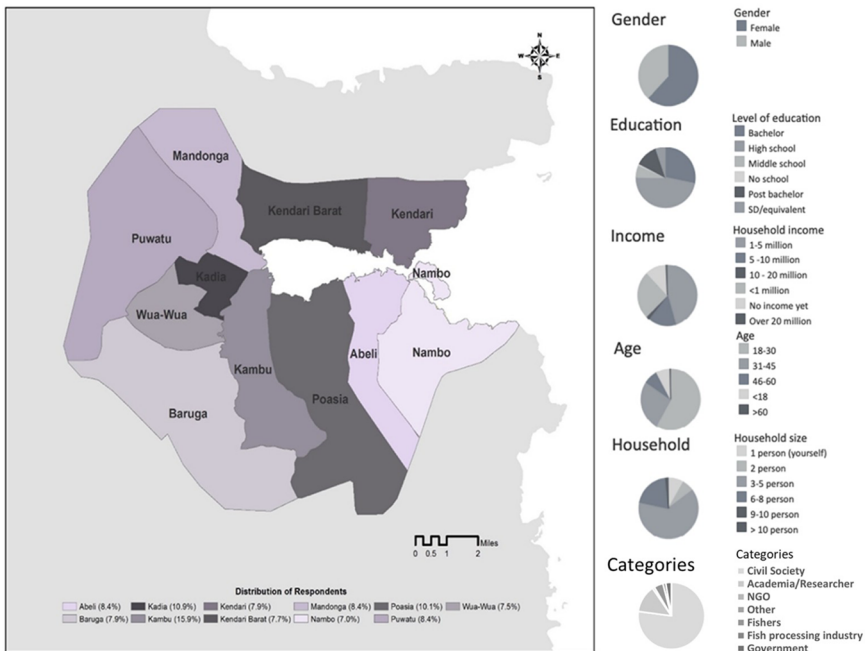
Quantitative Questionnaire Methods

Quantitative Questionnaire Participants

The sample of $N = 585$ respondents from the quantitative questionnaire was distributed across 11 sub-districts (Figure 1). For the analyses, we aimed for a final sample of 400 (Slovin formula, SI 3 (Preston-Whyte et al., 2026) for further information); however, 585 were attained. The socio-economic parameters of the sample are available in Figure 1. With a predominance of female participants (63%), the majority of respondents were aged 18–30 (58%) and 31–45 (26%). Senior high school leavers comprised the largest education group (47%), followed by undergraduates (28%). Approximately 46% of participants were from low-income backgrounds. The majority of respondents were from civil society (77%, $N = 451$), with academia/researchers accounting for 13% ($N = 78$), followed by fishers (4%, $N = 26$), government (3%, $N = 16$), fish processing industry (1%, $N = 8$) and NGO ($N = 6$). The sample matched the population in terms of age. However, the sample is limited and not fully representative of the population or stakeholders.

Figure 1

Geographic Distribution and Demographic Information of the Quantitative Questionnaire



Quantitative Questionnaire Procedure

The quantitative online form (via Google Forms) was shared across WhatsApp and Facebook network groups, including those for government officials, educators, and NGOs like Komunitas Teras. The questionnaire was further distributed via direct approach and public announcements on social networks, including LinkedIn, Facebook, and Twitter. Due to internet connectivity issues, certain sub-districts face challenges accessing online questionnaires, particularly among fishers in coastal areas. In these regions, online quantitative questionnaires were conducted in person to ensure an equitable distribution of participants and prevent exclusion. Therefore, 23% of the quantitative questionnaire was gathered through direct interviews (Abeli = 49, Nambo = 41, Kendari Barat = 45, Figure 1). These in-person interactions employed two approaches: door-to-door visits in the affected subdistricts and direct engagement with fishers at the harbour. The in-person quantitative questionnaires were conducted to address issues related to internet access and literacy. The team administering the in-person questionnaire received training to reduce bias and ensure a consistent understanding of the questions. Care was taken to avoid influencing the responses during all in-person questionnaires.

The opening paragraph (see SI 1 in Preston-Whyte et al., 2026) of the quantitative questionnaire introduces the research concept to participants, explains privacy and anonymity and obtains participants' consent. For the questionnaires where respondents were approached in person, the research concept was described (in similar wording to the opening paragraphs of the online questionnaire (SI 1, Preston-Whyte et al., 2026). As with the online questionnaire, privacy and anonymity were explained, and interviewees granted consent. Researchers read aloud each question. Interviewers spoke to each participant individually to prevent a group setting from influencing their answers.

Both electronic and in-person participants could leave the questionnaire at any time. Questionnaires did not continue without consent. In-person questionnaires provided the option to request additional information or raise any ethical concerns. All data was processed and will continue to be processed in strict adherence to the highest standards of anonymity (following both General Data Protection Regulation [GDPR] and Protection of Personal Information Act [POPIA]).

Measures and Quantitative Questionnaire Development

The quantitative questionnaire was initially developed in Bahasa Indonesia and translated into English during the development phase to facilitate coordination among authors. Once fully developed, the quantitative questionnaire was translated back into Bahasa for rollout. For the quantitative questionnaire, the English equivalent was aligned for analysis. Bahasa-English-speaking members of our research group did the translations. During the development and internal piloting phase, detailed internal discussions were conducted for each question to ensure the correct question and wording were used in Bahasa. The questions were developed without elicitation or word associations (Gelcich

et al., 2014). Our stakeholders have varying levels of literacy and vocabulary; with this in mind, questionnaires were constructed where possible, using basic vocabulary. Consideration of the question interpretation was applied to each question, to ensure the question was easy to understand (in the manner intended) and answer (Fowler, 1992; Lenzner & Menold, 2016). Despite this, some stakeholders still required explanations of specific terms for in-person questionnaires. Leading questions were avoided, time frames were made unambiguous, response categories matched the question, and they were organised systematically (Lenzner & Menold, 2016). The English translations are direct translations, and so any “unnaturalness” within the English questionnaire may be due to the direct translation.

The online quantitative questionnaire required all questions to be answered. However, only some questions had an “I do not know” option for participants who did not know the answer. For in-person questionnaires, participants could seek clarification from the interviewer, thereby overcoming any literacy barriers among the quantitative stakeholders (fishers or low-income civil society).

Measures of the Quantitative (Online) Questionnaire — SI 1 (see Preston-Whyte et al., 2026) contains the full English version of the quantitative questionnaire. The questionnaires consisted of general and stakeholder-specific questions, yielding both nominal and ordinal data. The questions that were used in, or adapted from, previous studies are detailed below and in Table 1. Any adaptations were applied to accommodate local or study-specific contexts. The remaining questions were created uniquely for this study. Each question, or group of questions, responded to a single psychological construct (Simmons & Fielding, 2019). All responses were given on a 5-point Likert scale, ranging from low agreement (or minimum) to high agreement (or maximum). The empirical factor for each measure was the average of the statement scores. Any variation from this is noted in Table 1 with the relevant corrections applied during the analysis step. Additional questions assessing responses beyond the described variables were also collected to gather background information and deepen our understanding.

Table 1

Questions Grouped to Provide a Latent Variable for All Psychological Constructs Explored, Their ‘Cronbach’s Alpha’ (α), Range and Associated Limitations

Topic/Cronbach’s alpha (α)/range/ source	Item	Scale
Subjective knowledge $\alpha = 0.83$ Range: 1–5 Adapted from van der Linden (2015), Kramm et al. (2022) and own specific context-dependent features.	Q14. Do you have practical knowledge of the various categories of waste? (e.g., organic, inorganic, plastic and hazardous waste, etc.).	5 - point rating scale from 1 (Never) to 5 (Yes, everyday)
	Q19. How knowledgeable are you on the types of plastic waste? (e.g., recyclability, different types of polymers).	5 - point rating scale from 1 (Know nothing) to 5 (Expert)
	Q20. Are you aware of plastic pollution?	5 - point rating scale from 1 (Know nothing) to 5 (Expert)
	Q28. Have you heard about interactions between plastic pollution and marine animals?	5 - point rating scale from 1 (Never) to 5 (Frequently)
	Q27. How knowledgeable are you about microplastics? (small pieces of plastic size less than 5 mm).	5 - point rating scale from 1 (Know nothing) to 5 (Expert)
	Q24. Are you aware of different marine litter sources and pathways?	5 - point rating scale from 1 (Know nothing) to 5 (Expert)
	Q35. Have you ever heard of plastic contamination of seafood in the Sulawesi Sea and Kendari Bay?	5 - point rating scale from 1 (Never) to 5 (Frequently)
	‘Q31. Are you aware of the risk of plastic to marine ecosystems and human health?	5 - point rating scale from 1 (Know nothing) to 5 (Expert)
	Q32. Are you aware of the risk of microplastics to marine ecosystems and human health?	5 - point rating scale from 1 (Know nothing) to 5 (Expert)
	Q25. Do you see plastic pollution in the area that you live?	5 - point rating scale from 1 (Nowhere) to 5 (Everywhere)
Plastic experience for waste management in their Neighbourhood ($\alpha = n/a$)		

