

Health-related quality of life and marine-related health risks in coastal communities of Palawan, Philippines

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ABSTRACT

Coastal fishing communities depend on marine resources yet face significant occupational and environmental health risks. This study assessed health-related quality of life (HRQoL) and self-reported accidents and health outcomes among adults in three coastal municipalities of Palawan, Philippines. A cross-sectional survey recruited 431 adults across 10 barangays, with 401 complete responses analyzed. The HRQoL was assessed using the Philippine Short Form-12 (SF-12), producing Physical Component Summary (PCS-12) and Mental Component Summary (MCS-12) scores. Fifteen self-reported health items were examined using exploratory factor analysis, identifying three domains: marine accidents, musculoskeletal complaints, and infections and skin diseases. Women had higher odds of reporting marine-related accidents compared than men (OR = 2.07; 95% CI: 1.87–2.54). More than half of respondents (56.9%, $n = 228$) had PCS-12 ≤ 50 (mean 48.3 ± 5.7), indicating poor physical health, while 26.4% ($n = 106$) scored MCS-12 ≤ 42 (mean 47.3 ± 8.3), suggesting possible mental health concerns. Musculoskeletal complaints were the most prevalent health outcome, affecting up to 71.1% of respondents, while those in the poorest marine-based income bracket had nearly twice the odds of reporting infections and skin diseases (OR = 1.87; 95% CI: 1.22–3.86). The HRQoL varied by study site, gender, age, and education, whereas ethnicity, religion, and coastal proximity were not significantly associated. These findings showed that women and low-income fishers face greater occupational and environmental health risks. Interventions should prioritize gender-responsive safety, ergonomic support, accessible healthcare, and stronger social protection. Further qualitative research is needed to clarify the pathways that drive these disparities.

Keywords: general well-being, marine exposure, musculoskeletal disorders, occupational health risk, small-scale fisheries

INTRODUCTION

Approximately 62% of the Philippine population depends directly or indirectly on marine resources for livelihood and sustenance, with small-scale fishing forming a cornerstone of both the economy and social identity in coastal communities (Wijayanti and Pratomo 2016; Canlas and Mula 2021). While fisheries contribute substantially to food security and local economies, fishers are increasingly recognized as a vulnerable occupational group with elevated health risks. Evidence from Norway shows that small-scale fishers report poorer self-rated health than non-fishing populations (Hjorthen et al. 2021). However, there is a notable lack of comparable empirical studies in the Global South, including Southeast Asian and Philippine coastal communities, leaving the health and well-being of these populations comparatively underexamined (Weeratunge et al. 2013; Miñarro et al. 2022).

In the Philippines, health is constitutionally recognized as a fundamental human right, yet barriers to accessing primary care remain, particularly among geographically isolated and underserved populations. These challenges may be compounded in coastal areas by geographic isolation, environmental hazards, livelihood insecurity, and socioeconomic marginalization (Dayrit et al. 2018; Kramer et al. 2019). Moreover, the combined pressures of climate change, declining fish stocks, and fluctuating fisheries productivity create unique vulnerabilities for coastal populations, highlighting the absence of systematic health assessments in these settings (White et al. 2020; Asthana and Gibson 2021). Self-reported health measures, including health-related quality of life (HRQoL), are strong predictors of healthcare utilization and long-term morbidity (Demakakos et al. 2008), making them particularly relevant for understanding the lived experiences of coastal populations in Asia (Fleming et al. 2021, 2023, 2024). These challenges are particularly relevant to universal health coverage (UHC), primary healthcare access, and health equity in geographically isolated and underserved communities. The Philippine Universal Health Care Act emphasizes equitable access to quality and affordable healthcare, accessible primary care, and a whole-of-government and whole-of-society approach to health policy and service delivery (Republic Act No. 11223 2019). In this context, evidence on HRQoL and marine-related health risks may contribute to evidence-informed planning for primary healthcare and occupational and environmental health protection in coastal communities. Given the interconnected nature of livelihood, environmental, and socioeconomic conditions in coastal settings, coordinated action across health, fisheries, environmental management, and social protection sectors may be needed to address health risks that extend beyond the health sector alone.

Environmental and social contexts shape health outcomes, well-being, behavior, and environmental stewardship, particularly through ecological and economic pressures such as overfishing, habitat degradation, and commercial fleet encroachment, which reduce fish stocks and heighten livelihood insecurity (MRAG Asia Pacific and Oceana 2022). Combined with weak social safety nets and persistent poverty, these stressors create multifactorial vulnerability, where physical labor, ecological uncertainty, and psychosocial strain converge to impact health and quality of life (Maliao et al. 2023; Obligar 2025). Socio-demographic factors—gender, age, education, income, ethnicity, and coastal proximity—further modulate vulnerability and resilience in coastal communities (Hjorthen et al. 2021).

To address these knowledge gaps, this study pursued three primary objectives: (1) to assess the HRQoL of coastal populations in Palawan, Philippines, using the culturally adapted Philippine Short Form-12 (SF-12) instrument; (2) to document the prevalence and nature of self-reported marine-related accidents and health outcomes; and (3) to identify socio-demographic factors associated with these health outcomes, thereby providing an evidence base for context-specific well-being and resilience strategies.

METHODS

Study Area

Palawan, southwestern Philippines, spans approximately 14,896 km² with a population density of ~58 persons/km², increasing to ~107 persons/km² in Puerto Princesa City. In 2021, the province had 431 registered health facilities, including hospitals, rural health units, infirmaries, and community health stations. This study focused on three coastal communities: Puerto Princesa City (central Palawan), Aborlan (69 km south), and Taytay (206 km north) (Figure 1).

