Innovations

Post Traumatic Stress Disorder: Construction of the Tehri Dam and Forced Migration

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Abstract: *This study explores the psychological impact of forced migration resulting from the construction of the Tehri Dam in Uttarakhand, India, with a specific focus on the development of Post-Traumatic Stress Disorder (PTSD) among displaced populations. While the socio-economic consequences of such large-scale development projects are widely documented, their emotional and cognitive repercussions remain underexamined. Employing a cross-sectional research design, data were collected from 457 displaced individuals using a purposive random sampling method. A structured questionnaire comprising 17 PTSD indicators, rated on a five-point Likert scale, assessed psychological distress across emotional, mental, and physical domains. Using Python, Structural Equation Models (SEM) and Ordinal Logistic Regression analysis have been performed, which demonstrate that emotions have a strong impact on behaviour. Statistical analyses, including the Mann-Whitney U test, Wilcoxon, and Kruskal-Wallis tests conducted in SPSS, revealed that nine indicators demonstrated strong statistical significance ($p < 0.001$), with two showing moderate associations with PTSD symptoms. Principal Component Analysis (PCA) in R Studio was employed to identify latent patterns among the variables, enhancing the interpretive understanding of psychological dimensions. Spatial distribution of PTSD severity was visualized using ArcGIS, applying the Inverse Distance Weighting (IDW) technique to map the level of Post Traumatic Stress Disorder among the migrants. Findings indicate that females exhibited higher levels of PTSD compared to males. Among the factors studied, rehabilitation status, gender, and occupation showed the most significant associations with PTSD symptoms.*

Keywords: *Post-Traumatic Stress Disorder, Forced Migration, Development-Induced Displacement, Mental Health, Tehri Dam, Psychological Trauma, Rehabilitation Policy, Spatial Pattern.*

Introduction

According to Cernea (1998), when displacement is planned and organized, a vast amount of impoverishment is not necessary, but, in many cases, there is a need for resettlement of displaced people. Cernea Introduce (IRR) Impoverishment Risk and Reconstruction Model of Population. It has two main aims: Firstly, to explain what happens during forced displacement, and secondly, to create a planning and guiding policy as a guideline for resettlement. Chamber (1969) explained the three-stage model in Africa. Soon after, Nelson (1973) introduced many patterns of land settlement in Latin America. Later, Scydder& Colson (1982) introduced a theoretical model of settlement, based on the previous model, which introduced four stages and then three. It focused on settlers' stress and their behavioural reactions at every stage. Michael Cernea (Cernea, 2000) developed the Improvishment Risk and Reconstruction (IRR) Model in the 1990s, which outlines the social and economic risks associated with forced development and provides a framework for mitigating them. The model identifies eight primary risks: landlessness, joblessness, homelessness, marginalization, food insecurity, increased morbidity and mortality, loss of access to common property resources, and social disarticulation —each of which constitutes a profound disruption to the socio-economic and cultural fabric of displaced populations. Drawing from empirical insights across India, Sri Lanka, and China, the model reveals how dislocation not only severs people from material assets but also from their symbolic and relational worlds. Cernea's paradigm does not merely diagnose the afflictions of displacement; it offers a normative reconstruction strategy that reimagines resettlement as an avenue for regeneration. Advocating land-based rehabilitation, skill-based reemployment, durable housing, and the revitalization of communal bonds, the IRR model envisions a transition from vulnerability to empowerment.

Migration to a new environment often leads to significant changes in human lifestyles. When people are forced to relocate, they may develop various psychological disorders. Common mental health issues in such situations include stress, depression, anxiety, post-traumatic stress disorder (PTSD), and schizophrenia (Gramaglia et al., 2022). During and after migration, individuals may face traumatic events that leave lasting memories, potentially leading to PTSD. As the aftermath of forced migration, individuals may suffer from stressful experiences leading to loss of social status, developing inadequacy, unemployment, loss of interest in entering into relationships, and developing a sense of not belonging. The traumatic events pre-migration, during migration, and post-migration result in increased anxiety and reduced life satisfaction. Traumatic events and experiences faced by migrants lead to mental health issues, including Post Traumatic Stress Disorder (Gramaglia *et al.*, 2022; Siriwardhana& Stewart, 2012). In 1980, PTSD was introduced by the American Psychological Association, stating that it can be caused by both the natural and

social environment (Mucci et al., 2018). Its inclusion in the DSM marked a recognition of the profound effects that exposure to traumatic events can have on an individual's mental well-being. The DSM criteria for diagnosing PTSD include experiencing a traumatic event, along with specific symptoms such as intrusive memories or nightmares, avoidance behaviours, negative shifts in mood and cognition, and increased arousal (Kirmayer et al., 2011). This condition can cause physical, mental, and behavioural challenges, affecting an individual's ability to adjust. While some people recover from PTSD relatively quickly, others may suffer from its effects for a lifetime (Cornelius et al., 2010) (Cukor et al., 2009; Donato et al., 2020; Dyer et al., 2009; Farhood & Dimassi, 2009; Kedia and Willigen, 2001; Mangrio et al., 2021; Solomon et al., 1993; Siriwardhana & Stewart, 2012; Virupaksha et al., 2014; Young-Wolff et al., 2014).PTSD is characterized by constant anxiety, nightmares, and memories of the traumatic event. In severe cases, it may lead to depression, bipolar disorder, and schizophrenia. As a coping mechanism, individuals may resort to alcoholism, smoking, the use of cannabis, and drug use (Cornelius et al., 2010; Solomon et al., 1993; Vries et al., 2018; Young-Wolff et al., 2014). In youth, symptoms like hyper vigilance, difficulty concentrating, distressing recollection of events like images and thoughts, flashbacks of events, lack of interest in hobbies, sense of foreshortened future, and other symptoms may arise, as a result of untreated trauma (Kearny et al., 2009). Such patients may also experience *fibromyalgia*, a severe, chronic, non-articular rheumatic condition causing muscular and skeletal pain. A person experiences extreme fatigue, impaired cognition, non non-restorative sleeping difficulties. Such patients develop self-harm behaviour and give up taking care of themselves (Conversano et al., 2019). PTSD is characterized by anger and hostility traits; hence,*Post Traumatic Growth* is a chance for an individual to value life and ponder upon its fragility. Meditation, spiritual, and religious activities play an important role in post-bereavement enhancements (Dyer et al., 2009; Gerrish et al., 2009).

The Tehri Dam, located in Uttarakhand at a height of 260 meters, is the tallest in India. However, the construction of the dam has had significant emotional and psychological impacts on the local inhabitants (Agrawal et al., 2018). Over the years, the project has faced numerous political, social, and environmental challenges (Pathak 2002; Rajlakshmi 2022). The construction led to the submergence of 24 villages in Old Tehri Town, with 88 villages experiencing partial impact and 13 villages affected due to the establishment of new settlements for those relocated. In total, 3,442 families were fully affected, and 1,857 families were partially affected by the Tehri Dam project. Despite the benefits associated with the dam construction, the dam also brought forward the socio-political and economic aspects that raised concerns. The protestors called for the shutdown of the Tehri Dam project due to the mass displacement it would

cause. Losing their land meant losing their natural habitat, lifestyle, social connections, and agricultural livelihood (Devendra &Naithani, 2022; Padiyar, 2023). After the construction of the Tehri dam, a large number of elderly Garhwali population were displaced from their native land of Tehri and thereafter experienced difficulty in adapting to the new environment. These difficulties resulted in stress and psychosomatic illness despite being relocated to the flourished plains of Dehradun. Elders experience nostalgia, insomnia, tiredness, and insecurity, feeling discontent and phobic of the rush, pollution, and adversities of city life. The development of PTSD is different in males and females. Study reveals that men are most likely to experience a traumatic event as compared to females (Kedia &Welligon, 2001; Olff, 2017). Similarly, the location, surroundings, and characteristics of rehabilitation experience influence the mental health of migrants. The neighborhood plays a significant role in the development of stress. Negative social interactions, lack of acceptance in the neighborhood, and lack of association lead to PTSD. In lower socio-economic classes, women are at a higher risk of facing Post Traumatic Stress Disorder than men. As a result of embarrassment, harassment, economic distress, and physical abuse, they tend not to seek any professional treatment, even when they know about their mental distress (Allen,1996). *Do They Hear You When You Cry* is an autobiography that highlights the impact of dramatic events on the psyche. Forced migration causes maltreatment in women, and they suffer from Hysteria, sexist denial, false accusations, and personality changes (Mabura, 2011). Glaring poverty levels, income inequality, food security, human labor, and an underdeveloped structure are some of the other factors that lead to traumatic experiences during displacement (Ansari, 2017).The villagers protested against the project for cultural, economic, environmental, and social reasons, voicing concerns over their safety and the challenges of restarting their lives in unfamiliar places. They were particularly distressed about losing their fertile agricultural land, cattle, and homes. (Aryal, 1995) (Chand, 2014)Additionally, many villages in Tehri were closely tied to specific families, and displacement would disrupt these long-standing familial and community bonds. For the residents of Old Tehri, the forced migration represented a dramatic shift from living in the mountains to being relocated to the plains of Dehradun, Haridwar, and Rishikesh, where adapting to urban life posed significant challenges. In response to the needs of the displaced population, the Indian government introduced the Rehabilitation and Resettlement Policy of 1998, which provided guidelines for resettlement, compensation, and the proper implementation of the policy. The goal of the policy was to reduce the economic and socio-cultural hardships faced by the displaced, though it overlooked the psychological and emotional impacts of forced displacement (Yadav et al., 2018). Such involuntary moves are linked to physical, psychological, and social challenges, disrupting traditions, cultural practices, relationships, and a sense of place. These factors contribute to long-term mental health issues, including Post-Traumatic Stress Disorder (PTSD),