Topic/Cronbach's alpha (α)/range/ source	Item	Scale
Range: 1–5 Adapted from van der Linden (2015).		
Plastic experience for waste management in the environment ($\alpha = \text{n/a}$) Range: 1–5 Adapted from van der Linden (2015).	Q26. How often do you observe plastic litter in the environment?	5 - point rating scale from 1 (Never) to 5 (Almost everyday)
Microplastic experience for consumption ($\alpha = \text{n/a}$) Range: 1–5 Adapted from van der Linden (2015).	Q36. Have you observed microplastic contamination of seafood in your area?	5 - point rating scale from 1 (Never) to 5 (Always)
Plastic concern ($\alpha = \text{n/a}$) Range: 1–5	Q29. Do you think we should be worried about plastics in the environment?	5 - point rating scale from 1 (Strongly disagree) to 5 (Strongly agree)
Microplastic concern ($\alpha = \text{n/a}$) Range: 1–5	Q30. Do you think we should be worried about microplastics in the environment?	5 - point rating scale from 1 (Strongly disagree) to 5 (Strongly agree)
Attitude $\alpha = \text{n/a}$ Range: 1–5	Q23. Is it important to recycle your plastic waste?	5 - point rating scale from 1 (Strongly disagree) to 5 (Strongly agree)
Self-assessed waste management behaviour ($\alpha = 0.58$) Range: 1–5	Q15. Do you do waste sorting at home? Q16. Level of waste sorting	5 - point rating scale from 1 (Never) to 5 (Yes, everyday) ^a 5 - point rating scale: None, 2 types of sorting (Organic and Inorganic), 2 types of sorting (Everything else and hazardous, e.g., batteries, e-waste), 3 types of sorting

Topic/Cronbach's alpha (α)/range/ source	Item	Scale
	Q18. Do you litter, dump or dispose of your waste unmanaged? Q22. Do you manage your plastic waste at home? (e.g., reduce, reuse and recycle).	(Organic, Recyclable and Nonrecyclable), 4 types of sorting (Organic, Recyclable, Nonrecyclable and Hazardous) ^b 5 - point rating scale from 1 (Almost every time) to 5 (Never) ^a 5 - point rating scale: Never, Almost never (Once a week), Sometimes (Two or three times a week), often (Four times a week), Almost everyday
Self-assessed willingness to consume ($\alpha = \text{n/a}$) Range: 1–5	Q38. Does the presence of (micro)plastics in seafood influence your willingness to consume fish or other marine products from your region?	5 - point rating scale from 1 (Strongly not influence) to 5 (Strongly influence)
Self-assessed consumption ($\alpha = \text{n/a}$) Range: 1–5	Q33. How often do you and your family consume fish or other marine products?	5 - point rating scale from 1 (Never) to 5 (Everyday)

Note. ^a In the questionnaire, this looks like it is not on a 5-point rating scale. However, this is due to a limitation in the survey software's layout. It is still a 5-point scale, increasing from minimum to maximum, and was converted to a 1–5 scale during analysis.

^b This question was accidentally placed in a reverse 5-point rating system with the maximum at 1. The relevant corrections were applied to these questions in the analysis step – to go from 1 (Never) to 5 (Almost everytime).

^c The questions posed knowledge of risks, i.e., environmental and human health (Q31), but did not allow for one to be answered over the other. This was to gain overall subjective knowledge of risk, while avoiding influencing questions on seafood consumption (which followed this question). Question Q28 focuses specifically on the respondent's knowledge of plastic pollution's interaction with marine animals. Any inference about the relative difference between environmental and human risk can be drawn by considering the two questions together.

Subjective knowledge, encompassing perceived factual knowledge (van der Linden, 2015), was assessed using nine questions. The questions focused on estimated knowledge of waste categories, types of plastic waste, plastic and microplastic pollution, emissions pathways, risks associated with (micro)plastic pollution, and contamination of local seafood. Questions resemble other measures employed in the context of subjective knowledge about microplastics (e.g., Kramm et al., 2022), while others aim to capture specific, context-dependent features of self-assessed knowledge. Cronbach's Alpha (Table 1) across all subjective knowledge questions was 0.83 (good).

Considering the experiential aspect, the *personal experience* questions were adapted from questions related to personal experience with climate change (van der Linden, 2015).

The *plastic experience* was considered in two parts. First, a *plastic experience for waste management in the participants' neighbourhood*, using a single question directed at observed plastic pollution in the participants' neighbourhood. Second, *plastic experience for waste management in the environment*, using one question directed at observed plastic pollution in the environment.

The *experience of microplastics in consumption* was measured using a single question that inquired about observations of microplastic contamination of seafood.

Plastics and microplastics concerns were each measured using a single question directed at: (1) plastic concern, and (2) microplastics concern.

Attitude was adapted from TPB (Ajzen, 1985) and assessed with a single question asking participants how important they felt it was to recycle plastic waste.

Self-assessed behaviour was measured as:

1. Waste management behaviour using four questions that indicate the extent to which participants are engaging with recycling, reduction of waste production, reuse, waste sorting and littering, which resulted in Cronbach's alpha (Table 1) of 0.58 (moderate).
2. Seafood consumption using: (A) a single question looking at willingness to consume seafood, and (B) a single question looking at seafood consumption.

Quantitative Questionnaire Data Analyses — Multiple Regression Analysis

All participants' responses were used in the quantitative analysis of the questionnaire.

Descriptive statistics are provided and further detailed in SI 5 (see Preston-Whyte et al., 2026).

Regarding the quantitative questionnaire, a Multiple Regression Analysis (MRA) was conducted. Utilising the 'lavaan' package in R, focusing on factor analysis, MRA was undertaken to understand self-assessed behaviour and the influence of variables. Our MRA analysis approach considered combined stakeholders (which combined all participants, $N = 585$), those who do not work within the fishing or plastic pollution space, i.e. civil society ($N = 451$) and involved groups (everyone working within fishing or plastic

pollution space, i.e. academia, NGOs, fishers, fish processing industry and government, $N = 134$). Within the stakeholder groupings, three sets of MRA were conducted regressing self-assessed behaviour regarding waste management ($\alpha = 0.58$, Table 1), willingness to consume, and seafood consumption, with the independent variables: subjective knowledge ($\alpha = 0.83$, Table 1), plastic experience for waste management in the participants neighbourhood, plastic experience for waste management in the environment, experience of microplastics in consumption, plastic concern, microplastic concern, and attitude.

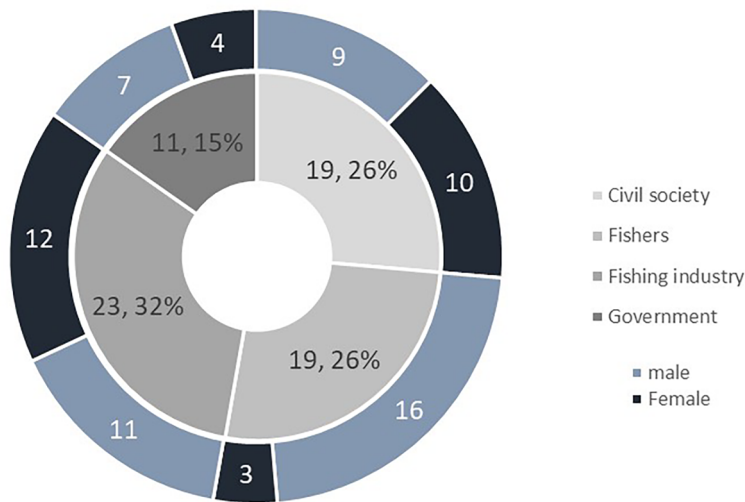
For academic interest, Ordered Logistic Regression (OLR) models were applied. The OLR results were similar to the MRA results and are provided in the SI 4 (Preston-Whyte et al., 2026) for interest.

Qualitative Interview Methods

Qualitative Interview Participants

For the qualitative interview analysis, we aimed for a final sample of 40 (purposive sampling, Sugiyono, 2013; SI 3, Preston-Whyte et al., 2026, for further information); however, a sample of $N = 72$ was attained. Figure 2 shows the socio-economic parameters of the sample. Males comprised the majority (60%). Respondents were among the fish processing industry (32%), fishers (26%), civil society (26%), and the government (15%).

Figure 2
Demographic Information of the Qualitative Questionnaire



Qualitative Interview Procedure

The team administering the in-person interviews received training to reduce bias and ensure a consistent understanding of the questions. Care was taken to avoid influencing the responses during all in-person interviews.

The qualitative interviews focused on government officials at different levels, including Southeast Sulawesi Province and Kendari City levels, seafood companies, fishermen, and civil society. For government stakeholders, the authors utilised diverse recruitment approaches (e.g., mailing lists, direct contact), focusing exclusively on officials from key government agencies, including the Ministry of Marine Affairs, environmental agencies at both provincial and local levels and fisheries agencies within regional and local governments. The researchers scheduled appointments and visited participants to conduct interviews with representatives from the fisheries industry. Refer to SI 2a (Preston-Whyte et al., 2026), the consent form, as part of the background information provided during the scheduling process. The following stakeholders were approached:

1. Three agencies manage the fisheries sector at both the provincial and local levels, including the Marine and Fisheries Agency of Southeast Sulawesi Province, the Directorate of Capture Fisheries of the Ministry of Marine and Fisheries, and the Marine and Fisheries Agency of Kendari City.
2. Three fisheries companies, including a state-owned and a privately owned company.
3. 30 local individual and group fishers.
4. 218 households of local civil society.

For the government and company qualitative interviews, participants were approached through official channels (email and telephone) to arrange appointments in advance. Stakeholders outside these groups were approached more informally door-to-door. Local networks played a crucial role in recruiting participants.

Regarding the qualitative semi-structured interviews, a consent form (SI 2a, Preston-Whyte et al., 2026) providing research context, privacy, and anonymity was provided, read, explained, and signed. For those formal interviews set up in advance, this consent form was provided before the interview and reiterated before it commenced. For those approached door-to-door, the information on this form was explained and signed in advance of the interview. Interviews were conducted individually.

Participants could leave the interview at any time. Interviews did not continue without consent. In-person interviews allowed participants to ask for additional information or raise any ethical concerns. All data was processed and will continue to be processed in strict adherence to the highest standards of anonymity (under both GDPR and POPIA).

