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Social networks and non-communicable disease risk in the Solomon Islands: gendered patterns of support and health outcomes

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Abstract

Non-communicable diseases (NCDs) are the leading causes of death globally, and Pacific Island countries have among the world's highest rates of obesity and diabetes. While social networks shape health behaviors, their relation to NCD risk and gender differences in the Pacific remains understudied. This cross-sectional study involved 190 adults (66 men, 124 women) from urban and peri-urban neighborhoods in Honiara, Solomon Islands. Participants completed egocentric social network interviews, structured questionnaires, and health assessments. Multiple regression analyses were stratified by sex, and interaction models tested gender differences. The results revealed that close family members were the most frequent support providers for important discussions and help-seeking among men and women, followed by relatives. Women were significantly more likely to discuss personal matters with spouses (34.7% vs. 19.7%, $p=0.044$) and seek help from them (27.4% vs. 10.6%, $p=0.009$). Among men, discussing health issues with relatives was associated with lower fasting blood glucose ($\beta=-40.04$, 95% CI −76.46 to −3.62, $p=0.031$). Among women, discussing important matters ($\beta=25.99$, $p<0.001$) and seeking help from non-family members ($\beta=20.59$, $p=0.0048$) were associated with higher body mass index (BMI). Social support's health effects depend on its source and cultural context. Kin-based networks may protect men's glucose regulation, whereas non-family ties may contribute to women's higher BMI, possibly reflecting communal eating practices. These findings highlight the need for gender-sensitive, culturally informed public health strategies in the Pacific.

Keywords Non-communicable diseases, Social networks, Egocentric network analysis, Social support, Solomon Islands, Pacific Island health, Health behavior, Cultural context

1 Introduction

Non-communicable diseases (NCDs) like heart disease, diabetes, respiratory diseases, and cancer are the leading causes of death globally. According to the World Health Organization (WHO), more than 41 million of the 55 million deaths in 2019 were due to NCDs. Among them, over 77% occurred in low- and middle-income countries (LMICs), where the populations face the dual burden of infectious and chronic diseases [1].

In the Solomon Islands, a Pacific Island country (PIC), NCDs pose a serious public health challenge. Recent estimates indicate that 60.4% of adult women and 46.7% of adult men are overweight, and 27.8% of women and 17.5% of men are obese [2]. As NCDs account for approximately 70% of all deaths nationally, the burden on the health system and households is growing [3]. Over the past decades, dietary patterns have undergone a nutrition transition, where traditional foods like root crops and fresh fish have increasingly been replaced by imported, ultra-processed products, including rice, instant noodles, sugar-sweetened beverages, and canned fish. This shift has been driven by changes in trade policy, market availability, and price incentives [4–7].

Similar gender differences are observed across the Pacific, where women generally exhibit higher obesity rates than men. Notably, nine of the ten countries with the highest obesity prevalence worldwide are small Pacific Island countries [2, 8].

In addition to biological risks, behavior factors like poor diet, physical inactivity, smoking, and excessive alcohol consumption exacerbate the NCD burden. These behaviors are shaped by a complex interplay among people's genetics, age, environment, socioeconomic status, and sociocultural systems [9]. Sociocultural systems such as the *wantok* system—a Melanesian kinship and reciprocity network based on shared language and obligations—might influence household food practices, caregiving responsibilities, and access to resources, which may in turn affect Solomon Islanders' health behaviors [10, 11].

In recent years, the roles of social networks have garnered increasing attention in shaping health-related behaviors, including people's family, friends, and community ties. Such networks can significantly influence individual health behaviors, including diet, exercise, and healthcare utilization. Support from social network members—whether emotional, informational, or instrumental—can encourage healthy behaviors and assist disease management [12, 13]. Conversely, stress caused by strained or demanding relationships may negatively affect health or hinder healthy behavior maintenance [14].

Both the structure of social networks (e.g., size, density, and frequency of contact) and their function (e.g., types of support and shared health norms) are associated with key NCD risk factors, including obesity, hypertension, and diabetes [15, 16]. While a growing body of research on informal support networks and health exists, evidence from PICs remains scarce. Furthermore, few studies have examined how network structure and function are associated with NCD outcomes in the Pacific region, particularly those that follow egocentric network approaches.

