



Bridging the watershed–urban disconnect: The interplay of risk perception, self-efficacy, and institutional trust in flood preparedness in Pakistan

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Abstract

Purpose: This study examines how cognitive attributions of flood causality, self-efficacy, and institutional trust interact to shape household preparedness in a flood-prone downstream community in Pakistan.

Methodology: A sequential explanatory mixed-methods design was employed in Taunsa Sharif, combining a household survey ($n = 350$) with in-depth interviews ($n = 15$). Quantitative data were analysed using hierarchical regression and mediation analysis; qualitative data were analysed using reflexive thematic analysis.

Findings: Educational attainment strongly predicts recognition of watershed-scale flood drivers (72.5% among bachelor's-educated vs 9.1% among uneducated respondents). Self-efficacy ($\beta = 0.38$) and institutional trust ($\beta = 0.23$) are the strongest direct predictors of preparedness. Mediation analysis indicates that self-efficacy partially accounts for the relationship between watershed understanding and adaptive action. Qualitative findings illuminate how “flood fatigue” erodes personal agency while institutional distrust creates governance traps that perpetuate inaction.

Originality: This study integrates Social-Ecological Systems theory, Protection Motivation Theory, and Social Cognitive Theory within a unified framework, demonstrating that an interdependent triad of watershed knowledge, perceived agency, and institutional trust governs flood preparedness. Findings underscore the need for integrated strategies that combine risk communication with psychosocial capacity-building and governance reforms.

Keywords: Flood preparedness, risk perception, self-efficacy, institutional trust, watershed disconnect, Pakistan

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1 Introduction

Floods remain among the most frequent and destructive natural hazards globally, with intensifying hydrological extremes linked to climate change, land-use transformation, and rapid urbanisation (Suyuhan and Khoso, 2026). While structural flood-control infrastructure, such as embankments, barrages, and levees, continues to play a central role in risk mitigation, recent scholarship in disaster risk reduction (DRR) increasingly emphasizes household-level preparedness and community resilience as critical complements to engineering solutions (Gaillard, 2021; Norton and Gibson, 2019). Experience from major flood events demonstrates that infrastructure alone cannot eliminate risk; adaptive capacity at the community level ultimately determines disaster outcomes (Agapito et al., 2026).

However, household-level readiness is not a natural consequence of risk exposure. A long-standing problem in flood hazard areas, particularly in the Global South, is that basin-level processes generating floods are disconnected from local risk perception (Sauri et al., 2026). Floods are inherently social-ecological phenomena that arise from upstream–downstream interactions generated by land-use change, deforestation, sedimentation, and catchment hydrology (Mensah et al., 2026). However, affected populations often interpret floods as the result of well-defined, visible, and proximate infrastructural failures or deficiencies (Mashwama and Phesa, 2025), such as a clogged drainage system, municipal neglect, or failure to maintain local hydraulic structures (De Oliveira et al., 2022). This spatial scale discord, frequently characterised as a watershed–

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urban divide, can skew risk attribution, limit policy demands to technical fixes, and inhibit long-term adaptive thinking (Menoni, 2025).

While scale mismatches in social-ecological systems have been studied before (Cumming et al., 2013; Falco et al., 2022), there is little empirical work on how understanding of watershed-scale processes translates into direct preparedness behaviour. In addition, the connection between knowledge and action is theoretically contentious. Redundant data in the literature on environmental education indicate that an awareness of risk is insufficient to sustain continued behaviour change (Varela-Candamio et al., 2018). The Protection Motivation Theory (PMT) may address this deficit by distinguishing between threat and coping appraisals (Rogers, 1983). Although anticipated flood level and perceived susceptibility may predict how people expect to be affected by floods, preparedness behaviour is more accurately predicted by the other two factors (in particular, self-efficacy and response efficacy). Self-efficacy is also a central component of social cognitive theory (SCT) within the construct of human agency (Bandura, 1989). People must recognize that they cannot take action to protect themselves; they must change their behaviour. Such self-efficacy, however, could decline in flood-prone areas where people repeatedly experience property loss (Hudson et al., 2020). Cyclical destruction and partial reconstruction would cause psychological ‘tiredness’ which, in turn, would erode the incentive to invest in preparedness (Cambri and Bosque, 2025; Carroll et al., 2009). Institutional trust, however, is also important in driving adaptive responses (Wiering et al., 2017). When households have confidence in the efficacy and fairness of governance systems for delivering effective warnings, and authorities are perceived as legitimate enforcers of mitigation measures, compliance increases (Soane et al., 2010). Quite the opposite, mistrust among disaster organisations could lower trust at both the collective and individual levels (Fornalé et al., 2023).

Although there is a rich literature on scale mismatch (Räsänen, 2021), psychosocial determinants (Benjamin et al., 2022), and institutional trust have historically developed in isolation from one another (Akbar and Aldrich, 2017). Empirical work that harmonises site-level perception, self-efficacy, and institutional trust within a single analytical framework is uncommon, particularly in the South Asian floodplains, where exposure is chronic and governance capacity is uneven (Faruk and Maharjan, 2023; Suyuhan and Khoso, 2026).

To fill this gap, this paper investigates household-level preparedness to flood vulnerability in Taunsa Sharif, a flood-prone downstream community along the Indus River in Pakistan. Using an integrated model based on the Social-Ecological Systems (SES) (Bronfenbrenner, 1994), Protection Motivation Theory (PMT) (Rogers, 1975), and Social Cognitive Theory (Bandura, 2001), we examine how watershed-scale perceived causation, self-efficacy, and institutional trust interact to influence preparedness behaviour. SES theory guides our examination of the scale mismatch between basin-level hydrological processes and local risk perception; PMT frames the psychological appraisal pathways (threat and coping appraisals) that translate risk

awareness into action; and SCT centres on self-efficacy as a key mechanism of human agency that mediates knowledge and behaviour.

Specifically, the study addresses the following hypotheses:

- H1:** Watershed-scale flood causality attribution is positively associated with household preparedness behaviour.
- H2:** Self-efficacy mediates the relationship between watershed-scale perception and preparedness.
- H3:** Institutional trust is positively associated with preparedness behaviour.
- H4:** Socio-economic vulnerability is negatively associated with both self-efficacy and preparedness outcomes.