Measures and Interview Development

The qualitative interview was initially developed in Bahasa Indonesia and translated into English during the development phase to facilitate coordination among authors. Once

fully developed, the qualitative interview questions were translated back into Bahasa for rollout. For the qualitative interviews, English translations were applied during analysis. Bahasa-English-speaking members of our research group did the translations. During the development and internal piloting phase, detailed internal discussions were conducted for each question to ensure the correct question and wording were used in Bahasa. The questions were developed without elicitation or word associations (Gelcich et al., 2014). Our stakeholders have varying levels of literacy and vocabulary; with this in mind, qualitative interview questions were constructed where possible using basic vocabulary. Consideration of the question interpretation was applied to each question, to ensure the question was easy to understand (in the manner intended) and answer (Fowler, 1992; Lenzner & Menold, 2016). Despite this, some stakeholders still required explanations of specific terms. Leading questions were avoided, and questions were organised systematically (Lenzner & Menold, 2016). The English translations are direct translations, and so any “unnaturalness” within the English interview questions/quotes may be due to the direct translation.

For in-person interviews, participants could seek clarification from the interviewer.

Empirical Methods and Measures of the Qualitative (In-Person) Interview – The qualitative semi-structured interview questions were designed to solicit feedback and data on each of these theoretically important concepts.

SI 2 (Preston-Whyte et al., 2026) contains the full English version of the qualitative (in-person) interview. A trained team collected qualitative data in Kendari City through in-person, semi-structured interviews with open-ended questions, which supported the online questionnaire. Information was gathered to deepen understanding of the participants' perspectives, barriers, motivations, and concerns.

Qualitative Interview Data Analyses

All participants' responses were utilised in the qualitative data analysis.

Regarding the qualitative interviews, the data, including interview records and notes, printed documents, and government statistics data, were organised and broken down into manageable units, categorised and organised by research concept/question (Bogdan & Biklen, 2007; Miles et al., 2014). The interview records were transcribed and translated into English for further analysis (Ochs, 1979). We clustered similar codes to construct fewer categories, then defined pattern codes (Miles et al., 2014). Coding to arrange the various responses by clustering, creating similar topics, and subsequently defining patterns (Miles et al., 2014) was conducted manually. Analysis included both thematic and content analysis. We filtered, clustered, and coded them into themes and sub-subthemes, and presented the results in two columns: frequency/co-occurrence and percentages, which were then interpreted. Coding was reviewed by at least two members of the research team to ensure consistency and theoretical coherence. Where possible, data

gained from participants and interpretations derived from the data were shared with key participants to ensure the accurate capture of their comments (Bogdan & Biklen, 2007).

Results

Quantitative Questionnaire Results

Descriptive Statistics

Figure 3 presents descriptive statistics for subjective knowledge, experience, and concern (further details in SI 5, Figures S1 and S2; Preston-Whyte et al., 2026), indicating that participants possess a moderate level of awareness ($M = 3.92$, $SD = 1.10$) regarding plastic pollution. Participants frequently observe plastic in the environment ($M = 3.82$, $SD = 1.04$). Additionally, participants regularly witness plastic pollution in their neighbourhood ($M = 3.96$, $SD = 1.04$). Participants expressed uncertainty about their level of awareness of microplastic pollution ($M = 2.61$, $SD = 1.15$). Participants have “rarely” heard about seafood microplastic contamination ($M = 2.44$; $SD = 1.25$). Observations of microplastics in seafood by respondents are infrequent ($M = 2.10$; $SD = 1.14$). Participants are highly aware of the risks associated with plastic pollution ($M = 4.14$, $SD = 1.04$). However, they show lower but still notable awareness of microplastics risks ($M = 3.78$, $SD = 1.17$). The participants “strongly agree” that there should be concern about plastics in the environment ($M = 4.62$, $SD = 0.77$). The participants “agree” that there should be concern about microplastic pollution ($M = 4.39$, $SD = 0.89$).

Multiple Regression Analyses (MRA)

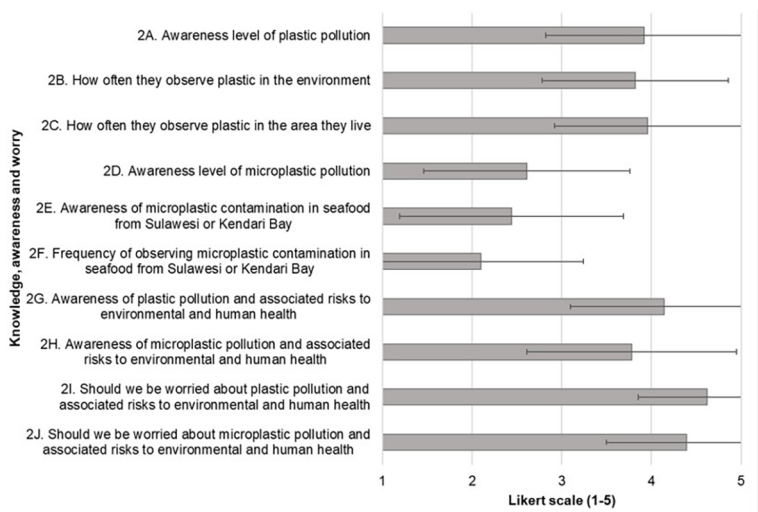
A comprehensive summary of the regression models is presented in Table 3, with a complementary summary and additional information provided in SI 4, Tables S2a and S2b (Preston-Whyte et al., 2026). Table 2 summarises the means, standard deviations, correlations and indicators of statistical significance for these correlations among the independent variables across the combined stakeholders, civil society and involved groups. Multicollinearity diagnostics (VIF) values were acceptable, and regression residuals showed no major violations of normality or homoscedasticity. Including demographic covariates (age, gender, education, income) improved model fit for self-assessed waste management behaviour and self-assessed consumption. The adjusted models did not alter the statistical significance of the main predictors and revealed that some demographic factors were also significant. Although the magnitude of the coefficient varied across models, the overall interpretation of the results remains unchanged (SI4, Tables S2c–e; Preston-Whyte et al., 2026).

Considering Table 2 and Table 3 together, higher subjective knowledge is associated with increased self-assessed pro-environmental behaviour among combined stakeholders, civil society and involved groups. Additionally, for combined and civil society stake-

holders, increased plastic experience in the environment and increased experience of microplastics in seafood are associated with increased self-assessed pro-environmental behaviour. Increased experience of plastic pollution in their neighbourhoods is associated with increased self-assessed pro-environmental behaviour for combined stakeholders but with a decrease in self-assessed pro-environmental behaviour for civil society stakeholders. Among combined stakeholders, civil society, and involved groups, higher subjective knowledge is associated with less willingness to consume seafood. For civil society, higher microplastic experience is associated with lower willingness to consume seafood. For civil society, increased self-assessed seafood consumption is associated with increased subjective knowledge. Increased self-assessed seafood consumption is associated with increased plastic and microplastic concerns among combined stakeholders and increased microplastic concerns among involved groups.

Figure 3

The Indonesian Quantitative Response (Mean and Standard Deviation) to B) Questions Regarding Some Subjective Knowledge, Awareness of Risk and Concern



Note. Mean results are shown. Error bars represent standard deviation.

Table 2

Means, Standard Deviations, And Correlations With Confidence Intervals for Combined Stakeholders, Civil Society and Involved Groups

Correlation Matrix										
Combined stakeholders (N = 585)										
	M	SD	1	2	3	4	5	6	7	8
1. Subjective knowledge	3.5	0.75								
2. Self-assessed waste management behaviour	2.87	0.76	.40**							
			[.33, .46]							
3. Plastic experience for waste management in the neighbourhood	3.96	1.04	.19**	0.01						
			[.11, .27]	[-.07, .09]						
4. Plastic experience for waste management in the environment	3.82	1.04	.30**	.20**	.37**					
			[.22, .37]	[.12, .28]	[.30, .44]					
5. Microplastic experience for consumption	2.1	1.14	.43**	.22**	0.05	.08*				
			[.36, .49]	[.14, .30]	[-.03, .13]	[.00, .16]				
6. Plastic concern	4.62	0.77	.25**	.15**	.25**	.28**	-.09*			
			[.17, .33]	[.07, .23]	[.17, .32]	[.20, .35]	[-.17, -.01]			
7. Microplastic concern	4.39	0.89	.40**	.19**	.24**	.30**	0.02	.70**		
			[.33, .47]	[.11, .27]	[.16, .32]	[.22, .37]	[-.06, .10]	[.66, .74]		
8. Attitude	4.38	0.99	.35**	.21**	.19**	.22**	0.06	.32**	.35**	
			[.28, .42]	[.13, .29]	[.11, .27]	[.14, .30]	[-.02, .14]	[.24, .39]	[.27, .42]	
9. Self-assessed consumption	4.13	0.94	.14**	.19**	.13**	.15**	-.002	.26**	.26**	.16**
			[.06, .22]	[.11, .26]	[.05, .21]	[.07, .23]	[-.10, .06]	[.18, .33]	[.19, .34]	[.08, .24]
10. Self-assessed willingness to consume	3.67	1.16	.31**	.21**	.14**	.18**	.16**	.20**	.24**	.21**
			[.24, .39]	[.13, .29]	[.06, .22]	[.10, .26]	[.08, .24]	[.12, .28]	[.16, .32]	[.13, .28]
Civil Society (N = 451)										0.07
										[-.02, .15]

