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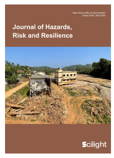

Article

Salinity and Livelihoods: Dermatological Health Challenges in Coastal Bangladesh

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Abstract: Salinity intrusion in coastal Bangladesh presented critical challenges to both health and livelihoods, particularly in communities reliant on saline-exposed water sources and occupations. This study investigated how environmental salinity exposure and related socio-demographic and resilience factors influenced dermatological health outcomes in coastal Bangladesh. A cross-sectional survey of 400 randomly selected households was conducted in Gabura Union, Shyamnagar subdistrict, complemented by seven focus group discussions (FGDs) to triangulate findings. Probit regression analysis revealed that using unsafe drinking water (45.2%, $p < 0.001$), living more than 1 km from a safe source (17.1%, $p < 0.001$), and working in salinity-linked occupations (14.3%, $p < 0.001$) significantly increased the likelihood of reporting skin disease. Notably, higher coping capacity was also associated with an increased probability of skin disease (2.3%, $p < 0.05$), which appeared counterintuitive. While gender was significant in the bivariate analysis, it did not remain significant in the multivariate model. However, FGDs and KIIs supported the overall findings, highlighting occupational exposure, water insecurity, and gendered vulnerabilities as key contributors to dermatological health risks. Although the study revealed important associations, its cross-sectional design and reliance on self-reported symptoms limited causal inference and biochemical specificity. The findings underscore the urgent need for comprehensive policy measures that advance sustainable water resource management, promote alternative livelihood strategies, and strengthen access to dermatological healthcare in coastal communities.

Keywords: salinity; dermatological/skin disease; health impact; livelihoods; coastal bangladesh

1. Introduction

Salinity intrusion in coastal areas is a problem that impedes sustainable development, thereby affecting food security, health, and access to freshwater in those regions [1,2]. Salinity in the water source contributes to decreased access to safe drinking water, thereby increasing vulnerability among communities that derive their livelihoods from water [3,4]. Climate change-induced salinity, among other environmental influences, has posed serious conditions to people living in the coastal areas of Bangladesh due to the high population increase in those areas [5,6]. Furthermore, salinity compromises health and well-being (SDG 3) by limiting access to clean water and sanitation (SDG 6), thereby posing significant public health risks [7].

Despite ambitious global targets for drinking water, sanitation, and hygiene under the SDGs, salinity is a prevalent and concerning issue in coastal regions worldwide [8–10]. In Africa, North [11] East, and Southern parts, the western part of the United States of America, the Middle east countries, Australia, Central and Western China, and Central Asia are severely affected by saline intrusion [12]. Salinity also directly or indirectly affects the Asian mega-delta systems, with particular intensity in the Ganga-Brahmaputra-Meghna (GBM) Delta spanning Bangladesh and India [13] In the delta region in Bangladesh, approximately 1.02 million hectares (or nearly 70%) of coastal farmland is negatively impacted by soil salinity [14]. About 35 million people, representing 29% of the population, live in these 19 coastal districts [15]Furthermore, according to [16]the coastline area had a population of 35.1 million people, increasing from 8.1 million a century ago. The coastal population is expected to increase to around 41.8 million in 2015 and 57.9 million in 2050 [17]. More than 25 million people are at risk of unsafe drinking water due to saline intrusion [18].

The factors influencing salinity intrusion in the coastal regions of Bangladesh (Figure 1) have contributed to increasing salinity levels in both surface and groundwater, which in turn pose a serious threat to the health of coastal populations ([19]. Communities often consume highly salted water, leading to adverse health outcomes [18,20]. Salinity affects human well-being directly and indirectly, influencing living standards, health, and livelihoods [21,22]). Many residents remain unaware of these risks and continue using unsafe water sources despite known dangers [23]. High salinity in drinking water has been linked to hypertension and other waterborne diseases [24].with studies across coastal districts confirming associations between saline water and multiple health problems [18,25,26].

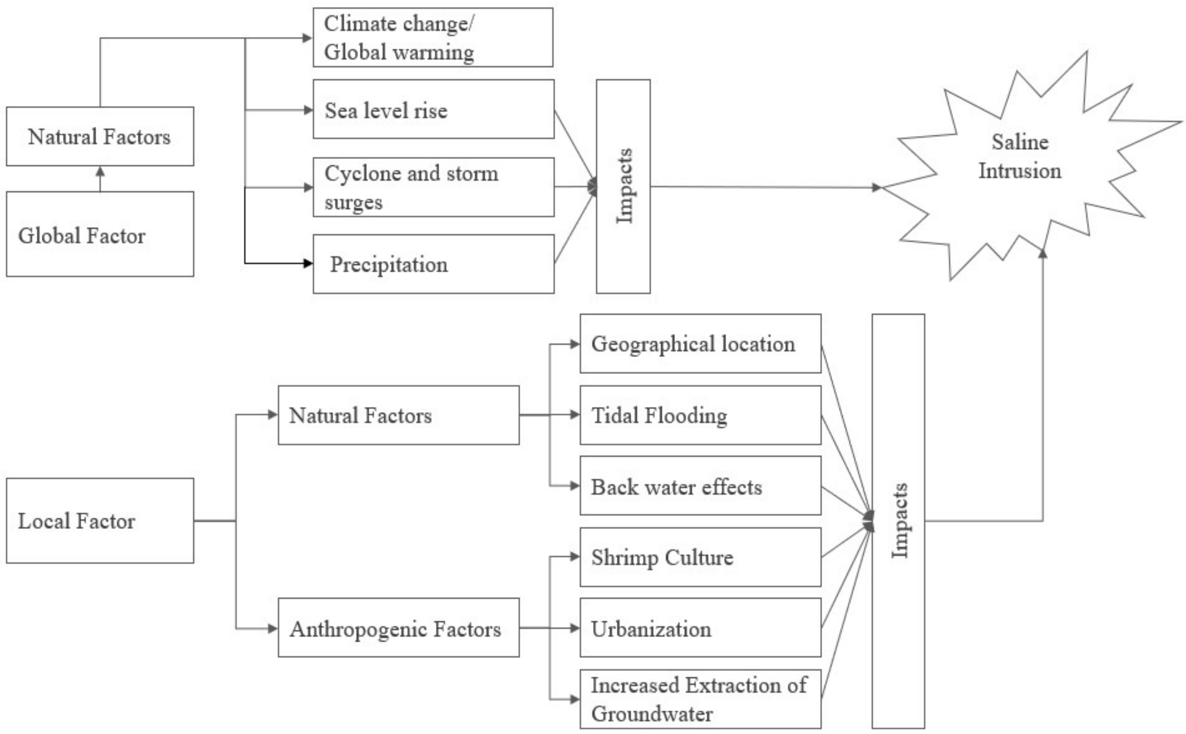

Figure 1. The factors influencing salinity intrusion in the coastal regions of Bangladesh.