Given the pronounced gender disparities in obesity and diabetes prevalence rates as well as the strong influence of gender roles on social interactions and caregiving patterns, studies that examine sex differences in network characteristics and their associations with NCD outcomes are critical.

Therefore, the present study aimed to achieve the following three objectives:

1. To describe the sociodemographic and network characteristics of adults in the Solomon Islands;
2. To examine the associations between network structure and function and NCD outcomes (body mass index [BMI], blood pressure, and fasting blood glucose);
3. To determine whether these associations differ by sex and type of social support (important discussions, health discussions, and help seeking).

Accordingly, we addressed the following specific research questions:

1. What are the sociodemographic and social network characteristics of adults in urban and peri-urban areas of Honiara, Solomon Islands?
2. How are the structure and function of social networks associated with NCD-related health outcomes such as BMI, blood pressure, and fasting blood glucose?
3. Do these associations vary by gender and the type or source of social support (e.g., family, relatives, or non-family members)?

The study's findings are intended to inform the development of culturally and gender-sensitive strategies to prevent NCDs in the Solomon Islands.

2 Methods

2.1 Study design and setting

This cross-sectional study was designed to investigate the associations between social network characteristics and NCD outcomes. The design included a particular focus on gender differences and types of support.

This study was conducted in the Solomon Islands, a PIC located to the northeast of Australia.

Two neighborhoods were purposively selected in consultation with local collaborators to capture variations between urban and peri-urban settings. Fishing Village, the first site, is a coastal settlement located along the Kukum Highway in east Honiara. Jericho, the second site, lies inland in the hills that overlook Honiara, with limited road access and services. These diverse locations allowed us to compare social network structures and health outcomes across two contrasting environments.

2.2 Sampling and participants

Local community leaders announced the study and encouraged participation during community meetings; however, as non-attendance was not systematically tracked, participation rates could not be calculated. Adults aged 20–80 years who were permanent residents of the Solomon Islands were eligible, while visitors or those who fell outside of this age range were excluded. Pregnant women and individuals who were unable to provide informed consent were also excluded from participating in the study.

A total of 200 participants were recruited—115 from Fishing Village and 75 from Jericho. After individuals with missing data for primary outcomes or key covariates were excluded, 190 participants (66 men and 124 women) were included in the final analysis. The higher proportion of women likely reflects the greater availability of women at home during recruitment times, which is common in this setting.

The sample size was determined a priori using BMI data from a previous survey in the Solomon Islands (mean BMI = 30.3, SD = 5.7 kg/m^2). Assuming a two-sided $\alpha = 0.05$ and 80% power, we calculated that detecting a 3.0 kg/m^2 sex difference would require approximately 57 participants per sex (total ≈ 114), while a 2.5 kg/m^2 difference would require ≈ 82 per sex (total ≈ 164). Therefore, the final analytic sample of 190 participants exceeded the requirement for detecting moderate sex differences in BMI.

The data were collected in 2019 across the two aforementioned study sites. Trained local fieldworkers fluent in Pijin conducted all interviews and health measurements in

the participants' homes or at a private location of their choice. All participants provided written informed consent, and no incentives were offered for them to participate.

2.3 Cultural considerations

The study team met with community leaders before the data were collected to explain the study's objectives and procedures and obtain approval to conduct research in their communities. The data collection was performed in a manner respectful of local customs, and participants were invited to attend data collection sessions at a designated central location in their community. This approach ensured a consistent and private setting for the interviews and measurements.

2.4 Physical measurements

The collected health-related data were the participants' height, weight, blood pressure, and fasting blood glucose. Height was measured using a portable stadiometer (Seca 213, Seca GmbH & Co. KG, Hamburg, Germany); body weight was recorded with a digital scale (BC-705N, Tanita Corporation, Tokyo, Japan); blood pressure was measured using an automatic sphygmomanometer (OMRON HEM-7122, Omron Healthcare Co., Ltd., Kyoto, Japan); and fasting blood glucose was measured using a OneTouch® UltraVue™ glucometer (LifeScan, Inc., Milpitas, CA, USA).

BMI was calculated and categorized according to WHO standards as follows: normal (<25), overweight (25–29.9), and obese (≥ 30); blood glucose levels ≥ 126 mg/dL were classified as elevated; and hypertension was defined as blood pressure $\geq 140/90$ mmHg [17–19].

