SiRad: Pelita Wawasan
E-ISSN: 3090-5591| DOI: 10.64728/sirad.v2i3.art11 pp. 507-520

Hydropower Displacement and Self-Reported Health in Azad Pattan and Karot, Pakistan

Nusrat Azeema & Muhammad Afzal*

School of Public Administration, Department of Sociology, Hohai University, Nanjing 211100, P.R. China.

Abstract

Large hydropower projects can advance energy goals while redistributing social and health costs to affected communities. This study examines how project-related land acquisition, displacement and resettlement are associated with self-reported health and everyday wellbeing in Azad Pattan and Karot, Pakistan. A qualitative comparative case study used in-depth interviews with 22 purposively selected adults from a sampling frame of 102 affected households, comprising 10 participants from Azad Pattan and 12 from Karot. English translations of Urdu or Punjabi interviews were analyzed manually using framework-guided thematic analysis informed by Cernea's Impoverishment Risks and Reconstruction model. Participants linked land-based livelihood loss, reduced physical activity, confined housing, dependence on purchased food and weakened social networks to perceived health deterioration. Ten reported new or worsened blood-pressure problems, seven persistent joint or back pain, and smaller numbers sleep disturbance, fatigue, medication dependence, weight gain, breathing difficulties or diabetes onset. These retrospective reports are neither clinically verified diagnoses nor population prevalence estimates. Project stages differed, and the relocation status of every Azad Pattan household could not be verified. The findings identify perceived pathways connecting livelihood insecurity, spatial change, nutrition and social disarticulation with health. Health-sensitive resettlement requires livelihood reconstruction, activity-supporting space, food security, social continuity and longitudinal monitoring beyond compensation and housing delivery.

Keywords: displacement; resettlement; hydropower; health; livelihoods; nutrition; stress; Pakistan

Pemindahan Penduduk akibat Proyek PLTA dan Kesehatan yang Dilaporkan di Azad Pattan dan Karot Pakistan

Abstrak

Proyek pembangkit listrik tenaga air (PLTA) dapat mendukung pemenuhan kebutuhan energi sekaligus membebankan biaya sosial dan kesehatan kepada masyarakat terdampak. Penelitian ini mengkaji keterkaitan pembebasan lahan, pemindahan penduduk, dan permukiman kembali dengan kesehatan yang dilaporkan sendiri serta kesejahteraan sehari-hari di Azad Pattan dan Karot, Pakistan. Studi kasus komparatif kualitatif menggunakan wawancara mendalam terhadap 22 orang dewasa yang dipilih secara purposif dari kerangka pemilihan 102 rumah tangga terdampak, terdiri atas 10 peserta dari Azad Pattan dan 12 dari Karot. Terjemahan bahasa Inggris dari wawancara berbahasa Urdu atau Punjabi dianalisis secara manual menggunakan analisis tematik berpanduan kerangka model Risiko Pemiskinan dan Rekonstruksi Cernea. Peserta mengaitkan kehilangan penghidupan berbasis lahan, berkurangnya aktivitas fisik, keterbatasan ruang hunian, ketergantungan pada pangan yang dibeli, dan melemahnya jaringan sosial dengan penurunan kesehatan yang dirasakan. Sepuluh peserta melaporkan masalah tekanan darah yang baru atau memburuk, tujuh nyeri sendi atau punggung menetap, dan sebagian lainnya gangguan tidur, kelelahan, ketergantungan obat, kenaikan berat badan, kesulitan bernapas, atau awal diabetes. Laporan retrospektif ini bukan diagnosis yang terverifikasi secara klinis maupun estimasi prevalensi populasi. Tahap proyek berbeda, dan status relokasi setiap rumah tangga Azad Pattan belum dapat dipastikan. Temuan mengidentifikasi jalur yang dipersepsikan menghubungkan ketidakpastian penghidupan, perubahan ruang, gizi, dan disartikulasi sosial dengan kesehatan. Permukiman kembali yang memperhatikan kesehatan memerlukan pemulihan penghidupan, ruang pendukung aktivitas, ketahanan pangan, kesinambungan sosial, serta pemantauan longitudinal melampaui kompensasi dan penyediaan hunian.

Kata kunci: pemindahan; relokasi; PLTA; kesehatan; penghidupan; gizi; stres; Pakistan

Contact: Muhammad Afzal | muhammadafzal11085@yahoo.com
This is an Open Access article distributed under the terms of the Creative Commons Attribution-ShareAlike 4.0 International **(CCBY-SA 4.0)** License (https://creativecommons.org/licenses/by-sa/4.0/).

Submitted: September 28, 2026	Accepted: October 20, 2026	Published: October 23, 2026

INTRODUCTION

Hydropower is frequently presented as a strategic response to energy insecurity and climate-change mitigation, especially in countries seeking to expand electricity generation without deepening dependence on imported fossil fuels. Yet the benefits of large infrastructure projects are unevenly distributed. Reservoir construction and related land acquisition can require physical relocation, disrupt livelihoods and alter the social and ecological conditions through which households sustain health and wellbeing. International evidence shows that compensation and replacement housing do not necessarily prevent post-resettlement impoverishment, particularly when livelihood restoration, social continuity and long-term monitoring are weak (Cernea, 1997; Vanclay, 2017; World Commission on Dams, 2000).