Salinity intrusion is reflected in elevated Total Dissolved Solids (TDS) and Electrical Conductivity (EC), with World Health Organization (WHO) guidelines recommending TDS below 500 mg/L and EC below 1500 µS/cm for safe drinking water. Recent hydro-geochemical assessments in Tuticorin District reported that 75% of samples exceeded the permissible TDS limit, underscoring the widespread challenge of water unsuitability in coastal regions [27]. In Gabura Union, where households depend on saline water for drinking, bathing, and occupational use, such exceedances translate into heightened dermatological risks, making technical thresholds of salinity directly relevant to disease pathways in water-dependent livelihoods. Beyond drinking water, salinity exposure permeates daily activities and agricultural practices, particularly shrimp farming, further intensifying health vulnerabilities among coastal populations [6,20].

Research Gap and Novelty

While considerable attention has been given to drinking water crises and broader health challenges linked to salinity, its specific dermatological health effects remain underexplored (Figure 2). Existing studies have not examined how occupational exposure and water accessibility interact to shape dermatological health risks in coastal Bangladesh. This research contributes uniquely to understanding dermatological health risks in coastal Bangladesh by applying a mixed-methods approach to livelihoods and salinity exposure, specifically in Gabura Union (Figure 2), offering new insights into salinity-related disease pathways.

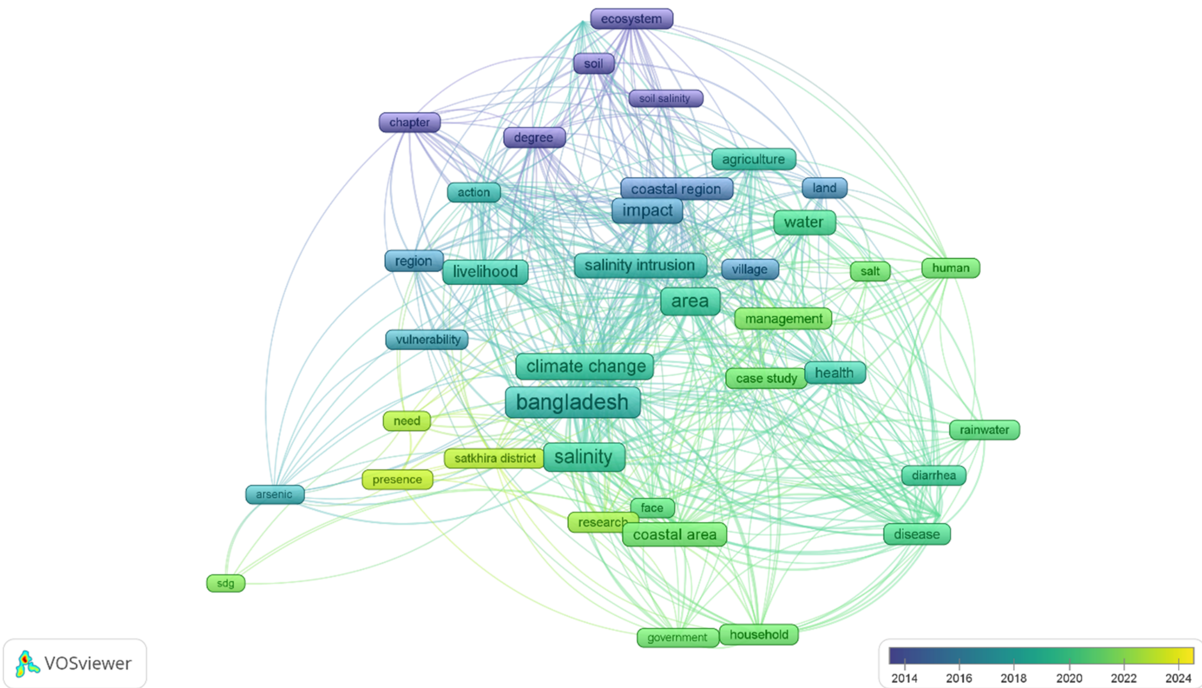

Figure 2. Visualization of keyword co-occurrences in drinking water crises and broader health challenges in Bangladesh from January 2014 to December 2024 based on bibliographic data, by VOSviewer® 1.6.20 software in November 2024.

Given this research gap, the study sets out the following objectives to quantify dermatological disease prevalence and identify the key socio-demographic and occupational factors driving vulnerability.

- To assess the prevalence of dermatological diseases among coastal populations exposed to salinity.
- To identify key socio-demographic, occupational, and water-access factors associated with dermatological health risks.
- To provide evidence-based recommendations for climate-resilient health services and livelihood adaptation strategies.

2. Materials and Methods

This manuscript draws on both quantitative and qualitative data collected from coastal districts in Bangladesh. A cross-sectional survey was conducted in Gabura Union, the coastal region of Satkhira, which is known to be severely impacted by salinity. The sample population consisted of 400 individuals from households reliant on saline water sources.

2.1. Study Area

The study was conducted in Gabura Union, Shyamnagar, Satkhira (Figure 3), a coastal area of Bangladesh severely affected by salinity. Situated within the Ganges–Brahmaputra–Meghna (GBM) Delta, Gabura experiences high salinity due to sea-level rise, reduced upstream freshwater flow, and recurrent tidal surges [20]. Additional pressures such as poor embankment management, breaches for shrimp farming, and prolonged saline waterlogging further intensify exposure, making Gabura an appropriate case for examining the health impacts of saline water intrusion [28].