2.5 Social network measures

Social support was assessed using the name generator–interpreter method, which is a widely used approach in egocentric network analysis [20–22]. The participants were asked the following three name-generator questions:

1. With whom have you discussed important personal matters in the past 6 months (emotional support)?
2. From whom have you sought help when you faced problems (practical support)?
3. With whom have you discussed health-related concerns (instrumental support)?

Participants could nominate up to four alters per question (maximum = 12 unique alters). Although classical designs often allow up to five or six names, we limited nominations to four per question to reduce respondent burden. Another reason for doing so is because prior research demonstrated that network characteristics can be reliably captured with up to four alters [23]. Lastly, name duplication was allowed across questions but not within them, which allowed an overlap to be captured between support domains.

For each nominated alter, interpreter data were collected, including sex, relationship to the participant, place of residence, contact frequency, whether they encouraged physical activity, and whether they were perceived to practice healthy behaviors (e.g., having a balanced diet and taking regular exercise). This aligns with best practices in egocentric network analysis. Relationships were categorized into the following four groups: (1) spouse; (2) close family members (siblings, children, parents, and grandparents); (3) other relatives; and (4) non-family members (friends, coworkers, neighbors, and others).

These four categories were used in subsequent analyses to examine associations between support type and NCD outcomes.

Furthermore, the following variables were computed:

- Total network size: The number of unique alters named across all three questions (max = 12);
- Important discussion network size: The number of alters for important personal matters (max = 4);
- Health discussion network size: The number of alters for health-related discussions (max = 4);
- Help-seeking network size: The number of alters for help seeking (max = 4);
- Exercise encouragement: The count of alters who encouraged physical activity;
- Healthy alter score: The count of alters perceived to practice healthy eating or regular exercise.

2.6 Covariates and analysis

Additional collected information included age, sex, marital status, education, income, and employment status. Clinical measures were conducted by trained healthcare workers in community settings.

Multiple linear and logistic regression analyses were performed to assess associations between social support (by type and relationship) and health outcomes—BMI, blood glucose, blood pressure, and self-rated health. The models were stratified by sex for interpretability: Model 1 adjusted for age and sex, while Model 2 additionally controlled for education, income, marital status, and residential settings (urban or peri-urban). Analyses were conducted using complete-case data, with participants who had missing values for primary outcomes or key covariates being excluded from the corresponding regression models. Analyses were performed using the EZR software package with statistical significance set at $p < 0.05$ [24].

2.7 Ethical approval

This study was conducted in accordance with the guidelines of the Declaration of Helsinki. It was approved by the Ethics Committee of Kyoto University (Project number R1691) as well as the Solomon Islands Health Research and Ethics Review Board of the Ministry of Health and Medical Services (HRE029/18).

3 Results

Across all 190 participants, close family members were the most frequently reported sources of support for having important discussions, holding discussions about health, and seeking help. Among the men, 75.8% reported discussing important matters with close family members, followed by relatives (42.4%), their spouse (19.7%), and non-family members (18.2%). Health-related discussions exhibited the following slightly different pattern: 71.2% of men reported holding them with close family members, followed by their spouse (54.5%), relatives (19.7%), and others (10.6%). Lastly, for help seeking, men again relied most on close family (77.3%), followed by relatives (37.9%), others (16.7%), and their spouse (10.6%).

Among the women, a similar pattern was observed for important discussions and help seeking, with 76.6% reporting such behaviors with close family members, followed by

relatives (41.9%), their spouse (34.7%—significantly higher than the proportion of men, $p = 0.044$), and others (12.1%). For health discussions, women reported close family (69.4%) most frequently, followed by their spouse (42.7%), relatives (34.7%—significantly higher than the proportion of men, $p = 0.044$), and others (12.1%). For help seeking, women reported close family (85.5%), relatives (38.7%), their spouse (27.4%—significantly higher than the proportion of men, $p = 0.009$), and others (8.1%).

No significant gender differences were observed for support from close family (all $p > 0.05$) or non-family members across any domain. Such differences were also not observed for the total network size, discussion network size, health discussion network size, help-seeking network size, or exercise encouragement scores.