The health implications of displacement are rarely confined to access to clinics. They can emerge through changes in work, diet, housing, mobility, environmental quality, social support and perceived control. Farming, livestock care and the collection of natural resources may function simultaneously as livelihood activities, routine physical exercise and sources of social interaction. When resettlement separates households from land and common resources, these activities can be replaced by sedentary routines, insecure wage work and dependence on purchased food. Research on the Three Gorges project and other large-dam settings has similarly connected resettlement with disrupted social relations, unmet expectations, psychological distress and changing physical-health risks (Tilt et al., 2009; Xi & Hwang, 2011).

Pakistan has a long history of dam-related displacement, with research addressing compensation, livelihood loss and the quality of resettlement schemes. Studies of hydropower-affected communities have examined housing, infrastructure, livelihood opportunities, cultural resilience and subjective wellbeing (Abid et al., 2023; Qayum et al., 2024). These contributions establish that resettlement outcomes extend beyond the replacement dwelling. However, the everyday pathways through which changes in physical activity, food practices, social roles and stress become perceived health problems warrant closer qualitative examination in Azad Pattan and Karot.

Contemporary evidence strengthens the case for examining health within this wider social setting. Research in the Brazilian Amazon links changes in community resources and social capital with self-rated health and identifies stress associated with large hydropower developments despite compensation efforts (Mayer et al., 2022, 2023). A One Health perspective likewise draws attention to the interdependence of energy, food systems, ecosystem conditions, inclusion and human wellbeing in dam planning (Ramamurthy et al., 2023). These studies do not establish that the same outcomes occur in Pakistan, but they support investigating the social and environmental pathways through which affected people understand their health.

Livelihood and nutrition research also cautions against equating compensation with recovery. Studies in Vietnam document persistent food insecurity and loss of productive resources, while a longer-term investigation shows that livelihood pathways may change as households gain access to urban markets and local support (Ty, 2023; Ty et al., 2023). Work in Nepal and Myanmar examines the importance of livelihood assets, agricultural land and viable work after displacement (Khanal et al., 2024; Lin & Yao, 2023). Evidence from the Brazilian Amazon further connects poverty and food insecurity after dam construction (Johansen et al., 2024). Taken together, this literature supports examining work and diet as connected dimensions of wellbeing rather than treating a new house as a sufficient indicator of recovery.

Project timing is equally important. Research on delays at the Dasu and Diamer Basha projects in Pakistan highlights disruption and uncertainty during extended resettlement processes (Ahmad et al.,

2023; Ilyas et al., 2025). Studies of stakeholder strategies and environmental assessment in Pakistan also identify the relevance of participation, implementation capacity and mitigation arrangements (Ali et al., 2022; Butt et al., 2024). The distinction between an operational project and a delayed project therefore matters analytically: land acquisition, expectations and restrictions may affect daily life before commercial operation, whereas relocation introduces additional changes in housing, mobility and community relationships.

Recovery is neither uniform nor necessarily complete at the time of relocation. Work in Ghana examines the promise and limitations of livelihood revitalization programs, while research in China evaluates livelihood capital, gendered resilience, multidimensional livelihood assessment and continuing post-relocation support (Hao et al., 2023; Liang et al., 2023; Owusu et al., 2024; Shi et al., 2022; Xu et al., 2022). Some monitored Three Gorges resettlers reported improved living conditions, illustrating that adverse outcomes are not inevitable; policy coordination and local opportunities remain relevant to recovery (Peng et al., 2022; Wu et al., 2025). Benefit-sharing research distinguishes access to continuing project benefits from compensation for losses (Schulz & Skinner, 2022), while qualitative work in Cambodia highlights the emotional significance of disrupted relationships with place (Mahanty et al., 2024). The present study brings these concerns together through participants' accounts of health and everyday life in two Pakistani settings.

This article addresses that gap through a qualitative comparative study of households affected by land acquisition, displacement or resettlement associated with the Azad Pattan and Karot hydropower developments in the Kahuta region. Rather than treating health as an isolated outcome, the analysis examines how livelihood, spatial, nutritional and relational changes combine to shape participants' perceptions of health following these project-related changes. The article makes three contributions. First, it provides local evidence from a comparatively under-researched area of Pakistan. Second, it connects Cernea's impoverishment-risk categories to a social-determinants-of-health pathway. Third, it translates participants' accounts into practical criteria for health-sensitive resettlement governance.

The study addresses two research questions:

RQ1. How do affected participants in Azad Pattan and Karot describe changes in physical health, activity and fitness associated with hydropower-related land acquisition, displacement or resettlement?

RQ2. Which social and environmental changes, particularly changes in diet, housing, occupation, mobility and stress, help to explain the reported health outcomes?

CONCEPTUAL FRAMEWORK

Cernea's Impoverishment Risks and Reconstruction (IRR) model conceptualizes development-induced displacement as a process that can produce eight interconnected risks: landlessness, joblessness, homelessness, marginalization, food insecurity, increased morbidity and mortality, loss of access to common property resources, and social disarticulation (Cernea, 1997). The model is useful because it moves analysis beyond the physical act of relocation. It directs attention to the assets, institutions, relationships and capabilities that may be lost even when households receive monetary compensation or a replacement dwelling.