depression, anxiety, and stress. (Allen, 1996) (Altemus et al., 2006; Bryant et al., 2009; Carroll et al., 2020; Cloitre, 2014; Conversano et al., 2014; Cornelius et al., 2010; Gerrish et al., 2009; Vries et al., 2019). This study was conducted to correlate PTSD and Forced Migration among the migrated population of Old Tehri. This study aimed to understand how the change in physical environment affects the mental health of an individual. To assess the presence of PTSD, a survey was conducted on the migrants residing in the rehabilitated locations of Uttarakhand. PTSD may arise due to medical, psychological, cultural, social, and policy-related domains, which this research work has inculcated during the survey. With the motive to understand the psychological, social, and economic impact, resilience & coping mechanisms, the impact of migration on different age groups and genders, this research work has been conducted. The research targets the field of behavioural geography, which deals with aspects of human geography. While physical phenomenon is based on scientific technicality, this study features mental and emotional aspects that are affected by the physical environment. Richard L. Warms' *In the Valley of the River* (1994) mentions the Tiv people of Nigeria, focusing on how external forces, including development projects, impact traditional societies. The work explores cultural and political structures, while indirectly relating to broader research on dam-induced displacement, which has been extensively studied in African contexts. Moreover, Scudder (2005) presents a long-term framework for understanding the resettlement process caused by dam construction, noting that inadequate planning can lead to long-term impoverishment. The study supports Warms' insights by contextualizing how large-scale infrastructural changes—such as dam building—disrupt indigenous ways of life, reinforcing the need for culturally sensitive development policies.

Study Area

Old town Tehri was a small town, situated 16km away from New Tehri on the confluence of the Bhagirathi and Bhilangana rivers in Uttarakhand, fully submerged in the water. The old town was known for its historical buildings and temples, which is now submerged beneath the Tehri dam. The population of Old Tehri town was forced to move to the New Tehri town. New Tehri Town, also known as Tehri, is a town in the Garhwal segment of Uttarakhand. The town is centred around the Tehri Lake at an elevation of 1550 m to 1950 m. New Tehri Town is an example of development-induced resettlement for displaced people by the Tehri dam construction in India. Geographically, the New Tehri town is located in the Lesser Garhwal Himalaya at 30° 22′34.5036" N latitude and 78° 26′7.3644″ E longitude. The Tehri Lake is built on the Tehri Dam. The Tehri Dam is the tallest in India, located at a height of 260m in the state of Uttarakhand.

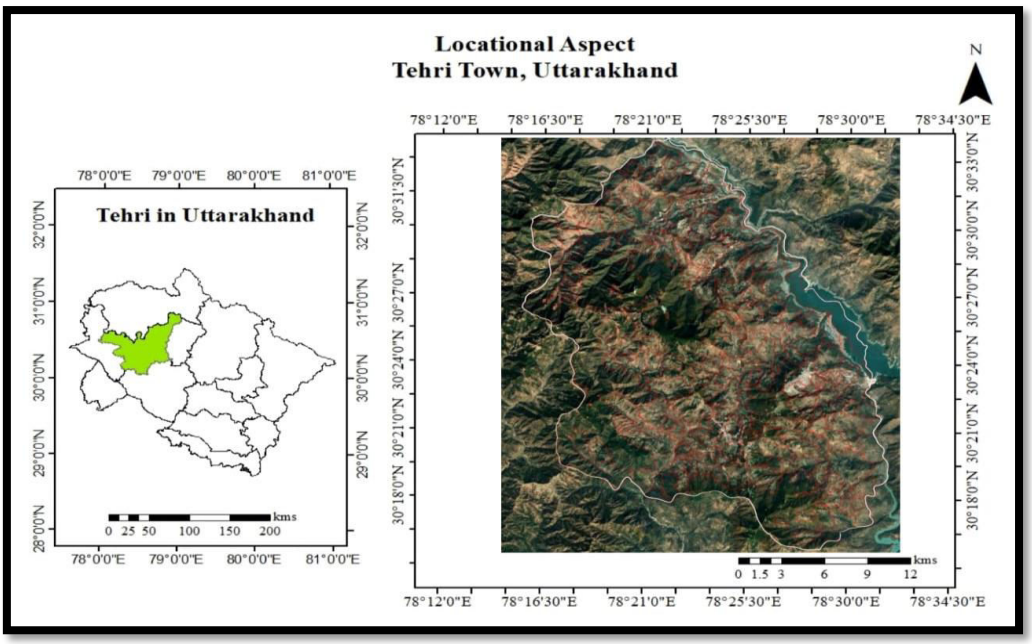


Figure 1 – Locational Aspect, Tehri Town.

Rehabilitation Policy

The rehabilitation policy presented compensations for the rehabilitated population of Old Tehri Town. Despite recommendations from the government, involvement of locals, and careful observations, the policy had social, emotional, psychological, and economic impacts on the displaced population. The Rehabilitation Policy associated with the Tehri Hydro-Electric Project (THDC), especially its Rural and Urban Rehabilitation Packages of December 9, 1998, provides a framework for compensating and resettling displaced populations. The implementation of the policy has had social and economic consequences and psychological impacts on affected communities. The policy provided joint benefits in the name of both husband and wife, which promoted gender inclusivity. Community relocation aimed to minimize the disruption of social networks by resettling people in clusters. However, submergence of Old Tehri Town, a culturally and historically significant place, led to the erosion of cultural roots, temples, and social practices. The families dispersed during relocation weakened traditional support structures. The forced displacement generated emotional stress, feelings of rootlessness, and depression, especially among the elderly. Both rural and urban packages provided mechanisms for monetary compensation or land allotment, attempting to restore economic security. Grants were provided for construction and shifting, which helped mitigate immediate post-displacement expenses. Compared to the rural package, the urban packages provided employment provisions and income schemes to stabilize livelihoods in the longer term. However, the market value-based cash compensation often failed to match the actual value or productivity of the land in fertile rural areas. In many rural areas, the promised irrigated land was either not developed or located in inaccessible regions, making agricultural recovery

difficult. While the landless labourers were entitled to land, implementation was uneven, and many were excluded due to a lack of proper records. Despite being displaced to urban locations, many urban displaced persons lost access to location-based informal jobs with no effective skill-based rehabilitation. The displaced people felt excluded from the planning process, leading to mistrust toward authorities. The elderly displaced population expressed concern more as compared to adults. Younger generations grew up in an atmosphere of instability and often struggled to adjust socially and economically. While the Rehabilitation Policy for Tehri Dam was progressive in theory, its effectiveness was undermined by implementation gaps, inadequate monitoring, and a lack of participatory planning. Displacement, especially on such a massive scale, requires not just compensatory measures but holistic human development approaches that consider psychological, social, and economic well-being. In *The Future of Large Dams*, Scudder (2005) provides a comprehensive analysis of the long-term social, environmental, and political impacts of dam construction, arguing that large dams often fail to deliver their projected benefits due to inadequate planning and disregard for the human and ecological systems they disrupt.

Methodology and Data Collection

This research followed a survey-based methodology via purposive random sampling to study the psychological impacts of forced migration, focusing specifically on the population displaced from Old Tehri following the construction of the Tehri Dam. The study targeted a sample size of 457 families from Tehri town, who were forced to migrate during the construction of the Tehri Dam. A structured questionnaire was designed using a five-point Likert scale, through which participants were asked to reflect on their post-migration experiences, encompassing physical, emotional, mental, and economic aspects of their lives. To comprehensively assess the impacts of displacement, the survey included 17 indicators aligned with symptoms of Post-Traumatic Stress Disorder (PTSD). These indicators were broadly categorized into physical, emotional, and mental health dimensions. The physical health section examined variables such as ability to work, interest in work, physical fatigue or distress, changes in appetite, and sleep disturbances. Emotional well-being was evaluated through items addressing feelings of detachment from familiar individuals, difficulty in adapting to new environments, increased involvement in interpersonal conflicts, and emotional numbness. The mental health component of the survey included queries related to anxiety, stress, episodes of re-experiencing traumatic events, substance abuse, frequency of intrusive thoughts, and tendencies toward self-harm. Each of these indicators was assigned a weight, allowing the researchers to calculate the overall PTSD level for each respondent.

Factors	Variables
Physical Factors	**Sleep, Appetite, Physical Activity, Recklessness, Distress**
Mental Factors	**Stress & Anxiety, Triggering, Flashbacks, Avoidance, Premonition, Anger, Distracted**
Social Factors	**Emotional Numbness, Culture, Distanced, Conflict**

Table 1 – Variables used for Analysis.