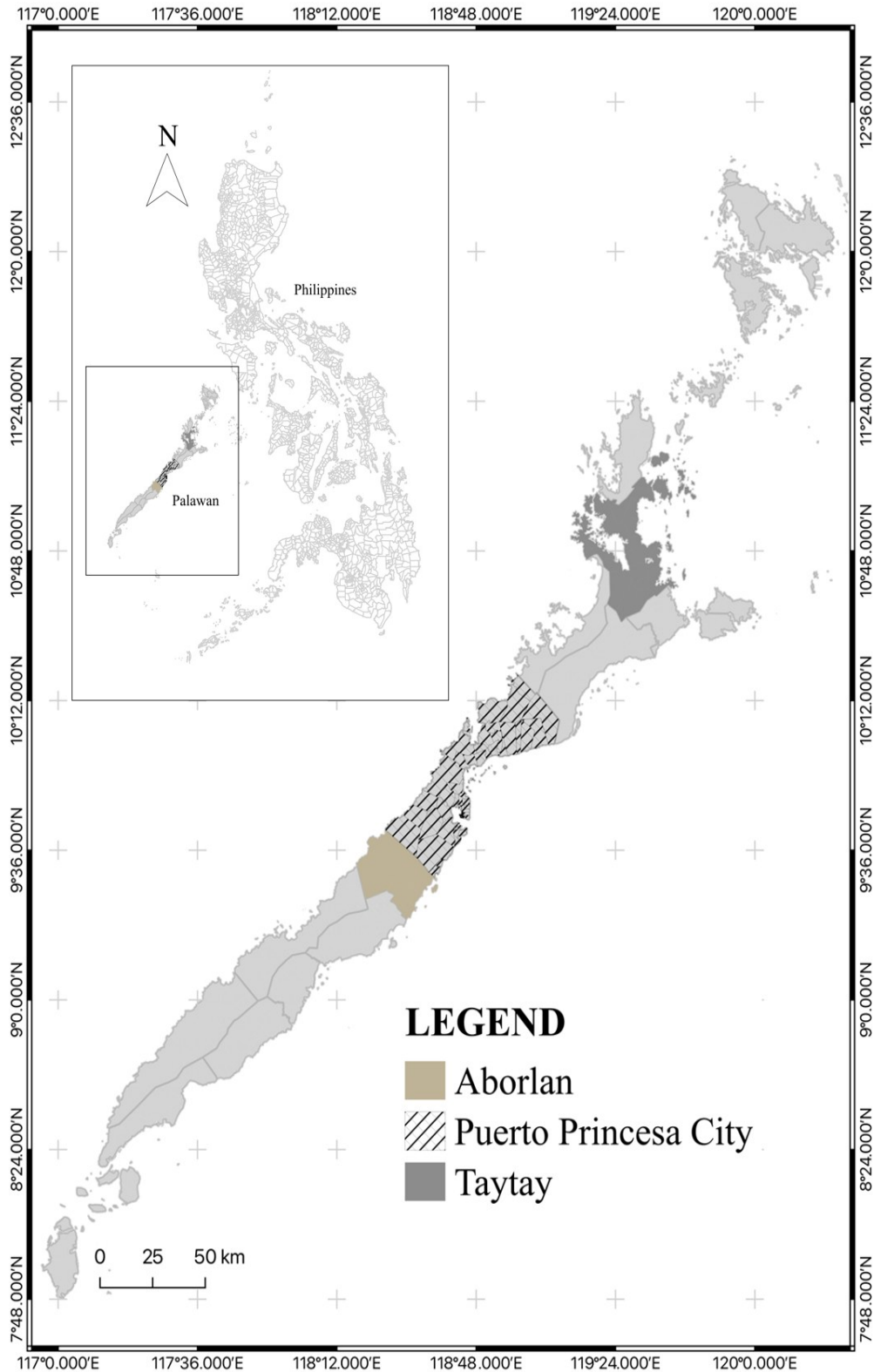


Figure 1. Map of the Philippines showing Palawan and the three case study sites of the Blue Communities Philippines project: Aborlan, Puerto Princesa City, and Taytay.

Sample Population and Data Collection

This cross-sectional study was conducted under the GCRF-funded Blue Communities Project (University of Plymouth 2026). The survey received ethical approval from the National Ethics Committee of the Philippines (2-19-002-Creencia-Blue) and the University of Exeter Medical School Research Ethics Committee (May19/B/1985). A total of 431 respondents were recruited using convenience sampling from June to July 2019 across 10 barangays in Aborlan, Puerto Princesa City, and Taytay. Convenience sampling was used to recruit participants who were available and willing to participate within the selected study communities during the survey period. Data were collected through face-to-face interviews in Filipino or English using a tablet-based computer-assisted personal interviewing (CAPI) system.

Outcome Measures

Two primary outcomes were assessed. First, HRQoL was measured using the Short Form-12 (SF-12) health survey, a validated instrument generating Physical Component Summary (PCS-12) and Mental Component Summary (MCS-12) scores on a 0–100 scale, with higher scores indicating better health (Ware et al. 1996; Burholt and Nash 2011). The validated Philippine version of SF-12 covers eight domains: physical functioning, role limitations due to physical health, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems, and mental health (Resnick and Nahm 2001). PCS-12 ≤ 50 indicated potential physical limitations, and MCS-12 ≤ 42 suggested possible clinical depression. Scores were computed using Quality Metric Health Outcomes Scoring Software 2.

Second, self-reported accidents and health outcomes associated with marine exposure were assessed using 15 items with responses originally coded as “no,” “yes, but did not consult health workers,” and “yes, and consulted health workers.” For analysis, the two affirmative categories were combined. Exploratory factor analysis identified three constructs: directly marine-related accidents, muscle aches, and infections and skin diseases (Kılıç 2020).

Data Analysis

Descriptive statistics (mean, standard deviation, frequency, and percentage) were used to summarize the socio-demographic characteristics. The PCS-12 and MCS-12 scores were computed using Quality Metric Health Outcomes Scoring Software 2. Multiple linear regression assessed associations between socio-demographic variables and PCS-12 and MCS-12 scores (Al-Shehri et al. 2008). All predictors were entered as categorical variables to facilitate comparisons across socio-demographic groups, consistent with the approach of Gupta et al. (2021) for capturing group-level differences rather than continuous dose–response effects. A stepwise backward

elimination procedure improved model parsimony and interpretability. Analyses were conducted in R (v3.6.2) using the *lm* function, with supplementary group comparisons via Welch's t-tests (Lu and Yuan 2010) and one-way ANOVA (Mishra et al. 2019). Model diagnostics (residual normality, homoscedasticity, and multicollinearity checks) confirmed estimate robustness.

Logistic regression models were fitted to evaluate socio-demographic predictors of dichotomous self-reported health outcomes. This approach quantifies the likelihood of experiencing directly marine-related accidents, muscle aches, and infections and skin diseases across population subgroups, allowing for assessment of which factors increase vulnerability while controlling for other covariates. Predictor multicollinearity and residual patterns were examined before model interpretation. Model performance and discrimination ability were evaluated using receiver operating characteristic (ROC) curves and the area under the curve (AUC; Sarkar and Midi 2010). Analyses were again conducted in R (v3.6.2) using the *glm* function. Multiple linear regression models diagnostics supported assumptions of linearity, residual normality, and homoscedasticity for all regressions (Supplementary Figures S1–S3).