Correlation Matrix		
1. Subjective knowledge	3.49	0.71
2. Self-assessed waste management behaviour	2.84	0.75 .38** [.30, .45]
3. Plastic experience for waste management in the neighbourhood	3.93	1.07 .19** -0.03 [.10, .28] [-.12, .06]
4. Plastic experience for waste management in the environment	3.78	1.06 .32** .18** .35** [.23, .40] [.09, .27] [.26, .42]
5. Microplastic experience for consumption	2.08	1.11 .42** .23** 0.05 0.08 [.34, .50] [.14, .31] [-.04, .14] [-.01, .17]
6. Plastic concern	4.59	0.81 .27** .16** .25** .27** -.11* [.18, .36] [.07, .25] [.16, .33] [.18, .35] [-.20, -.02]
7. Microplastic concern	4.36	0.9 .40** .20** .26** .30** -.01 .72** [.32, .48] [.11, .29] [.17, .35] [.22, .38] [-.10, .08] [.68, .76]
8. Attitude	4.37	1 .35** .18** .19** .20** 0.04 .31** .35** [.27, .43] [.09, .27] [.10, .28] [.11, .29] [-.06, .13] [.23, .39] [.27, .43]
9. Self-assessed consumption	4.08	0.94 .19** .20** .13** .14** -0.02 .24** .24** .19** [.10, .28] [.11, .29] [.04, .22] [.05, .23] [-.12, .07] [.15, .32] [.15, .32] [.10, .28]
10. Self-assessed willingness to consume	3.66	1.17 .30** .20** .14** .20** .18** .21** .26** .21** 0.09 [.22, .39] [.11, .29] [.05, .23] [.11, .29] [.09, .27] [.12, .30] [.17, .34] [.12, .30] [-.00, .18]
Involved Groups (N = 134)		
1. Subjective knowledge	3.55	0.85
2. Self-assessed waste management behaviour	2.97	0.78 .45** [.31, .58]
3. Plastic experience for waste management in the neighbourhood	4.06	0.96 .20* 0.13 [.04, .36] [-.04, .29]

Correlation Matrix									
4. Plastic experience for waste management in the environment	3.96	0.98	.23**	.27**	.45**				
			[.06, .39]	[.10, .42]	[.31, .58]				
5. Microplastic experience for consumption	2.17	1.23	.44**	.20*	0.04	0.08			
			[.29, .57]	[.03, .36]	[-.13, .21]	[-.09, .25]			
6. Plastic concern	4.7	0.65	.19*	0.13	.23**	.32**	-0.03		
			[.02, .35]	[-.04, .30]	[.07, .39]	[.16, .47]	[-.20, .14]		
7. Microplastic concern	4.5	0.86	.39**	0.14	0.15	.27**	0.13	.61**	
			[.24, .53]	[-.03, .31]	[-.02, .31]	[.10, .42]	[-.04, .30]	[.49, .71]	
8. Attitude	4.43	0.97	.35**	.30**	.20*	.28**	0.13	.34**	.34**
			[.19, .49]	[.14, .45]	[.03, .36]	[.12, .43]	[-.04, .30]	[.18, .48]	[.18, .48]
9. Self-assessed consumption	4.28	0.9	-0.01	0.12	0.09	0.16	-0.04	.31**	.33**
			[-.18, .16]	[-.05, .28]	[-.09, .25]	[-.01, .32]	[-.20, .13]	[.15, .45]	[.18, .48]
10. Self-assessed willingness to consume	3.69	1.16	.35**	.25**	0.15	0.11	0.1	0.16	.17*
			[.19, .49]	[.09, .41]	[-.02, .31]	[-.06, .28]	[-.08, .26]	[-.01, .32]	[.00, .33]
								.20*	-.02
								[.03, .36]	[-.19, .15]

Note. M and SD are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014).

* $p < .05$. ** $p < .01$.

Table 3

Multiple Regression Analysis to Explore the Dependent Variables of Self-Assessed Waste Management Behaviour, Willingness to Consume Seafood and Seafood Consumption

Regression Analysis						
Combined Stakeholders (N = 585)						
Self-Assessed Waste Management Behaviour						
Variable	Estimate	SE	t value	Pr (> t)	CI (lower)	CI (upper)
(Intercept) ^a	1.15	0.21	5.43	< 0.001***	0.74	1.57
Subjective knowledge ^c	0.32	0.05	6.46	< 0.001***	0.22	0.41
Plastic experience for waste management in the neighbourhood ^f	-0.09	0.03	-3.13	< 0.01**	-0.15	-0.04
Plastic experience for waste management in the environment ^g	0.09	0.03	2.82	< 0.01**	0.03	0.15
Microplastic experience for consumption ^h	0.06	0.03	2.10	0.04*	0.00	0.12
Plastic concern	0.07	0.05	1.25	0.21	-0.04	0.17
Microplastic concern	-0.01	0.05	-0.24	0.81	-0.10	0.08
Attitude	0.06	0.03	1.85	0.06.	0.00	0.12
• Residual standard error: 0.6893 on 577 degrees of freedom						
• Multiple R ² : 0.1907, Adjusted R ² : 0.1809						
• F-statistic: 19.42 on 7 and 577 DF, p-value: < 2.2e-16						
Self-Assessed Willingness to Consume						
(Intercept) ^b	0.88	0.34	2.62	< 0.01**	0.22	1.54
Subjective knowledge ^d	0.30	0.08	3.89	< 0.001***	0.15	0.45
Plastic experience for waste management in the neighbourhood	0.04	0.05	0.85	0.40	-0.05	0.13
Plastic experience for waste management in the environment	0.06	0.05	1.14	0.26	-0.04	0.15
Microplastic experience for consumption	0.07	0.05	1.61	0.11	-0.02	0.16
Plastic concern	0.09	0.08	1.11	0.27	-0.07	0.26
Microplastic concern	0.09	0.08	1.20	0.23	-0.06	0.24
Attitude	0.09	0.05	1.69	0.09.	-0.01	0.19
• Residual standard error: 1.092 on 577 degrees of freedom						
• Multiple R ² : 0.1308, Adjusted R ² : 0.1202						
• F-statistic: 12.4 on 7 and 577 DF, p-value: 7.822e-15						
Self-Assessed Consumption						
(Intercept) ^a	2.30	0.28	8.31	< 0.001***	1.75	2.84
Subjective knowledge	0.05	0.06	0.85	0.40	-0.07	0.18
Plastic experience for waste management in the neighbourhood	0.03	0.04	0.84	0.40	-0.04	0.11
Plastic experience for waste management in the environment	0.04	0.04	1.01	0.31	-0.04	0.12
Microplastic experience for consumption	-0.04	0.04	-0.96	0.34	-0.11	0.04
Plastic concern ^j	0.14	0.07	1.99	0.05*	0.00	0.27
Microplastic concern ^k	0.13	0.06	2.15	0.03*	0.01	0.26
Attitude	0.05	0.04	1.13	0.26	-0.03	0.13
• Residual standard error: 0.8976 on 577 degrees of freedom						
• Multiple R ² : 0.08958, Adjusted R ² : 0.07854						
• F-statistic: 8.111 on 7 and 577 DF, p-value: 1.972e-09						
Civil Society (N = 451)						
Self-Assessed Waste Management Behaviour						
(Intercept) ^a	1.24	0.24	5.22	< 0.001***	0.77	1.70
Subjective knowledge ^c	0.29	0.06	4.88	< 0.001***	0.17	0.40

Regression Analysis						
Plastic experience for waste management in the neighbourhood ^f	-0.11	0.03	-3.35	< 0.001***	-0.18	-0.05
Plastic experience for waste management in the environment ^g	0.07	0.03	2.04	0.04*	0.00	0.14
Microplastic experience for consumption ^h	0.08	0.03	2.40	0.02*	0.01	0.15
Plastic concern	0.06	0.06	0.96	0.34	-0.06	0.17
Microplastic concern	0.03	0.06	0.59	0.55	-0.08	0.14
Attitude	0.04	0.04	1.21	0.23	-0.03	0.11
• Residual standard error: 0.6877 on 443 degrees of freedom						
• Multiple R^2 : 0.1804, Adjusted R^2 : 0.1674						
• F -statistic: 13.93 on 7 and 443 DF, p -value: 2.406e-16						
Self-Assessed Willingness to Consume						
(Intercept) ^b	0.81	0.38	2.15	0.03*	0.07	1.55
Subjective knowledge ^d	0.22	0.09	2.39	0.02*	0.04	0.41
Plastic experience for waste management in the neighbourhood	0.03	0.05	0.53	0.59	-0.08	0.13
Plastic experience for waste management in the environment	0.08	0.05	1.45	0.15	-0.03	0.19
Microplastic experience for consumption ⁱ	0.13	0.05	2.38	0.02*	0.02	0.23
Plastic concern	0.08	0.09	0.83	0.41	-0.11	0.26
Microplastic concern	0.14	0.09	1.63	0.10	-0.03	0.32
Attitude	0.10	0.06	1.66	0.1.	-0.02	0.21
• Residual standard error: 1.092 on 443 degrees of freedom						
• Multiple R^2 : 0.1386, Adjusted R^2 : 0.125						
• F -statistic: 10.18 on 7 and 443 DF, p -value: 7.683e-12						
Self-Assessed Consumption						
(Intercept) ^a	2.19	0.31	7.04	< 0.001***	1.58	2.81
Subjective knowledge ^e	0.16	0.08	2.02	0.04*	0.00	0.31
Plastic experience for waste management in the neighbourhood	0.04	0.04	0.94	0.35	-0.04	0.13
Plastic experience for waste management in the environment	0.02	0.05	0.53	0.59	-0.06	0.11
Microplastic experience for consumption	-0.06	0.04	-1.32	0.19	-0.14	0.03
Plastic concern	0.13	0.08	1.69	0.09.	-0.02	0.29
Microplastic concern	0.06	0.07	0.86	0.39	-0.08	0.21
Attitude	0.08	0.05	1.60	0.11	-0.02	0.17
• Residual standard error: 0.9035 on 443 degrees of freedom						
• Multiple R^2 : 0.09133, Adjusted R^2 : 0.07697						
• F -statistic: 6.361 on 7 and 443 DF, p -value: 3.873e-07						
Involved Groups (N = 134)						
Self-Assessed Waste Management Behaviour						
(Intercept) ^a	1.02	0.50	2.06	0.04*	0.04	2.01
Subjective knowledge ^c	0.38	0.09	4.30	< 0.001***	0.21	0.56
Plastic experience for waste management in the neighbourhood	-0.05	0.07	-0.67	0.50	-0.19	0.09
Plastic experience for waste management in the environment	0.14	0.07	1.95	0.05	0.00	0.28
Microplastic experience for consumption	0.01	0.05	0.09	0.93	-0.10	0.11
Plastic concern	0.05	0.12	0.43	0.67	-0.19	0.30
Microplastic concern	-0.12	0.10	-1.29	0.20	-0.31	0.07
Attitude	0.12	0.07	1.69	0.09.	-0.02	0.26
• Residual standard error: 0.6916 on 126 degrees of freedom						
• Multiple R^2 : 0.2588, Adjusted R^2 : 0.2176						
• F -statistic: 6.285 on 7 and 126 DF, p -value: 2.477e-06						
Self-Assessed Willingness to Consume						
(Intercept)	1.13	0.79	1.43	0.16	-0.44	2.70