The reconstruction dimension of the model is equally important. Each impoverishment risk implies a corresponding policy obligation: restoring land or productive assets, rebuilding livelihoods, securing adequate housing, reconstructing community institutions, improving food security and health, restoring access to shared resources, and rebuilding social networks. This perspective is consistent with international resettlement standards, which emphasize avoidance or minimization of involuntary

resettlement and the restoration or improvement of livelihoods and living standards (International Finance Corporation, 2012).

A social-determinants-of-health perspective complements the IRR model by clarifying how displacement risks become embodied. Employment and income affect the capacity to obtain nutritious food and healthcare; housing form and neighborhood design shape ventilation, mobility and exposure to open space; social networks provide emotional and practical support; and control over land and work influences dignity and psychological security. In this study, health is therefore understood as an outcome of social and ecological reorganization rather than only an individual medical condition.

METHODS

Research Design and Study Setting

The study used a qualitative comparative case-study design to examine experiences of hydropower-related land acquisition, displacement and resettlement in Azad Pattan and Karot, two project-affected communities in the Kahuta region of Pakistan. The study sampling frame comprised 102 project-affected households in the selected communities: 42 in Azad Pattan and 60 in Karot. These local counts do not represent the total number of households affected by either hydropower project. The case-study design was selected to examine the relationships among displacement, environmental change, livelihoods and self-reported health within participants' everyday contexts.

The Karot Hydropower Project is a 720-MW scheme on the Jhelum River at the boundary of Rawalpindi District, Punjab, and Kotli District, Azad Jammu and Kashmir. The International Finance Corporation's (2015) environmental and social review identified a project footprint covering 16 villages and directly affecting 186 households, including 74 households in Karot and Hollar expected to experience both physical and economic displacement. Official project-status information records commissioning on 29 June 2022 (Private Power and Infrastructure Board, 2026). The Azad Pattan Hydropower Project is a planned 700.7-MW run-of-river scheme on the Jhelum River in District Sudhnoti, Azad Jammu and Kashmir. The developer reports that land acquisition began in 2017 and that private-land acquisition is complete, with some government and forest-land processes outstanding (Azad Pattan Power Private Limited, n.d.). As of 30 June 2026, the Private Power and Infrastructure Board (2026) listed the project as on hold pending the final outcome of the CPEC Projects List Adjustment Study, with an indicative commercial-operation date of September 2033. These public records establish project context rather than the dates of participants' interviews or relocations.

Participant-level field records did not contain a complete chronology of relocation or consistent measurements of the distance between former and current residences. The interview dataset nevertheless identified participants as members of households affected by project-related land acquisition, displacement or resettlement. Karot accounts are interpreted in relation to an operational hydropower project and include participants' descriptions of post-relocation changes. For Azad Pattan, because the project had not entered commercial operation and the available records do not verify whether every interviewed household had completed physical relocation, the findings are described more cautiously as experiences associated with land acquisition and displacement processes, including relocation where reported, rather than as consequences of an operational dam. Exact relocation dates and distances are therefore not used for site comparison, and the absence of these participant-level details is acknowledged as a study limitation.

Sampling and Participants

Participants were selected purposively from project-affected households because they had direct experience of livelihood and lifestyle changes associated with land acquisition, displacement or relocation. The final sample comprised 22 adults: 10 from Azad Pattan and 12 from Karot. Participants included men and women across young-adult, middle-aged and older-adult life stages, and represented homemakers, small farmers, laborers and retired workers. Individual-level ages were not consistently documented in the available field records; therefore, an exact age range, mean and median are not reported. Recruitment ended when the principal researcher judged that interviews were no longer producing substantially new information. No formal saturation log or site-specific saturation assessment was available. Sample adequacy is therefore treated as a researcher judgment rather than established by the sample size alone (Hennink & Kaiser, 2022).

Eligible participants were adults aged 18 years or older from the 102 project-affected households identified in the two study sites. They were required to have direct experience of project-related land acquisition, displacement, relocation or associated changes in livelihood and daily life, to be able to communicate in Urdu or Punjabi, and to be willing to participate. Individuals were excluded if they were younger than 18 years, were not members of an affected household, lacked direct experience of the changes under study or did not wish to participate. Potential participants were identified purposively with the assistance of the two locally recruited undergraduate research assistants and were invited through local community contact. The available field records do not document a formal gatekeeper procedure, the number of people who declined participation or whether more than one participant was recruited from any household; these details are therefore not presented as verified facts. This transparent reporting follows qualitative-research guidance on describing participant selection and recruitment (Tong et al., 2007).

Table 1. Study Setting and Participant Overview

Characteristic	Azad Pattan	Karot	Total / description
Affected households	42	60	102
Interview participants	10	12	22
Participant profile	Men and women	Men and women	Homemakers, farmers, laborers and retired workers across adult life stages

Data Collection

The study used in-depth interviews to elicit participants' accounts of life before and after project-related land loss, displacement or relocation. Interview topics included livelihood activities, daily physical activity, housing and environmental conditions, food practices, access to healthcare, stress, social relationships and perceived changes in health. Participants' explanations, such as linking pain to inactivity or diabetes to dietary change, are treated as self-reported attributions rather than medically verified causal relationships. Data collection was undertaken by the principal researcher with the assistance of two locally recruited undergraduate research assistants, one from Azad Pattan and the other from Karot. Their local residence and familiarity with the social, cultural and linguistic context of the two communities supported access, communication and rapport with participants. At the same time, their insider position was considered reflexively, because local familiarity may strengthen contextual understanding while also shaping what participants choose to disclose and how accounts are interpreted (Berger, 2015; Tong et al., 2007).