Globally, household flood preparedness is shaped by a constellation of factors that extend beyond individual risk awareness. Comparative studies across Europe, Asia, and the Americas have identified urbanisation patterns, perceptions of climate change, governance quality, and social capital as consistent macro-level determinants (Bubeck et al., 2012; Wiering et al., 2017). In many low- and middle-income countries, however, rapid urban sprawl into flood-prone areas, weak enforcement of building codes, and fragmented disaster governance create a context in which even well-informed households fail to act (Mensah et al., 2026; Agapito et al., 2026). Moreover, social vulnerability – including poverty, precarious housing, and limited access to early warnings – systematically interacts with psychological factors such as fatalism and low self-efficacy (Hudson et al., 2020). Thus, while the present study focuses on a downstream Pakistani community, its findings speak to broader global challenges: how to transform systemic flood knowledge into sustained action when institutional trust is fragile and repeated losses erode personal agency.

1.1 Contribution of the Study

This study makes three specific contributions to disaster risk knowledge. First, a novel contribution is the first empirical test of an integrated analytical framework that leverages Socio-Ecological Systems perspectives on scale mismatch, Protection Motivation Theory’s threat/coping appraisal pathways, and Social Cognitive Theory’s focus on self-efficacy as a mediator, advancing theoretical integration beyond simply using them in parallel. Second, using a sequential explanatory mixed-methods approach, it shows that self-efficacy partially mediates the relationship between watershed-level understanding and household readiness in a flood-prone context; this psychological mechanism has been posited conceptually but rarely empirically measured in South Asian flood settings. Third, the research provides qualitative evidence that flood fatigue and institutional distrust combine to create governance traps, illuminating the dynamic social processes by which available knowledge does not translate into action. Taken together, these contributions have implications for any discussion of how best to build resilience: it will not be achieved by watershed education alone, but rather by an education intentionally linked

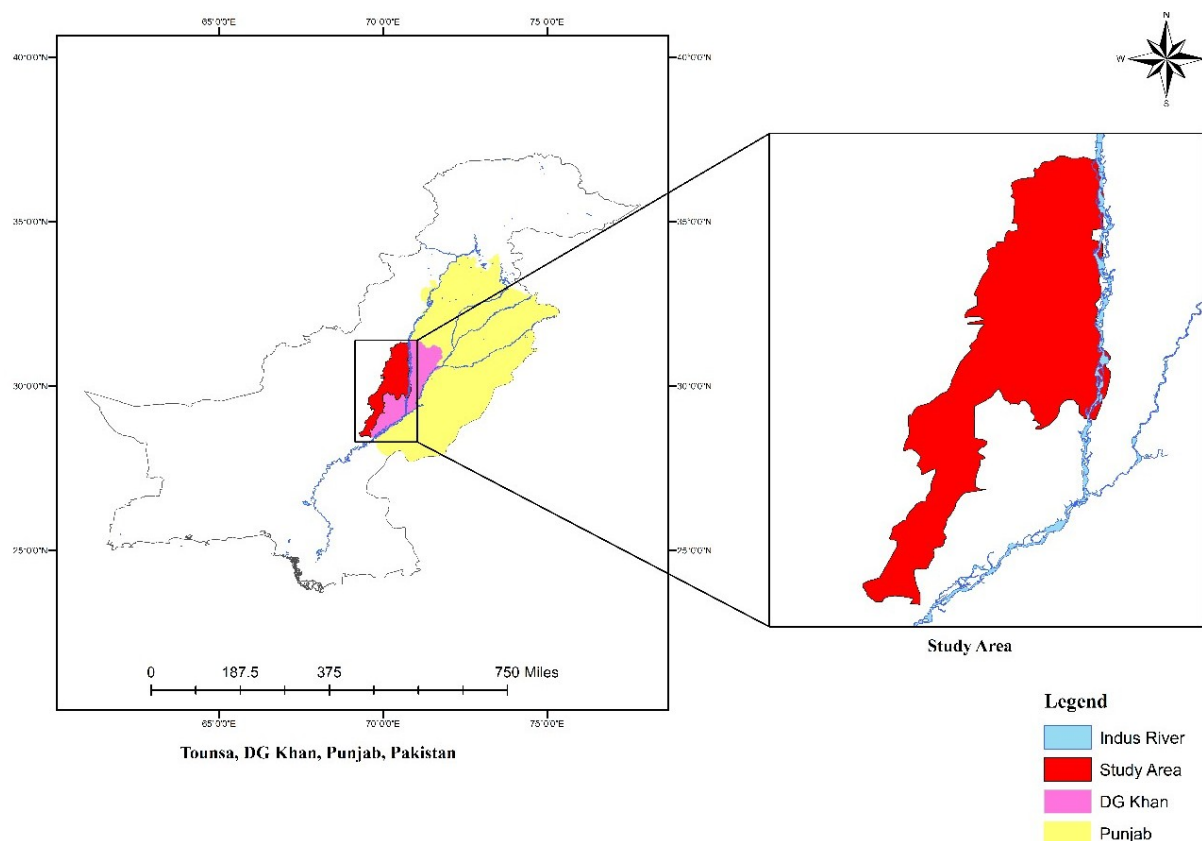


Fig. 1. Study area.

to approaches to enhancing agency and opportunities, and to institutional adjustments capable of restoring trust in the system of sharing in society.

2 Research Methodology

2.1 Study Design

A sequential explanatory mixed-methods design was used, rather than a cross-sectional, causal study design, to examine relationships. The study comprised two stages: a quantitative in-household survey to elicit patterns and relationships, followed by qualitative data collection through in-depth interviews to explore and interpret the quantitative findings. This mode is highly suited to risk research, as it combines statistical generalization with situational insight within intricate socio-cognitive and institutional dynamics.

2.2 Study Area

The research was conducted in Taunsa Sharif, a tehsil of Dera Ghazi Khan District, situated on the eastern bank of the Indus River, downstream of the Taunsa Barrage, and underlain by the Indus Basin Irrigation System (IBIS), established in 1958 (Fig. 1). It remains highly sensitive to seasonal and extreme flooding, particularly in 2010 and 2022. The site is an appropriate social-ecological setting through which basin-inundating flood dynamics interact with place-specific risk perception and management. A range of settlement types and modes of living also enables consideration of differences in risk perception, adaptive behaviour, and institutional trust.

2.3 Population and Sampling

Our target population consisted of adult residents (18 years) from selected urban and peri-urban councils of Taunsa Sharif who had experienced at least one major flood since 2010.