To evaluate statistical significance, the study applied non-parametric hypothesis tests using SPSS software. The Mann-Whitney U test (Schober & Vetter, 2020), along with Wilcoxon and Kruskal-Wallis tests, was applied to assess variations across demographic and social categories (Macunluoğlu & Ocakoğlu, 2023). The significance threshold was set at $p = 0.05$. In addition to traditional statistical analysis, Principal Component Analysis (PCA), Scree Plot analysis, and Loading plot were created using R-Studio. Biplots generated using R-studio enhanced the interpretative clarity of the variable relationships, identifying clusters of interrelated symptoms that collectively defined trauma profiles. To visualize the spatial distribution of psychological vulnerability among the displaced population, geographic mapping was performed using ArcGIS software. Coordinates collected via Google Earth Pro were converted into a point file, each attributed with individual PTSD scores. These data points were then interpolated using the Inverse Distance Weighting (IDW) method, a spatial analysis technique that estimates unknown values based on the proximity and magnitude of known values. The IDW technique relies on a specific mathematical formula to control the surface smoothness, thereby producing a continuous map of PTSD intensity across the region (Rana & Singh, 2019). The Structural Equation Model (SEM) and Ordinal Logistic Regression Model were used to model PTSD among migrants and understand the factors influencing PTSD. The integration of SPSS, R-Studio, Python, and ArcGIS software provided a robust analytical framework, yielding high-precision results. With the use of Python, the Structural Equation Model and Ordinal Logistic Regression have been performed. The SEM models PTSD by grouping the variables and determining their impact on each other (McNeish et al., 2024; Kupek, 2006).

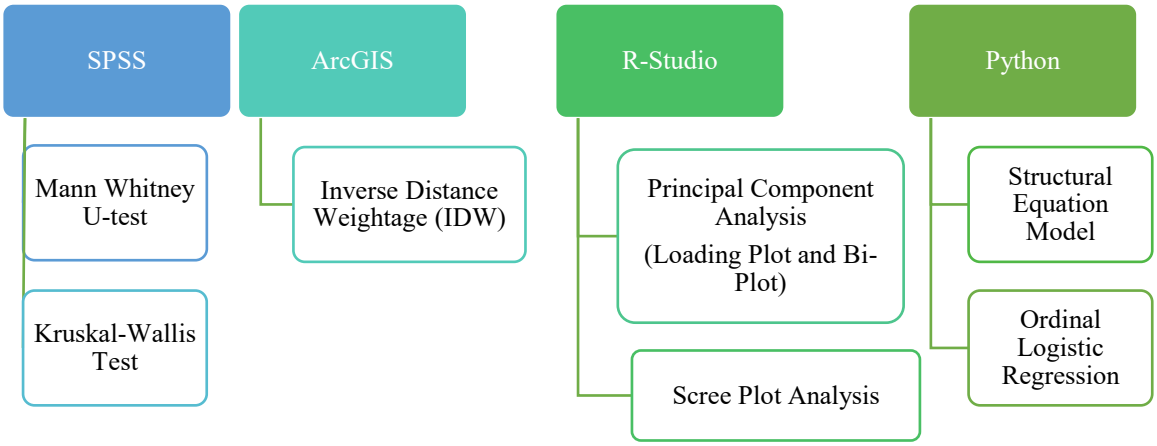


Figure 2 - Software and Technique Used for Data Analysis

Each variable was assigned weightage based on its influence on mental health and impact on Post Traumatic Stress Disorder. The following legend has been prepared to depict variables used during the survey, their abbreviations used in models, and their respective weightage.

LEGEND			WEIGHTAGE ASSIGNED
Repeated, disturbing memories, thoughts, or images of the stressful experience?	Intrusiveness	Mental Health Factors	5
Suddenly acting or feeling as if the stressful experience were happening again (as if you were reliving it)?	Flashbacks		4
Feeling very upset when something reminded you of the stressful experience?	Trigering		3
Avoiding activities or situations because they reminded you of the stressful experience?	Avoidance		5
Feeling as if your future will somehow be cut short?	Premonition		2
Feeling irritable or having angry outbursts?	Exasperation		2
Having difficulty concentrating?	Distractability		2
Loss of interest in activities that you used to enjoy?	Anhedonia	Physical Health Factors	3
Trouble falling or staying asleep?	Insomnia		3
Did you seek comfort in substance abuse?	Substances		5
Did you loose your appetite?	Appetiteloss		5
Taking too many risks or doing things that could cause you harm?	Recklessness		4
Intense physical distress when you are exposed to things that remind you of the event?	Distress		3
Feeling emotionally numb or being unable to have loving feelings for those close to you?	Blunting	Emotional Well-being Factors	5
Did you face difficulty in accepting the new environment and people around you?	Culturalshock		4
Did you often indulge in conflicts with people around you?	Conflicts		4
Feeling distant or cut off from other people?	Distant		4

Table 2 – Legend.

Based on the survey, the following percentage of responses were recorded for each variable. Figure 5 presents a detailed comparative table that categorises and contrasts various physical, mental, and social factors typically associated with psychological trauma and stress-related conditions. The structure of the table reveals trauma across different dimensions of human experience—bodily, cognitive/emotional, and interpersonal.The bar graph shows responses across various behavioural variables, for which the responses are segmented into five categories of Strongly Disagree (dark blue), Disagree (orange). Maybe (grey), Agree (yellow) and Strongly Agree (light blue). Each variable on the X-axisrepresents behavioural traits such as Intrusiveness, Flashbacks, Triggering, Avoidance, Premonition, Exaggeration, etc.Variables including Blunting, Recklessness, Distress, and Distant have a very high proportion of "Strongly Agree" responses, indicating widespread acknowledgement or experience of these traits/symptoms among respondents.Especially for Blunting, "Strongly Agree" nearly reaches 100%, showing near-universal agreement.Triggering, Substances, Appetite loss, and Insomnia show a balanced mix across all five response categories, suggesting varied experiences or opinions among respondents.Triggering, in particular, has notable grey ("Maybe") responses, indicating uncertainty or ambivalence.For most variables, "Strongly Disagree" and "Disagree" form a smaller portion of the bar, indicating fewer people rejected these traits or experiences outright.Many variables, such as Avoidance, Premonition, Exaggeration, and Distractibility show significant "Agree" and "Strongly Agree" percentages, indicating these are common experiences. Variables like Triggering and Substances have the lowest "Strongly Agree" levels, suggesting these are either less universally experienced or more controversial.

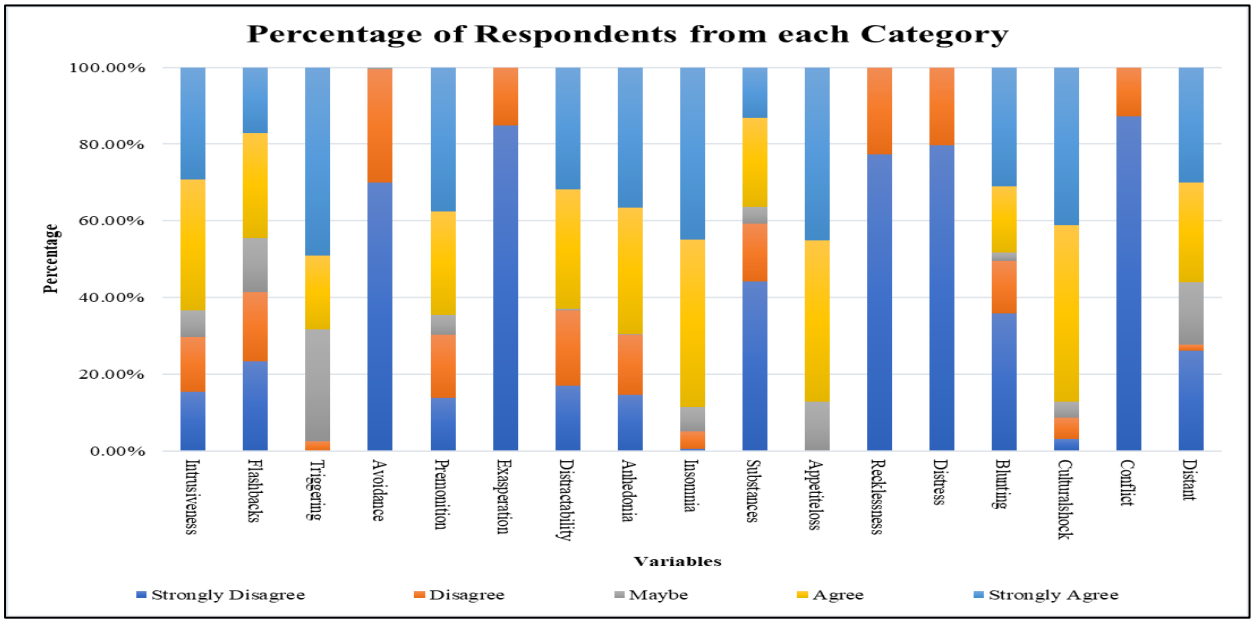


Figure 3– Percentage of Respondents for each Score across Variables.

Results and Findings

The Structural Equation Model analysis reveals that behaviour has a strong positive effect on Emotions (coefficient: 0.9654). This implies that individuals engaging in more behaviours (like active efforts, perhaps coping mechanisms) show higher emotional responses. Social Stress has a very weak negative effect on Emotions (coefficient: -0.0337), indicating it's a minimal suppressor in this model. (ε_1: unexplained variance in Emotions).

Emotions = 0.9654 × Behaviour - 0.0337 × SocialStress + ε_1 -------- *Equation 1*

Social Stress has a moderate negative effect on Behaviour (coefficient: -0.34), implying that increased social stress reduces positive behavioural engagement (e.g., sleep, diet, activity). (ε_2: unexplained variance in Behaviour).

Behaviour = -0.3400 × SocialStress + ε_2--------- *Equation 2*

Indicator	Equation	Loading	Interpretation
stress	stress = 1.0000 × Emotions + ε_s	1	Strong core indicator of Emotions.
flashbacks	flashes = 0.3236 × Emotions + ε_f	0.3236	Moderate loading, contributes moderately to Emotions.
triggering	trigger = 0.5517 × Emotions + ε_t	0.5517	Moderate loading, relevant emotional indicator.
avoidance	avoid = 0.0152 × Emotions + ε_a	0.0152	Very weak loading, almost negligible in defining Emotions.
premonition	future = 0.0687 × Emotions + ε_fu	0.0687	Weak loading.
anger	anger = -0.0884 × Emotions + ε_an	-0.0884	Negative weak loading - inverse relation.
distractability	distract = -0.4970 × Emotions + ε_di	-0.497	Strong negative loading – inversely related to Emotions.