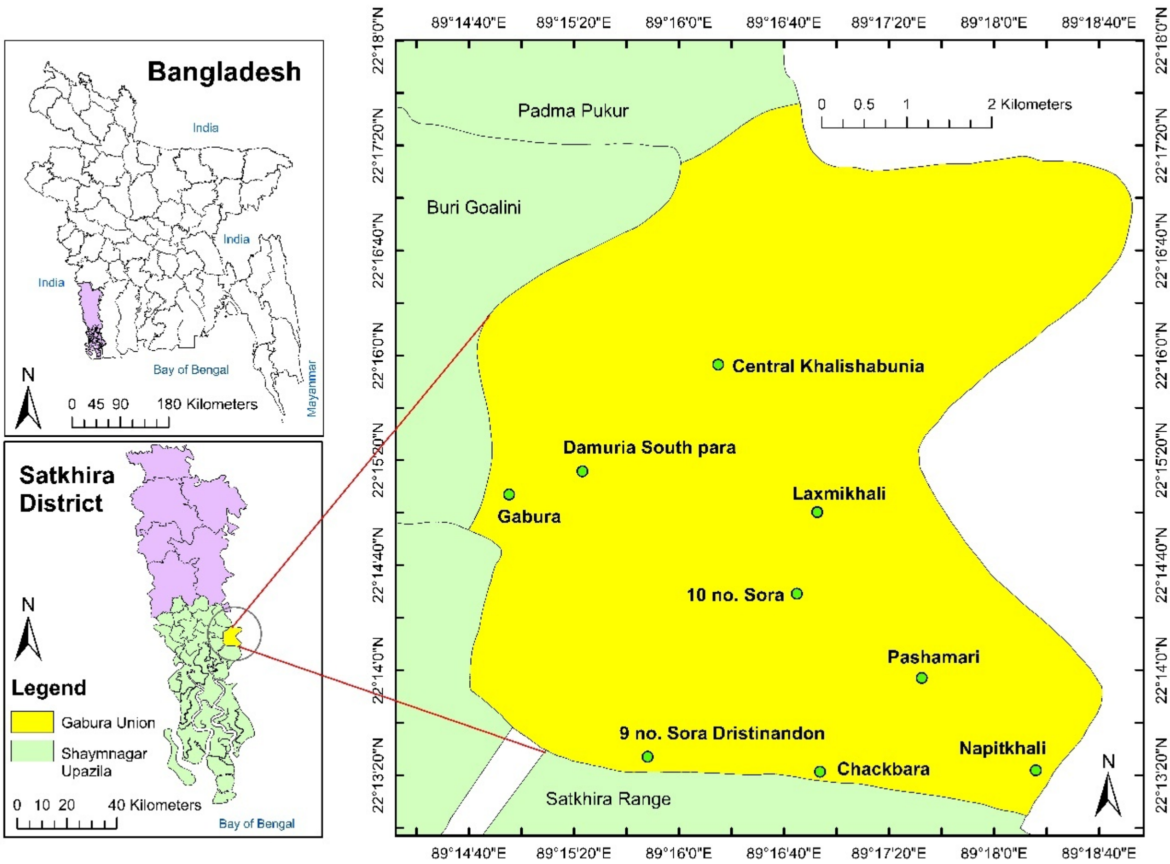

Figure 3. Study area: Gabura Union, Satkhira, Bangladesh.

2.2. Study Design and Sampling

A cross-sectional study design was employed to assess the Dermatological health impacts of salinity among the coastal population of Bangladesh (Study area Figure 3). This study employed a mixed method approach. A quantitative design for data collection with a total calculated sample size of 382 based on the following formula to assess the health impact of salinity in coastal communities in Bangladesh. A simple random sampling technique was employed to ensure that each individual within the specified age group had an equal chance of being selected. Specifically, this study focused on the dermatological health impact of saline water. Seven focus group discussions were conducted across seven villages in the study area, engaging participants from diverse age groups.

2.3. Inclusion and Exclusion Criteria

2.3.1. Household Survey

Inclusion criteria: Household head, or spouse, adults aged 18–80 years, households relying on local water sources for daily activities (drinking, cooking, bathing, washing, etc.)

Exclusion criteria: Children <18; individuals with cognitive disorders; households relying exclusively on bottled water or recent migrants.

2.3.2. Focus Group Discussions

Inclusion: Lactating mothers; women 18–49; women 50+; school-going girls (Class IX & X, post-menarche); men 18–59; men 60+; women engaged in shrimp/crab farming**.**

2.4. Sample Size Determination

The sample size for the selected union was calculated via Yamane's formula.

$$n = N/\{1 + N(e)^2\}.$$

where, n = the sample size

N = Total number of households

e = Level of precision (5 percent)

$n = 8321/1 + 8321(.05)^2$

$n = 381.69$

$= 382$

Thus, the minimum required sample size was 382 households. To account for potential non-response, an additional 10% was included, yielding a final target sample size of 420 households.

2.5. Data Collection Tool

Data were collected using a structured survey questionnaire designed to capture detailed information on the dermatological health of coastal communities. The questionnaire has been constructed into four sections (i) demographic information (ii) dermatological disorders (skin diseases) (iii) safe drinking water and practices (iv) health facilities (v) social resilience to the health impact of salinity.

2.6. Operational Definition

2.6.1. Dermatological Problems

In this study, Dermatological problem refers to skin diseases with different symptoms. They were defined as red, itchy welts, often an allergic reaction, hair loss, abnormally dry, scaly skin, dermatitis, dryness, tightness, and a rough texture of skin. Rash with reddish pimples and itching or burning in the intertriginous region.

2.6.2. Access to Safe Drinking Water

To assess practices related to safe water, five questions were used: water consumption habits, household water usage practices, adaptation measures for safe water practices, involvement in water safety activities, and water treatment and purification. A Likert scale questionnaire was employed to measure these practices, with each question rated on a scale from 1 to 5 (1 = never, 2 = rarely, 3 = seldom, 4 = often, 5 = always). The total score for each respondent ranged from 5–25.