RESULTS

Characteristics of the Study Population

Of the 431 individuals interviewed across 10 communities in Palawan, 401 with complete data were analyzed (Table 1). The sample is predominantly female (60.1%) with a mean age of 44.97 ± 13.66 years. The ages were distributed as 40–49 (26.7%), 30–39 (23.2%), and 50–59 (20.0%). Education was mainly secondary (46.4%) or elementary (39.2%). Participants identified primarily as Visayans (42.1%), “Others” (37.7%), or Cuyonon (19.7%); 80.0% identified as Roman Catholic. The large proportion of households living below poverty threshold (63.6%) reflects the limited and often unstable livelihoods common in rural Palawan.

Table 1. Socio-demographic characteristics of adult participants from coastal communities involved in the Blue Communities Project in Palawan, Philippines, used to analyze health-related quality of life and marine-associated health outcomes.

Predictors	Aborlan (n = 72) n (%)	Puerto Princesa (n = 154) n (%)	Taytay (n = 175) n (%)	Total (N = 401) n (%)
Gender				
Female	31 (43.06)	59 (38.31)	69 (39.43)	241 (60.10)
Male	41 (56.94)	95 (61.69)	105 (60.00)	159 (39.65)
Missing			1 (0.57)	1 (0.25)
Age Group				
Age 19-29	14 (19.44)	22 (14.29)	21 (12.00)	57 (14.21)
Age 30-39	16 (22.22)	42 (27.27)	35 (35.00)	93 (23.19)
Age 40-49	17 (23.61)	44 (28.57)	46 (26.29)	107 (26.68)
Age 50-59	16 (22.22)	30 (19.48)	34 (21.14)	80 (19.95)
Age 60-90	9 (12.50)	16 (10.39)	37 (21.14)	62 (15.46)
Missing			2 (1.4)	2 (0.50)
Education				
Elementary	9 (12.50)	61 (39.61)	60 (32.29)	157 (39.15)
Secondary	36 (50.00)	75 (48.70)	84 (48.00)	186 (46.36)
Tertiary	27 (37.50)	17 (11.04)	28 (16.00)	54 (13.47)
Missing		1 (0.65)	3 (1.71)	4 (1.00)
Marine-based Income				
Poor (< PhP 9,520)	55 (76.39)	87 (56.49)	113 (64.57)	255 (63.59)
Low Income (PhP 9,520-19,040)	14 (19.44)	52 (33.77)	37 (21.14)	103 (25.69)
Middle-Upper Income (> PhP 19,040)	2 (2.78)	9 (5.84)	14 (8.00)	25 (6.23)
Missing	1 (1.39)	6 (3.90)	11 (6.29)	18 (4.49)
Ethnicity				
Visayan	47 (65.28)	96 (62.34)	26 (14.86)	169 (42.14)
Cuyonon	2 (2.78)	6 (3.90)	71 (40.57)	79 (19.70)
Others	23 (31.94)	52 (33.77)	76 (43.43)	159 (37.66)
Missing			2 (1.14)	2 (0.50)
Religion				
Roman Catholic	46 (63.89)	130 (84.32)	143 (82.66)	319 (79.95)
Non-Roman Catholic	26 (36.11)	24 (15.58)	30 (17.14)	80 (19.95)
Missing			2 (1.14)	2 (0.50)
Proximity to the Coast				
< 1 km	56 (77.78)	105 (68.18)	134 (76.57)	295 (73.57)
> 1 km	7 (9.72)	31 (20.13)	22 (12.57)	60 (14.96)
Missing	9 (12.50)	18 (11.69)	18 (10.86)	45 (11.47)
Cigarette Smoker				
No	42 (58.33)	85 (55.19)	114 (65.14)	241 (60.10)
Yes	30 (41.67)	69 (44.81)	61 (34.86)	160 (39.90)
Liquor Drinker				
No	29 (40.28)	58 (37.66)	77 (44.00)	164 (40.90)
Yes	43 (59.72)	96 (62.34)	98 (56.00)	237 (59.10)

Health-Related Quality of Life

The mean PCS-12 was 48.3 ± 5.65 and the mean MCS-12 was 47.3 ± 8.26 (Table 2). Over half of respondents (56.9%, $n = 228$) had PCS-12 scores ≤ 50 , and 26.4% ($n = 106$) had MCS-12 scores ≤ 42 . Group comparisons revealed significant differences in mental health by gender and age and in physical health by study site and ethnicity, while most other socio-demographic variables were not significantly associated with HRQoL.

(Table 2, Figure 2). Women had lower mean MCS-12 scores than men (46.6 ± 7.98 vs. 48.4 ± 8.59 , $P = 0.04$), and participants aged 60–90 scored lower than those aged 19–29 (44.3 ± 8.09 vs. 48.4 ± 8.06 , $P = 0.03$). PCS-12 scores were lower in Puerto Princesa City (46.1 ± 5.97) than in Aborlan (49.6 ± 4.45) and Taytay (49.8 ± 5.18 , $P < 0.01$). Scores were also lower among Visayans (47.4 ± 5.83) than among Cuyonon (49.4 ± 5.41) or “Others” (48.7 ± 5.51 , $P = 0.02$).

Table 2. Health-related quality of life among adults in coastal communities of Palawan, Philippines, presenting the mean, standard deviation, and range of the physical component summary (PCS-12) and mental component summary (MCS-12) from the SF-12, disaggregated by socio-demographic characteristics. †Significant difference in means.