Table 3– Indicator of Emotions (latent variable).

The latent variable Emotions is primarily defined by stress and to a lesser extent by trigger and flashes. Avoidance, premonition, and anger contribute little. Distractability is notably negatively related, which could suggest suppression or a distinct factor structure.

Indicator	Equation	Loading	Interpretation
active	active = 1.0000 × Behavior + ε_ac	1	Core behavior indicator.
insomnia	sleep = 0.3086 × Behavior + ε_sl	0.3086	Moderate loading.
substances	intox = -0.3037 × Behavior + ε_in	-0.3037	Moderate negative loading – perhaps maladaptive coping.
appetiteloss	diet = 0.0488 × Behavior + ε_d	0.0488	Weak loading.
recklesness	reckless = -0.0307 × Behavior + ε_re	-0.0307	Negligible negative loading.

Table 4– Indicators of Behaviour.

Active and insomnia are primary positive behaviour indicators. Substances and recklessnessbehaviours are negativelyassociated, which may imply these are behaviours that reduce overall functioning or coping ability.

Indicator	Equation	Loading	Interpretation
distress	distress = 1.0000 × SocialStress + ε_ds	1	Core indicator of Social Stress.
blunting	numb = -0.3056 × SocialStress + ε_nu	-0.3056	Negative loading – inversely related to Social Stress.
culturalshock	culture = -0.0303 × SocialStress + ε_cu	-0.0303	Very weak negative loading.
conflict	conflict = -0.0109 × SocialStress + ε_co	-0.0109	Negligible.
distant	distant = -0.6195 × SocialStress + ε_di	-0.6195	Strong negative loading – inverse relationship.

Table 5 – Indicators of Social Stress.

Only distress is a solid positive indicator. Distant and blunting have moderate to strong negative loadings, indicating perhaps a suppression effect or a need to re-express the latent factor to align with these observed effects. Since Behaviour predicts emotions strongly and is affected by Social Stress, it plays a central mediating role.

Principal Component Analysis is a technique used in statistics known as a dimensionality reduction technique. It transforms high-dimensional data into smaller sets of uncorrelated variables called principal components and preserves variance. It simplifies complex data while retaining essential information.In the following biplot, variables pointing in the same direction are positively correlated, while the ones pointing in opposite directions are negatively correlated. Dim 1 (22.07%) and Dim 2 (14.29%) together explain 36.36% of the total variance in the dataset. Variables near the centrecontribute less to Dim 1 and Dim 2, showcasing that they have lower variance explained by these components. The PCA was carried out on R-Studio Programming Software. The variables clustered in the same quadrant and point in the same direction indicate that these are positively correlated. Positive correlations exist within clusters, for example, between Triggering ↔ Flashbacks. Whereas, negative correlations between opposing clusters, like that of Premonition ↔ Distant. These variables include Premonition, Recklessness, Triggering, Flashbacks, and Intrusiveness. These factors collectively contribute to Dim 1. While the lower-left quadrant suggests a positive correlation and strong contribution to Dim 1 and Dim 2, consisting of factors such as Distant, Avoidance, and Anhedonia. Distress and Distractibility are another set of positively correlated indicators of PTSD. Some sets of indicators, including Premonition and Distant, Anhedonia and Exasperation, depict no correlation. Dim 1 indicates a dimension of emotional or cognitive activity while Dim2 represent a dimension of externalised or behavioural responses.Principal Component Analysis biplot or Loading Plot

visually represents both the observations (black dots) and the variables (blue arrows) on the first two principal components — Dim1 (22.1%) and Dim2 (12.4%). Factors trigger, stress, active, sleep in the right direction (positive Dim1) are the long-arrowed variables that contribute strongly to Dim1. These variables are positively correlated with each other and significantly influence the first principal component. Individuals scoring high on PC1 likely experience more of these states. Variables numb, flash, avoid point in the slightly down-right (positive Dim1, slight negative Dim2). The long arrows show a strong association with each other. These are strongly associated with Dim1 but less so with Dim2. They are slightly aligned with variables like stress and trigger, suggesting a possible symptom cluster. Culture pointing in the slightly right (near centre) direction with a shorter arrow length is a variable with minimal influence on the variation in either dimension. It doesn't contribute significantly to the separation of data points in this PCA. Anger, distress, reckless, conflict pointing in the Upper left direction (positive Dim2, negative Dim1) with medium to long length arrows; these variables cluster together, suggesting a shared dimension of emotional dysregulation or interpersonal turmoil, opposing the trigger or stress cluster. Distant in the extreme (strongly) downward direction (negative Dim2) with medium length, this variable primarily affects Dim2. It relates to withdrawal or emotional disengagement, possibly leading to future distress.The Principal Component Analysis (PCA) and scree plot provide a comprehensive summary of the underlying structure within the dataset. The PCA biplot illustrates the relationship between variables and observations based on the first two principal components, which together explain 34.5% of the total variance (Dim1 = 22.1%, Dim2 = 12.4%). Variables such as *trigger*, *stress*, *active*, and *sleep* are aligned strongly with the first principal component (Dim1), suggesting these factors are major contributors to the primary dimension of variation. Similarly, *numb*, *flash*, and *avoid* also show a strong positive alignment with Dim1, indicating a pattern of emotional or cognitive responses that are likely interrelated. On the other hand, variables like *anger*, *distress*, *reckless*, and *conflict* are aligned more toward the second principal component (Dim2) and are negatively correlated with Dim1, suggesting they may represent a distinct behavioural or emotional dimension, potentially related to internalized conflict or interpersonal issues. Variables like *inox (intoxication)* and *distant* lie in the negative quadrants of both axes, indicating their opposing nature to the high-activation symptoms found in the positive Dim1 direction. The vector for *culture* is short and centred, implying a minimal direct contribution to the variance captured by the first two dimensions.

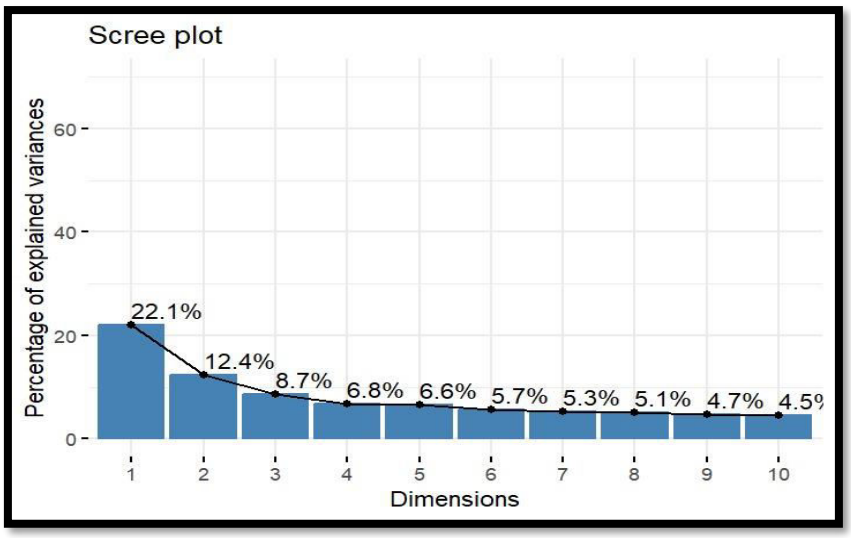
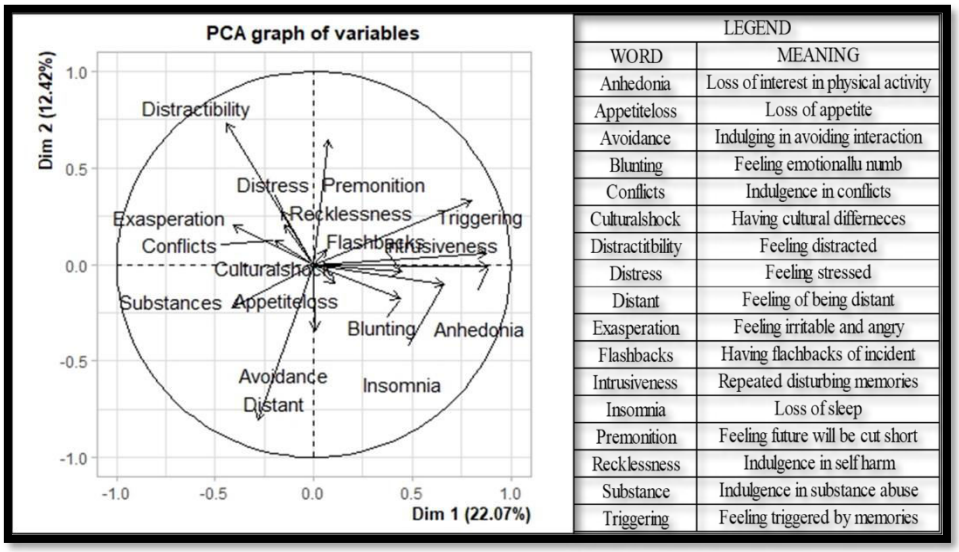
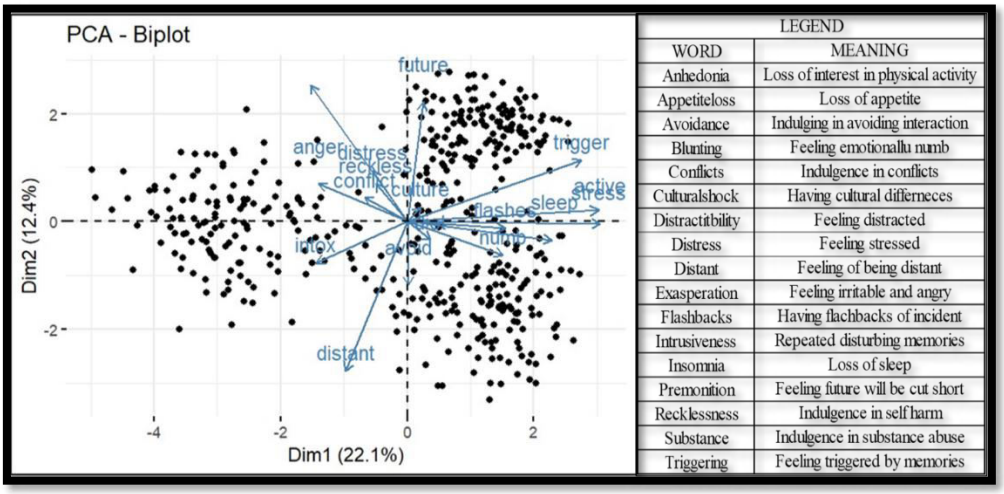