Although the women had a higher mean BMI than the men (34.7 vs. 28.9 kg/m^2), the difference was statistically nonsignificant ($p = 0.091$). Likewise, no significant gender differences were observed for fasting blood glucose, systolic blood pressure, diastolic blood pressure, or age (all $p > 0.05$).

Next, separate multiple regression analyses were conducted for men and women with the aim of assessing the associations between different social support types and health outcomes. Among the men, support from relatives was found to be a significant protective factor. Men who discussed health-related matters with relatives had significantly lower fasting blood sugar ($\beta = -40.04$, 95% CI −76.46 to −3.62, $p = 0.031$). Furthermore, discussing important personal matters with relatives was found to be associated with lower blood sugar levels ($\beta = -28.10$, 95% CI −56.55 to −0.43, $p = 0.059$). No other forms of social support—including from spouses, close family, or non-family members—were found to be significantly associated with blood sugar, BMI, or blood pressure among men.

By contrast, among the women, support from non-family members exhibited a different pattern, as women who discussed important personal issues with non-family members were found to have a significantly higher BMI ($\beta = 25.99$, 95% CI 14.05 to 37.92, $p < 0.001$). Similarly, seeking help from non-family members was found to be associated with a higher BMI ($\beta = 20.59$, 95% CI 6.71 to 34.48, $p = 0.0048$). No other forms of social support were found to be significantly associated with fasting blood sugar or systolic blood pressure in women.

Moreover, the sex-by-network interaction terms were statistically significant for BMI (important discussion and help seeking). This confirmed that the positive association was stronger among women. For fasting blood glucose, the interaction term between sex and discussing health with relatives approached significance ($p = 0.076$), which suggested that the inverse association was stronger among men. This finding was consistent with the stratified analyses.

Overall, the total network size, discussion network size, health-related support network size, help network size, and encouragement-for-exercise scores were found not to be significantly associated with BMI, blood pressure, blood sugar, self-rated health, or dietary outcomes.

Table 1 presents a comparison of sociodemographic and network characteristics by sex, and then Table 2 presents a comparison of consultation partners by type of support and sex:

Table 1 Comparison of sociodemographic and network characteristics by sex

Variable	Men (n = 66)	Women (n = 124)	*p*-value
BMI (kg/m^2), mean (SD)	28.93 (5.25)	34.72 (27.34)	0.091
Blood sugar (mg/dL), mean (SD)	133.48 (57.16)	126.12 (40.60)	0.305
SBP (mmHg), mean (SD)	137.20 (21.30)	137.31 (28.87)	0.977
DBP (mmHg), mean (SD)	82.89 (12.18)	83.06 (14.13)	0.937
Age (years), mean (SD)	45.85 (14.55)	44.00 (12.53)	0.362
Total network size (max = 12)	6.76 (3.01)	7.35 (3.02)	0.202
Important discussion network size (max = 4)	3.18 (1.05)	3.10 (1.07)	0.6
Health discussion network size (max = 4)	2.33 (1.14)	2.49 (1.21)	0.381
Help-seeking network size (max = 4)	2.92 (1.11)	2.85 (1.08)	0.677
Encouragement for exercise	9.73 (8.95)	10.98 (10.99)	0.426
Healthy alter score	7.26 (3.17)	7.32 (3.81)	0.91

All network variables are based on the name generator responses. Definitions are provided in the Methods section

Table 2 Comparison of consultation partners by type of support and sex

Support type	Partner type	Men (n = 66)	Women (n = 124)	*p*-value
Important discussion	Close family*	50(75.8%)	95 (76.6%)	1
	Relatives	28 (42.4%)	52 (41.9%)	1
	Spouse	13 (19.7%)	43 (34.7%)	0.044
	Others	12 (18.2%)	15 (12.1%)	0.279
Health discussion	Close family*	47 (71.2%)	86 (69.4%)	0.869
	Relatives	13 (19.7%)	43 (34.7%)	0.044
	Spouse	36 (54.5%)	53 (42.7%)	0.13
	Others	7 (10.6%)	15 (12.1%)	0.817
Help seeking	Close family*	51 (77.3%)	106 (85.5%)	0.272
	Relatives	25 (37.9%)	48 (38.7%)	1
	Spouse	7 (10.6%)	34 (27.4%)	0.009
	Others	11 (16.7%)	10 (8.1%)	0.09

*Close family includes parents, children, siblings, and/or grandparents living in the same household or maintaining regular contact

We note that Tables 1 and 2 are necessary for describing participant characteristics and network composition, as these contextualize the following multivariable findings presented in Table 3.