Predictors	Physical Composite Scale (PCS-12)				Mental Composite Scale (MCS-12)			
	<i>n</i>	Mean $\pm$ SD	Min / Max	<i>P</i> -value	<i>n</i>	Mean $\pm$ SD	Min / Max	<i>P</i> -value
Gender								
Male	158	48.4 ± 5.59	30.6 / 60.1	0.91	158	48.4 ± 8.59	28.0 / 67.7	0.04†
Female	234	48.3 ± 5.50	29.5 / 59.4		235	46.6 ± 7.98	29.1 / 66.5	
Age Group								
Age 19-29	53	47.9 ± 6.16	33.8 / 60.1	0.35	54	48.4 ± 8.06	33.8 / 64.4	0.03†
Age 30-39	93	48.1 ± 5.26	35.8 / 58.0		93	48.1 ± 8.34	28.0 / 65.6	
Age 40-49	104	49.3 ± 5.67	32.4 / 59.3		104	47.8 ± 8.37	32.3 / 67.7	
Age 50-59	79	47.9 ± 5.97	30.6 / 57.9		79	47.5 ± 8.05	29.0 / 66.5	
Age 60-90	61	47.7 ± 5.38	29.5 / 56.0		61	44.3 ± 8.09	29.1 / 66.2	
Study Site								
Puerto Princesa City	150	46.1 ± 5.97	29.5 / 58.5	0.00†	150	48.6 ± 8.04	30.4 / 66.5	0.03†
Aborlan	69	49.6 ± 4.45	40.4 / 59.3		69	47.3 ± 7.88	28.0 / 64.4	
Taytay	173	49.8 ± 5.18	30.6 / 60.1		174	46.2 ± 8.48	29.0 / 67.7	
Education								
Elementary	155	47.8 ± 5.81	29.5 / 59.3	0.09	155	46.9 ± 7.57	29.1 / 66.2	0.54
Secondary	180	48.9 ± 5.32	30.6 / 60.1		182	47.3 ± 8.77	28.0 / 67.7	
Tertiary	52	47.4 ± 6.30	33.2 / 57.6		52	48.4 ± 8.63	35.3 / 65.6	
Marine-based Income								
Poor (< PhP 9,520)	246	48.6 ± 5.52	29.5 / 59.4	0.23	245	47.6 ± 8.43	28.0 / 67.7	0.90
Low Income (PhP 9,520-19,040)	103	47.5 ± 6.02	33.0 / 60.1		103	47.2 ± 8.00	29.1 / 66.5	
Middle-Upper Income (> PhP 19,040)	25	48.2 ± 6.16	32.4 / 57.6		25	47.1 ± 8.87	29.0 / 63.1	
Ethnicity								
Visayan	164	47.4 ± 5.83	29.5 / 59.4	0.02†	154	47.7 ± 8.71	28.0 / 67.7	0.81
Cuyonon	77	49.4 ± 5.41	33.2 / 58.7		79	47.5 ± 8.45	29.0 / 66.2	
Others	149	48.7 ± 5.51	30.6 / 60.1		139	47.1 ± 7.84	29.1 / 66.5	
Religion								
Roman Catholic	310	48.4 ± 5.74	29.5 / 60.1	0.58	311	47.6 ± 8.32	28.0 / 67.7	0.17
Non-Roman Catholic	80	48.0 ± 5.41	33.0 / 58.3		80	46.2 ± 8.10	29.0 / 66.5	
Proximity to the Coast								
< 1 km	285	48.3 ± 5.81	29.5 / 60.1	0.38	288	47.2 ± 8.30	28.0 / 67.7	0.07
> 1 km	58	47.6 ± 5.66	32.4 / 56.5		58	49.4 ± 8.54	34.4 / 66.5	
Cigarette Smoker								
Yes	235	48.2 ± 5.93	32.4 / 58.7	0.73	235	46.8 ± 7.87	29.0 / 67.7	0.16
No	157	48.4 ± 5.22	29.5 / 60.1		158	48.1 ± 8.79	28.0 / 66.5	
Liquor Drinker								
Yes	230	48.5 ± 5.65	30.6 / 60.1	0.47	230	47.4 ± 7.93	28.0 / 65.6	0.85
No	162	48.1 ± 5.67	29.5 / 59.4		162	47.2 ± 8.74	29.1 / 67.7	