2.6.3. Occupation of the Respondents

Occupations were categorized into two groups: those exposed to saline water and those not exposed. Homemakers were included in the non-exposure group.

2.6.4. Perceived Health Impact

The perceived health impact of salinity is how people believe their skin is affected by high salt levels in the water, influencing their behaviours and adaptation efforts.

2.7. Measure

2.7.1. Outcome Variable

Self-reported dermatological disorder was categorized based on response to the question: “Have you ever suffered from any type of dermatological disease in the last three months?” The response of an individual was coded as “1” if he/she said “Yes” and “0” if they replied otherwise.

2.7.2. Predictors/Confounders

A set of explanatory variables was selected for this analysis, including the age of the respondent (years), gender (male/female), education status of the respondent (Illiterate/Literate), size of household, water source (open/filter/rainwater harvesting), monthly income, land ownership, Housing material (Katcha/Semi-pacca and pacca) Toilet condition (Sanitary/non-sanitary). Access to health care (Accessibility Availability/Affordability) Social resilience (Community knowledge and skill regarding salinity/Economic resilience/Social bonding/Coping capacity/Social Awareness/Access to health care).

2.7.3. Data Analysis

Data were analyzed using SPSS 26. Respondents were categorized into groups with and without dermatological problems. Categorical data are presented as numbers (%) and continuous data as means (SDs). For skewed data, median with interquartile range (IQR) was used. Health impact was categorized into high and low groups. Dermatological diseases in the last three months were denoted as yes/no. Accessibility, availability, and affordability were combined to denote access to health facilities. For social resilience, six indicators with different variables were used. Groups were compared using chi-square test and Fisher's exact test for categorical variables, *t*-test for normal continuous variables, and Mann-Whitney U test for skewed data. *p*-value < 0.05 was considered significant in two-tailed tests. Significant variables from bivariate analyses were entered into multivariate probit regression to identify dermatological problem predictors.

3. Results

3.1. Descriptive Analysis

3.1.1. Sociodemographic Characteristics of the Respondents

The baseline characteristics of the respondents (*n* = 400) reveal a predominantly female sample (70%), with an average age of 39.8 years (±12.3).

A significant portion of respondents are engaged in labour-intensive behaviours occupations such as day labour (29.5%), agriculture (23.3%), and homemaking (23.8%), with only 7% involved in business. Educational attainment is notably low, with over half being illiterate (50.7%) and 43.5% having only primary education. The median monthly family income is modest at 8000 BDT (86 USD), and households typically have 4 members (median [IQR] 4 [4, 5]). Land ownership is minimal, with a median of 0.0121 hectares [0.008, 0.0202]. While most housing materials are semi-pacca or pacca (83.5%), a significant majority (84%) lack access to sanitary toilets. Additionally, 46.2% of households have at least one child under five years of age (Table 1).

Table 1. Baseline characteristics of the respondents (*n* = 400).

Baseline Characteristics	Frequency	Percentage
Gender		
Male	120	30.0
Female	280	70.0
Age (in years) (mean ± SD)	39.8 ± 12.3	
Occupation		
Homemaker	95	23.8
Agriculture	93	23.3
Day labor	118	29.5
Business	28	7.0
Education		
Illiterate	203	50.7
Up to Primary	174	43.5
Monthly family income (in * BDT) (Median [IQR])	(8000.0 [6000, 10.000])	
None	215	53.8
One	154	38.5
Housing material		
Katcha	66	16.5
Semi-pacca and pacca	334	83.5
Toilet condition		
Sanitary	64	16.0
Non sanitary	336	84.0

* Note: Exchange rate during data collection: 1 BDT = 0.01075 USD.

Dermatological conditions varied significantly across socio-demographic and occupational groups. Prevalence was higher among women (52%) compared to men (38%) (Figure 4), reflecting greater exposure through domestic water use. Younger adults (18–35 years) reported more frequent symptoms (47%) than older groups (31%), suggesting cumulative resilience or underreporting among elders. Salinity-linked occupations such as shrimp farming and salt harvesting showed elevated prevalence (60%) relative to non-salinity livelihoods (30%). Households' dependent on long-distance water collection also exhibited higher risk, underscoring the compounded vulnerability of water-dependent livelihoods in Gabura Union.

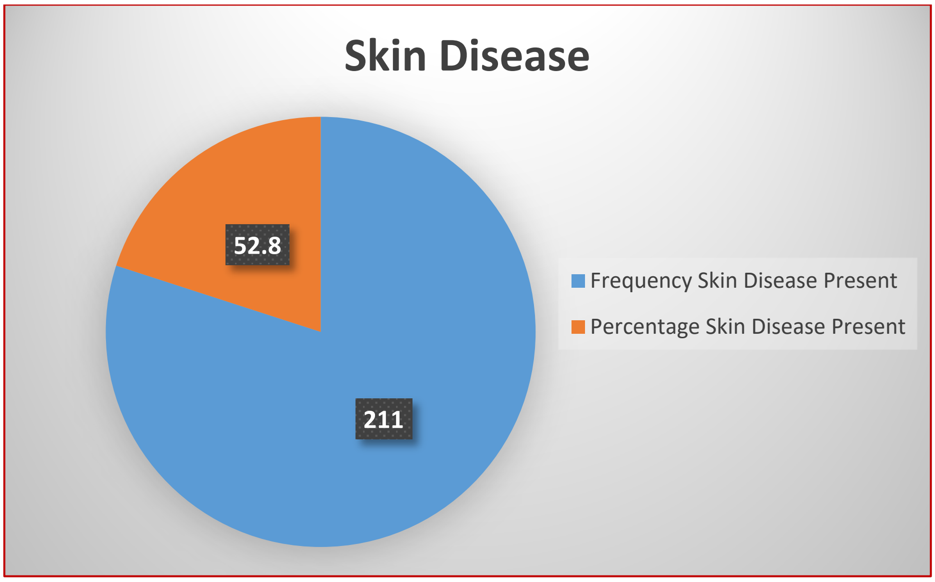

Figure 4. Distribution of the respondents by the skin disease for visiting OPD/doctor within the last 3 months (n = 400).