Quantitative Phase. A multistage cluster sampling method was used to recruit 350 households. The sample was calculated based on methodological criteria and statistical power. For hierarchical multiple regression with eight potential predictors, the 350 cases are well above the commonly recommended minimum of 10–15 cases per predictor (Green, 1991). A priori power analysis using G*Power (Faul et al., 2007) indicated that a minimum of 109 cases was needed to achieve 0.95 power ($\alpha = 0.05$; $f^2 = 0.15$) for the primary regression model. Therefore, the final sample ($n = 350$) had strong statistical power (>0.99) and was adequate for mediation and subgroup analyses. Specifically, the larger sample size was intended to power the following a priori subgroup comparisons: (a) flood preparedness across four education levels (none, primary, intermediate, bachelor's+), expecting small-to-medium effect sizes (Cohen's $f = 0.20$); (b) gender-based comparisons (male vs. female) in self-efficacy and preparedness; and (c) settlement-type analyses (urban vs. peri-urban). With $n = 350$, even the smallest subgroup (bachelor's+ education, $n = 69$) provides 80% power to detect a moderate effect ($d = 0.50$) in two-group comparisons, and the full sample supports chi-square tests with small effect sizes ($w = 0.15$) across the four education categories.

Table 1. Reliability, validity, and sources of measurement constructs.

Construct	No. of items	Cronbach's α	Composite Reliability (CR)	Average Variance Extracted (AVE)	Scale Source/Adaptation
Perception of Local Causes	5	0.82	0.85	0.58	Developed for this study based on community consultations (Suyuhan and Khoso, 2026)
Perception of Watershed Causes	5	0.79	0.83	0.55	
Self-Efficacy	4	0.86	0.89	0.67	(Bubeck et al., 2012)
Institutional Trust	5	0.89	0.91	0.66	(Adger et al., 2018)
Socio-Economic Vulnerability	6	0.84	0.87	0.57	(Cutter, 2003)
Preparedness Behaviour	8	0.81	0.84	0.52	(Bubeck et al., 2012)

Discriminant Validity: Fornell-Larcker criterion satisfied ($\sqrt{\text{AVE}} > \text{inter-construct correlations}$); HTMT ratios all < 0.85 .

Qualitative Phase. Fifteen participants were purposively sampled from the survey respondents based on education, occupation, extent of flood exposure, and residential location to encompass a wide range of experiences and perspectives. Interviews were conducted iteratively, and data collection ceased when thematic saturation was reached, defined as the point at which three consecutive interviews yielded no new codes or insights relevant to the core research questions (flood causality narratives, self-efficacy barriers, and institutional trust). This was confirmed by two researchers independently reviewing the coding logs after interview 12, with interviews 13–15 confirming saturation.

2.4 Data Collection Instruments and Procedures

2.4.1 Quantitative Survey

The items in the questionnaire were derived from constructs of Protection Motivation Theory and Social Cognitive Theory. The instrument was translated into Urdu and conceptually validated by a group of experts. Predictors asked about included socio-demographics, perceived causes of flooding (localised drivers situating drainage failure and barrage operations within broader catchment-scale processes, including upstream deforestation and basin hydrology), psychological constructs (self-efficacy, institutional trust, perceived vulnerability), and a household preparedness eight-item adaptation questionnaire.

The attitude items in the survey were measured on a 5-point Likert scale. The instrument was pre-tested with 30 respondents, and modifications were made to enhance clarity and contextual applicability. The final version of the questionnaire, in simplified, culture-sensitive language, was administered in face-to-face interviews by trained enumerators under strict field supervision to ensure quality control.

2.4.2 Qualitative Interviews

Semi-structured interview guides were designed to elicit flood experiences and attributions, attitudes toward barrage management, interactions with disaster institutions, and barriers to preparedness. Interviews were conducted in local languages (Urdu and Siraiki), audiotaped with participants' permission, and later translated into English for analysis.

2.5 Data Analysis

Quantitative Analysis: Quantitative results were analyzed using SPSS 28.0, Python, and Anaconda Jupyter Notebook. Sample characteristics were summarized with descriptive statistics, and Cronbach's alpha, composite reliability, and average variance extracted were used to assess scale reliability and validity (see Table 1). Bivariate associations were tested using chi-square tests and correlation matrices, and hierarchical regression analyses were conducted to assess the incremental validity of the main predictors. PROCESS Macro 4 in Hayes was used to conduct a mediation analysis to test whether self-efficacy mediated the relationship between watershed-scale flood perception and household preparedness behaviour.

Qualitative Analysis: Transcriptions of interviews were coded using reflexive thematic analysis according to the six-phase method (Braun and Clarke, 2006). NVivo 12 was used for analysis to systematically track and organize the coding applied to the data, identify potential themes, and produce an audit trail. This involved transcribing, reading, and rereading for immersion; generating initial codes; searching for themes; reviewing themes against the coded extracts to ensure they fit within the dataset, defining and naming them; and developing the analytic narrative iteratively.

Data Integration: Integration proceeded sequentially, using an explanatory design, with lessons learned from the quantitative data analysis (e.g., education and risk perception; institutional trust and self-efficacy) directly incorporated into the development of interview guides based on earlier interviews. The qualitative findings used context to provide depth and explain the statistical associations, while the quantitative data strengthened the external validity of these interpretations.

2.6 Reliability of the Data

The Socio-Economic Vulnerability (SEV) scale comprised six items adapted from Cutter's (2003) social vulnerability framework, tailored to the Pakistani flood context: (1) monthly household income (PKR), (2) housing construction type (kacha/semi-cemented/pucca), (3) ownership of

Table 2. Background of the respondents.

Variable	Category	<i>n</i>	%
Gender	Male	182	52.0
	Female	168	48.0
Age Group (years)	18–30	98	28.0
	31–45	149	42.6
	46–60	80	22.9
	60+	23	6.6
	No formal education	55	15.7
Education Level	Primary	126	36.0
	Intermediate	100	28.6
	Bachelor's or higher	69	19.7
	No formal education	55	15.7
Monthly Household Income (PKR)	<30,000	119	34.0
	30,000–60,000	144	41.1
	>60,000	87	24.9
Housing Type	Kacha (Mud)	125	35.7
	Semi-Cemented	136	38.9
	Pucca (Cemented)	89	25.4
Prior Flood Experience	Yes	285	81.4
	No	65	18.6

durable assets (e.g., refrigerator, motorcycle, livestock), (4) household debt burden (none, moderate, heavy), (5) livelihood diversity (single vs. multiple income sources), and (6) access to social support networks (scored 1–5 from “very inadequate” to “very adequate”). Each item was standardised (z-score) and summed to create a composite SEV index ($\alpha = 0.84$). Higher scores indicate greater vulnerability. This study operationalises “risk perception” specifically as causal attribution, i.e., how respondents explain the origins of flood events (local vs. watershed drivers). We do not measure the affective components of risk perception (worry, dread, or emotional response), which are also part of full risk perception constructs (Sjöberg, 2000). This cognitive-attributional focus was chosen because the theoretical gap concerns scale mismatches between hydrological processes and local mental models. Readers should interpret our use of “risk perception” throughout as referring to this causal-attribution dimension.