Regression Analysis						
Subjective knowledge ^d	0.47	0.14	3.30	< 0.01**	0.19	0.75
Plastic experience for waste management in the neighbourhood	0.08	0.11	0.66	0.51	-0.15	0.30
Plastic experience for waste management in the environment	-0.03	0.12	-0.26	0.80	-0.26	0.20
Microplastic experience for consumption	-0.05	0.09	-0.62	0.54	-0.23	0.12
Plastic concern	0.14	0.20	0.74	0.46	-0.24	0.53
Microplastic concern	-0.04	0.15	-0.26	0.79	-0.34	0.26
Attitude	0.08	0.11	0.68	0.50	-0.14	0.30
• Residual standard error: 1.103 on 126 degrees of freedom						
• Multiple R^2 : 0.1407, Adjusted R^2 : 0.09298						
• F -statistic: 2.948 on 7 and 126 DF, p -value: 0.006806						
Self-Assessed Consumption						
(Intercept) ^a	2.40	0.61	3.93	< 0.001***	1.19	3.61
Subjective knowledge	-0.16	0.11	-1.42	0.16	-0.37	0.06
Plastic experience for waste management in the neighbourhood	0.02	0.09	0.18	0.86	-0.16	0.19
Plastic experience for waste management in the environment	0.07	0.09	0.82	0.42	-0.10	0.25
Microplastic experience for consumption	0.00	0.07	-0.05	0.96	-0.14	0.13
Plastic concern	0.20	0.15	1.35	0.18	-0.09	0.50
Microplastic concern ^k	0.33	0.12	2.78	< 0.01**	0.09	0.56
Attitude	-0.08	0.09	-0.91	0.37	-0.25	0.09
• Residual standard error: 0.8517 on 126 degrees of freedom						
• Multiple R^2 : 0.1598, Adjusted R^2 : 0.1131						
• F -statistic: 3.424 on 7 and 126 DF, p -value: 0.002195						

Note. Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

^a The intercepts for self-assessed waste management behaviour and consumption are highly significant across combined stakeholder groups, civil society and involved stakeholder groups, suggesting a strong baseline perception of waste management behaviour and consumption.

^b However, the intercepts for self-assessed willingness to consume, only combined stakeholder groups and civil society, are significant.

^c Subjective knowledge and self-assessed waste management behaviour were significantly correlated across combined stakeholder groups, civil society and involved stakeholder groups.

^d Subjective knowledge appeared to influence willingness to consume significantly across combined stakeholder groups, civil society and involved stakeholder groups.

^e Subjective knowledge appeared only to influence civil society participants' self-assessed consumption significantly.

^f A significant relationship between plastic experience for waste management in the neighbourhood and self-assessed waste management behaviour for combined stakeholders and civil society groups.

^g A significant relationship between plastic experience for waste management in the environment and self-assessed waste management behaviour for combined stakeholders, and civil society groups.

^h A significant relationship between microplastic experience for consumption and self-assessed waste management behaviour for combined stakeholders, and civil society groups.

ⁱ Microplastic experience for consumption appeared to influence civil society participants' self-assessed willingness to consume significantly.

^j Plastic concern significantly influences self-assessed consumption for combined stakeholders, but not for any particular stakeholder group.

^k Microplastic concern indicates a significant influence on the combined and involved group participants' self-assessed consumption.

Qualitative Interview Results

The qualitative results, organised into themes, are presented in Figure 4.

For the combined stakeholders (Figure 4A), the qualitative data reveals a mid (46%) to high (35%) level of self-assessed subjective knowledge, with 58% recognising plastic pollution as lethal to marine species, human health and the environment. The civil society stakeholders (Figure 4B) have a mid (90%) level of self-assessed subjective knowledge, with 100% recognising plastic pollution as lethal to marine species, human health and the environment. The involved stakeholders (Figure 4C) have a range of self-assessed subjective knowledge, with high (44%), mid (29%), and low (27%) levels, and 46% recognise plastic pollution as sublethal to marine species, human health, and the environment.

Figure 4A

The Indonesian Qualitative Interview Results Organised by Themes for Combined Stakeholders (N = 72)

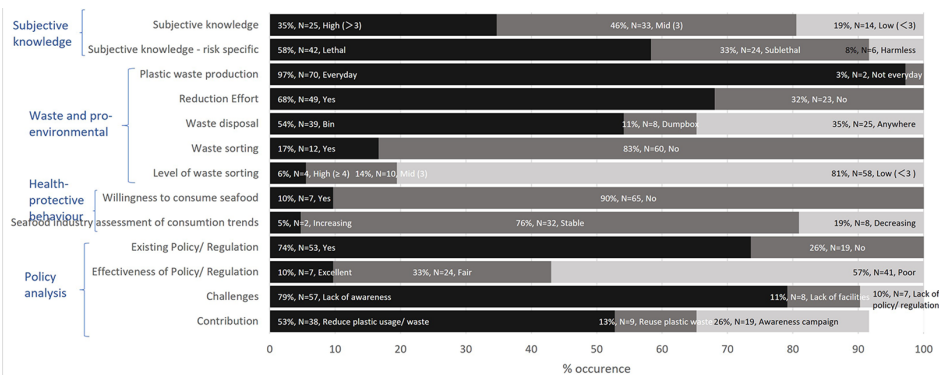


Figure 4B

The Indonesian Qualitative Interview Results Organised by Themes for Civil Society (N = 20)

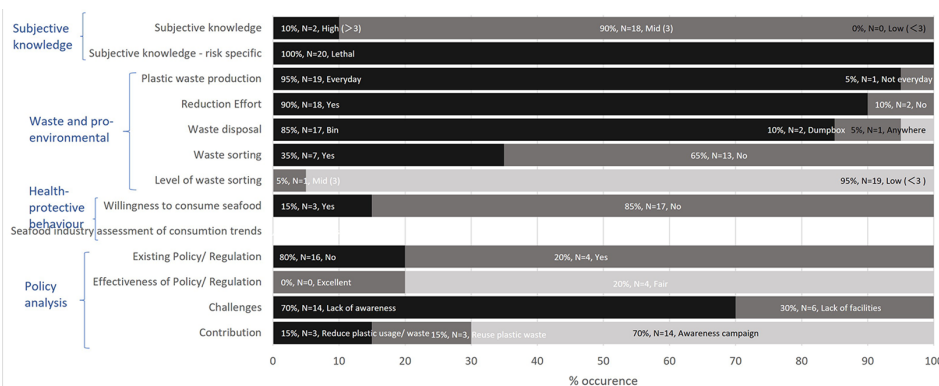
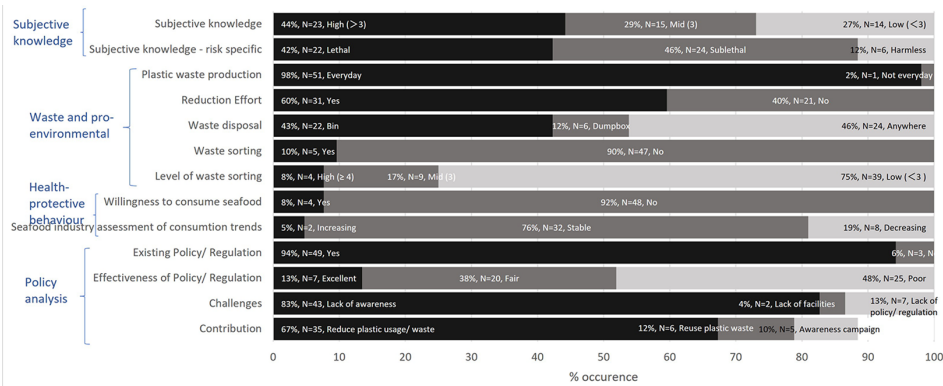


Figure 4C

The Indonesian Qualitative Interview Results Organised by Themes for Involved Groups (N = 52)



Regarding pro-environmental waste management behaviour, 97% of combined stakeholders (Figure 4A), 95% of civil society (Figure 4B), and 98% of involved groups (Figure 4C) produce plastic waste every day. Plastic waste reduction efforts are practised by 68% of combined stakeholders (Figure 4A); however, 83% do not practice waste sorting, and 35% still dispose of it indiscriminately. A minor fraction (17%) engages in waste sorting, predominantly at a low level (81%). Regarding civil society (Figure 4B), 90% reported engaging in plastic waste reduction efforts. However, 65% do not practice waste sorting, and only 5% still dispose of it indiscriminately. Waste sorting is predominantly at a low level (95%). Regarding involved groups (Figure 4C), 60% practice plastic waste reduction efforts; however, 90% do not practice waste sorting, and 46% still dispose of it indiscriminately. A minor fraction (10%) engages in waste sorting, predominantly at a low level (75%).