Figure 4 – Scree Plot for Post-Traumatic Stress Disorder.



LEGEND	
WORD	MEANING
Anhedonia	Loss of interest in physical activity
Appetiteloss	Loss of appetite
Avoidance	Indulging in avoiding interaction
Blunting	Feeling emotionallu numb
Conflicts	Indulgence in conflicts
Culturalshock	Having cultural differneces
Distractibility	Feeling distracted
Distress	Feeling stressed
Distant	Feeling of being distant
Exasperation	Feeling irritable and angry
Flashbacks	Having flachbacks of incident
Intrusiveness	Repeated disturbing memories
Insomnia	Loss of sleep
Premonition	Feeling future will be cut short
Recklessness	Indulgence in self harm
Substance	Indulgence in substance abuse
Triggering	Feeling triggered by memories

Figure 5 – Loading Plot for Post-Traumatic Stress Disorder.



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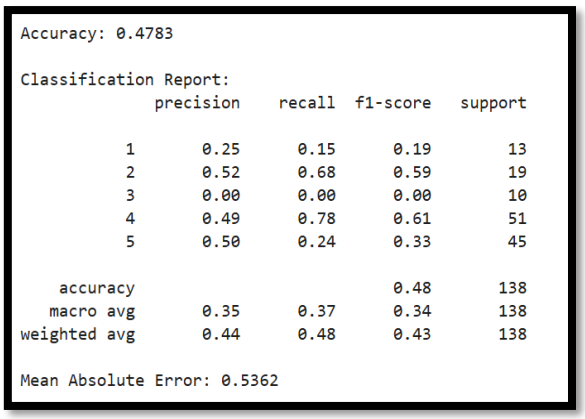
Conflicts	Indulgence in conflicts
Culturalshock	Having cultural differneces
Distractibility	Feeling distracted
Distress	Feeling stressed
Distant	Feeling of being distant
Exasperation	Feeling irritable and angry
Flashbacks	Having flachbacks of incident
Intrusiveness	Repeated disturbing memories
Insomnia	Loss of sleep
Premonition	Feeling future will be cut short
Recklessness	Indulgence in self harm
Substance	Indulgence in substance abuse
Triggering	Feeling triggered by memories

Figure 6 – Biplot for Post-Traumatic Stress Disorder.

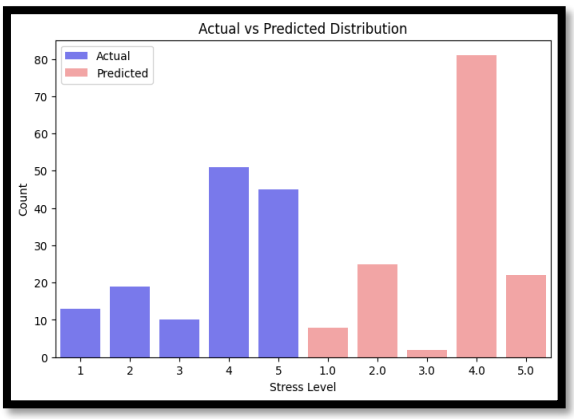
The scree plot further supports this interpretation by visually displaying the diminishing returns of each successive dimension. It reveals a clear ‘‘elbow’’ after the second principal component, signifying that Dim1 and Dim2 capture the most meaningful structure in the dataset. While subsequent dimensions (from Dim3 to Dim10) still contribute to explaining variance, their individual contributions are relatively modest, each accounting for less than 9% of the total variance. Cumulatively, the first five dimensions together explain 56.6% of the total variation, suggesting a moderate level of dimensional complexity within the data. In summary, the dataset demonstrates a multi-faceted structure, with two principal dimensions capturing core emotional and behavioural patterns. The PCA biplot reveals clusters of related variables—indicative of symptom groupings or thematic constructs—while the scree plot guides the optimal dimensionality for further analysis or model building. This combination of tools provides a powerful foundation for interpreting complex psychological or behavioural data.

Figure 5 depicts accuracy of 0.4783, indicating that the model predicts the correct stress level about 48% of the time. The Macro Average (F1-Score = 0.34) treats all classes equally. The low score suggests that the model is struggling, especially with minority classes. Weighted Average (F1-Score = 0.43) indicates moderate performance, weighted by class frequencies. Better than macro average due to better performance on class 4 and 5 (majority classes). The model performs well on dominant classes (especially class 4), but fails on minority or underrepresented classes (like class 3). The MAE (Mean Absolute Error = 0.5362) confirms the average deviation from true class labels. The bar graph of Actual vs Predicted Distribution depicts that predicted values are heavily concentrated in class 4 while actual values are more evenly distributed. Classes 1 and 3 are underrepresented in predictions. Model shows bias toward predicting class 4, possibly due to class imbalance. This reinforces the observations from the classification report. The confusion matrix shows that most true class 4 instances are predicted correctly (40 out of 51), but some are misclassified as 5 or 3. Class 3 is poorly classified – most of its instances are predicted as class 4. Class 1 and 2 are often misclassified as class 2 or class 4. Class 5 is often confused with class 4. The model often confuses adjacent stress levels, which is expected in ordinal regression. However, the complete failure on class 3 and frequent misclassification of class 1 suggest that class imbalance or feature representation issues are present. The coefficient bar chart reveals that positive features that increase stress level are distant, conflict, culture, numb, distress while top negative features that decrease stress level are flashes, trigger, avoid, future, anger.

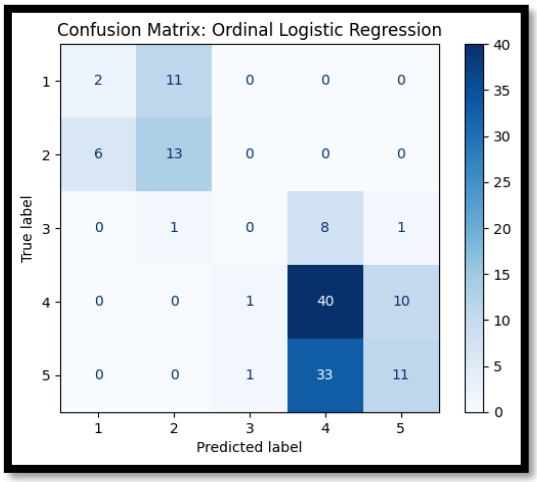


```
Accuracy: 0.4783

Classification Report:
              precision    recall  f1-score   support

           1       0.25      0.15      0.19        13
           2       0.52      0.68      0.59        19
           3       0.00      0.00      0.00        10
           4       0.49      0.78      0.61        51
           5       0.50      0.24      0.33        45

    accuracy                           0.48       138
   macro avg       0.35      0.37      0.34       138
weighted avg       0.44      0.48      0.43       138

Mean Absolute Error: 0.5362
```

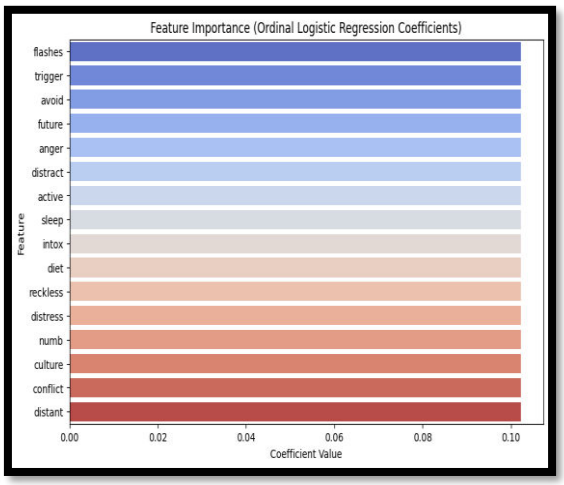
(a)



(b)



(c)



(d)

Figure 7 – a: Ordinal Logistic Regression Analysis. b: Actual and Predicted Stress Graph. c: Confusion Matrix. d: Ordinal Logistic Regression Coefficients graph.