2.7 Ethical Considerations

Ethical approval was not required for this study in accordance with the national legislation and the institutional requirements, as vulnerable groups were not enrolled, minors were given special protection measures, and risk to participants was at a minimum level or no greater than that experienced in normal life; standard survey and interview processes were implemented with voluntariness and anonymity ensured (Number of Reference: SPA: 20250906). This research was conducted in compliance with the Declaration of Helsinki and its subsequent amendments. The participants received detailed information about the study's aims and procedures, after which they provided written informed consent. Confidentiality and anonymity of participants' responses were ensured, and respondents were informed of their right to withdraw from the study at any time without incurring consequences.

3 Results of the Study

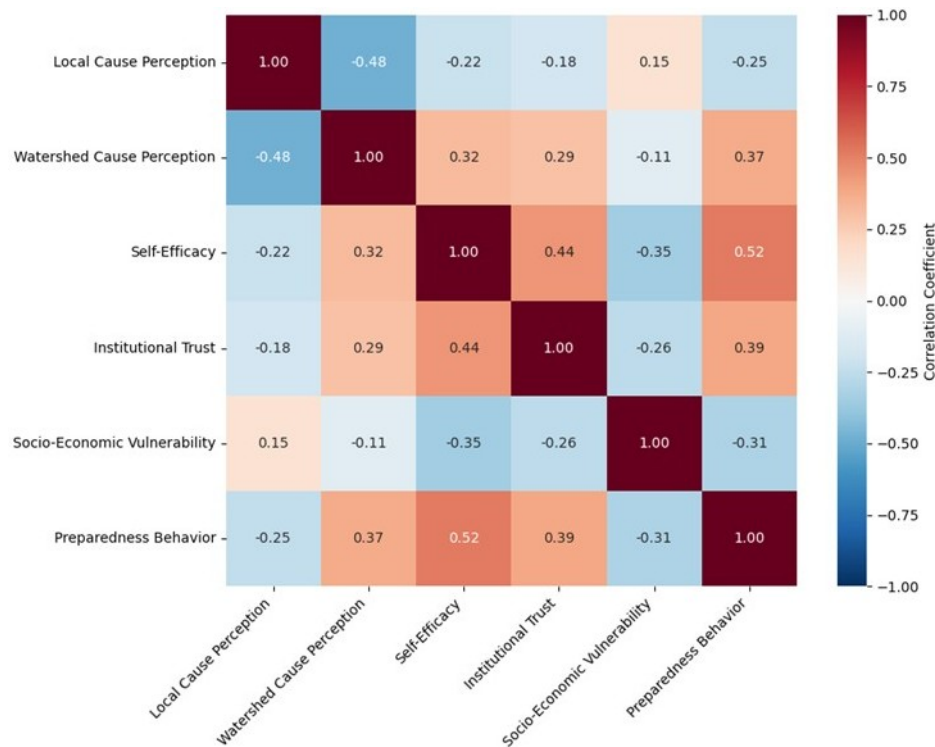
3.1 Demographic Characteristics of the Respondents

The sample comprised 350 participants, with a relatively balanced gender distribution (52% male, 48% female). Most respondents were aged 31–45 years (42.6%), followed by 18–30 years (28.0%), 46–60 years (22.9%), and 60+ years (6.6%). In terms of education, 36% had completed primary education, 28.6% intermediate, 19.7% held a bachelor's degree or higher, and 15.7% had no formal education. Monthly household income was predominantly in the 30,000–60,000 PKR range (41.1%), with 34% earning less than 30,000 PKR and 24.9% earning more than 60,000 PKR. Regarding housing, 38.9% lived in semi-cemented houses, 35.7% in kacha (mud) houses, and 25.4% in pucca (cemented) houses. A large majority (81.4%) reported prior flood experience, while 18.6% had not experienced floods, as shown in Table 2.

The chi-square test of independence in Table 3 showed that the association between the attribution factor and educational attainment was statistically significant ($\chi^2 = 42.15$, $p < 0.001$) for subjects' first most likely cause explanation of the flood. The pattern is a clear and strong education gradient: in no education, the large majority (90.9%) identified as the causes of the flooding local and proximate factors like mismanaging barrage, failure of drainage system, or poor maintenance by Municipal authority, only minority recognizes these floods causative factors such as watershed level dynamics including intensive deforestation in upstream side of catchment (upstream land-use change), basins hydrology etc. This pattern reverses, albeit gradually, with increasing education: among primary-educated respondents 19.8% ascribed flood causes to the watershed and 80.2% to localities; this proportion approaches parity (58.0% local vs 42.0% watershed) in the case of intermediate-educated respondents; however, specifically for respondents with a bachelor's

Table 3. Primary flood causality perception by education level.

Education Level	Primarily Local Cause	Primarily Watershed Cause	Total
No formal education	50 (90.9%)	5 (9.1%)	55
Primary	101 (80.2%)	25 (19.8%)	126
Intermediate	58 (58.0%)	42 (42.0%)	100
Bachelor's or Higher	19 (27.5%)	50 (72.5%)	69
χ^2 (p-value)	42.15 (<0.001)		

**Fig. 2.** Correlation matrix relationships between flood perceptions, psychological factors, socioeconomic vulnerability and preparedness behavior.

degree or more than that, majority (72.5%) displayed systemic, basin-scale understanding of mechanism behind flood generation processes. This result provides strong empirical evidence of a cognitive scale mismatch in flood risk perception that is systematically associated with education, and it supports the conceptualization of watershed literacy as a form of human capital that shapes how hazard-threatened communities frame environmental hazards and, correspondingly, develop their preparedness responses.