4 Discussion

This study identified important gender differences in the patterns and health impacts of social support among adult Solomon Islanders. Both men and women reported most frequently relying on close family members for important discussions, health-related discussions, and help seeking, which underscores the central role of household kin in support provision. To address the first research question—what are the sociodemographic and social network characteristics of adults in urban and peri-urban areas of Honiara—the following patterns were identified.

Relatives were the second most common source for important discussions and help seeking, while spouses were the second most common source for health discussions. Women were significantly more likely than men to involve their spouse in both important discussions ($p = 0.044$) and help seeking ($p = 0.009$). Furthermore, women were significantly more likely to discuss health issues with relatives ($p = 0.044$), while men were somewhat more likely to discuss health concerns with their spouse.

Table 3 Associations between social support and health outcomes, stratified by sex

Outcome	Social support type	β (men) [95% CI]	*p* (men)	β (women) [95% CI]	*p* (women)
Fasting blood sugar	Relatives (health discussion)	−40.04 [−76.46, −3.62]	0.031	–	–
	Relatives (important discussion)	−28.10 [−56.55, −0.43]	0.059	–	–
BMI	Others (important discussion)	–	–	+25.99 [14.05, 37.92]	< 0.001
	Others (help seeking)	–	–	+20.59 [6.71, 34.48]	0.0048

All estimates are from Model 2 and adjusted for age, education, income, marital status, and residential setting

Regarding the second research question—how the structure and function of social networks associated with NCD-related health outcomes—we found gender-specific associations. Although men and women were found to have similar overall social network sizes and support scores, the health impacts of support were found to differ by gender and source of support. These findings suggest that the origin and context of social support—not merely its availability—have critical roles in shaping health outcomes.

Among the men, discussing personal or health-related matters with relatives—especially extended family members—was found to be statistically significantly associated with lower fasting blood glucose levels (β = −40.04, $p = 0.031$). In the Solomon Islands, such kin-based ties are often embedded in the *wantok* system, a sociocultural structure that is rooted in shared language and reciprocal obligations within extended family networks [10, 11]. The system shapes everyday interactions, resource exchange, and caregiving norms, which encourages individuals to seek advice, share their problems, and mobilize support within kin networks. This cultural framework likely explains why both men and women were found to turn first to close family and relatives, and also why kin-based ties appear to play a protective role for men's fasting blood glucose. Since men are often culturally discouraged from expressing vulnerability or seeking emotional support from their spouse, extended kin may provide a culturally acceptable avenue for discussing health issues and seeking advice [25].

Conversely, among the women, support from non-family members was statistically significantly associated with higher BMI (β = 25.99, $p < 0.001$ for important discussions; β = 20.59, $p = 0.0048$ for help seeking). This may reflect women's participation in communal activities—such as church, neighborhood, and village gatherings—where energy-dense foods are commonly shared. In these settings, food not only serves nutritional purposes but also has important social and cultural roles, potentially increasing women's calorie intake [26, 27]. These findings align with a previous study conducted in the Solomon Islands by Tsuchiya et al. (2023), who found that structural social capital—including group membership and civic participation—was linked to negative health outcomes like higher BMI and elevated blood glucose. An alternative explanation is that women with higher BMI may seek more non-family support as a coping mechanism, which raises the possibility of reverse causality. Longitudinal research is now required to clarify the direction of these associations. Although the overall network size was found to be similar across the men and women participant.

These findings were robust to models that included sex-by-network interaction terms. Interaction models statistically confirmed that the positive association between non-family support and BMI was specific to women. By contrast, they confirmed that the inverse association between health-related discussions with relatives and fasting blood

glucose was stronger among men. These results support our decision to present sex-stratified analyses as the main findings for the sake of cultural interpretability.

Our results differ from those of studies conducted in high-income countries, such as the Maastricht Study (Brinkhues et al. 2018) Said study reported that small, family-based networks with limited informational support were linked to poorer health outcomes, particularly among women [28]. By contrast, our findings suggest that in the Solomon Islands, non–family-based communal ties may present greater risks to women, particularly through social environments that encourage calorie-dense food consumption and create strong social obligations.