Interviews were conducted in Urdu or Punjabi according to participants' linguistic preferences. The Urdu- and Punjabi-language interview material was subsequently transcribed and translated into English, and the English transcripts were used for coding, interpretation and manuscript preparation. Because translation is an interpretive component of cross-language qualitative research, the movement from participants' original-language accounts to English is acknowledged as a methodological consideration (Squires, 2009; Temple & Young, 2004). Exact data-collection dates, interview locations, average interview duration, audio-recording procedures, formal piloting of the interview guide and systematic use of field notes were not documented in the available field records and are therefore not reported retrospectively.

Data Analysis and Rigor

The translated English transcripts were analyzed using a framework-guided thematic approach that combined deductive and inductive coding. Cernea's Impoverishment Risks and Reconstruction model supplied the initial deductive domains: landlessness, joblessness, homelessness, marginalization, food insecurity, increased morbidity, loss of access to common property resources and social disarticulation. Within these domains, recurrent patterns concerning physical activity, diet, occupational change, stress, housing, environmental conditions and social relationships were identified inductively from participants' accounts. This hybrid strategy allowed the analysis to remain theoretically informed while retaining sensitivity to experiences emerging from the interview material (Fereday & Muir-Cochrane, 2006).

The principal researcher manually read and coded the English-language transcripts; qualitative data-analysis software was not used. Two local undergraduate assistants supported community access and interviews, but no independent second analyst coded the transcripts. Coding involved repeated reading, assigning excerpts to the initial IRR framework domains, refining inductively identified subthemes and comparing convergent and divergent accounts across sites. Independent double coding and an intercoder-reliability statistic were not implemented as part of the original researcher-led analytic design; they cannot be represented retrospectively as procedures conducted. To support transparency, the analysis is presented with direct quotations, its analytic framework is specified, and the absence of independent coding is acknowledged as a limitation rather than evidence of reliability.

Credibility was strengthened through prolonged engagement with the interview material, cross-case comparison, transparent presentation of participant quotations and reflexive consideration of how the researcher and locally recruited assistants may have shaped data collection and interpretation. Formal member checking, independent double coding, peer debriefing and a documented audit trail were not undertaken and are not claimed as study procedures. The reporting approach follows established guidance for thematic analysis and qualitative interview studies (Braun & Clarke, 2006; Tong et al., 2007). Numerical counts summarize how many of the 22 participants reported a particular health change and are not interpreted as population prevalence estimates.

Ethics

The study involved non-clinical qualitative interviews with adults. Participation was described as voluntary, and interview material is presented without names or direct personal identifiers. Urdu- and Punjabi-language accounts were translated into English for analysis and publication, with quotations intended to preserve their substantive meaning. The retained documentation did not establish an institutional ethics approval or exemption, or specify how consent for participation and publication of translated quotations was obtained. No approval, exemption or consent procedure is therefore asserted here.

FINDINGS

The interview material indicates convergence in the themes reported across the two sites. Participants linked perceived health changes to the reorganization of work, space, food and relationships following project-related land loss, displacement or relocation. The themes below summarize these accounts; they do not establish that every participant experienced physical relocation or that the frequency or severity of changes differed between sites.

Land Loss and the Disappearance of Routine Physical Activity

In accounts of life before project-related land loss or relocation, participants' livelihoods required sustained movement through fields, grazing areas, riverbanks and household compounds. Farming, livestock care, fodder collection and kitchen gardening were described not only as productive work but also as the ordinary exercise through which people maintained strength and stamina. The loss of agricultural land therefore removed both an income source and an embedded form of physical activity.

"That walking was my exercise; now I just sit and my body feels heavy." - Woman, 60, Karot

"After moving to the new colony, our hands forgot the feel of soil." - Male participants, Azad Pattan

Several participants associated reduced greenery and construction dust with breathing discomfort, while older participants emphasized the loss of open air and the daily rhythm of outdoor work. The accounts suggest a transition from activity integrated into livelihood to a more sedentary domestic routine. This shift was especially consequential for participants who lacked safe or culturally acceptable alternatives for exercise.

Joblessness, Rising Costs and Chronic Stress

Compensation did not necessarily provide a continuing source of income. Older participants reported difficulty finding new work, women lost small-scale income from milk, eggs or vegetables when they could no longer keep animals or gardens, and some younger men described temporary construction employment that ended. Participants also reported that food, water, electricity and transport had become recurring cash expenses. The combination of reduced income and higher expenditure produced stress, inactivity and a loss of purpose.

"We thought living in the city would give us work, but our costs went up faster than our income." - Middle-aged participant

"When a man sits idle, his heart becomes sick." - Male participant

The phrase "heart becomes sick" captures the overlap between economic and psychological wellbeing. Unemployment was experienced not only as material deprivation but also as diminished dignity and social participation. Participants described restlessness, worry and withdrawal from communal activities, indicating that livelihood loss can operate as a pathway to both emotional distress and reduced physical activity.