Considering health-protective behaviour, most (90%) combined stakeholders (Figure 4A) do not consider (micro)plastic contamination of seafood to affect their willingness to consume seafood. Most (85%) of civil society (Figure 4B) do not consider (micro)plastic contamination of seafood to affect their willingness to consume seafood. Most (92%) of the involved stakeholders (Figure 4C) do not consider (micro)plastic contamination of seafood to affect their willingness to consume seafood. Seventy-six percent of respondents in the fishing and seafood processing industry perceive their productivity and profits as stable (Figure 4A and Figure 4C).

Regarding policy regulations on plastic pollution, 74% of the combined stakeholders were aware of existing policy regulations related to waste management. However, 57% perceived the current policies or regulations as ineffective. Additionally, 79% of participants identified the most significant challenge in addressing plastic/microplastic pollu-

tion as a lack of awareness. The emphasis is placed on reducing plastic usage and waste, with 53% and 26% considering it more crucial than awareness campaigns and programs. Regarding civil society (Figure 4B), 20% of respondents were aware of policy regulations related to waste management. However, 80% perceived the current policies or regulations as ineffective. Additionally, 70% of participants identified the most significant challenge in addressing plastic/microplastic pollution as a lack of awareness. The emphasis is on awareness campaigns (70%) as most participants already practice reducing plastic use and waste. Regarding the involved stakeholder groups (Figure 4C), 94% of respondents were aware of existing waste management policies. However, 48% perceived the current policies or regulations as ineffective. Additionally, 85% of participants identified the most significant challenge in addressing plastic/microplastic pollution as a lack of awareness. The emphasis is on reducing plastic use and waste, with 67% considering it more crucial than awareness campaigns and programs.

Key identified quotes from the qualitative interviews are provided in Table 4, with their importance highlighted in the table’s footnotes. Participants regularly experience plastic pollution in a wide range of environments. For participants, the blocking and related flooding of sewers and storm drains are of notable concern, as is the human health and ecosystem risks. The fishers themselves identify additional risks they face in their industry, such as entanglement with plastic pollution. Participants exhibit varying levels of knowledge regarding waste and plastic waste. Participants demonstrate a discrepancy in their understanding of organic/inorganic waste. Levels of concern about microplastic contamination in seafood varied between participants. However, participants overwhelmingly did not consider microplastic contamination to affect their seafood consumption. Many participants do not consider the deep-sea fish they eat to be contaminated by microplastics. Fishing industry stakeholders see their profits as currently stable but acknowledge the possibility of future impacts.

Table 4
Indonesian Qualitative Interviews Results Through Key Quotes: Summarising the Interviews

Discourse and Dimension	Detailed Example Quotes and Stakeholder Group Source
Subjective Knowledge and Concern	
^a Regular observation	“What I see is a lot of plastic waste scattered in the sea.” (involved group – fisher) “...in the new Kendari Bay, there is a lot of plastic waste. In the middle of the sea, it is still rare.” (involved group – fisher)
^b Upstream risk	“Yes, I know that plastic waste can cause blockage of sewer lines.” (involved group – fisher and fishing industry) “Can cause flooding.” (repeated across 1 civil society, 4 involved groups – 1 fisher, 1 government, 1 fishing industry) “Can cause blockage.” (repeated by 2 involved groups – fishers) “I think we have to because garbage usually causes disasters, such as floods.” (civil society)

Discourse and Dimension	Detailed Example Quotes and Stakeholder Group Source
^c Risk on human and ecosystem health	<i>“Marine ecosystems can be polluted due to plastic waste, for example, there are fish that die from eating plastic waste, and if humans consume fish, it will also be dangerous for humans.”</i> (involved group – fishers quote, concept echoed by 1 civil society, 2 involved group – government and fisher) <i>“More to the food chain, the process is from fish eating plastic waste – humans eating fish so it will endanger health.”</i> (involved group – government) <i>“It is possible for the fish to consume the small-sized waste. It is dangerous because we consume them.”</i> (repeated by 1 civil society, 1 involved group – government) <i>“The accumulation of plastic waste in the sea will cause long-lasting serious impacts such as damaging marine ecosystems, disrupting the marine’s life food chain, increasing pollution, damaging fish and others that can be consumed by humans.”</i> (involved group – government)
^d Risk to fishing industry	<i>“It is polluted because it hinders the fishermen’s way in the sea. For example: usually, there is sack-like garbage attached to the propeller of a boat which stops the boat’s motion and once a boat propeller even fell due to being entangled in sack-like garbage.”</i> (involved group – fishers) <i>“I don’t know. I only know that it hinders the way at the sea and sometimes entangled to boat propellers.”</i> (involved group – fishers) <i>“I have, for example, fish in Karamba often enter plastic bags. Yesterday I catch fish from the sea, and it was polluted by plastic waste.”</i> (concept repeated by 2 involved groups – fishers)
^e Worry or concern	<i>“Yes, I’m worried, especially cases of plastic waste pollution are increasing.”</i> (civil society quote, similar quote echoed by 3 civil society, 5 fishers) <i>“Concerned, so we must be selective when choosing fish or other type of seafood.”</i> (civil society quote, similar quote echoed by 2 civil society and 1 involved group – government) <i>“Concerned because we could also get contaminated.”</i> (civil society) <i>“Very concerned because of the chemical content of the plastic.”</i> (involved group – fisher)
Self-Assessed Waste and Pro-Environmental Behaviour	
^f High level of knowledge	<i>“The domestic waste mostly from the river flow. From what we know, the current condition of waste processing has the potential to penetrate around 300 tons per day... Approximately, there are 80 tons of waste goes into canal every day. Night activity. As for the night activity around the coast, there are janitor whose job to cleans it every night (waste from merchant activities).”</i> (involved group – government) <i>“3 ISO 1402015 group regarding environmental management, namely liquid waste, industry, solid waste managed eight cubic meters per day, and B3 waste” / “B3 type of waste comes from industrial waste and hospitals. All sectors produce plastic waste, starting from restaurants, households, offices and so on. Organic waste from restaurants and households.”</i> (involved group – government)
^g Organic waste	<i>“Plastic waste and food waste are sorted because usually, we use organic waste for fertiliser, just store it under the plants.”</i> (similar quotes by 2 civil society) <i>“Separated waste that is used as fertiliser and that is not used as fertiliser.”</i> (civil society)
^h Discrepancy in organic knowledge	<i>“Yes, I know [about plastic pollution] because it takes a long time to decompose, stays on the ground and pollutes the environment. If it’s in the sea, it can be eaten and attached to the bodies of marine life.”</i> (involved group – government) <i>“Because it takes time when you’re in a hurry you want instantaneously, so you forget to sort it, but for organic waste, like leftover food, you just throw it away at the back of the house.”</i> (involved group – government)
ⁱ Lack of infrastructural support	<i>“It is usually disposed of into the sea if dry waste such as plastic and leaves is usually burned, but if it cannot be burned, it will be thrown into the sea.”</i> (involved group – fisher) <i>“Behind the house, piled them up and then burned.”</i> (involved group – fisher) <i>“Infront of the house.”</i> (involved group – fisher) <i>“If plastic is usually burned, if organic waste is disposed of at home.”</i> (involved group – fishing industry) <i>“Actually, it’s important, simply there is no place (container), so it [recycling] cannot be done...”</i> (involved group – fisher)

Discourse and Dimension	Detailed Example Quotes and Stakeholder Group Source
	“...the scavengers, however, participate around 5 to 10% in managing the waste...” (involved group – government, concept echoed by government and fishing industry) “Everything is diverted to the sea (and there are about 190 that go to landfills. The rest end in the river, but some are taken by scavengers, so if we do the math, they participate to decrease about 10%.” (involved group – government) “Customers in Srikandi would frequently gather their empty water bottles and give them to scavengers.” (involved group – fishing industry)
Self-Assessed Health-Protective Behaviour	
^j No perceived effect of microplastics on consumption patterns	“Not affecting. I’m still eating fish every day.” (quote from civil society, but concept repeated across stakeholder groups) “Maybe it will have an effect, but not too big of an impact. It’s unlikely to have a big impact because the community is still new to things like this, so it might not have too much of an impact.” (involved group – fishing industry)
^k Rational	“In spite of being concerned, still fish is a basic necessity, and there has been no success in finding a solution.” (involved group – government) “Not at all, because the fish was captured far in the deep ocean where it was not reached by the plastic pollution.” – (quote from civil society, this concept is repeated across 13 interviews)
^l Fishers and fish processing industry perception of consumption patterns	“Not for now, but maybe in the future.” (involved groups – 2 governments, 1 fishing industry)

Note. ^a Participants report a wide range of places where they observe plastic regularly, with many mentioning “around the house”, “on the side of the roads”, “rivers”, “canals”, and “in the sea” – with a focus on “Kendari Bay”.

^b Participants identified blockages of sewers and stormwater drains, resulting in flooding, as an upstream plastic pollution risk.

^c Participants identify “human health” and ecosystem risks (“ocean”, “marine animals”, “ocean animals”), with “fish eat[ing] plastic”.

^d Fisher stakeholders noted the direct risks of plastic pollution to fishing.

^e Concerning worry or concern, the sentiment appears varied throughout the interviews, especially concerning seafood contamination.

^f Regarding self-assessed waste and pro-environmental behaviour, participants exhibit varying knowledge levels regarding waste and plastic waste. High levels of subjective knowledge are evident, while the phrase “I do not know” is also frequently used across interviews. Those with a high level of subjective knowledge provide detailed information, including quantities produced and standard practices.

^g There is a more precise comprehension of terms like “organic and inorganic” or “wet and dry waste” and, at the very least, “organic and plastic waste”. The responses also indicate that home composting occurs.