The correlation matrix in Fig. 2 illustrates relationships between flood risk perception factors and adaptive behaviours. Watershed-scale cause perception is positively correlated with self-efficacy (0.32), institutional trust (0.29), and preparedness behaviour (0.37), indicating that understanding systemic flood drivers is associated with greater personal agency and adaptive actions. Conversely, local cause perception correlates negatively with watershed perception (-0.48) and preparedness (-0.25), reflecting a cognitive divide. Self-efficacy and institutional trust are strongly linked ($r = 0.44$), and both are positively associated with preparedness (0.52 and 0.39, respectively), underscoring their combined role in facilitating adaptive behaviour. In

contrast, socioeconomic vulnerability is consistently negatively associated with these enabling factors.

The hierarchical multiple regression analysis in Table 4 examined the unique contributions of demographic, perceptual, and psychosocial factors to household flood preparedness. In Model 1, socio-demographic variables accounted for 12% of the variance ($R^2 = 0.12$, $p < 0.001$), and income ($\beta = 0.22$, $p < 0.001$) and education ($\beta = 0.18$, $p < 0.01$) were identified as significant positive predictors of the outcome variable. Regression model 2 added flood causality perceptions, which significantly improved the model's predictability ($\Delta R^2 = .16$, $p < .001$; total $R^2 = .28$). Perception of watershed-scale was positively related to preparedness ($\beta = 0.26$, $p < 0.001$), and perception at the local scale was negatively related ($\beta = -0.14$, $p < 0.05$). Model 3 added psychosocial traits and was also associated with an additional explained variance ($\Delta R^2 = 0.13$, $p < .001$; total $R^2 = 0.41$). Self-efficacy ($\beta = 0.38$, $p < 0.001$) and trust in the watershed institution ($\beta = 0.23$, $p < 0.001$) were the most salient predictors, with the effect of watershed perception still significant despite mediation ($\beta = 0.17$, $p < 0.01$), indicating partial mediation. In conclusion, this study has

Table 4. Hierarchical Regression Analysis predicting household flood preparedness.

Predictor	Model 1 (β)	Model 2 (β)	Model 3 (β)
Step 1: Demographics			
Age	0.07	0.05	0.04
Gender (Female=1)	0.03	0.02	0.01
Education	0.18**	0.15*	0.11*
Income	0.22***	0.19**	0.16**
Step 2: Perceptions			
Local Cause Perception		-0.14*	-0.09
Watershed Cause Perception		0.26***	0.17**
Step 3: Psychosocial			
Self-Efficacy			0.38***
Institutional Trust			0.23***
R²	0.12	0.28	0.41
Adjusted R²	0.11	0.26	0.39
ΔR^2	0.12***	0.16***	0.13***

Table 5. Mediation Analysis: Watershed Perception $\rightarrow$ Self-Efficacy $\rightarrow$ Preparedness.

Path	Effect (β)	SE	95% Bootstrap CI
Total Effect (X $\rightarrow$ Y)	0.26	0.04	[0.182, 0.338]
Direct Effect (X $\rightarrow$ Y)	0.17	0.04	[0.095, 0.245]
Indirect Effect (X $\rightarrow$ M $\rightarrow$ Y)	0.09	0.02	[0.042, 0.138]

shown that household preparedness for flooding is determined by a combination of socio-economic resources and systemic risk perceptions, alongside crucial psychosocial assets such as personal agency and institutional trust.

Mediation analysis was conducted using ordinary least squares path analysis with bias-corrected bootstrap resampling (5,000 samples) to examine whether self-efficacy serves as a psychological mechanism through which watershed-scale flood perception influences household preparedness behaviour, as shown in Table 5. The total influence of perception on preparedness to the watersheds was positive and significant ($\beta = 0.26$, 95% CI [0.182, 0.338]). When adjusting for the mediator, the direct effect was found to be significant but greatly reduced ($\beta = 0.17$, 95% CI [0.095, 0.245]), indicative of partial mediation. The indirect effect through self-efficacy was also positively and significantly related ($\beta = 0.09$, 95% CI [0.042, 0.138]), with the confidence interval not including zero. These findings provide evidence of a total 35% indirect effect (i.e., mediated) between watershed-scale flood understanding and household preparedness via perceived self-efficacy. This finding provides empirical support for Social Cognitive Theory in flood-risk settings, where systemic environmental knowledge not only directly triggers adaptive action but also yields psychological benefits, including greater confidence in one's ability to prepare and sustain this protective behaviour. Partial mediation also indicates, however, that knowledge alone is insufficient; watershed education interventions must be systematically developed to cultivate experiential mastery and coping appraisal to achieve behavioural benefits.

The descriptive analysis revealed a marked and consistent educational pattern in household flood-preparedness behaviour (Table 6). Among those with no formal educa-

tion, the mean preparedness adoption rate was 18.9% (SD = 10.2%), with no respondent adopting more than four of the eight preparedness activities. This increased linearly among primary-educated respondents (M = 31.8%, SD = 13.5%), then to intermediate (M = 48.2%, SD = 16.4%), and highest among bachelor's+ respondents (M = 60.3%, SD = 15.3%). The overall mean was 40.3% (SD = 14.3%). The educational gradient was near-perfect, with approximately 1.1 additional preparedness actions per higher education level. The gradient was most pronounced for resource-intensive actions (e.g., structural home strengthening: 5.5% among no formal vs. 40.6% among bachelor's+) and least for low-effort steps (e.g., following flood warnings: 21.8% vs. 76.8%).

The analysis of all eight preparedness behaviours measured in Table 7 revealed similar, large, and significant educational differentials. Among the total sample, saving money for emergencies (55.1%) and following flood warnings (55.4%) were the most frequently taken actions, whereas structural reinforcement of houses was least commonly implemented (21.7%), followed by participation in a community drill (19.1%). For each preparedness action, one observes a monotonic educational gradient: those with a bachelor's degree or higher had the highest uptake of all vehicles, followed sequentially by those with intermediate, primary, or no education. The largest gaps between the highest and lowest education groups were observed for resource-intensive activities: reinforcing house structure (40.6% vs 5.5%; absolute gap = 35.1 percentage points), attending community drills (36.2% vs 7.3%; gap = 28.9), and elevating important items (56.5% vs 10.9%; gap = 45.6). However, even with low-effort measures, there were substantial education-based gaps: heeding flood warnings (76.8% vs

Table 6. Educational gradient in flood preparedness adoption.