Housing Confinement and the Loss of Health-Supporting Space

Participants acknowledged that replacement housing provided shelter, but many contrasted the new dwellings with larger rural compounds that had accommodated livestock, food storage, gardening, extended-family living and outdoor domestic work. Smaller plots and enclosed rooms restricted movement and reduced exposure to sunlight and open air. Some participants also described overcrowding when previously separate family units were combined.

"Before, our small house had sky above; now three rooms feel like a prison." - Male participant, Karot

"A cage with cement all around." - Woman, 45 years old

Women particularly emphasized the disappearance of courtyards where food preparation, gardening and social interaction had occurred. These seemingly minor activities had previously generated routine movement and contact with neighbors. The findings therefore distinguish physical rehousing from the restoration of a health-supporting habitat.

From Household Food Production to Market Dependence

Relocation shifted many households from partial food production to market dependence. Participants reported buying milk, vegetables and meat that they had previously produced or obtained locally. Some described greater consumption of oily, spicy or prepared food and reduced access to fresh vegetables. The problem was not described as absolute food shortage; rather, it concerned affordability, perceived quality and the loss of control over diet.

"Before, our cuisine was simple and pure; now even milk feels fake." - Woman, Azad Pattan

"Kids do not want vegetables anymore; they want store-bought food." - Young mother

Participants linked these changes to digestive problems, fatigue, weight gain and reduced stamina. Although the interviews cannot establish biomedical causation, the accounts identify a plausible nutritional pathway connecting land loss, higher living costs and perceived chronic-disease risk.

Marginalization and Social Disarticulation

Resettlement altered social roles as well as material conditions. Elderly men described losing authority associated with land, farming knowledge and village decision-making. Women who had managed livestock, gardens or informal care networks reported that their practical knowledge was less valued in the resettlement setting. Some participants felt that they had become economically dependent on younger relatives and were treated as burdens.

"In the village, people respected my advice; here, no one knows who I am." - Man, 68, Azad Pattan

"We were people of value when we had land; now we are just tenants of walls." - Male participant

The weakening of neighborhood and kinship networks compounded this loss of status. Participants recalled shared work, visits, mosque conversations, gatherings at wells and collective recreation. After relocation, some extended families and neighbors were dispersed across different colonies, and participants described loneliness and reduced mutual assistance.

"We were like sisters; here, I do not even know who lives next door." - Elderly woman

Social disarticulation had direct health meanings in participants' accounts. Loneliness was linked to sadness, worsening blood pressure, disturbed sleep and lower motivation to leave the house. The loss of common property resources like riverbanks, grazing land, springs, trees and open grounds also removed spaces where social interaction and physical activity had previously occurred together.

Self-Reported Health Changes

Participants described a cluster of health changes in relation to project-related land loss, displacement or relocation. The most frequently reported were new or worsened blood-pressure problems and persistent joint or back pain. Sleep disturbance, dizziness and fatigue were also common, while smaller numbers reported breathing difficulty, weight gain or reduced endurance, increased reliance on daily medication, and the onset of diabetes. Because these data are based on retrospective interviews, they should be interpreted as reported experiences rather than clinically verified incidence.

Table 2. Self-reported health changes following project-related displacement or relocation (n = 22)

Reported change	Participants (n)	Participants (%)
New or worsened blood-pressure problem	10	45
Persistent joint or back pain	7	32
Sleep problems, dizziness or fatigue	6	27
Dependence on daily medication	5	23
Weight gain or reduced endurance	4	18
Shortness of breath / "heavy air"	3	14
Reported onset of diabetes	2	9

Note. Percentages are rounded to the nearest whole number and use all 22 interview participants as the denominator. Categories overlap because participants could report more than one change. Diagnoses and timing were not independently verified. Counts are pooled across sites and do not support a comparison of site-specific health frequencies.

DISCUSSION

Participants linked perceived health deterioration to interacting material, spatial and relational changes. For those describing relocation, the transition involved more than a change of dwelling: land-based work and open, socially connected environments gave way to less secure employment, higher cash expenses, greater dependence on purchased food, constrained movement and weakened social roles. This interpretation reflects the interdependence of risks in Cernea's IRR model (Cernea, 1997). Land loss was associated in participants' accounts with joblessness and food dependence; smaller housing and reduced access to common resources with inactivity; and marginalization and social disarticulation with stress. These are qualitative interpretations of reported experiences, not estimates of causal effects.

The study adds a health mechanism to this framework. Routine physical activity in the original settlements was embedded in productive and reproductive labor. When farming, grazing, gardening and resource collection disappeared, participants did not necessarily replace them with formal exercise. Reduced movement was then linked in their accounts to pain, declining stamina, weight gain and blood-pressure problems. Similar concerns have been reported in international dam-resettlement research, which emphasizes that changes in livelihood and settlement form can reshape both physical activity and psychosocial wellbeing (Tilt et al., 2009; Xi & Hwang, 2011).

A second mechanism was nutritional transition. Loss of land and livestock converted households from producers into consumers and exposed them more directly to food prices. Participants' concerns about processed foods, dietary quality and diabetes should not be interpreted as proof that resettlement caused disease. Nevertheless, the consistency of their accounts indicates that food sovereignty and nutrition are important components of post-resettlement health. This complements Pakistani research showing that wellbeing in resettled communities depends on a combination of livelihood opportunities, health services, housing, infrastructure, environmental conditions and social cohesion (Abid et al., 2023; Qayum et al., 2024).