3.1.2. Access to Water

The data on water sources and access highlights significant reliance on open and non-improved water sources. For drinking, 45.5% use rainwater, while 33.3% rely on open sources, with only 21.3% using filtered water. Cooking, bathing, and toilet water predominantly come from open sources (91.0%, 90.3%, and 85.5%, respectively). Access to safe drinking water is limited, with 60.3% traveling more than 1 km to access it. A majority (75.5%) purchase drinking water, primarily during the dry season (56.5%), spending a median of 30 BDT per purchase [IQR: 25, 30]. Only 1.3% buy drinking water year-round, while 17.8% purchase it occasionally (Table 2).

Table 2. Water source of the respondents (n = 400).

Water Source	Frequency	Percentage
Drinking water		
Tube well/filter	58	14.5
Rainwater	178	44.5
Open source	164	41.0
Cooking water		
Tube well/filter	36	9.0
Open source	364	91.0
Bathing water		
Tube well/filter	39	9.8
Open source	361	90.3
Toilet water		
Tube well/filter	58	14.5
Open source	342	85.5
Distance to safe drinking water		
Within 1 km	159	39.8
More than 1 km	241	60.3
Buy drinking water		
No	98	24.5
Yes	302	75.5
When buying drinking water		
All the year-round	5	1.3
During dry season	226	56.5
Occasionally	71	17.8
Money spent to buy water (in * BDT) (Median [IQR])	30.0 [25.0, 30.0]	

* Note: Exchange rate during data collection: 1 BDT = 0.01075 USD.

Out of the 400 respondents, 46.3% used rainwater for drinking while most of them used open source for cooking (90.5%). The majority (60.3%) had a distance to safe drinking water of more than 1 km and during the dry season, 56.5% of respondents bought drinking water (Table 2).

3.1.3. Social Resilience of the Respondents toward Salinity

The results (Table 3) reveal a detailed understanding of the dimensions of social resilience in the context of salinity-related challenges.

The median and interquartile range (IQR) indicate that community knowledge and skills regarding salinity are relatively high, with a median score of 12.0 [IQR: 12.0, 15.0], supported by a mean of 13.3 ± 2.9. Economic resilience appears moderate, with a median of 12.0 [IQR: 11.0, 12.0] and a mean of 11.8 ± 1.3, reflecting consistent but limited financial coping mechanisms. Social bonding is a key strength, exhibiting the highest median score of 21.0 [IQR: 20.0, 22.0] and a mean of 20.9 ± 1.9, highlighting robust interpersonal connections within the community.

Coping capacity and awareness show comparable results, both with a median of 12.0 and 11.0, respectively, and means of 11.7 (±1.9 and ±2.4), indicating moderate levels of adaptive capacity and understanding of salinity issues. Access to healthcare is relatively low, with a median of 9.0 [IQR: 8.0, 11.0] and a mean of 9.4 ± 2.5, suggesting gaps in medical support. Overall, the composite social resilience score reflects a strong yet varied capacity for resilience, with a median of 79.0 [IQR: 75.0, 83.0] and a mean of 78.9 ± 6.7, underscoring the community's significant strengths in social bonding and knowledge while highlighting areas for improvement, particularly in economic resources and healthcare access.

Table 3. Social resilience of the respondents toward salinity (n = 400).

Social Resilience	Median [IQR]	Mean ± SD
Community knowledge and skills regarding salinity	12.0 [12.0, 15.0]	13.3 ± 2.9
Economic resilience	12.0 [11.0, 12.0]	11.8 ± 1.3
Social bonding	21.0 [20.0, 22.0]	20.9 ± 1.9
Coping capacity	12.0 [11.0, 12.0]	11.7 ± 1.9
Awareness	11.0 [10.0, 13.0]	11.7 ± 2.4
Access to healthcare	9.0 [8.0, 11.0]	9.4 ± 2.5
Overall social resilience	79.0 [75.0, 83.0]	78.9 ± 6.7

Footnote: IQR: interquartile range, SD = standard deviation.

Table 3 showed that moderate community knowledge regarding salinity (mean 13.3 ± 2.9 SD), strong social bonding (mean 20.9 ± 1.9 SD), but low economic resilience (mean 11.8 ± 1.3 SD), coping capacity (mean 11.7 ± 1.9 SD), and awareness (mean 11.7 ± 2.4 SD). Access to healthcare is similarly limited (mean 9.4 ± 2.5 SD). Overall social resilience is (mean 78.9 ± 6.7 SD).

3.2. Statistical Analysis and Significance of Results

3.2.1. Association of Different Independent Variables with the Occurrence of Dermatological Health Outcomes

In the bivariate analysis (Table 4), the occurrence of self-reported skin diseases was significantly associated with younger age ($p = 0.002$), female gender ($p = 0.014$), involvement in water-dependent occupations ($p = 0.011$), illiteracy ($p = 0.005$), residing more than 1 km from a safe drinking water source ($p = 0.001$), use of open sources for drinking water ($p < 0.001$), and higher coping capacity ($p = 0.032$). These findings highlight the influence of both socio-demographic and environmental factors on skin disease occurrence in the study area.

Table 4. Bivariate Analysis of Salinity Exposure, Livelihood, and Socio-Demographic Factors Associated with Dermatological Health Outcomes in Coastal Bangladesh (n = 400).