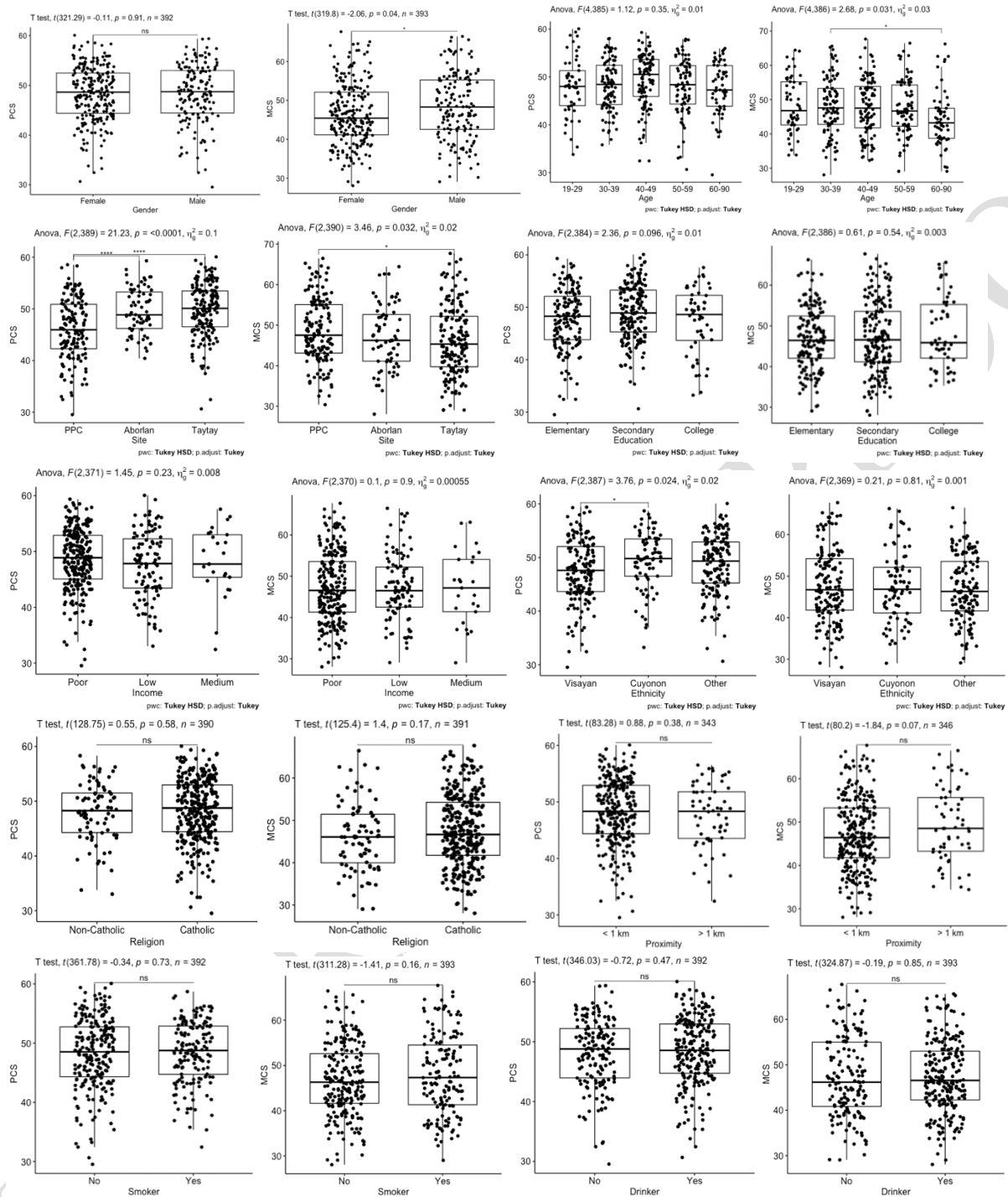


Figure 2. Distribution of the sampled data and statistical tests of mean differences in physical component summary (PCS-12) and mental component summary (MCS-12) scores across socio-demographic groups among adults in coastal communities in Palawan, Philippines.

In the final PCS-12 model (Table 3), study site was the strongest predictor: residents of Aborlan ($\beta_i = 3.55, t = 4.44, P < 0.001$) and Taytay ($\beta_i = 3.79, t = 6.08, P < 0.001$) reported higher PCS-12 scores than residents of Puerto Princesa City. Secondary education was marginally associated with higher PCS-12 scores compared

with elementary education ($\beta_t = 1.17$, $t = 1.94$, $P = 0.05$). No other socio-demographic variables retained significance in the final PCS-12 model.

Table 3. Summary of the physical component summary (PCS-12) and mental component summary (MCS-12) health models for adults in coastal communities in Palawan, Philippines. † Indicates the reference category. β_0 , β_i , SE, and AIC denote y-intercept, regression coefficient, standard error, and the AIC as an unbiased estimator of predictive accuracy. †† Marks significant association ($P < 0.05$).

Predictors	β_i (β_0)	SE	t-value	P-value (variable)	Adj. R-squared	AIC	P-value (model)
PCS-12							
(Intercept)	(45.58)	0.57	79.65	0.00 ††	0.10	1569.78	0.00 ††
Study Site [Puerto Princesa City†]							
Aborlan	3.55	0.80	4.44	0.00 ††			
Taytay	3.79	0.62	6.08	0.00 ††			
Education [Elementary†]							
Secondary	1.17	0.61	1.94	0.05 ††			
Tertiary	-0.98	0.90	-1.10	0.27			
MCS-12							
(Intercept)	(52.19)	1.68	31.10	0.00 ††	0.04	1260.17	0.00 ††
Gender [Male†]							
Female	-2.06	1.43	-0.33	0.02 ††			
Age Group [Age 19-29†]							
Age 30-39	-0.63	1.43	-0.44	0.66			
Age 40-49	-1.38	1.41	-0.98	0.33			
Age 50-59	-1.28	1.49	-0.86	0.39			
Age 60-90	-5.05	1.67	-3.14	0.00 ††			
Religion [Roman Catholic†]							
Non-Roman Catholic	-1.55	1.05	-1.47	0.14			
Proximity to the Coast [> 1 km†]							
< 1 km	1.99	1.19	-1.67	0.10			

For mental health, gender and age were significant predictors in the final MCS-12 model. Women had lower MCS-12 scores than men ($\beta_i = -2.06$, $t = -2.51$, $P < 0.05$), and respondents aged 60–90 had lower mental health scores compared with the reference group aged 19–29 ($\beta_i = -5.05$, $t = -3.14$, $P < 0.01$). Other variables, including religion and proximity to the coast, were retained in the model but did not reach statistical significance. These results indicate that study site and education level were associated with physical health, whereas gender and older age were the primary predictors of mental health in this coastal population. The models explained a modest proportion of variance in HRQoL (*Adj. R*² = 0.10 for PCS-12, $P < 0.001$; *Adj. R*² = 0.04 for MCS-12, $P < 0.001$), indicating that substantial variation in physical and mental health remained unexplained by the socio-demographic variables included in the models.

Self-Reported Accidents and Health Outcomes

Exploratory factor analysis of self-reported health items revealed three distinct domains: directly marine-related accidents, muscle aches, and infections and skin diseases. The factor structure demonstrated strong

reliability, with Cronbach's α ranging from 0.844 to 0.949, and correlations between factors ranging from $r = 0.293$ to $r = 0.830$. Sampling adequacy was excellent ($KMO = 0.92$), and Bartlett's test was significant, indicating that the correlation matrix was suitable for factor analysis ($\chi^2 = 14,068.2$, $P < 0.05$).

Descriptive statistics indicated that directly marine-related accidents were generally rare among participants (mean $\pm$ standard deviation = 1.12 ± 0.35 ; Table 4). When accidents did occur, 22.7% of respondents reported cuts or stings, 2.5% with no parasitic infections, 8.0% experienced near-drowning events, 11.5% disclosed diving-related problems, and 16.0% experienced sunburn or sunstroke. Muscle aches (1.46 ± 0.59) were more commonly reported, with 49.6% reporting fever or headache, 71.1% experiencing leg cramps, and 49.6% with other body pains. Infections and skin diseases (1.28 ± 0.56) affected 24.7–53.4% of respondents, with vomiting, diarrhea, or stomach ache reported by 24.7%, ear problems by 7.2%, eye problems by 18.4%, new skin issues by 11.5%, urinary tract infections by 27.4%, and breathing difficulties by 7.5%.

Table 4. Descriptive statistics for Section 4, Question 5 of the Blue Communities Project survey, summarizing marine-related health risks among adults in coastal communities of Palawan, Philippines.