A third mechanism concerned place, identity and social continuity. Land, courtyards, riverbanks and village institutions carried economic, cultural and relational meanings. Their loss reduced access to resources as well as recognition, purpose and belonging. Solastalgia describes distress associated with environmental change while people remain connected to their home environment (Albrecht et al., 2007); it may illuminate accounts of altered local surroundings, but should not be used as a diagnosis or as a

synonym for all relocation-related distress. Participants' accounts also resonate with research on the emotional significance of dam-related disruption and the emotional toll of resettlement (Mahanty et al., 2024; Vanclay, 2017).

The accounts therefore suggest a perceived transition in health-supporting conditions associated with project-related land loss and, where reported, resettlement. Participants contrasted physically active rural livelihoods with inactivity, stress, market dependence and social isolation. This interpretation is analytically useful because it avoids reducing health to a list of symptoms. It identifies a sequence of change that can be addressed through policy and monitored over time. It also clarifies why cash compensation alone cannot restore wellbeing. Money may replace a portion of asset value, but it does not automatically reconstruct livelihoods, everyday activity, food systems, social status or community support.

The study's contribution is not statistical generalization. Its value lies in revealing how project-affected people connect changes in work, space, food and relationships to changes in health. These mechanisms may be relevant to other rural communities undergoing infrastructure-led relocation, but their transferability should be assessed against local conditions, project design and resettlement governance.

The comparison must explicitly recognize unequal project stages. Karot was commissioned in June 2022, whereas Azad Pattan was listed as on hold in the official June 2026 project record. For Karot, participants' accounts may relate to actual post-relocation circumstances. For Azad Pattan, experiences may reflect land acquisition, loss or restriction of access to resources, uncertainty and, where individually reported, relocation; they cannot be attributed to the physical operation of a dam that had not been commissioned. The available field records do not consistently establish interview dates, the relocation status of each respondent, or the timing of individual exposures. Consequently, pooled symptom frequencies in Table 2 cannot be compared between sites or interpreted as evidence that one project caused greater health harm. This is a contextual, thematic comparison—not a matched before-and-after or causal evaluation.

Across these settings, the analytical sequence is land or resource loss, altered livelihoods and daily space, changes in activity and food practices, stress and weakened social connections, and perceived health change. The sequence summarizes participants' interpretations rather than a tested causal model. The policy implication is to monitor these linked conditions throughout land acquisition and resettlement, while distinguishing physical relocation from economic displacement and prolonged project uncertainty.

POLICY IMPLICATIONS

Resettlement plans should document pre-project and pre-relocation health, activity, nutrition and medication use and should follow vulnerable groups after land acquisition, displacement or relocation. Monitoring should distinguish self-reported symptoms from clinically assessed conditions and should include referral mechanisms. Programs should provide land-based options where feasible, vocational training matched to local labor markets, support for women's home-based livelihoods, and continuing income-transition assistance rather than relying on one-time payments. Replacement housing should consider extended-family arrangements, ventilation, courtyards, safe walking routes, community gardens, livestock needs where appropriate, and accessible communal and recreational space. Resettlement packages should support household or community food production, affordable access to fresh food, and nutrition screening and counseling, particularly for older adults and households facing livelihood loss. Where possible, kinship and neighborhood clusters should be relocated together. Community facilities, participatory planning and psychosocial support can help rebuild social capital and reduce isolation. Affected people should participate in defining indicators of successful resettlement, reviewing outcomes

and resolving grievances. Ex-post social and health impact assessment should continue after physical relocation and project commissioning.

LIMITATIONS

This study has several limitations. First, the sample was small and purposive, so numerical summaries cannot be generalized to all project-affected households. Second, retrospective self-reports were not supported by pre-project health records, clinical examination or an unaffected comparison group; causal claims and prevalence estimates are therefore unwarranted. Third, complete individual-level demographic records were unavailable. Ages accompanying a small number of quotations do not constitute a complete demographic profile. Participant-level relocation dates and distances were not consistently documented, and the relocation status of every Azad Pattan household could not be verified. The interview period was also unavailable, limiting assessment of exposure timing against public project milestones. Fourth, refusals, formal gatekeeper involvement and the number of participants per household were not fully documented. Pooled symptom counts and uneven attribution of quotations prevent systematic comparison of health frequencies between the two sites. Fifth, recall bias, current economic circumstances, translation and researcher interpretation may have influenced the accounts. The transcripts were coded manually by one researcher without independent double coding, formal member checking or a documented audit trail. No reproducible household-level spatial analysis was available. Finally, the absence of documented ethics review or exemption and consent procedures limits assessment of the study's ethical safeguards.

CONCLUSION

The experiences reported in Azad Pattan and Karot suggest that hydropower-related land acquisition, displacement and resettlement can reorganize the everyday conditions that sustain health. Participants linked livelihood loss, reduced physical activity, more confined housing, market-dependent diets, weakened social roles and fragmented networks to blood-pressure problems, pain, fatigue, sleep disturbance and declining stamina. These accounts do not establish clinical causation, but they illustrate why physical relocation and compensation are insufficient measures of resettlement success. Health-sensitive resettlement requires the reconstruction of capabilities and social-ecological conditions: viable livelihoods, nutritious food, activity-supporting space, community continuity and accessible long-term care. Incorporating these dimensions into ex-post impact assessment would allow hydropower development to be evaluated not only by energy production and compensation delivery but also by the durable wellbeing of the communities that bear its local costs.