Baseline Characteristics	Dermatological Diseases		p Value
	Absent	Present	
Age	41.9 ± 13.1	38.1 ± 11.2	0.002 [a]
Gender			
Male	68 (56.7%)	52 (43.3%)	0.014 [b]
Female	121 (43.2%)	159 (56.8%)	
Occupational status			
Homemaker and water-independent occupations	102 (54.0%)	87 (46.0%)	0.011 [b]
Water dependent occupations	87 (41.2%)	124 (58.8%)	
Educational status			
Illiterate	110 (54.2%)	93 (45.8%)	0.005 [b]
Literate	79 (40.1%)	118 (59.9%)	
Monthly family income	8000 [6000, 10,000]	8000 [6000, 10,000]	0.846 [c]

Table 4. *Cont.*

Baseline Characteristics	Dermatological Diseases		p Value
	Absent	Present	
Distance to safe drinking water			
Within 1 km	91 (57.2%)	68 (42.8%)	0.001 [b]
>1 km	98 (40.7%)	143 (59.3%)	
Drinking water			
Filter	167 (70.8%)	69 (29.2%)	<0.001 [b]
Open source	22 (13.4%)	142 (86.6%)	
Cooking water			
Filter	12 (33.3%)	24 (66.7%)	0.080 [b]
Open source	177 (48.6%)	187 (51.4%)	
Bathing water			
Tube well	19 (48.7%)	20 (51.3%)	0.847 [b]
Open source	170 (47.1%)	191 (52.9%)	
Toilet water			
Tube well	28 (48.3%)	30 (51.7%)	0.866 [b]
Open source	161 (47.1%)	181 (52.9%)	
Distance to nearest health facility			
Within 2 km	129 (49.0%)	134 (51.0%)	0.318 [b]
>2 km	60 (43.8%)	77 (56.2%)	
Time to reach to nearest health facility			
Within 30 m	107 (49.5%)	109 (50.5%)	0.321 [b]
>30 m	82 (44.6%)	102 (55.4%)	
Knowledge	5.7 ± 1.8	5.5 ± 1.7	0.365 [a]
Attitude	13.3 ± 3.4	13.5 ± 2.3	0.605 [a]
Practice	10.9 ± 1.7	11.2 ± 2.1	0.085 [a]
Accessibility	2.2 ± 1.2	2.3 ± 1.2	0.601 [a]
Availability	4.6 ± 1.7	4.8 ± 1.7	0.348 [a]
Affordability	2.4 ± 0.9	2.3 ± 0.9	0.254 [a]
Access to healthcare	9.3 ± 2.5	9.4 ± 2.5	0.640 [a]
Community knowledge and skills regarding salinity	13.3 ± 2.9	13.4 ± 2.9	0.852 [a]
Economic resilience	11.7 ± 1.4	11.9 ± 1.3	0.191 [a]
Social bonding	20.8 ± 1.9	21.1 ± 1.9	0.299 [a]
Coping capacity	11.5 ± 1.9	11.9 ± 1.9	0.032 [a]
Awareness	11.7 ± 2.4	11.7 ± 2.4	0.975 [a]

Footnote: IQR: interquartile range, SD = standard deviation, [a] = unpaired t test, [b] = chi square test, [c] = Mann -Whitney U test, [d] = Fisher exact test.

3.2.2. Determinants of Dermatological Problems: Probit Regression Analysis

In the multivariate probit regression analysis (Table 5), unsafe drinking water (+45.2%), distance greater than 1 km to safe water (+17.1%), salinity-dependent occupation (+14.3%), and coping capacity (+2.3%) emerged as statistically significant predictors of dermatological problems. In contrast, age, sex, and literacy did not remain significant after adjustment, indicating that environmental and livelihood factors exert stronger influence than individual demographic characteristics.

Table 5. Factor influencing skin diseases: marginal effects on probability estimated by probit.

Explanatory Variables	Coefficient (β)	Std. Error	Marginal Effect	p-Value
Drinking water (1 = unsafe; ref = safe water)	1.7168	0.1616	0.4523	<0.001 ***
Distance to safe water (1 = >1 km; ref = ≤1 km)	0.6486	0.1578	0.1709	<0.001 ***
Occupation (1 = salinity-dependent; ref = non-salinity-independent)	0.5425	0.1589	0.1429	<0.001 ***
Coping capacity (continuous; higher score = more coping capacity)	0.0863	0.0376	0.0227	0.0194 **
Sex (1 = female; ref = male)	0.2187	0.1945	0.0576	0.2588
Education (1 = literate; ref = illiterate)	0.2034	0.1810	0.0536	0.2597
Age (in years)	−0.0098	0.0086	−0.0026	0.2564

Footnote: Model type: Probit regression. Marginal effects computed using the 'margins' package in R. Model Fit: Chi-square = 130.8, df = 7, $p < 0.001$, Significance Codes: *** $p<0.001$, ** $p<0.01$.

3.3. Focus Group Discussion

This section explores the relationship between dermatological health outcomes and socio-environmental factors using focus group discussions (FGDs). This approach provided deeper insights into quantitative findings, validated results, and explored emerging themes to understand the health burden in salinity-affected areas. The FGDs examined how salinity impacts the lives and health of individuals along the shore, specifically concerning dermatological conditions. Focus groups were conducted to understand local experiences, coping mechanisms, and impacts of salinity on daily life. The FGD respondents were from different age groups in Gabura in seven different villages (Table 6).

Table 6. Location and respondent criteria for FGD.

SL No.	Location of FGD	Ward No.	Respondent Criteria	Respondents No.	Remarks
1	Chackbara	8	Lactating mother	12	Experienced in pregnancy
2	Damuria South para	7	Adult female 18 to 49 years	12	Reproductive age group
3	9 no. Sora Dristinandon	9	Adult Male 60 years to above	09	Senior citizen
4	Pashamari village	5	Adult male 18 to 59 years	12	Young Age group
5	10 no. Sora	6	Adult Female 49 years to above	10	Postmenopausal women
6	Laxmikhali	4	School girls (Class IX and X)	12	Girls experienced menarche.
7	Gabura	2	Female Day labor	11	Work in/Shrimp/Crab firm

3.3.1. FGD-1 (Lactating Mothers)

There were 12 lactating mothers in the FGD. Most of them experienced some form of skin problems during their pregnancy and lactating period. Out of 12, four mothers complained of having rashes, itching, and skin irritation.

One of the four mothers shared, *"I had severe itching all over my body, especially in the last trimester. I developed a rash on my belly and legs that would worsen at night. I was diagnosed with cholestasis of pregnancy, which made my skin condition unbearable. During the lactating period, my skin became very sensitive, and I had constant irritation."*

3.3.2. FGD-2 (Female Adults)

There were nine females (age limit 18 years to 49 years) were present in the FGD held in Damuria South para. Most of the respondents claimed that they have different types of skin related problem.