Education Level	Mean Preparedness (%)	Standard Deviation	Range (Min–Max)	Actions >50%
No Formal	18.9	10.2	5.5–32.7	0/8
Primary	31.8	13.5	12.7–47.6	0/8
Intermediate	48.2	16.4	23.0–68.0	4/8
Bachelor's+	60.3	15.3	36.2–76.8	6/8
Total	40.3	14.3	19.1–55.4	3/8

Table 7. Adoption of flood preparedness actions by education level (% yes).

Preparedness Action	No Formal	Primary	Intermediate	Bachelor's+	Total
Follows flood warnings/news	21.8	45.2	68.0	76.8	55.4
Has an emergency contact plan	25.5	38.1	55.0	66.7	46.9
Prepared an emergency kit	18.2	31.0	47.0	59.4	39.4
Elevated important belongings	10.9	23.0	42.0	56.5	34.0
Identified safe evacuation route	29.1	41.3	60.0	71.0	50.9
Saved money for emergencies	32.7	47.6	63.0	75.4	55.1
Reinforced house structure	5.5	15.1	28.0	40.6	21.7
Participated in community drills	7.3	12.7	23.0	36.2	19.1
Mean # of Actions (SD)	1.51 (1.2)	2.54 (1.8)	3.86 (1.9)	4.83 (1.7)	3.22 (2.1)

21.8%; gap = 55.0) and maintaining contacts in case of emergencies (66.7% vs 25.5%; gap = 41.2). Average cumulative preparedness actions increased monotonically from 1.51 (SD = 1.2) among those with no formal education to 4.83 (SD = 1.7) among bachelor's degree holders, a difference of more than threefold and a linear slope increase of approximately 1.1 actions per higher level of education.

3.2 Qualitative Insights From the In-depth Interviews

3.2.1 Divergent Causal Narratives: Barrage-Centric vs. Basin-Scale Perspectives

Participant accounts of flooding clustered around two separate – and often competing – story lines. The first and dominant narrative, especially among respondents with lower levels of education, centred on the Taunsa Barrage as a symbol of protection and a site of failure. In this view, flooding was attributed to mismanagement or dereliction in the maintenance of the barrage and/or its structural integrity, and/or to breakdowns in local municipal services within the sub-barrage.

“Our safety is all locked up in the barrage. When it is closed tightly, we are secure. When floods occur, it is because the flood-gates were not opened in time, the gates were broken, or too much water was deliberately released downstream. The problem is here, in this structure and the officers who make up these satraps.” (Male, 52, Fisherman)

“Our streets flood, because there is plastic and garbage in our drains. The city does not clean them. Even in normal rainfall, there is waterlogging. How could we take care of river water when we cannot even handle rain?” (Female, 45, Homemaker). An alternative, and less prevalent, narrative in the educated CHR segment was that flooding should be understood as a systemic, basin-scale phenomenon. These individuals reported a process of upstream causation and viewed the barrage as merely one aspect of a larger, delicate hydrological system.

“The barrage is the symptom, not the cause. The real culprit is in the mountains. There are no trees here, and so when they

cut the forests there, the soil runs down and fills up the river bed here. Then, when the monsoon rains begin, there is no room for the water. The barrage, however, cannot contain the whole Indus basin.” (Male, 38, School Teacher)

“We are the end of the pipe. Everything that happens upstream, in factories, farms, cities, dumping, and deforestation all ends up here. “You cannot fix a flood by only fixing the last mile.” (Male, 41, NGO Worker)

This contrasted with the quantitative finding of a strong negative association between local and catchment perceptions. It reveals a cognitive aspect of the scale mismatch in flood risk perception. The abundance-focused story creates demand for local technical fixes; the even larger-scale one (more scientifically accurate) breeds fatalism, as the drivers of perceived risk lie beyond local reach.

3.2.2 Cycles of Material Loss and Psychological Erosion

Interviewee accounts suggested that a vicious cycle was at play: repeated flooding events erode material resources and psychological resilience, resulting in what we refer to as “flood fatigue.” The participant explained that with each additional flood, their capacity to bounce back decreased, and thus their interest in future risk preparation waned.

“After the flood we had in 2010, we rebuilt our house with a loan. It was torn down again in 2022. Well, now we have no more to build with. What kind of mindset to have about an ‘emergency kit’ when I am already paying the debt for the previous emergency?” (Male, 47, Daily Wage Labourer).

“And you are starting to feel a profound fatigue in your soul. The first time, you fight. You save what you can. The second time, you cry. However, with our clouds of war, we feel only a numbing dread. However, we pray without preparing. Those who prepare are optimists, because they believe the next time it will be different,” (Female, 50, Farmer)

One daily wage labourer described the psychological toll of repeated flooding:

“After the 2010 flood, we rebuilt our house with a loan. It

was destroyed again in 2022. Now we have nothing left to rebuild with.”

A female farmer added: “You start to feel a deep tiredness in your soul. The first time, you fight. The second time, you cry. Now we feel only a numbing dread. We pray without preparing. Preparation is for optimists who believe next time will be different.”

These recurring losses erode both material resources and psychological resilience, contributing to a sense of hopelessness. Individuals internalise a helpless attitude the belief that whatever they do has no real effect on their world. This qualitative pattern is consistent with the negative correlation found between self-efficacy and socioeconomic vulnerability ($r = -0.35$).

3.2.3 The Paralysis of Distrust

One of the most serious hindrances to adaptive behaviour was found to be a widespread and deeply rooted lack of trust in institutions. This mistrust cut across a range of governing agencies, from barrage authorities, municipal governments, and disaster management institutions to political agents. It disrupted the link between risk consciousness and collective mobilization, resulting in a social and behavioural impasse.

“Why should we listen to them?” Last time, they called it a ‘moderate flood.’ What came was a disaster. The last time, they warned too late. Either they are fake news, or if they are thinking it is not fake news, they should have reported it.” We watch the trucks carrying supplies pass through, but down our road, they never go. We were advised to run to ‘safe camps,’ but there is no water and no sanitation in those places. You are better off hugging the river than relying on the government. (Female, 43, Community Health Worker)

Third wrote, “They build levees, their contracts go to their brothers and sisters. And then, with a clatter, the scaffolding gives way, and we are in the water. So, here come the same individuals with the contract to rebuild it. It’s not a flood we are drowning in; it is a system.” (Male, 60, Retired Government Clerk)

This institutional mistrust also explains the strong relationship between trust and self-efficacy ($r = 0.44$). When authorities who issue warnings and intervene are perceived as untrustworthy or corrupt, such distrust not only diminishes public confidence in institutions as a whole but also in their capacity to effect change. “When you know no one is coming to help, you stop believing you can help yourself,” was the way one participant expressed it. This manifests a paradox of governance within the SES framework: low trust leads to less action and, consequently, greater vulnerability.