Marine environment and health and well-being	Mean $\pm$ Standard Deviation	Response frequencies (Valid %) ($N = 401$)			
		No	Yes – but did not talk to health worker	Yes + talked to health worker	Don't know/Prefer not to answer
Directly marine-related accidents	1.12 ± 0.35				
Got cut/stung/bitten by something in/by the water	1.28 ± 0.53	295 (73.57)	91 (22.69)	12 (2.99)	3 (0.75)
Picked up a parasite from the sand/water	1.01 ± 0.19	386 (96.26)	10 (2.49)		5 (1.25)
Got into difficulties in water/came close to drowning	1.07 ± 0.30	369 (92.02)	27 (6.73)	2 (0.50)	3 (0.75)
Had diving-related problems (e.g., decompression sickness/the bends)	1.10 ± 0.37	355 (88.53)	37 (9.23)	4 (1.0)	5 (1.25)
Got sunburn/sunstroke at the sea/on the beach	1.15 ± 0.38	337 (84.04)	60 (14.96)	1 (0.75)	3 (0.75)
Muscle aches	1.46 ± 0.59				
Had fever/headache	1.58 ± 0.66	199 (49.63)	163 (40.65)	36 (8.98)	3 (0.75)
Had cramps in legs or other areas	1.26 ± 0.51	285 (71.07)	103 (25.69)	5 (1.25)	8 (2.00)
Other muscular/body pains	1.53 ± 0.59	199 (49.63)	182 (45.39)	17 (4.24)	3 (0.75)
Infections and Skin diseases	1.28 ± 0.56				
Vomiting, diarrhoea, or stomach ache	1.41 ± 0.66	263 (65.59)	99 (24.69)	35 (8.73)	4 (1.00)
Had earache or discharge from ears	1.12 ± 0.42	357 (89.03)	29 (7.23)	11 (2.74)	4 (1.00)
Had red, painful eyes or discharge from eyes	1.22 ± 0.49	313 (78.05)	74 (18.45)	10 (2.49)	4 (1.00)
Had a new skin problem (e.g., itchy/allergic reaction)	1.18 ± 0.50	335 (83.54)	46 (11.47)	16 (3.99)	4 (1.00)
Had a urinary tract infection	1.61 ± 0.79	214 (53.37)	110 (27.43)	70 (17.46)	7 (1.75)
Had breathing difficulties/infection	1.16 ± 0.51	345 (86.03)	30 (7.48)	20 (4.99)	6 (1.50)

Binary logistic regression identified socio-demographic predictors of self-reported accidents and health outcomes. Women had higher odds of marine-related accidents than men ($OR = 2.07$; 95% CI: 1.87–2.54; Table

5). Respondents in the lowest income group (poor marine-based) were more likely to report infections and skin diseases than those in the low or middle-upper income groups (OR = 1.87; 95% CI: 1.22–3.86). No significant associations were found for age, education, ethnicity, religion, coastal proximity, smoking, or alcohol use. Model performance was strong for marine-related accidents and infections and skin diseases (93% accuracy for both), while the muscle aches model showed moderate accuracy (65%) (Figure 3). Accuracy was calculated at the ROC-derived optimal probability cutoff, with AUC values indicating overall model discrimination.

Table 5. Binary logit models (exponentiated odds ratios, OR, 95% CI) for socio-demographics, directly marine-related accidents, muscle aches, and infections and skin diseases, summarizing marine-related health risks among adults in coastal communities of Palawan, Philippines. † Indicates the reference category. †† Marks variables whose odds-ratio confidence intervals exclude 1.0, indicating statistical significance ($P < 0.05$).

Predictors	Directly marine-related accidents	Muscle aches	Infections and Skin diseases
	OR (CI)	OR (CI)	OR (CI)
(Intercept)	2.09 (1.22, 2.52)[†]	2.52 (0.41, 4.65)	1.89 (1.33, 2.76)[†]
Gender			
Male [†]			
Female	2.07 (1.87, 2.54)^{††}	1.39 (0.39, 2.76)	1.32 (0.42, 3.54)
Age Group			
Age 19-29 [†]			
Age 30-39	1.32 (0.89, 2.87)	1.31 (0.98, 2.76)	0.86 (0.02, 1.91)
Age 40-49	0.75 (0.01, 1.69)	1.38 (0.61, 2.95)	0.94 (0.21, 2.53)
Age 50-59	0.52 (0.04, 1.97)	0.62 (0.03, 2.45)	0.20 (0.05, 1.75)
Age 60-90	1.63 (0.98, 3.92)	1.41 (0.87, 2.75)	1.32 (0.53, 3.26)
Study Site			
Puerto Princesa City [†]			
Aborlan	0.94 (0.04, 1.76)	1.65 (0.24, 2.74)	1.45 (0.53, 4.69)
Taytay	1.72 (0.45, 2.64)	0.30 (0.02, 2.11)	1.69 (0.73, 3.21)
Education			
Elementary [†]			
Secondary	1.87 (0.58, 2.79)	0.64 (0.09, 1.96)	0.42 (0.11, 2.63)
Tertiary	1.73 (0.49, 2.87)	0.53 (0.20, 1.93)	1.43 (0.85, 4.87)
Marine-based Income			
Poor (< PhP 9,520)	2.97 (0.35, 3.74)	0.87 (0.21, 3.75)	1.87 (1.22, 3.86)^{††}
Low Income (PhP 9,520-19,040) [†]			
Middle-Upper Income (> PhP 19,040)	1.52 (0.76, 6.89)	2.87 (0.69, 3.87)	3.52 (0.75, 5.57)
Ethnicity			
Visayan	1.75 (0.65, 2.91)	1.72 (0.54, 2.86)	1.51 (0.61, 3.75)
Cuyonon	2.55 (0.85, 5.84)	2.91 (0.53, 3.87)	1.54 (0.54, 4.82)
Others [†]			
Religion			
Roman Catholic [†]			
Non-Roman Catholic	1.66 (0.74, 4.29)	2.86 (0.31, 5.47)	2.82 (0.50, 4.84)
Proximity to the Coast			
> 1 km [†]			
< 1 km	2.84 (0.74, 5.95)	1.72 (0.54, 2.48)	1.98 (0.54, 3.81)
Cigarette Smoker			
No	1.64 (0.75, 3.91)	0.98 (0.02, 2.53)	1.51 (0.92, 4.61)
Yes [†]			
Liquor Drinker			
No	2.29 (0.41, 4.46)	1.21 (0.74, 2.64)	1.84 (0.65, 4.76)

Yes [†]			
Null deviance (DF)	261.45 (400)	377.57 (400)	206.66 (400)
Akaike Information Criterion	267.34	401.30	254.21
N	401	401	401