Acknowledgments

We thank the participants in Azad Pattan and Karot for sharing their experiences. We also acknowledge the two locally recruited undergraduate research assistants for their support with community access, communication and interviewing.

Funding

The authors received no external funding for this research.

Conflicts of Interest

The authors declare no conflicts of interest.

REFERENCES

Abid, S., Shi, G., Hussain, A., & Rauf, A. (2023). Fostering well-being in resettled communities: Cultivating cultural resilience and sustainable development in resettlement caused by Ghazi Barotha Hydropower Project, Pakistan. *Water, 15*(22), Article 3973. https://doi.org/10.3390/w15223973

Ahmad, S., Shi, G., & Zaman, M. (2023). Resettlement delays in the Dasu Hydropower Project: Assessing impacts on the affected people and communities. *International Journal of Water Resources Development, 39*(4), 663–680. https://doi.org/10.1080/07900627.2022.2128078

Albrecht, G., Sartore, G.-M., Connor, L., Higginbotham, N., Freeman, S., Kelly, B., Stain, H., Tonna, A., & Pollard, G. (2007). Solastalgia: The distress caused by environmental change. *Australasian Psychiatry, 15*(Suppl. 1), S95–S98. https://doi.org/10.1080/10398560701701288

Ali, S., Duan, Y., Bilal, H., & Ramsey, T. (2022). From displacement to resettlement: The stakeholders strategies to mitigate impoverishment risks of the Ghazi Barotha Hydropower Project Pakistan. *Impact Assessment and Project Appraisal, 40*(4), 305–319. https://doi.org/10.1080/14615517.2022.2080490

Azad Pattan Power Private Limited (n.d.). *Current status.* Retrieved October 21, 2026, from https://azadpattanhpp.com/current_status.php

Berger, R. (2015). Now I see it, now I don't: Researcher's position and reflexivity in qualitative research. *Qualitative Research, 15*(2), 219–234. https://doi.org/10.1177/1468794112468475

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Butt, A. Q., Shangguan, D., Ding, Y., Banerjee, A., Sajjad, W., & Mukhtar, M. A. (2024). Assessing the existing guidelines of environmental impact assessment and mitigation measures for future hydropower projects in Pakistan. *Frontiers in Environmental Science, 11*, Article 1342953. https://doi.org/10.3389/fenvs.2023.1342953

Cernea, M. M. (1997). The risks and reconstruction model for resettling displaced populations. *World Development, 25*(10), 1569–1587. https://doi.org/10.1016/S0305-750X(97)00054-5

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative Methods, 5*(1), 80–92. https://doi.org/10.1177/160940690600500107

Hao, Y., Zhang, F., & Sun, C. (2023). Evaluation of sustainable livelihood of reservoir resettlement based on the fuzzy matter-element model. *Frontiers in Environmental Science, 11*, Article 1224690. https://doi.org/10.3389/fenvs.2023.1224690

Hennink, M., & Kaiser, B. N. (2022). Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Social Science & Medicine, 292*, Article 114523. https://doi.org/10.1016/j.socscimed.2021.114523

Ilyas, M., Chen, S., Li, Y., & Abid, S. (2025). Development-induced displacement and resettlement project delay impacts on affected people: A case study of Diamer Basha Dam Project in Pakistan. *Sustainability, 17*(6), Article 2387. https://doi.org/10.3390/su17062387

International Finance Corporation (2012). *Performance Standard 5: Land acquisition and involuntary resettlement.* https://www.ifc.org/en/insights-reports/2012/ifc-performance-standard-5

International Finance Corporation (2015). *Karot Hydro: Environmental and social review summary (Project No. 36008).* https://disclosures.ifc.org/project-detail/ESRS/36008/karot-hydro

Johansen, I. C., Calvi, M. F., Luz, V. G., Segall-Corrêa, A. M., Arantes, C. C., Isaac, V. J., Utsunomiya, R., Reis, V. C. E. S., & Moran, E. F. (2024). Poverty–food insecurity nexus in the post-construction context of a large hydropower dam in the Brazilian Amazon. *International Journal of Environmental Research and Public Health, 21*(2), Article 155. https://doi.org/10.3390/ijerph21020155

Khanal, R., Duan, Y., Ramsey, T. S., Ali, S., & Oo, K. H. (2024). Impacts of livelihood assets on hydropower displacees' livelihood strategies: Insights from the Tanahu hydropower project in Nepal. *Heliyon, 10*(14), Article e34485. https://doi.org/10.1016/j.heliyon.2024.e34485

Liang, B., Shi, G., Sun, Z., Wang, Y., Zhang, B., Xu, Y., & Dong, Y. (2023). Impact assessment of the implementation effect of the post-relocation support policies of rural reservoir resettlers' livelihoods in energy transition. *Water, 15*(17), Article 3129. https://doi.org/10.3390/w15173129

Lin, A. T., & Yao, K. (2023). Resettlement and compensation practice in the context of the Tha Htay hydropower project in Rakhine, Myanmar. *Water, 15*(13), Article 2496. https://doi.org/10.3390/w15132496

Mahanty, S., Chann, S., & Suong, S. (2024). The emotional life of rupture at Cambodia's Lower Sesan 2 hydropower dam. *Environment and Planning E: Nature and Space, 7*(1), 330–352. https://doi.org/10.1177/25148486231162087