Across Genders (Figure 8) - Variables with p-values < 0.05 indicate a statistically significant difference across gender and these include Intrusiveness, Flashbacks, Triggering, Avoidance, Premonition, Anhedonia, Insomnia, Substance Use, Distress, Blunting and Cultural Shock. Psychological variables, flashbacks, intrusiveness, avoidance, distress, and cultural shock depict significant gender-based differences, indicating a possible variation in PTSD between genders. Whereas, variables such as distractibility, exasperation, and conflict do not exhibit significant gender-based variation, meaning they might be uniform across genders. Intrusiveness, Flashbacks, and Triggering are symptoms associated with PTSD and the significant difference suggests that females might be more prone to intrusive thoughts, past trauma recall, and emotional triggers. For indicators like Exasperation, Distractibility,Appetiteloss, Recklessness, Conflict, and Distant, the null hypothesis was retained, indicating no gender-based differences in behaviour.Across Occupation (Figure 9) - Intrusiveness,

Flashbacks, Triggering, Premonition, Anhedonia, Insomnia, Substance Use, Appetite Loss, Blunting and Cultural Shock are indicators that vary significantly among occupational groups, indicating, occupation plays a role in the experience or prevalence of these symptoms. Occupations involving high stress, which include migrants with private jobs and business owners who have a higher degree of trauma exposure or unpredictability, show greater psychological distress and coping mechanisms. Traits like Intrusiveness, Flashbacks, and Cultural Shock are highly significant, while traits like Recklessness and Distractibility show no occupational influence. High-stress jobs tend to show higher levels of intrusiveness, flashbacks, insomnia, substance use, and anhedonia. Professions dealing with trauma or uncertainty are more affected. Conversely, traits like avoidance, exasperation, distractibility, recklessness, distress, conflict, and distance do not show significant occupational differences ($p > 0.05$), suggesting they are more personality-driven than job-related. Overall, the findings emphasise the influence of work environments and stress levels on mental health contributing to PTSD, with high-stress professions potentially exacerbating psychological distress, while certain behavioural traits remain stable across different occupations.

Hypothesis Test Summary

Null Hypothesis	Test	Sig.[a,b]	Decision
The distribution of Intrusiveness is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	<.001	Reject the null hypothesis.
The distribution of Flashbacks is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	<.001	Reject the null hypothesis.
The distribution of Triggering is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	<.001	Reject the null hypothesis.
The distribution of Avoidence is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.031	Reject the null hypothesis.
The distribution of Premonition is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	<.001	Reject the null hypothesis.
The distribution of Exasperation is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.700	Retain the null hypothesis.
The distribution of Distractability is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.601	Retain the null hypothesis.
The distribution of Anhedonia is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	<.001	Reject the null hypothesis.
The distribution of Insomnia is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	<.001	Reject the null hypothesis.
The distribution of Substance is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	<.001	Reject the null hypothesis.
The distribution of Appetiteloss is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.716	Retain the null hypothesis.
The distribution of Recklessness is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.437	Retain the null hypothesis.
The distribution of Distress is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.019	Reject the null hypothesis.
The distribution of Blunting is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	<.001	Reject the null hypothesis.
The distribution of Culturalshock is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	<.001	Reject the null hypothesis.
The distribution of Conflict is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.939	Retain the null hypothesis.
The distribution of Distant is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.381	Retain the null hypothesis.

significance level is .050.

Figure 8 – Mann-Whitney Hypothesis test Hypothesis test across Genders.

Hypothesis Test Summary

Null Hypothesis	Test	Sig.[a,b]	Decision
The distribution of Intrusiveness is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Flashbacks is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Triggering is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Avoidence is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	.064	Retain the null hypothesis.
The distribution of Premonition is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Exasperation is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	.319	Retain the null hypothesis.
The distribution of Distractability is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	.572	Retain the null hypothesis.
The distribution of Anhedonia is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Insomnia is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Substance is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Appetiteloss is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	.047	Reject the null hypothesis.
The distribution of Recklessness is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	.899	Retain the null hypothesis.
The distribution of Distress is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	.083	Retain the null hypothesis.
The distribution of Blunting is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Culturalshock is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Conflict is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	.385	Retain the null hypothesis.
The distribution of Distant is the same across categories of Occupation.	Independent-Samples Kruskal-Wallis Test	.105	Retain the null hypothesis.

significance level is .050.

Figure 9 – Kruskal Wallis across Occupations.

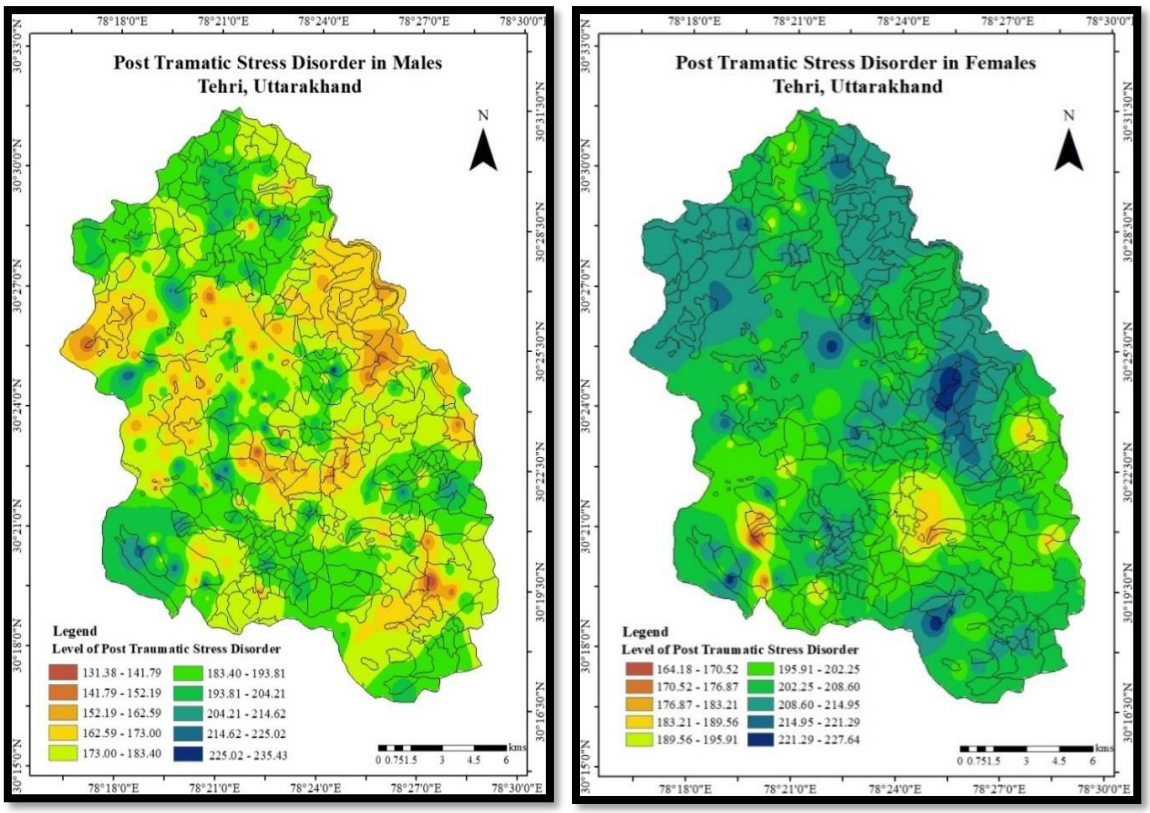
Hypothesis Test Summary

Null Hypothesis	Test	Sig.[a,b]	Decision
The distribution of Intrusiveness is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Flashbacks is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Triggering is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Avoidence is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Premonition is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Exasperation is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Distractability is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Anhedonia is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Insomnia is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Substance is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Appetiteloss is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	.169	Retain the null hypothesis.
The distribution of Recklessness is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Distress is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Blunting is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.
The distribution of Culturalshock is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	.758	Retain the null hypothesis.
The distribution of Conflict is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	.029	Reject the null hypothesis.
The distribution of Distant is the same across categories of Rehabilition.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.

significance level is .050.

Figure 10-Wilcoxon & Kruskal-Wallis Test across Rehabilitation.

Across Rehabilitation Location (Figure 10) - The results indicate that most traits, including intrusiveness, flashbacks, triggering, avoidance, premonition, exasperation, distractibility, anhedonia, insomnia, substance use, recklessness, distress, blunting, conflict, and distant behaviour, exhibit statistically significant differences across rehabilitation categories where, $p < 0.05$, leading to the rejection of the null hypothesis. This suggests that these variables vary significantly among the locations of new settlements. However, two traits—appetite loss ($p = 0.169$) and cultural shock ($p = 0.758$)—do not show significant differences, leading to the retention of the null hypothesis, implying that these two factors are more uniformly distributed across rehabilitation categories. This indicates that individuals undergoing rehabilitation experience different levels of emotional and cognitive responses, likely shaped by their backgrounds, coping mechanisms, and the rehabilitation environment. The data present heightened symptoms of PTSD, which includebehaviour (flashbacks, avoidance, triggering), emotional dysregulation (exasperation, distress, anhedonia), and maladaptive coping mechanisms (substance use, recklessness) among the migrants. Traits like appetite loss ($p = 0.169$) and cultural shock ($p = 0.758$) do not exhibit significant differences, which indicates that these experiences may be more universally distributed across individuals in rehabilitation, possibly reflecting general stress responses rather than rehabilitation-specific influences.



(a) (b)

Figure 11– (a) Level of PTSD in Males. (b) Level of PTSD in Females.