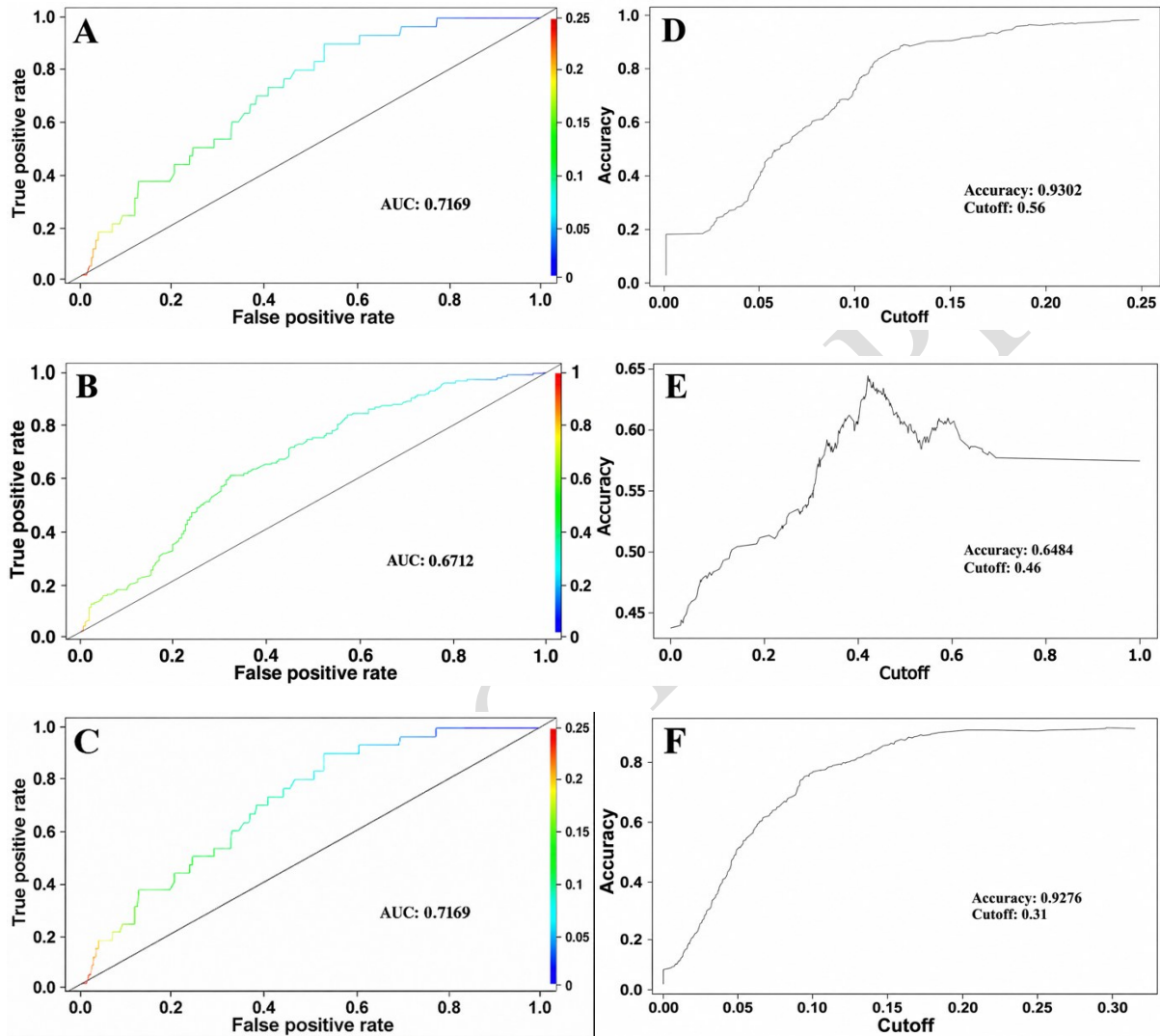


Figure 3. Plot of area under the receiver operating characteristic (ROC) curve (AUC) as a measure of classifier performance for the three binary logit models: (A) directly marine-related diseases; (B) muscle aches; and (C) infections and skin diseases. Optimal Cutoff values plotted against the accuracy of the three models: (D) directly marine-related diseases; (E) muscle aches; and (F) infections and skin diseases.

DISCUSSION

Characteristics of the Study Population

The study sample consisted predominantly of middle-aged coastal residents with low income and limited educational attainment, characteristics that are recognized as socioeconomic factors increasing vulnerability to occupational and environmental health risks in Philippine fishing communities (De Guzman et al. 2021; Labayo

and Preña 2021). The high proportion of households living below the poverty threshold also indicates limited economic capacity among the study population. With incomes below PHP 9,520/month, households may face constraints in meeting food and other basic needs, potentially affecting the quantity, diversity, and types of foods they can afford. Although dietary intake was not directly assessed in the present study, these economic constraints provide important context for understanding the broader socioeconomic vulnerability of coastal households. Structural factors such as persistent poverty, constrained healthcare access, and environmental exposures may contribute to HRQoL and vulnerability to occupational hazards, although in the present study, self-reported accidents and health outcomes were largely unrelated to most socio-demographic factors except for gender and low income (for infections and skin diseases). Similar associations between income instability and reduced psychosocial well-being have been reported in artisanal fishing communities in Aklan during the COVID-19 pandemic (Maliao et al. 2023), highlighting the potential role of structural determinants in shaping health outcomes even when not detected in cross-sectional self-reports.

One of the clearest findings is the lower physical health status of respondents in Puerto Princesa City compared with those in Aborlan and Taytay. Mean PCS-12 scores were 46.1 in Puerto Princesa, compared with 49.6 in Aborlan and 49.8 in Taytay, and study site remained the strongest predictor in the final PCS-12 model. This pattern suggests that differences in the local context of the three study sites may be relevant to physical health. Puerto Princesa represents the more urban setting among the three study sites, whereas Aborlan and Taytay are comparatively less urbanized coastal settings. Such differences may shape the types and intensity of livelihood activities, daily mobility, occupational demands, and environmental exposures experienced by coastal residents. The lower PCS-12 scores in Puerto Princesa may therefore reflect the combined influence of coastal livelihood demands and the pressures associated with an urban coastal environment. However, occupation type, workload, commuting, environmental exposure, and access to preventive health services were not directly measured in this study; these mechanisms therefore remain plausible explanations rather than demonstrated causes of the observed site difference.