Mayer, A., Cavallini Johansen, I., Lopez, M. C., Paes de Souza, M., & Moran, E. F. (2023). Large hydropower projects increase stress despite compensation efforts: Evidence from the Brazilian Amazon. *PLOS ONE, 18*(7), Article e0284760. https://doi.org/10.1371/journal.pone.0284760

Mayer, A., Lopez, M. C., Cavallini Johansen, I., & Moran, E. (2022). Hydropower, social capital, community impacts, and self-rated health in the Amazon. *Rural Sociology, 87*(2), 393–426. https://doi.org/10.1111/ruso.12419

Owusu, K., Obour, P. B., Asiedu, A. B., & Dye, B. J. (2024). Post-dam construction and livelihood revitalization of affected communities at Ghana's Bui dam. *Natural Resources Forum, 48*(4), 1299–1315. https://doi.org/10.1111/1477-8947.12365

Peng, Z., Xiao, X., Lv, Y., Guan, X., & Wang, W. (2022). A large-scale investigation of the status of out-resettlers from the Three Gorges area based on the production–living–social security–social integration–satisfaction perspective. *Sustainability, 14*(23), Article 15613. https://doi.org/10.3390/su142315613

Private Power and Infrastructure Board (2026). *China Pakistan Economic Corridor (CPEC) projects under PPIB: As on June 30, 2026.* Retrieved October 21, 2026, from https://www.ppib.gov.pk/cpec.html

Qayum, M., Li, W., & Sohail, M. T. (2024). Evaluating the quality-of-life and happiness indices of hydropower project-affected people in Pakistan: Towards a sustainable future. *Water, 16*(22), Article 3225. https://doi.org/10.3390/w16223225

Ramamurthy, R., Bleser, J., Konradsen, F., Kibret, S., Opperman, J., You, L., Sloff, K., McCartney, M., Fèvre, E. M., & Boelee, E. (2023). Human health impacts of dams and reservoirs: Neglected issues in a One Health perspective. *Aquatic Ecosystem Health & Management, 26*(2), 96–112. https://doi.org/10.14321/aehm.026.02.096

Schulz, C., & Skinner, J. (2022). Hydropower benefit-sharing and resettlement: A conceptual review. *Energy Research & Social Science, 83*, Article 102342. https://doi.org/10.1016/j.erss.2021.102342

Shi, G., Zhao, Y., Mei, X., Yan, D., Zhang, H., Xu, Y., & Dong, Y. (2022). Livelihood resilience perception: Gender equalisation of resettlers from rural reservoirs—Empirical evidence from China. *Sustainability, 14*(17), Article 11053. https://doi.org/10.3390/su141711053

Squires, A. (2009). Methodological challenges in cross-language qualitative research: A research review. *International Journal of Nursing Studies, 46*(2), 277–287. https://doi.org/10.1016/j.ijnurstu.2008.08.006

Temple, B., & Young, A. (2004). Qualitative research and translation dilemmas. *Qualitative Research, 4*(2), 161–178. https://doi.org/10.1177/1468794104044430

Tilt, B., Braun, Y., & He, D. (2009). Social impacts of large dam projects: A comparison of international case studies and implications for best practice. *Journal of Environmental Management, 90*(Suppl. 3), S249–S257. https://doi.org/10.1016/j.jenvman.2008.07.030

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care, 19*(6), 349–357. https://doi.org/10.1093/intqhc/mzm042

Ty, P. H. (2023). Long-term outcomes of the livelihoods of displaced households after hydropower dam construction: A case study in Thua Thien Hue Province, Vietnam. *Environmental & Socio-economic Studies, 11*(2), 1–15. https://doi.org/10.2478/environ-2023-0007

Ty, P. H., Baas, L., Phuong, T. T., & Tan, N. Q. (2023). Impoverishment persistence in hydropower dam-induced resettled communities: A sociological investigation on livelihood and food security in Vietnam. *Social Sciences, 12*(4), Article 222. https://doi.org/10.3390/socsci12040222

Vanclay, F. (2017). Project-induced displacement and resettlement: From impoverishment risks to an opportunity for development? *Impact Assessment and Project Appraisal, 35*(1), 3–21. https://doi.org/10.1080/14615517.2017.1278671

World Commission on Dams (2000). *Dams and development: A new framework for decision-making.* Earthscan. https://www.routledge.com/Dams-and-Development-A-New-Framework-for-Decision-making--The-Report-of-the-World-Commission-on-Dams/Dams/p/book/9781853837982

Wu, X., Lu, J., & Chen, S. (2025). A study on the evolution and interrelation of China's reservoir resettlement policies over 75 years. *Water, 17*(10), Article 1444. https://doi.org/10.3390/w17101444

Xi, J., & Hwang, S.-S. (2011). Relocation stress, coping, and sense of control among resettlers resulting from China's Three Gorges Dam Project. *Social Indicators Research, 104*(3), 507–522. https://doi.org/10.1007/s11205-010-9758-5

Xu, Y., Shi, G., & Dong, Y. (2022). Effects of the post-relocation support policy on livelihood capital of the reservoir resettlers and its implications—A study in Wujiang sub-stream of Yangtze River of China. *Sustainability, 14*(5), Article 2488. https://doi.org/10.3390/su14052488