The variation in the scores of males and females has been identified across space by creating maps using the IDW technique. Map 11 (a) represents the spatial distribution of PTSD levels among males in Tehri, Uttarakhand. The colour gradient indicates varying intensities of PTSD levels, ranging from low in red and high in green and blue. The majority of the region is covered in green and yellow shades, indicating moderate to high PTSD levels (173.00 and above). The regions of orange and red indicate lower PTSD levels (below 173.00), spread across the area. The central and southeastern parts show elevated PTSD levels, possibly corresponding to areas with greater displacement. Isolated blue spots in the western and southern parts indicate localized high PTSD levels. Map 11 (b) represents PTSD levels among females in Tehri, Uttarakhand. The colour gradient represents varying PTSD intensity, ranging from low in red to high in blue and green. The majority of the region is covered in shades of green and blue, indicating a higher PTSD level (164.18 and above). Regions in yellow and orange signify moderate PTSD levels (188.21- 195.91). A few red areas suggest low PTSD severity in select locations. A high concentration of PTSD in females is spread across the space. Central and northeastern areas also exhibit PTSD elevation. This depicts that PTSD is severe in case of females than in males.

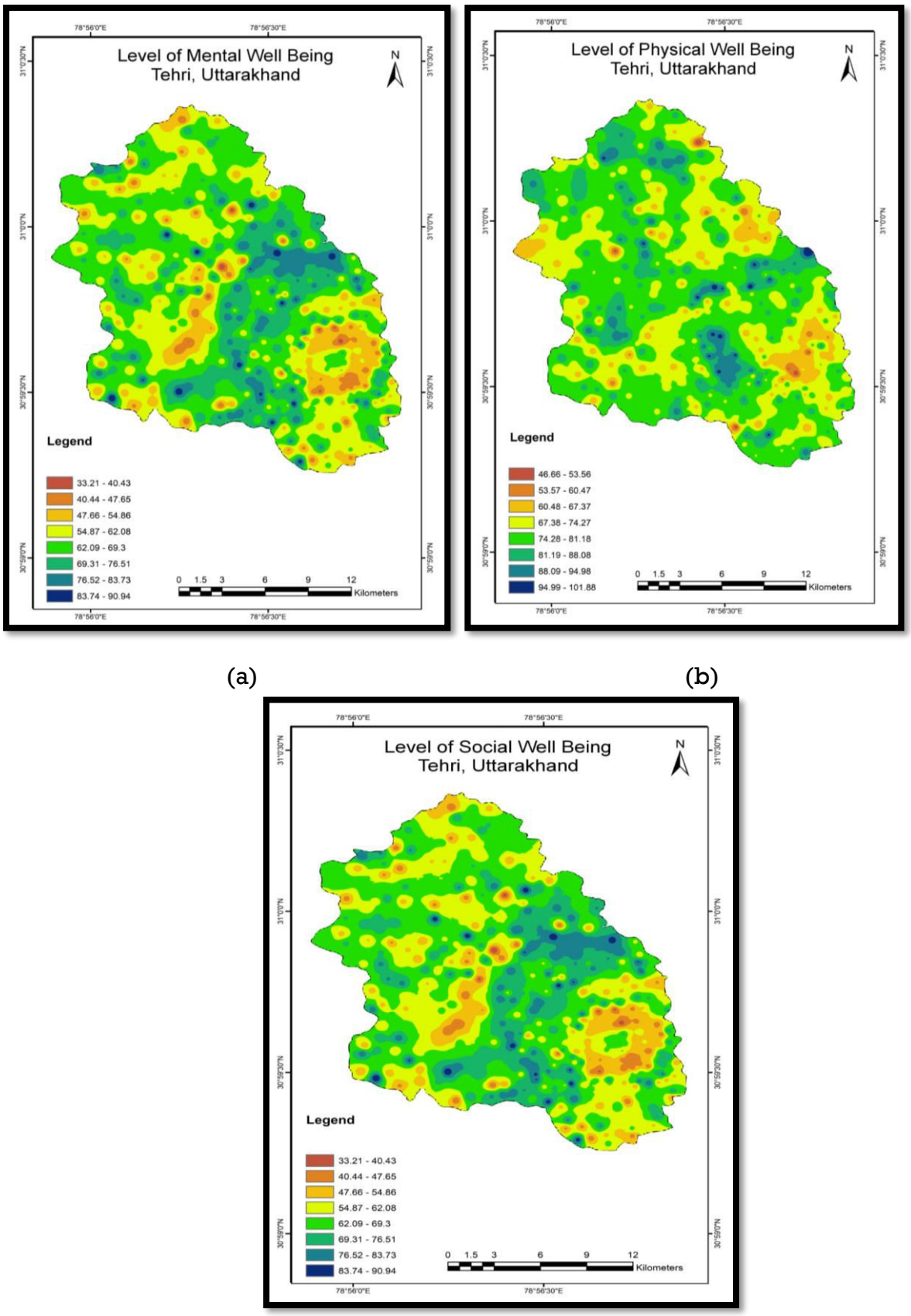


Figure 12 – (a) Level of Mental Well-Being. (b) Level of Physical Well-Being. (c) Level of Social Well-Being.

Map 12 (a) represents the level of mental well-being among the residents of Tehri Town. The North and North-Western Tehri region is dominated by green to light green shades, indicating moderately high to high mental well-being. Central and South-Central Areas show a mix of yellow and orange, representing moderate to moderately low levels. The Eastern and Southeastern Tehri regions, in blue and light blue, signify very high to exceptionally high well-being. The lowest level of well-being is in the Southwestern regions of Tehri. Map 12 (b) has low well-being Zones in shades of Red to Orange. In eastern and southeastern Tehri, these spots are scattered. Yellow to Light Green colours represent moderate well-being and cover the majority of Tehri, suggesting average health conditions. The high well-being zones are in the Green to Blue shade, concentrated in the northern and southwestern parts of Tehri. Map 12 (C) represents social well-being. Eastern Tehri has scattered locations of low well-being represented in orange and brown. Central and Northern Tehri displays moderate well-being in the shades of greens and yellows. Northwest and parts of the West exhibit higher social well-being (green to blue-green). Regions of extreme well-being (above 83.73) are sparsely located across Tehri.

Conclusions

The study reveals gender-based vulnerability. Higher PTSD prevalence in females is evident across indicators like intrusiveness, flashbacks, avoidance, anhedonia, insomnia, and distress. This is further supported by IDW maps, where PTSD intensity in females is markedly higher and more geographically widespread than in males. These results align with literature indicating that females are disproportionately affected by trauma, especially in patriarchal and socioeconomically constrained contexts, due to factors like reduced autonomy, caregiving roles, and systemic under-recognition of mental health needs. There is significant variation in PTSD symptoms across occupations, for flashbacks, insomnia, substance use, and anhedonia. Professionals in private sector jobs and business owners, which indicates unstable and high-pressure occupations post-migration, show elevated psychological distress, suggesting occupational environment post-displacement plays a critical role in trauma persistence or aggravation. Traits like conflict and exasperation do not vary significantly, indicating some behavioural responses might be personality-driven or universal across occupations. The rehabilitation geography significantly impacts PTSD. Nearly all trauma indicators showed statistically significant variation by location, except appetite loss and cultural shock—possibly reflecting common stressors across displaced populations. Higher PTSD symptoms in specific locations highlight how urban-rural transitions, loss of community networks, and change in the local environment affect psychological outcomes. The PCA biplots visually affirm this: variables such as flashbacks, triggering, and stress cluster tightly, showing their interconnectedness and dominance in urban displacement

contexts. Dim 1 (22.1%) represents cognitive-emotional burden (e.g., flashbacks, triggering, insomnia). Dim 2 (12.4%) relates to interpersonal conflict and emotional dysregulation (e.g., distress, conflict, anger). The scree plot confirms a 2- to 5-dimensional PTSD symptom structure, suggesting both internalized and externalized expressions of trauma. Some symptoms, like cultural shock, had minimal contribution, pointing to either measurement limitations or low variation across subgroups. Notably, clusters like trigger–stress–sleep, and flashback–numb–avoidance, suggest consistent, interlinked trauma syndromes that require holistic therapeutic approaches.

This study presents a multi-method evaluation of PTSD among populations forcibly displaced by the Tehri Dam, underscoring the multidimensional nature of trauma in the context of development-induced displacement. Gender, occupation, and rehabilitation location are statistically and practically significant variables influencing PTSD symptoms. Females and individuals in high-stress or unstable occupations are particularly vulnerable, suggesting the need for gender-sensitive and job-oriented psychosocial interventions. Spatial and statistical findings converge, emphasizing that psychological trauma is not uniformly distributed, but is shaped by individual, occupational, and geographic factors. Principal Component and Scree Plot analyses reinforce that PTSD in displaced populations comprises clustered, interdependent symptom dimensions, warranting multi-pronged treatment strategies including counselling, community integration, and occupational support. The study reveals gaps in rehabilitation policies, especially their psychological neglect.Ordinal Logistic Regression model shows moderate accuracy (47.83%) but suffers from class imbalance, notably underperforming on minority classes like class 3. The Structural Equation Model demonstrates that behaviour significantly predicts emotional response, while social stress negatively impacts both behaviour and emotions, albeit weakly. Key behavioural indicators include active engagement and sleep, while negative behaviours like substance use reduce coping ability. The model shows a tendency to misclassify adjacent stress levels, a common issue in ordinal regression. Overall, behaviour acts as a crucial mediator between social stress and emotional outcomes, highlighting its central role in stress response modelling.