Gender and age-related livelihood roles shape health risks in coastal fishing communities. Women, often described as “invisible producers of fishing sector,” are typically engaged in gleaning, processing, and household labor, which increases their exposure to waterborne hazards and occupational risks due to prolonged contact with marine environments, manual handling of seafood, and limited access to protective equipment or healthcare (Rubin 2021). Older adults showed reduced physical and mental health, reflecting cumulative vulnerability from aging, repeated environmental hazards, the physical demands of fishing, and heightened climate-risk perceptions

(Alcantara et al. 2023). These patterns mirror global evidence that older populations in coastal and small-island settings experience disproportionate health risks due to climate variability, extreme events, and fragile health systems (Balikuddembe et al. 2024; Prina et al. 2024), further exacerbated by repetitive manual labor and limited occupational safety and health measures (Agyekum et al. 2025).

Health-Related Quality of Life and Marine-Related Health Risks

The present findings indicate that health risks in the Palawan coastal communities are multidimensional, encompassing marine accidents, musculoskeletal complaints, and infections and skin conditions. These patterns are consistent with the broader understanding that coastal fishing communities experience overlapping occupational, environmental, socio-economic, and socio-cultural pressures (King et al. 2015; Rezaee et al. 2016). Physical strain arises from repetitive, labor-intensive tasks such as hauling nets, boat maintenance, and heavy lifting, leading to cumulative musculoskeletal stress and chronic pain (Laraqui et al. 2024). Limited occupational safety measures in the Philippines exacerbate these risks (Sibulan and Reyes 2023; Cadiz et al. 2024), while constrained healthcare access in coastal areas prolongs recovery from injuries and increases long-term disability (Iqbal 2019; Dahlui et al. 2020). In the present study, musculoskeletal complaints were the most frequently reported health concern, particularly leg cramps and other body pains. Musculoskeletal disorders are similarly common among fishers elsewhere, where repetitive labor, heavy lifting, and awkward postures are recognized contributors (Nørgaard Remmen et al. 2020). While this quantitative approach captures prevalence and clustering, future research employing qualitative methods is warranted to explore why certain groups experience specific risks, the context of exposure, and the mechanisms linking occupational activities to physical and mental health outcomes.

Mental health also varied across demographic groups in the present study. Women had lower MCS-12 scores than men, while respondents aged 60–90 years had lower scores than those aged 19–29 years. These differences may reflect the combined demands associated with livelihood and household responsibilities among women and the cumulative effects of aging among older coastal residents. Women in fishing communities may experience a dual burden of physically demanding livelihood activities and household responsibilities, which can amplify psychosocial stress and restrict opportunities for recovery (Rodríguez-Romero et al. 2013). Aging may similarly increase vulnerability through the cumulative effects of prolonged labor, environmental exposure, and potential social isolation (Noto 2023). High-dependence fisheries can expose households to additional stressors, including resource competition, seasonal variability, and socioeconomic pressures, which have been associated with anxiety and depression in artisanal fishing populations (Rodrigues et al. 2004; Bastos and Petrere 2010).

The present findings highlight that occupational health risks in small-scale fisheries are multidimensional, encompassing marine accidents, musculoskeletal complaints, and infections and skin conditions (Alayyannur et al. 2023). Although marine-related accidents were relatively uncommon, women had more than twice the odds of reporting these accidents compared with men (OR = 2.07; 95% CI: 1.87–2.54), reflecting possible gendered differences in exposure to ergonomic, chemical, and biological hazards inherent to coastal livelihoods (Halder et al. 2024). Musculoskeletal complaints appear to result from cumulative microtrauma and repetitive labor, with minimal variation across socio-demographic groups, suggesting that these burdens are pervasive and warrant universal ergonomic and workload interventions. Infections and skin conditions were concentrated among lower-income participants, emphasizing the interaction between socioeconomic disadvantage and occupational/environmental exposures, including prolonged wet conditions, saltwater contact, and UV exposure (Alayyannur et al. 2023; Halder et al. 2024). Other socio-demographic factors, such as age, education, and coastal proximity, were not predictive, reinforcing that gender and income are the principal determinants of vulnerability (Guillot-Wright et al. 2025).

These findings have practical implications for coastal public health in Palawan. The observed differences in HRQoL across study sites, lower mental health scores among women and older adults, higher odds of marine-related accidents among women, and greater odds of infections and skin diseases among participants in the poorest marine-based income group suggest the need for targeted rather than uniform health interventions. Community-based occupational health initiatives could incorporate gender-responsive safety measures, ergonomic support, health education, early recognition of musculoskeletal and skin conditions, and accessible referral pathways to primary healthcare services (WHO 2011, 2017, 2019). Such approaches are particularly relevant in geographically isolated and disadvantaged communities in the Philippines, where differences in health-worker availability, workload, geographic access, and local health-system capacity can affect the delivery of primary care (Parial et al. 2024). Philippine evidence from marine-based livelihoods also demonstrates the importance of recognizing occupational health hazards and developing context-specific measures to reduce work-related health risks (Dumilag et al. 2024).

Addressing these health concerns will require coordination between local governments, primary healthcare providers, fisheries and environmental agencies, and the communities themselves. Evidence from geographically isolated and disadvantaged communities in the Philippines suggests that local health-system needs vary by context and require coordination among the Department of Health, local government units, and health facilities (Parial et al. 2024). For coastal communities, this could include linking occupational health activities

with primary healthcare, environmental health measures, and social protection, particularly where health risks are closely tied to livelihood conditions.

This study is constrained by its relatively small sample, use of non-local SF-12 scoring norms, and reliance on self-reported data that may reflect cultural or situational bias. The reliance on self-reported accidents and health outcomes may have introduced recall and reporting bias, particularly for previous marine-related incidents and health conditions. In addition, the use of convenience sampling may have introduced selection bias because participation depended on respondents' availability and willingness to participate, which may limit the generalizability of the findings beyond the study communities. Its cross-sectional design also limits causal interpretation. Despite these constraints, the findings provide an initial empirical baseline for understanding HRQoL, musculoskeletal complaints, and infection risks in coastal Palawan fishing communities.

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GENERATIVE AI STATEMENT

Generative AI (Grammarly) was used only for minor language editing. All ideas, analyses, and interpretations are the authors' own.

ETHICAL CONSIDERATIONS

Approved by the Philippine National Ethics Committee (2-19-002-Creencia-Blue) and the University of Exeter Medical School Ethics Committee (May19/B/1985).

DECLARATION OF COMPETING INTEREST

The authors declare no competing interests.

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