One of the respondents age 39, named Yesmin, told *"I am suffering from hair loss, see my head. I have also skin allergy."*

Another Respondent, Samara 35 years old complained *"I have different types problems, including rash over the face, hair fall and vaginal inching. She also said that she had to work in waist deep water."* (Figure 5)

3.3.3. FGD-3 (Male)

There were 12 male ages (60 years and above) in FGD held in 9 no. Sora (Dristinandon). Most of them are resistant to saline water. Out of 12, no one experienced to any kind of dermatological problems.

But one of the respondents said, "*My daughter 30 years old is suffering from skin diseases.*"

3.3.4. FGD-4 (Male Adult)

There were 12 adult person age limit from 18 years to 59 years in this FGD in Pershamri village. Among them only one respondent said, "*I am suffering from skin irritation and eye problem due to work in the salt water and have to drink salt water frequently, I have no household level adaptive measures for safe drinking water (financial constraint)*."

Figure 5. Participation of women in shrimp cultivation (Source Author, 2024).

3.3.5. FGD-5 (Female)

10 female adults had an age limit from 49 years to above in this FGD held in 10 no. Sora. Most of them claimed they had suffered from different types of dermatological problems.

> One of the respondents age 50 years claimed, "*I am suffering from skin diseases such as itching, rash as well as gradually falling down my hair.*"

> Another woman 60 years old said, "*I am not suffering from any kind of skin diseases now, but once I suffered a lot from skin diseases*."

3.3.6. FGD-6 (School Girls)

There were 12 adolescent girls' study in classes IX and X. But after discussing with them regarding the health impact of salinity. Some of them felt shy to say anything regarding their problems. So, we provided a paper to write on it about their health problem. Most of them wrote/talked about dermatological problems.

> One of them wrote, "*I suffer skin allergy, irritation in vaginal orifice.*"

> Another student said, "*We frequently suffer from itching and rash on our face, hands, and legs. I think it would be due to exposure to saline water frequently*."

3.3.7. FGD-7 (Female who Works in Shrimp/Grab Firm or Collect Shrimp/Crab)

There were 11 females in FGD. Most of them suffer from dermatological diseases.

> One of the respondents Roksana age 33 years old said "*Sir, we are poor people and have to work in the Gher (Shirmp/Crab Firm) in waist-deep water and also use saline water for toileting. So, we suffer from different dermatology related problems*."

> Another respondent Asheya 27 years old, said "*I am suffering from severe skin diseases, look at my face and hands. However good doctor is not available here*."

4. Discussion

This study explored how environmental salinity exposure through water use, livelihood practices, and socio-demographic factors affect dermatological health outcomes in coastal Bangladesh. Findings show that unsafe drinking water, distance from safe sources, and salinity-linked occupations predict self-reported skin diseases. Higher coping capacity was unexpectedly associated with increased skin condition reporting. More than half of respondents (52.8%) reported skin disease in the past three months. Dermatological conditions varied across groups, with higher prevalence among women (52%) than men (38%), reflecting greater domestic water exposure. Younger adults (18–35 years) reported more frequent symptoms (47%) than older adults (31%). Salinity-linked occupations showed elevated prevalence (60%) compared to non-salinity livelihoods (30%). Households' dependent on long-distance water collection exhibited higher risk. Bivariate analysis showed younger individuals (mean age 38.1 years) and females were more likely to report skin disease. Previous studies have also observed that younger individuals suffer more from different types of skin diseases [29,30]. Women's increased exposure through domestic chores may contribute to their susceptibility [31–35]. Similar finding shows in our qualitative findings. Women often work in shrimp cultivation, spending prolonged hours in waist-deep water (Figure 5), which may increase their risk of dermatological problems. Additionally, extended exposure to extreme weather events further exacerbates skin conditions [36]. Gender-specific roles in water management influence disease prevalence [37] emphasizing health risks in saline-affected communities.

Our study found literate individuals reported higher skin diseases (59.9%) than illiterate ones (45.8%), contrasting with research linking education to better health outcomes [38,39]. This may stem from increased awareness among the literate or their work in high-exposure occupations despite limited health literacy. In our sample, 50.7% had no formal education, 43.5% had primary education, and 5.8% had secondary-level (SSC) education, suggesting basic literacy may not translate to prevention awareness. Many literate individuals work in high-risk jobs with exposure to saline water and environmental hazards. Without protective measures or specialized dermatological services in Gabura Union, knowledge alone cannot reduce skin disease risk.

The probability of skin disease increased by 45.2% among individuals relying on unsafe drinking water, as revealed by a probit regression model. This finding is consistent with previous work that identified saline water use as a major contributor to dermatological issues in coastal Bangladesh [40]. Similarly, a broader range of salinity-related health risks, including skin diseases, hypertension and gastrointestinal disorders has been reported [41]. Another study reported that drinking water salinity is linked with skin ailments, reinforcing the association [42]. Likewise, the distance to safe water sources was significantly associated with the risk of dermatological diseases. Households located more than one kilometer from a safe drinking water source experienced a 17.1% increase in the probability of developing skin diseases. This supports the WHO guidelines that recommend water access within one kilometer to reduce the water-related disease burden [43]. Similarly, another study emphasized that limited access to potable water compels communities to rely on unsafe alternatives, increasing their exposure to salt and other contaminants [44].