References:

1. *Agrawal, N. K., Lohani, A. K., & Goel, N. K. (2018). Physiographic analysis of Tehri Dam catchment and development of GIUH based Nash model for ungauged rivers. Current World Environment, 14(2), 206–217.*
2. *Allen, I. M. (1996). PTSD among African Americans. In A. J. Marsella, M. J. Friedman, E. T. Gerrity, & R. M. Scurfield (Eds.), Ethnocultural aspects of*

posttraumatic stress disorder: Issues, research, and clinical applications (pp. 209–238). American Psychological Association.

3. *Altemus, M., Dhabhar, M. A., & Yang, R. (2006). Immune functions in PTSD. Annals of the New York Academy of Sciences, 1071(1), 167–183.*
4. *Ansari, M. (2017). Distress migration and individual happiness in Bhutan. In Happiness and well-being in Bhutan (pp. 69–90). Springer International Publishing.*
5. *Aryal, M. (1995, July). Dams: The vocabulary of protest. Himal Southasian. www.himalmag.com*
6. *Bryant, R. A., Creamer, M., O'Donnell, M., Silove, D., Clark, C. R., & McFarlane, A. C. (2009). Post-traumatic amnesia and the nature of post-traumatic stress disorder after mild traumatic brain injury. Journal of the International Neuropsychological Society, 15(6), 862–867.*
7. *Carroll, H., Luzes, M., Freier, L. F., & Bird, M. D. (2020). The migration journey and mental health: Evidence from Venezuelan forced migration. Social Science & Medicine – Population Health, 10, 100551.*
8. *Cernea, M. M. (1998). The risks and reconstruction model for resettling displaced populations. World Bank.*
9. *Cernea, M. M. (2000). Risks, safeguards and reconstruction: A model for population displacement and resettlement. In M. M. Cernea & C. McDowell (Eds.), Risks and reconstruction: Experiences of resettlers and refugees (pp. 11–55). World Bank.*
10. *Chambers, R. (1969). Settlement schemes in tropical Africa: A study of organizations and development. Routledge and Kegan Paul.*
11. *Chand, J. (2014). Socio-economic and physical impact of Tehri Dam: A geographic review. Review of Research, 4(3), 1–6.*
12. *Cloitre, M., Garvert, D. W., Weiss, B., Carlson, E. B., & Bryant, R. A. (2014). Distinguishing PTSD, complex PTSD, and borderline personality disorder: A latent class analysis. European Journal of Psychotraumatology, 5(1), 25097.*
13. *Conversano, C., Carmassi, C., Bertelloni, C. A., Marchi, L., Micheloni, T., Carbone, M. G., Pagni, G., Tagliarini, C., Massimetti, G., Bazzichi, L. M., &Dell'Osso, L. (2019). Potentially traumatic events, post-traumatic stress disorder and post-traumatic stress spectrum in patients with fibromyalgia. Clinical and Experimental Rheumatology, 37(1, Suppl. 116), 39–43.*
14. *Cornelius, J. R., Kirisci, L., Reynolds, M., Clark, D. B., Hayes, J., & Tarter, R. (2010). PTSD contributes to teen and young adult cannabis use disorders. Addictive Behaviors, 35(2), 91–94.*
15. *Cukor, J., Spitalnick, J., Difede, J. A., Rizzo, A., & Rothbaum, B. O. (2009). Emerging treatments for PTSD. Clinical Psychology Review, 29(8), 715–726.*
16. *Devendra, K., & Naithani, B. P. (2022). Geographical study of migration in Tehri Garhwal district, Uttarakhand. The Deccan Geographer, 60, 76–88.*
17. *Dogra, B. (2022, March 12). Fear over India's dangerous dams. The Ecologist.*

18. *Donato, K. M., Caron, L., & Hamilton, E. (2020). Migration and mental health in Mexico: Domestic migrants, return U.S. migrants, and non-migrants. Frontiers in Psychiatry, 10, 970.*
19. *Dyer, K. F., Dorahy, M. J., Hamilton, G., Corry, M., Shannon, M., MacSherry, A., McRobert, G., Elder, R., & McElhill, B. (2009). Anger, aggression, and self-harm in PTSD and complex PTSD. Journal of Clinical Psychology, 65(10), 1099–1114. 9*
20. *Farhood, L. F., &Dimassi, H. (2011). Prevalence and predictors for post-traumatic stress disorder, depression and general health in a population from six villages in South Lebanon. Social Psychiatry and Psychiatric Epidemiology, 47(4), 639–649.*
21. *Gerrish, N., Dyck, M. J., & Marsh, A. (2009). Post-traumatic growth and bereavement. Mortality, 14(3), 226–244.*
22. *Gramaglia, C., Gambaro, E., Marangon, D., et al. (2022). Mental health in migrants contacting the mental health operational unit of the National Institute for Health, Migration and Poverty (NIHMP): Preliminary data. Journal of Public Health, 30, 1959–1967.*
23. *Kearney, C. A., Wechsler, A., Kaur, H., & Lemos-Miller, A. (2010). Posttraumatic stress disorder in maltreated youth: A review of contemporary research and thought. Clinical Child and Family Psychology Review, 13(1), 46–76.*
24. *Kedia, S., & Van Willigen, J. (2001). Effects of forced displacement on the mental health of older people in North India. Hallym International Journal of Aging, 3(1), 81–93.*
25. *Kirmayer, L. J., Narasiah, L., Munoz, M., Rashid, M., Ryder, A. G., Guzder, J., Hassan, G., Rousseau, C., &Pottie, K. (2011). Common mental health problems in immigrants and refugees: General approach in primary care. Canadian Medical Association Journal, 183(12), E959–E967.*
26. *Macunluoğlu, A. C., &Ocakoğlu, G. (2023). Comparison of the performances of non-parametric k-sample test procedures as an alternative to one-way analysis of variance. The European Research Journal, 9(4), 687–696.*
27. *Mangrio, E., Carlson, E., &Zdravkovic, S. (2021). Risk for mental illness and family composition after migration to Sweden. PLoS ONE, 16(5), e0251254.*
28. *Mabura, L. (2011). A gendered and Fanonian reading of "Do They Hear You When You Cry" (1999) by Fauziya Kassindja and Layli Bashir. The International Journal of the Humanities: Annual Review, 9(3), 309–317.*
29. *McNeish, D., Somers, J. A., &Savord, A. (2024). Dynamic structural equation models with binary and ordinal outcomes in Mplus. Behavior Research Methods, 56(3), 1506–1532.*
30. *Mucci, C., Scalabrini, A., &Northoff, G. (2018). Traumatogenic disturbances: PTSD, complex PTSD and trauma-related disorders. In H. Boeker, P. Hartwich, & G. Northoff (Eds.), Neuropsychodynamic psychiatry (pp. 325–340). Springer.*

31. *Nelson, N. (1973). Patterns of land settlement in Latin America. Economic Geography, 49(3), 233–250.*
32. *Olff, M. (2017). Sex and gender differences in post-traumatic stress disorder: An update. European Journal of Psychotraumatology, 8(sup4), 1351204.*
33. *Padiyar, G., Dutt, S., & Snehi, R. K. (2023). Cultural revival and social transformations in Tehri District: Understanding the implications of reverse migration. International Journal of Creative Research Thought, 11(5).*
34. *Rana, A., & Singh, R. C. (2019). Biological assessment, interpolation and land use and land cover changes: A case study of Ana Sagar Lake, Ajmer, Rajasthan, India. International Journal of Scientific Research and Reviews, 8(1), 1500–1505.*
35. *Schober, P., & Vetter, T. R. (2020). Nonparametric statistical methods in medical research. Anesthesia& Analgesia, 131(6), 1922–1923.*
36. *Scudder, T. (2005). The future of large dams: Dealing with social, environmental, institutional and political costs. Earthscan.*
37. *Scudder, T., & Colson, E. (1982). From welfare to development: A conceptual framework for the analysis of dislocated people. In A. Hansen & A. Oliver-Smith (Eds.), Involuntary migration and resettlement: The problems and responses of dislocated people (pp. 267–287). Westview Press.*
38. *Siriwardhana, C., & Stewart, R. (2012). Forced migration and mental health: Prolonged internal displacement, return migration and resilience. International Health, 4(1), 19–23.*
39. *Solomon, Z., Benbenishty, R., Neria, Y., Abramowitz, M., Ginzburg, K., &Ohry, A. (1993). Assessment of PTSD: Validation of the revised PTSD inventory. Israel Journal of Psychiatry and Related Sciences, 30(2), 110–115.*
40. *Virupaksha, H. G., Kumar, A., & Nirmala, B. P. (2014). Migration and mental health: An interface. Journal of Natural Science, Biology, and Medicine, 5(2), 233–239.*
41. *Vries, S., Juhnke, G. A., & Keene, C. T. (2019). PTSD, complex PTSD, and childhood abuse: Gender differences among a homeless sample. Journal for Social Action in Counseling& Psychology, 10(2), 2–15.*
42. *Warms, R. L. (1994). In the valley of the river: The ethnography of the Tiv. Waveland Press.*
43. *Yadav, A., Sharma, G., &Gangwar, R. (2018). Determining factors for migration in Uttarakhand. International Journal of Agricultural Science and Research, 8(1), 79–86.*
44. *Young-Wolff, K. C., Fromont, S. C., Delucchi, K., Hall, S. E., Hall, S. M., & Prochaska, J. J. (2014). PTSD symptomatology and readiness to quit smoking among women with serious mental illness. Addictive Behaviors, 39(8), 1231–1234.*