^h Certain participants demonstrate a discrepancy in their understanding of inorganic waste and perceive inorganic waste as compostable, simply taking a long time to decompose. “inconvenience”, “time”, and “it’s complicated” are listed as reasons why some participants do not sort waste. Interestingly, it is noted that at least one participant did not consider separating organic waste as a form of sorting.

ⁱ Although some participants experience waste collection at a “Temporary disposal site”, the lack of infrastructure for waste collection and recycling, as well as the importance of waste pickers (referred to as “scavengers”), are highlighted.

^{j-k} While individual concerns about plastic pollution in seafood are noted, participants do not think microplastics affect their consumption habits. Participants provide some reasons.

¹ Industry stakeholders self-assessed their productivity and profits as currently stable but acknowledged the possibility of future impacts.

Discussion

We sought to investigate the psychological links between knowledge of plastic and microplastic pollution and self-assessed behaviour. We considered different psychological variables (knowledge, experience, concern, and attitude) and their contribution to: (I) pro-environmental behaviour through waste management, and (II) health-protecting behaviour through seafood consumption. We considered these behaviours from the perspectives of combined stakeholders, civil society and involved groups. The current research employs a mixed-methods approach and contributes to the growing body of research exploring environmental issues and the psychological links to pro-environmental and health-protective behaviours. The study focuses on Kendari City, Indonesia, an underrepresented non-WEIRD country that is economically dependent on seafood, which serves as a primary protein source, yet experiences a disproportionately high leakage of plastic pollution into the marine environment.

Psychological Links of Plastic and Microplastic Pollution and Pro-Environmental Behaviour

Our quantitative results suggest that self-assessed pro-environmental behaviour is positively linked to self-assessed subjective knowledge among combined stakeholders, civil society, and involved groups. Additionally, for combined stakeholders and civil society, this behaviour is positively related to their experience of plastic pollution in the environment and of microplastic contamination of seafood. Greater experience of plastic pollution in neighbourhoods is associated with higher self-assessed pro-environmental behaviour when all stakeholders are considered together, but with lower self-assessed pro-environmental behaviour among civil society stakeholders. The qualitative interviews introduce nuances to subjective knowledge and self-assessed pro-environmental behaviour, with mid (46%) to high (35%) subjective knowledge among combined stakeholders, and only behaviour focused on reducing plastic waste production shows as a sufficient pro-environmental behaviour (68%) for combined stakeholder groups. However, this rises to 90% for civil society.

Past research has shown that knowledge or awareness influences individual perceptions of waste management behaviour (Deng et al., 2020) or willingness to adopt pro-environmental behaviour (Garcia-Vazquez & Garcia-Ael, 2021). Our MRA shows that increased subjective knowledge is associated with increased pro-environmental behaviour ($p < .001$, Table 2 and Table 3).

The results of both the questionnaire and interviews acknowledge that pro-environmental practices are not daily practices. The interviews underscore reasons for this,

citing “*inconvenience*,” “*time*,” and “*complicated*”. This finding is consistent with the TPB framework — if these actions were perceived as easier to do or people had higher self-efficacy to do them, engaging in waste management may be easier. The implication is: how can we make it easier for people? Further factors underpinning the above reasons may include service delivery, infrastructure deficiencies, or alternative reduction or disposal costs. Household waste management strategies are contingent on available services. In Kendari City, 32% of waste (by weight) remains uncollected, underscoring the lack of collection and recycling. Participants in the qualitative interviews emphasised the importance of waste pickers, often referred to as “*scavengers*”, in the absence of adequate waste management services.

Understanding the existing pro-environmental behaviour is essential. In the qualitative interviews, though there is variation between stakeholder groups, most participants reported practising plastic waste reduction (64% of combined stakeholders, 90% of civil society and 60% of involved groups, Figure 4), and both the questionnaire and survey results indicate that when sorting occurs, sorting out organics is the dominant practice (SI 5, Figure S4c, Preston-Whyte et al., 2026; and Table 4;). Reduction of waste production is recognised as important, as expressed by one respondent, “*in light of a large amount of unmanaged solid waste, particularly plastic, the only way to handle it was by reducing the waste*”. Participants show competence regarding separating organic waste, expressed in different terms. However, it is noteworthy that not all qualitative participants recognised removing organic waste as sorting, indicating a potential underestimation.

The importance of subjective knowledge in promoting more pro-environmental waste management practices suggests an opportunity to extend efforts to assess and implement tangible transformations. Khuc et al. (2023) highlight communication as a robust variable influencing waste-related decisions, focusing on household-level strategies to address plastic waste pollution in Vietnam. Their findings suggest that communication plays a role in reducing plastic waste by raising awareness. Our results suggest a similar case for Indonesia, provided that associated improvements in infrastructure or waste management service delivery support communication campaigns. The qualitative interviews highlight that stakeholders across stakeholder groups consider a lack of awareness as one of the barriers to effective policy and solutions (Figure 4). This finding aligns with Fian et al. (2024), who highlighted challenges in effective public communication as a barrier to effective regulations. There was variation in knowledge and awareness levels among participants, particularly evident in the in-person interviews, where open-ended questions allowed the authors to measure knowledge rather than self-assessed knowledge. Communication strategies would need to consider these differences in knowledge levels.

Our MRA ($p < .05$, Table 3) showed that plastic experience in the environment was positively associated with self-assessed pro-environmental behaviour for combined and civil society stakeholders. Greater experience of plastic pollution in neighbourhoods

is associated with higher self-assessed pro-environmental behaviour when all stakeholders are considered together, but with lower self-assessed pro-environmental behaviour among civil society stakeholders. Plastic experience with microplastics in seafood was positively associated with self-assessed pro-environmental behaviour among both combined and civil society stakeholders. Plastic pollution is prevalent in the participants' environment (as detailed in Figure 3 and Table 4), which was expected given the high leakage of plastic pollution from Indonesia (Jambeck et al., 2015). Previous Indonesian research has shown heightened environmental awareness and concern about plastic pollution (Tyllianakis & Ferrini, 2021); however, the translation of experiencing plastic pollution within their environment or seafood and increased pro-environmental behaviour is an interesting result. The contrasting behavioural effects of neighbourhood pollution are also interesting. The negative response of civil society aligns with the Broken Windows Theory (Kelling & Wilson, 1982; Zimbardo, 1969), the Focus Theory of Normative Conduct (Cialdini et al., 1990) and TPB (Ajzen, 1985). The Broken Windows Theory, though originally utilised to describe the link between visible signs of disorder and rising levels of crime, is also linked to antisocial behaviour such as littering (Cialdini et al., 1991). The Focus Theory of Normative Conduct directly shows that littering increases in the presence of existing litter. TPB explains that when people believe others litter, they themselves feel less social pressure to properly dispose of their own waste.

As in previous research (Dowarah et al., 2022), participants appear to demonstrate a greater awareness of plastic pollution than of microplastic pollution (Figure 3). However, the data's standard error does not allow for statistical inference. Additionally, participants showed awareness of the risks and concern for both.

Existing Policies and Regulations and Future Interventions Related to Pro-Environmental Behaviour

Plastic waste, pollution, and knowledge about microplastics influence policies in Indonesia ($p < .001$, Table S3, Preston-Whyte et al., 2026). Although levels vary across stakeholder groups, participants expressed doubts about the effectiveness of the existing policies (Figure 4). There is agreement amongst the combined qualitative participants (Figure 4A) that the primary focus should be on diminishing plastic use and minimising waste production, prioritising these actions over awareness campaigns and programs. However, when considering civil society and involved groups, the focus changes. There is an agreement amongst the civil society qualitative participants (Figure 4B) that the primary focus should be on awareness campaigns and programs. There is agreement amongst the involved qualitative participants (Figure 4C) that the primary focus should be on diminishing plastic use and minimising waste production. Reduction of plastic waste production has been identified across both the questionnaire and interviews as a widespread pro-environmental behaviour practised by participants; this may be useful for future intervention development.

Psychological Links of Plastic and Microplastic Pollution and Self-Assessed Health-Protective Behaviour

Despite concerns about microplastic contamination in seafood, our results suggest a nuanced relationship between self-assessed health-protective behaviour and awareness of plastic and microplastic pollution. The quantitative questionnaire ($p < 0.05$, Table 3) showed that higher subjective knowledge is associated with a lower willingness to consume seafood among combined stakeholders, civil society, and involved groups. For civil society, those who had experienced microplastic contamination in seafood were less willing to consume it. However, an increase in seafood consumption was associated with increased subjective knowledge among civil society, as well as increased concern about plastic and microplastics among combined stakeholder groups and increased concern about microplastics among the involved groups. The qualitative interviews show no effect on willingness to consume seafood (90% for combined stakeholders, Figure 4), nor any observed by the industry itself (Figure 4).

Previous research on other marine pollutants has demonstrated a negative impact on the willingness to consume seafood with increased knowledge of contamination (Fercudani, 2015). The current study shows more nuanced results, depending on stakeholder group analysis, and on willingness vs actual consumption. The MRA revealed that subjective knowledge affects all stakeholder groups, with increased subjective knowledge linked with reduced willingness to consume, while increased microplastic experience reduced civil society's willingness to consume. Regarding seafood consumption, a significant positive relationship exists between concerns about plastic and microplastics for combined stakeholder groups. There is a significant positive relationship between subjective knowledge and consumption in civil society, as well as between microplastic concern and consumption among involved groups. Thus, high levels of subjective knowledge and microplastic concern are not linked to reduced seafood consumption in the relative stakeholder groups. In line with this, the interviews reveal that 90% of participants do not believe this knowledge affects their seafood consumption (Figure 4, SI 6, Table S4; Preston-Whyte et al., 2026), indicating that a link between increased awareness of plastic pollution and seafood consumption could not be established. This concern, rather than knowledge and more nuanced overall results, raises the question of whether microplastic contamination carries less weight than other pollutants or if Indonesia presents an outlier where the concerns may not outweigh the health, economic, and cultural benefits of eating seafood or the availability of alternative protein sources.