In our study, individuals in water-dependent occupations had a 14.3% higher probability of reporting skin diseases, highlighting health risks from salinity exposure. While men work more in agriculture and fishing, women in Gabura Union face exposure through informal work like shrimp seed collection and crab farming, along with domestic tasks involving saline water. Focus groups revealed that prolonged exposure to saline water, particularly in shrimp cultivation fields (Gher), contributes to skin conditions. These results align with studies linking occupational salt and saline water exposure to dermatological conditions including dryness, irritation, fungal infections, and skin ulcers [45–50]. Studies show that saline water exposure disrupts skin barrier function, leading to transepidermal water loss (TEWL), making skin vulnerable to irritation and dermatitis [51,52]. Occupational exposure to water and chemical irritants is a major risk factor for dermatological diseases [30] The higher prevalence among workers exposed to contaminated water aligns with research on environmental and occupational exposure in dermatological health (Figure 5). Prolonged moisture exposure is a risk factor for irritant contact dermatitis [53] and chronic exposure can cause conditions like "Dogger Bank itch" [54]. Seawater exposure increases infection risks, particularly from Vibrio species [55]. Sodium intake promotes oxidative stress and inflammation, affecting dermatological health, with excessive salt potentially worsening psoriasis through Th17-driven inflammation [56]. Households using unsafe water sources had a 45.2% higher probability of dermatological issues. This aligns with Chakraborty et al. (2019), who found households in high-salinity areas had more frequent hospital visits than those in low-salinity areas. While the link between bathing water and skin disease was not statistically significant, qualitative data and FGD/KII findings confirmed that prolonged saline water exposure contributes to dermatological problems.

An unexpected finding was the positive association between higher coping capacity and reported skin disease, with a 2.3% increase in probability. This contrasts with prior research suggesting that stronger coping capacity reduces health risks by enhancing risk management and resource allocation [57]. In the context of chronic salinity exposure in coastal Bangladesh, however, coping capacity may function differently. Rather than reducing exposure, higher coping capacity may enable individuals to remain economically active within saline-dependent livelihood systems such as aquaculture, salt farming, or intensive water use thereby increasing the frequency and duration of direct contact with saline water and elevating dermatological risk.

From a theoretical perspective, this finding aligns with the concept of maladaptation in climate change and health literature, where adaptive responses to environmental stressors inadvertently reinforce exposure and generate adverse health outcomes. In highly constrained livelihood environments, coping strategies may prioritize income stability and survival over health protection, producing trade-offs between economic resilience and physical well-being. Moreover, coping mechanisms are often reactive rather than preventive; individuals with higher coping scores may develop these capacities precisely because they experience greater exposure and recurrent health challenges. Additionally, higher coping capacity may be associated with increased health awareness and symptom recognition, leading to greater reporting of dermatological conditions rather than a true increase in incidence. The coping index used in this study may therefore capture cognitive and social dimensions of resilience such as awareness, problem recognition, and resourcefulness rather than direct exposure-reducing behaviors (e.g., protective equipment uses or avoidance of saline water). This interpretation is consistent with prior evidence showing that while adaptive coping strategies (e.g., problem-focused coping and social support) can improve health-related quality of life, maladaptive or exposure-sustaining coping strategies may exacerbate health outcomes [58,59]. Overall, these findings suggest that in high-exposure coastal settings, coping capacity does not necessarily translate into reduced dermatological risk but may instead reflect continued engagement with hazardous environments and heightened health awareness.

5. Strengths of Study

This empirical study in Bangladesh explores the link between salinity and dermatological health outcomes, with a special focus on occupational exposure. The employment of a mixed-methods design, integrating household survey data with focus group discussions and key informant interviews, enhances the validity and depth of the findings. The incorporation of probit regression model strengthens the analytical rigor and enables the identification of statistically significant predictors. Furthermore, the purposive inclusion of diverse respondent groups, including lactating mothers, adolescent girls, and female laborers, reflects a gender- and age-sensitive approach that captures multiple dimensions of vulnerability. The emphasis on skin disease as a climate-sensitive health outcome introduces a novel perspective to the environmental health discourse in Bangladesh.

6. Limitations of the Study

This study has limitations, including reliance on self-reported data prone to recall bias in health condition reporting. The cross-sectional design limits establishing causal relationships between salinity exposure and dermatological outcomes. Without medical record triangulation, findings were not validated through clinical diagnosis. The absence of water quality testing limits attribution to specific causes. The results are specific to the study region with limited generalizability to other coastal areas. Unmeasured confounders like genetic predisposition, hygiene habits, and nutritional status were not included, which may have influenced associations.

7. Conclusions

This study shows that environmental salinity exposure through unsafe water use, salinity-linked occupations, and limited safe water access significantly affects dermatological health in coastal Bangladesh. Socio-demographic factors and coping capacity shape vulnerability, with coping capacity unexpectedly suggesting continued exposure despite adaptive awareness. Qualitative data reinforced these findings and highlighted gendered and occupational risks. Given the cross-sectional design and self-reported symptoms, future research should employ longitudinal and clinical approaches, including dermatological assessments and water quality testing integrated with health surveillance, to establish causal pathways.

Policy efforts should focus on concrete, study-driven actions: scaling up community rainwater harvesting with household storage, deploying solar-powered desalination units in saline-prone villages, and ensuring regular maintenance of pond sand filters through trained local committees. Dermatological care must be integrated into primary healthcare via routine skin screening, frontline worker training, and mobile clinics in high-salinity hotspots. Livelihood diversification such as salt-tolerant crops, low-contact aquaculture, and mangrove-based ecotourism can reduce direct exposure. Programs for women should include awareness campaigns and protective gear. Schools, workshops, and local media can help teach the community about hygiene and recognizing risks. Together, these strategies must be embedded within a place-based, climate-resilient health framework that aligns with the Sustainable Development Goals: SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), and SDG 13 (Climate Action) to reduce salinity-related health burdens and build resilient coastal health systems.

Author Contributions

Conceptualization: I.P., M.M.H., M.A.A. and M.S.; Methodology: Draft preparation: Writing—review and editing: I.P., M.H., M.A.A., M.S. and S.H.; Data collection and analysis: M.M.H. and S.H. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement

The research adheres to strict ethical guidelines, with approval granted by the Research Ethics Review Committee (RERC) of the Asian Institute of Technology (AIT) (Ref no RERC 2022/020), and all participants provided informed consent (Verbal and written). The study emphasizes the confidentiality and the privacy of the participants throughout the research process.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. Written informed consent for publication has also been obtained from patients who can be identified in this manuscript.

Data Availability Statement

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

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Conflicts of Interest

The authors declare no conflict of interest. Given the role as editorial board members, Indrajit Pal & Md. Shamsuzzoha had no involvement in the peer review of this paper and had no access to information regarding its peer-review process. Full responsibility for the editorial process of this paper was delegated to another editor of the journal.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

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