3.2.4 Synthesis: The Interlocking Triad of Inaction

The qualitative results suggest that knowledge, agency, and trust structures collectively shape flood preparedness in Taunsa Sharif as an interrelated trinity. To begin with, we understand flood causation only in fragmented and contested ways. Although some people do recognize the basin-wide picture, this is often mitigated by a sense of powerlessness to effect change. Agency and self-efficacy are then increasingly undermined by repeated material losses and

psychological breakdowns, including flood fatigue. Third, trust in institutions is being eroded, undermining the social contract at the heart of coordinated and collective risk management. All three of these dimensions interact. For example, actors with basin-wide knowledge and moderate awareness described their actions as confined to the household level, citing distrust of institutions. Some of them were residents or had some local knowledge and expressed low self-efficacy associated with socioeconomic deprivation. These effects were exacerbated by mistrust and fatalistic beliefs. The intricate nature of this relationship underscores that river perception, self-efficacy, and trust in the institution are strong predictors in our quantitative analysis. It also shows that educational and policy interventions cannot be confined to technical knowledge. Instead, they must work to empower local citizens while also restoring the legitimacy of formal institutions. All three elements must be addressed to close the gap between the watershed and urban areas successfully and to promote ongoing adaptive behaviour (Table 8).

4 Discussion

This study examined how watershed-scale flood perception, self-efficacy, and institutional trust jointly shape household preparedness. The findings confirm that adaptive capacity is a systemic phenomenon, not merely the sum of individual predictors. We focus on three cross-cutting implications: the cognitive scale mismatch in risk attribution, the mediating role of self-efficacy, and the governance paradox whereby institutional distrust undermines even well-informed agency.

The results reveal a clear educational gradient in flood causality attribution. Respondents with higher education backgrounds were significantly more likely to recognize causes of flooding risk at the watershed scale. In contrast, low-educated individuals most often associated the risk with direct infrastructure failures. This is a traditional scale mismatch from the lens of Social-Ecological Systems (Cumming et al., 2013; Falco et al., 2022). Hydrologic processes sometimes occur (or do not occur) at catchment scales, but many residents’ perceptions of risk are mediated by local infrastructure. This perceptual compression can short-circuit longer-term adaptive planning and lock in faith in purely technical fixes. However, watershed-level knowledge is not a sufficient condition for adaptive behaviour in its own right (Chess et al., 2000). Although system knowledge positively predicts preparedness, its predictive power is amplified by psychological drives, highlighting the need to combine cognitive and emotional levels in preparedness interventions. Consistent with Protection Motivation Theory (PMT) and Social Cognitive Theory (SCT), self-efficacy was the most robust predictor of preparedness behaviour (Bandura, 2001; Rogers, 1983). The data supported a mediating effect of self-efficacy, suggesting that while watershed-scale perception leads to action by raising risk awareness, an overemphasis on information alone may result in a passive audience response. What knowledge has the potential to do in relation to preparedness is only relevant if people believe they can act. In the face of agency scarcity, system knowledge

Table 8. Summary of the key findings from thematic analysis.

Theme	Sub-theme	Quote	Interpretation
1. Divergent Causal Narratives	Barrage-Centric View (Localized Attribution)	<i>“All our safety is tied to the barrage... The problem is here, with this structure and the officers who control it.”</i> (Fisherman)	Reflects a localized mental model in which flood causality is attributed to visible, proximate factors, such as infrastructure failure or poor maintenance. Common among less-educated respondents.
	Basin-Scale Perspective (Systemic Attribution)	<i>“The barrage is a symptom, not the cause. The real cause is in the mountains... The barrage cannot hold back the entire Indus basin.”</i> (School Teacher)	Indicates a systemic understanding of floods, linking them to upstream land-use changes and hydrological processes. More common among educated respondents.
2. Flood Fatigue	Material Depletion & Psychological Erosion	<i>“After the 2010 flood, we rebuilt... In 2022, it was destroyed again. Now we have nothing left to rebuild with.”</i> (Daily Wage Laborer)	Highlights how repeated flood losses erode both economic resources and psychological resilience, thereby reducing motivation and self-efficacy.
	Emotional Exhaustion & Fatalism	<i>“You start to feel a deep tiredness in your soul... Preparation is for people who believe the next time will be different.”</i> (Farmer)	Illustrates the emotional toll of recurring disasters, fostering fatalism and undermining proactive preparedness behaviours.
3. Institutional Distrust	Distrust in Warnings & Information	<i>“Why should I listen to their warnings? Last time, they said ‘moderate flood.’ What came was a disaster.”</i> (Shopkeeper)	Shows how past failures in communication and response undermine the credibility of official warnings, reducing compliance and trust.
	Perceived Corruption & Inequity	<i>“The aid is for the connected people, not for us... We are not victims of a flood; we are victims of a system.”</i> (Retired Clerk)	Reflects deep-seated distrust in governance due to perceived corruption, inequitable aid distribution, and a lack of transparency.
4. Interlocking Triad of Inaction	Fragmented Knowledge & Powerlessness	<i>“We are at the end of the pipe... You cannot fix a flood by only fixing the last mile.”</i> (NGO Worker)	Demonstrates that even systemic knowledge can be neutralized by feelings of powerlessness, especially when risks originate beyond local control.
	Agency Erosion via Flood Fatigue	Implicit in narratives of loss and exhaustion (e.g., Laborer, Farmer).	Self-efficacy is weakened by repeated losses, creating a cycle where material deprivation leads to psychological withdrawal from preparedness.
	Distrust Undermining Collective Action	<i>“When you know no one is coming to help, you stop believing you can help yourself.”</i> (Implicit in narratives)	Institutional distrust disrupts social coordination, leading to individual disengagement and paralysis in collective risk management.
5. Synthesis: Knowledge Agency–Trust Nexus	Interdependence of Cognitive, Psychological, and Governance Factors	<i>“Some participants with basin-scale knowledge... reported limiting their actions to household-level measures due to institutional distrust.”</i>	Emphasizes that flood preparedness is governed by an interdependent triad: knowledge, self-efficacy, and trust. Weakness in one dimension can destabilize the entire adaptive system.

can give rise to fatalism, especially when flood risks originate upstream and are perceived as beyond the local realm (Powell et al., 2018). Descriptive stories also show how repeated flood experiences erode psychological resilience. Stories of ‘flood fatigue’ suggest that experiences of sustained material loss erode confidence and reduce the willingness to invest in preparedness by highlighting how adaptive capacity is emotional and experiential as much as cognitive (Grothmann and Patt, 2005).