Overall, our findings highlight that social support is not inherently beneficial; rather, its effects depend on the source, the delivery, and the cultural and behavioral norms that surround it. Therefore, interventions aimed at NCD prevention must be focused on the quality and health-promoting potential of social ties, as opposed to simply focusing on increasing network size.

4.1 Implications for intervention and policy

This study underscores the importance of considering the type and context of social support when designing health interventions in the Solomon Islands, with particular attention to gender-responsive strategies.

First, support from non-family members was found to be statistically significantly associated with a higher BMI among the women. This likely reflects cultural practices like communal eating during church, neighborhood, or village gatherings, where women frequently consume energy-dense foods. Therefore, health programs should work collaboratively with communities to improve the food environment at such social events, thereby promoting healthier options without undermining residents' valued cultural traditions.

Second, support from relatives—particularly extended kin—was statistically significantly associated with lower fasting blood glucose among men. This highlights the protective role of kin-based networks, such as those structured through the *wantok* system, which shapes people's daily interactions, facilitates resource sharing, and provides emotional and practical support. Therefore, health promotion strategies should actively engage extended family networks to encourage preventive care and diabetes management, aligning with local cultural norms.

Third, no significant associations were observed between total network size and health outcomes. This suggests that the quality and function of social ties are more important than their quantity. Interventions should therefore be focused on strengthening supportive relationships that promote healthy behaviors, such as taking regular physical activity and holding open discussions about health concerns.

Overall, in its public health strategies, the Solomon Islands should adopt gender-sensitive, culturally grounded approaches that leverage citizens' kinship networks for health promotion while addressing potential nutritional risks associated with non-family social gatherings. Such approaches may be critical for reducing the burden posed on the country by NCDs and for improving the population's health in this unique PIC context.

4.2 Limitations

This study has several limitations. First, its cross-sectional design precludes causal inference; the associations observed between social support and health outcomes may be bidirectional, and we were unable to exclude the possibility of reverse causality. Second, the sample was restricted to two neighborhoods in Honiara and therefore may not represent the broader population of the country, particularly for rural or outer-island communities with distinct cultural and social network structures. Third, while the name-generator method offers insights into egocentric networks, it may not have fully captured the complexity, intensity, or quality of informal social ties and interactions. Lastly, reliance on self-reported data (e.g., diet and physical activity) may have introduced recall or social desirability bias.

Despite these limitations, this study provides rare and valuable evidence on the gendered patterns of people's social support and health in a PIC setting. It not only addresses a critical gap in the literature but also contributes to the growing understanding of the social determinants of NCDs in LMICs.

5 Conclusion

This study examined the relationships between social support networks and key NCD risk factors in the Solomon Islands, paying particular attention to gendered patterns. This study addressed three key research questions: (1) What are the sociodemographic and network characteristics of adults in Honiara? (2) How are the structure and function of social networks associated with NCD-related health outcomes? and (3) Do these associations vary by gender and the type or source of social support?

Although the overall network size was found to be similar across the men and women participants, the type and source of support—as well as their health associations—were found to differ significantly.

Among men, discussing health-related matters with relatives was statistically significantly associated with lower fasting blood glucose, which underscores the protective role of kin-based support embedded in the *wantok* system. This suggests that extended family ties may play an important role in diabetes prevention and management for men.

Among women, discussing important personal issues and seeking help from non-family members were statistically significantly associated with higher BMI. This possibly reflects social settings like church or community gatherings, where calorie-dense foods are commonly consumed.

Together, these findings highlight that social ties are not uniformly beneficial: their health impacts depend on the source of support, the behaviors they reinforce, and the cultural context in which they operate. Therefore, public health strategies in the Solomon Islands should focus not only on expanding social networks but also on improving their quality and health-promoting functions. Gender-sensitive and culturally tailored interventions that engage kinship networks and address food environments in communal settings may be essential to reduce NCD risks and improve the population's health.

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Author contributions
CT is the guarantor who accepts full responsibility for the study, had access to the data, and controlled the decision to publish; CT and TF contributed to the study design, data analysis, results interpretation, and manuscript drafting; and FP and JD contributed to the study design and conducted the field surveys. All authors reviewed and approved the final version of the manuscript.

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Data availability
The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Written informed consent was obtained from all participants prior to the data collection being performed.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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