The interviews offered insights into the contrasting results, which could not be captured in the online questionnaire, with one informant expressing, *"They still believed the fish was captured in a deep ocean where microplastics might not reach the area"* [sic]. Thirteen participants repeated this concept. Such quotations reveal an interesting form of geographical distance with depth. Psychological distance is linked to geographical distance, with close geographic, social, or temporal distances linked to more effective

concern and mitigating behaviour (Jones et al., 2017). Here, greater geographical distance (i.e., depth) reduces concern. Individuals do not believe that the fish they consume is contaminated, indicating either a disconnection of knowledge or distrust of information sources. This disconnection highlights a lack of understanding that the seafloor serves as a repository for plastic pollution (Harris et al., 2023).

Although concerned about microplastics, the local fishing industry does not associate awareness of microplastic pollution with decreased productivity or profits. The MRA revealed that concern about microplastics was significantly correlated with consumption among the involved groups. Nevertheless, the highest seafood consumption and willingness to consume seafood responses were from involved groups, potentially due to ease of access and reduced costs from fishers and seafood processing industry stakeholders. According to the interviews, 76% of the industry feels that their productivity and profits are stable but may be impacted in the future (Figure 4, SI 6, Table S4; Preston-Whyte et al., 2026). Various factors, including increased production, stock depletion, rising temperatures, and other forms of marine pollution, contribute to the fishing industry's profits (Costello et al., 2016). One interviewee said, "*The seafood business was not affected by the microplastic issue. It's reflected by the number of consumers that remain relatively steady*" [sic]. However, as our work did not consider these interpretations, any explanation would be conjecture. Future studies should consider the challenge of disentangling the influence of one factor from its cumulative and interconnected effects.

The use of knowledge, awareness and emotional responses, such as concern, to influence behaviour is employed in public health initiatives (Simpson, 2017). However, there is a lack of consensus within the threat and behaviour field (Palosaari et al., 2023), as the impact of behavioural interventions varies across audiences (Vlasceanu et al., 2024), underscoring the importance of baseline localised behaviour data. The graphic health warnings on cigarette packets have reduced, but they have not led to smoking cessation (Cummings, 2020). Within the Covid-19 pandemic, messaging that appealed to fear was polarising, producing a strongly negative emotional response and potentially undermining social cohesion (McClaghlin et al., 2023). When considering seafood consumption, the awareness disparities render microplastics a nuanced subject. It is possible that focusing on seafood consumption is a distraction. A more productive approach might focus on health concerns related to significant plastic pollution (such as nanoplastics in the bloodstream or societal health impacts) and explore ways to leverage such insights to instigate behavioural changes that reduce waste production and enhance waste management practices, thus combating plastic pollution itself.

Existing Policies and Regulations and Future Interventions Related to Health-Protective Behaviour

An underexplored risk to the seafood industry involves how individuals perceive plastic contamination and associated chemicals, and the potential shifts in consumer behaviour

prompted by growing awareness of marine plastic and microplastic contamination in seafood. This study aimed to close this gap within Indonesia. Although our results are nuanced, due to the contrasting nature of our findings, we conclude that the fisheries sector in Indonesia is currently unaffected by consumers' awareness of microplastics in seafood. The Indonesian government is aware of seafood contamination and has issued Law Number (No). 18 of 2012 on food safety as a form of consumer protection. This regulation aims to prevent contamination of food, especially seafood, by biological, chemical, and other objects that can interfere with, harm, or endanger human health.

Limitations of the Study and Future Research

The research context presented various challenges, including differences in internet access (discussed in the methods section) and literacy among the participants. Literacy differences may account for some participants not counting separating organics as waste separation, an issue identified during qualitative data analysis.

The quantitative questionnaire development contained limitations. The authors note that the online quantitative questionnaire required all questions to be answered, without an option for participants who did not know the answer. Unfortunately, this did not account for participants who may not have understood the question. However, the stakeholders who completed the online quantitative questionnaire had high literacy levels. A question-derived limitation, acknowledged by the authors and identified during the analysis phase, involved one double-barreled question (Lenzner & Menold, 2016) in the quantitative questionnaire, which may also be considered a leading question. Q31 and Q32 refer to the respondent's knowledge of the risks of plastic and microplastics, respectively (Table 1). However, both questions consider overall risks while referring to both the marine ecosystem and human health. The question does not allow for separating risk knowledge into environmental and human components.

There are limitations in the variables utilised in this study, especially regarding the risk aspect of subjective knowledge. By positioning the risks together, one cannot consider the subjective knowledge related to environmental or human health separately. If future studies wish to consider risk specifically, this should be split into two variables. Additionally, perceived behavioural control, values, and norms should be introduced in future studies.

This study has spatial-temporal limitations. Replication on more extensive and diverse scales is necessary to extrapolate the results to broader contexts.

Future research should prioritise investigating strategies that may facilitate positive outcomes concerning pro-environmental behaviour, with a primary focus on barriers to behaviour change and behavioural shifts over time. Even minor adjustments in waste management behaviour could significantly impact global sustainability. As one interviewee noted, *"Many people were aware of plastic waste; they have a willingness, but somewhat they did not take real action"* [sic]. Areas for future research include understand-

ing the differences between people's intended, self-assessed and actual behaviour, as well as any long-term changes and identifying factors that prevent positive change.

Conclusions

Our quantitative results indicate that self-assessed pro-environmental behaviour is positively associated with subjective knowledge among combined stakeholders, civil society, and involved groups. For both combined stakeholders and civil society, pro-environmental behaviour is also positively related to experience of plastic pollution in the environment and awareness of microplastic contamination in seafood. In contrast, experience of plastic pollution in neighbourhoods is positively associated with pro-environmental behaviour among combined stakeholders but negatively associated with such behaviour among civil society stakeholders. These findings suggest that pro-environmental behaviour may be enhanced in Indonesia by utilising additional awareness interventions, provided they are supported by enhanced service delivery and policy enforcement that overcome barriers such as socio-economic constraints, convenience, and effort. Keeping neighbourhoods clean is also important for supporting pro-environmental waste management behaviour. Reducing plastic waste production and sorting out organics are widespread pro-environmental behaviours that can be built upon for future mitigation strategies in Indonesia. Currently, policies addressing marine litter in Indonesia are known but deemed ineffective.

A conclusive link between the psychological links of (micro)plastic pollution and health-protective behaviours was not established, suggesting that the fisheries sector in Indonesia is currently unaffected by consumers' awareness of microplastics in seafood.

This study emphasises the importance of a mixed-methods approach in understanding self-assessed behaviour. It also helps close the data gap for non-WEIRD countries such as Indonesia, which, given the plastic pollution in and around Indonesia and the significant economic and cultural role of its fisheries sector, is critical.

Openness and Transparency Statements

The present article has been checked by its handling editor(s) for compliance with the journal's open science and transparency policies. The completed *Transparency Checklist* is publicly available at:

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Ethics Statement. Our research did not rely on personal-identifying data, an exception to ethics approval under Norwegian law (Norsk Senter for Forskningsdata). Therefore, no ethics approval has been required. However, informed consent was obtained from all participants. Informed consent was attained by asking participants to continue only if they were willing to participate and understood the instructions and information provided. Participation was voluntary, and participants had the right to withdraw from the study at any time. Names were collected voluntarily to check for duplicate participants. This information was protected within the framework of the European Union's General Data Protection Regulation (GDPR) and other personal data protection laws, and participants were informed of this.

Diversity Statement. In the list below, the check mark (☑) indicates which steps were taken to increase diversity within the context of this paper. Steps that were not taken or did not apply are unmarked (☐).

- ☒ Ethnically or otherwise diverse sample(s)
- ☒ Gender balanced sample(s)
- ☐ Inclusive gender measure
- ☒ Inclusive materials
- ☒ Sampling justification
- ☒ Extensive sample description
- ☒ Discussion of generalizability
- ☒ Diverse reference list
- ☒ Underprivileged / minority author(s)
- ☒ Early career author(s)
- ☐ Degree of privilege/marginalization considered in authorship order
- ☒ Author(s) from sampled population (avoiding 'helicopter science')

Data Availability. Full qualitative and quantitative surveys in Bahasa Indonesia and English, study variables rationale, analysis rationale, detailed survey results and summaries, supplementary tables and graphs are openly available at Preston-Whyte et al. (2026).

Supplementary Materials. The following table provides an overview of the accessibility of supplementary materials (if any) for this paper.

Type of supplementary material	Availability/Access
Data	
Detailed survey results	Preston-Whyte et al. (2026)
Code	
No code was provided.	—
Material	
Detailed survey analyses	Preston-Whyte et al. (2026)
Full qualitative survey in Bahasa Indonesia	Preston-Whyte et al. (2026)
Full qualitative survey in English	Preston-Whyte et al. (2026)
Full quantitative survey in Bahasa Indonesia	Preston-Whyte et al. (2026)
Full quantitative survey in English	Preston-Whyte et al. (2026)
Study/Analysis preregistration	
No preregistration	—
Other	
Study variables rationale	Preston-Whyte et al. (2026)
Analysis rationale	Preston-Whyte et al. (2026)
Detailed survey analysis	Preston-Whyte et al. (2026)
Supplementary tables and graphs	Preston-Whyte et al. (2026)

Badges for Good Research Practices.

Open data: YES.
Open code: NO.
Open materials: YES.
Preregistration: NO.
Diversity statement: YES.

Note: YES = the present article meets the criteria for awarding the badge. NO = the present article does not meet the criteria for awarding the badge or the criteria are not applicable.

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