Trust in institutions was a strong predictor of preparedness and was positively associated with self-efficacy, supporting the idea that the legitimacy of governance promotes individual agency. When decision-makers appear informed and open, households are more likely to perceive a point and to support their preparations. On the other hand, corruption, unequal aid allocation, and unreliability of warnings show how mistrust can undermine adaptation (Saharan, 2015). These dynamics are consistent with the

“governance traps” in the Social-Ecological Systems literature, in which institutional frailty leads to public disengagement, which in turn undermines institutional effectiveness (Bronfenbrenner, 1994). Even among respondents (including those highly knowledgeable about the watershed), some degree of limited preparedness was indicated due to institutional distrust; however, there was evidence that adaptive behaviours are socially embedded and dictated by political trust. The results suggest an integrated model of preparedness that conceptualizes watershed perception (knowledge), self-efficacy (agency), and institutional trust (governance legitimacy) as co-determining elements of adaptive capacity. Any of these domains can develop weak links that could threaten to destabilize the entire preparedness system. This model, replicated three times, demonstrates that adaptive capacity is systemic rather than additive. If governance institutions lack credibility, psychosocial empowerment is unlikely to be sufficient, and if efforts are limited to raising awareness, positive behavioural effects will be undermined (Miller and Pescaroli, 2018).

The results indicate that flood resilience agendas must move beyond awareness campaigns toward an integrated approach bridging cognitive knowledge, psychosocial agency, and governance legitimacy. Upstream–downstream connections can be made tangible through participatory mapping that traces local deforestation and sedimentation to downstream flood impacts using satellite imagery and hydrological data. For low-literacy communities, visual narratives (e.g., illustrated flood timelines, theatre skits of a raindrop’s journey) resolve scale mismatches. Self-efficacy is best built via hands-on workshops (e.g., bamboo safe-rooms, raised platforms) and community drills with mock alerts and evacuation routes, reinforced by peer-led “preparedness champions” demonstrating low-cost actions. Institutional trust requires public scorecards on warning accuracy, aid-tracking notice boards, and community monitoring committees that co-design plans. Economic support should include no-interest livelihood loans, microfinance for housing adaptation (raised plinths, roof anchors), and cash transfers within 72 hours of a warning to enable pre-emptive action. Preparedness thus demands specific, locally anchored, verifiable activities not generic exhortations.

By integrating social-ecological systems theory, protection motivation theory, and social cognitive theory into disaster studies, this research developed an integrated framework for flood preparedness. Simultaneous modeling of mesoscale perception, self-efficacy, and institutional trust at the watershed scale in this study revealed that response behaviour is co-produced rather than determined by individual determinants, but by collective ecological-scale cognition, individual agency, and local governance structures. The mediation model supports the view that self-efficacy accounts for the crucial internal psychological process underlying the translation of system-environment knowledge into specific preparedness behaviours, and thus offers new approaches to PMT and SCT for analyzing hazards. Theoretically, the research proposes an adaptable “knowledge–agency–trust” triad, recasting preparedness as a systemic

constellation of relational dimensions. Such an adaptive configuration of preparedness is vulnerable if any part is weak. Consequently, the model is not merely an empirical portrayal but also serves as a theoretically consistent point of reference for other hazard-prone areas.

5 Conclusion

The findings of this research present strong empirical evidence that residents’ perception and adaptation toward flood risk in flood-risk areas are significantly influenced by three interrelated factors (knowledge about the watershed, perceived self-efficacy, and institutional trust). The results lend weight to a substantial cognitive route-urban view divide, in which greater formal education powerfully predicts greater awareness of systemic, upstream flood drivers, and this awareness is positively associated with higher self-efficacy and preparedness. However, knowledge is not enough; it converts into practice through personal agency and can be particularly impeded by profoundly rooted distrust in institutional actors, while flood fatigue – the psychological impact of loss repetition – can severely limit its scope for deployment. Hence, successful flood-resilience initiatives must transcend generic awareness-raising and be grounded in integrated, participatory educational programs intentionally structured to bridge cognitive scale mismatches and concurrently foster practical self-efficacy through hands-on discovery learning, while serving as active agents in the regeneration of credible, transparent, and more equitable governance. Addressing this interlocking triad of knowledge, agency, and trust is crucial for translating systemic risk awareness into persistent, supply-driven adaptive capacity and for breaking the cycle of vulnerability over time in socially-ecological complex floodplains.

6 Limitations

Several methodological limitations warrant acknowledgement. First, the cross-sectional design precludes causal inference; longitudinal or experimental studies are necessary to confirm the proposed directional pathways. Second, reliance on self-reported preparedness measures may introduce social desirability bias; future research should triangulate findings with observational or administrative data. Third, the single-site context constrains generalisability; comparative case studies across river basins with divergent governance architectures (e.g., centralised versus decentralised flood management) are required to validate the external applicability of the knowledge–agency–trust triad. Fourth, common method bias cannot be ruled out given the exclusive use of survey data; nevertheless, a Harman’s single-factor test explained only 28.4% of total variance, well below the 50% threshold, indicating that common method bias does not substantively threaten the integrity of our findings. Finally, our operationalisation of risk perception focused on causal attribution rather than affective dimensions (e.g., worry, dread); subsequent research should integrate both cognitive and emotional components to capture the full construct.

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Conflicts of Interest

The authors declare no conflicts of interest.

CRediT statement

Saeed Ahmad: Writing Original Draft, Validation, Data Collection. **Shahnaz Bhutto:** Data Analysis, Software, Writing/Reviewing Original draft **Abdul Rasool Khoso:** Supervision, Writing/Reviewing Original Draft, **Khansa Maryam:** Instruments, Formal Analysis, Writing.

Data Availability

Data would be available upon request from the corresponding author.

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ChatGPT and Grammarly were used to improve language.

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