

# Assessment On Losses Due To The 2080/2023 Earthquake In Jajarkot District, Nepal

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## Abstract

Nepal, positioned along the tectonically active Himalayan zone, is particularly prone to earthquakes. The Jajarkot earthquake of November 3, 2023 (Mw 5.7, ML 6.4) caused significant loss of life and property in Chhedagad Municipality of Jajarkot District. This study aimed to assess the losses and their underlying causes in the aftermath of this earthquake. Data were collected through Primary and Secondary method. Quantitative data were analyzed using Microsoft Excel with Relative Importance Index (RII) applied to Likert-scale items. Results indicated that the most significant losses included damages to public infrastructure with RII = 0.80. The dominant causes was structural vulnerabilities of traditional stone-wall construction (RII = 0.80). Recommended mitigation measures include accurate mortality assessment, integrated planning with resilient infrastructure design, and multi-agency collaboration among local governments, NGOs, and international bodies. This study provides a critical evidence base for disaster risk reduction policy and practice in seismically active remote regions of Nepal.

*Keywords:* Earthquake 2023, Jajarkot, losses, public infrastructure, seismic resilience, disaster risk reduction

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## 1. INTRODUCTION

Nepal is one of the most seismically active nations in the world, situated along the collision boundary of the Indian and Eurasian tectonic plates within the Himalayan arc. This geodynamic setting has produced a long history of devastating earthquakes, including the 1934 Nepal-Bihar earthquake (Mw 8.0) and the 2015 Gorkha earthquake (Mw 7.8), both of which caused catastrophic human and structural losses [1]. Globally, nearly 400,000 deaths and one million earthquake-related injuries were reported over the past three decades, disproportionately affecting developing nations in Asia with limited infrastructure resilience and disaster preparedness [3].

On November 3, 2023, a destructive earthquake of magnitude Mw 5.7 (local magnitude ML 6.4) struck the Jajarkot district in western Nepal, resulting in over 500 fatalities and extensive damage to residential and public infrastructure. Chhedagad Municipality, located within Jajarkot District, was among the most severely affected areas. The earthquake exposed deep-rooted vulnerabilities in the built environment, characterized by traditional stone-and-mud-mortar construction with poor seismic resilience, inadequate enforcement of building codes, and challenging geographic conditions that impeded disaster response and recovery [7;5].

The 2015 Gorkha earthquake previously revealed critical weaknesses in Nepal's disaster management systems — including fragmented institutional coordination, insufficient emergency stockpiles, and underutilization of early warning technologies. Despite policy-level advancements following 2015, systemic barriers have persisted, particularly in remote districts like Jajarkot where governance capacity and resource allocation remain limited [6]. The Sendai Framework for Disaster Risk Reduction (2015–2030) calls for targeted, evidence-based strategies

to reduce disaster losses; yet localized empirical assessments of earthquake impacts in remote Nepalese municipalities remain scarce [8].

Earthquake losses are expected to escalate in coming decades due to population growth in high-risk seismic zones and persistently inadequate construction quality in low- and middle-income settings [2]. The primary cause of earthquake-related deaths globally is trauma from building collapse, with the very young, elderly, and economically marginalized populations at greatest risk [3]. In the Jajarkot context, these patterns were replicated: traditional houses lacking seismic resistance suffered the most damage, post-earthquake mortality rose due to exposure, illness, and restricted healthcare access, and livelihoods were severely disrupted through agricultural losses and displacement [4].

Previous research on the 2023 Jajarkot earthquake has documented broad impact metrics and structural failure patterns [7;5]; however, a systematic, community-level assessment of multidimensional losses and their underlying causes — including economic, social, environmental, and public health impacts — has not been conducted for Chhedagad Municipality specifically. This gap limits the ability of policymakers, local governments, and humanitarian organizations to design targeted and effective recovery and resilience-building interventions.

This study therefore addresses three specific objectives: (a) to assess the nature and magnitude of losses caused by the 2080/2023 earthquake in Chhedagad Municipality; (b) to identify the principal causes behind these losses; and (c) to propose mitigation measures to reduce future earthquake impacts. The findings are intended to serve as an evidence base for disaster risk reduction practitioners, seismologists, municipal engineers, policymakers, and other stakeholders engaged in earthquake risk management across Nepal and similar seismically active developing-country contexts.

## **2. Materials and Methods**

### **2.1 Research Design**

A mixed-methods research design was employed, integrating both quantitative and qualitative approaches to comprehensively assess earthquake losses in Chhedagad Municipality, Jajarkot District. The study was conducted over a four-month period encompassing literature review, questionnaire design, fieldwork, data analysis, and reporting. This approach aligns with established frameworks for post-disaster impact research, which require triangulation of multiple data sources to capture the breadth of seismic consequences.

### **2.2 Study Area**

The study was conducted in Chhedagad Municipality of Jajarkot District, western Nepal. The area is characterized by rugged, mountainous terrain with limited road connectivity, predominantly rural settlements, and a population dependent on subsistence agriculture and small-scale commerce. The municipality reported 7,895 residential structures prior to the earthquake, the majority of which were traditional stone-and-mud construction. Jajarkot District lies within a high seismic hazard zone and experienced the epicenter of the November 3, 2023 earthquake [7].

### **2.3 Data Collection Methods**

#### **2.3.1 Primary Data**

Four primary data collection methods were used. Field observation was conducted across residential areas, school compounds, health facilities, government buildings, roads, and water supply infrastructure to document visible damage and recovery status. In-depth interviews (IDI) were conducted with municipal engineers, sub-engineers, school staff, and municipal officers to capture expert and institutional perspectives on losses and causes. Focus group discussions (FGD) were held with school staff, local political representatives, and active community

members to elicit community-level narratives and perceptions of the earthquake's impact and recovery. A structured questionnaire survey was administered to 160 purposively sampled respondents using Google Forms, comprising community members, NGO officers, contractor and sub-engineers, municipal officers, and local political representatives. Closed-ended questionnaire items used a five-point Likert scale to assess the significance of specific losses and causes.

### **2.3.2 Secondary Data**

Secondary data were sourced from peer-reviewed journal articles, published theses, government annual reports, municipal databases, and the Nepal Disaster Report (2024). These sources provided contextual and comparative data on earthquake impacts, building vulnerability, and disaster response.

### **2.4 Sampling**

A total sample of 160 respondents was selected through purposive and convenience sampling from the population of stakeholders with direct experience or professional involvement in the earthquake response and recovery in Chhedagad Municipality. The sample included active community members (n=100), NGO officers (n=15), contractor representatives (n=14), political representatives (n=14), municipal officers (n=7), contractor sub-engineers (n=5), and municipal sub-engineers and engineers (n=5). Of the 160 respondents, 116 (72.5%) were male and 44 (27.5%) were female. The largest age cohort was 30–40 years (n=50), followed by 40–50 years (n=40). The majority had completed secondary-level education (n=90).

### **2.5 Data Analysis**

Quantitative data from the questionnaire survey were analyzed using Microsoft Excel. For Likert-scale items, the Relative Importance Index (RII) was calculated using the following formula:

$$RII = \Sigma W / (A \times N) = (1 \times n_1 + 2 \times n_2 + 3 \times n_3 + 4 \times n_4 + 5 \times n_5) / (5 \times N)$$

(Equation 1)

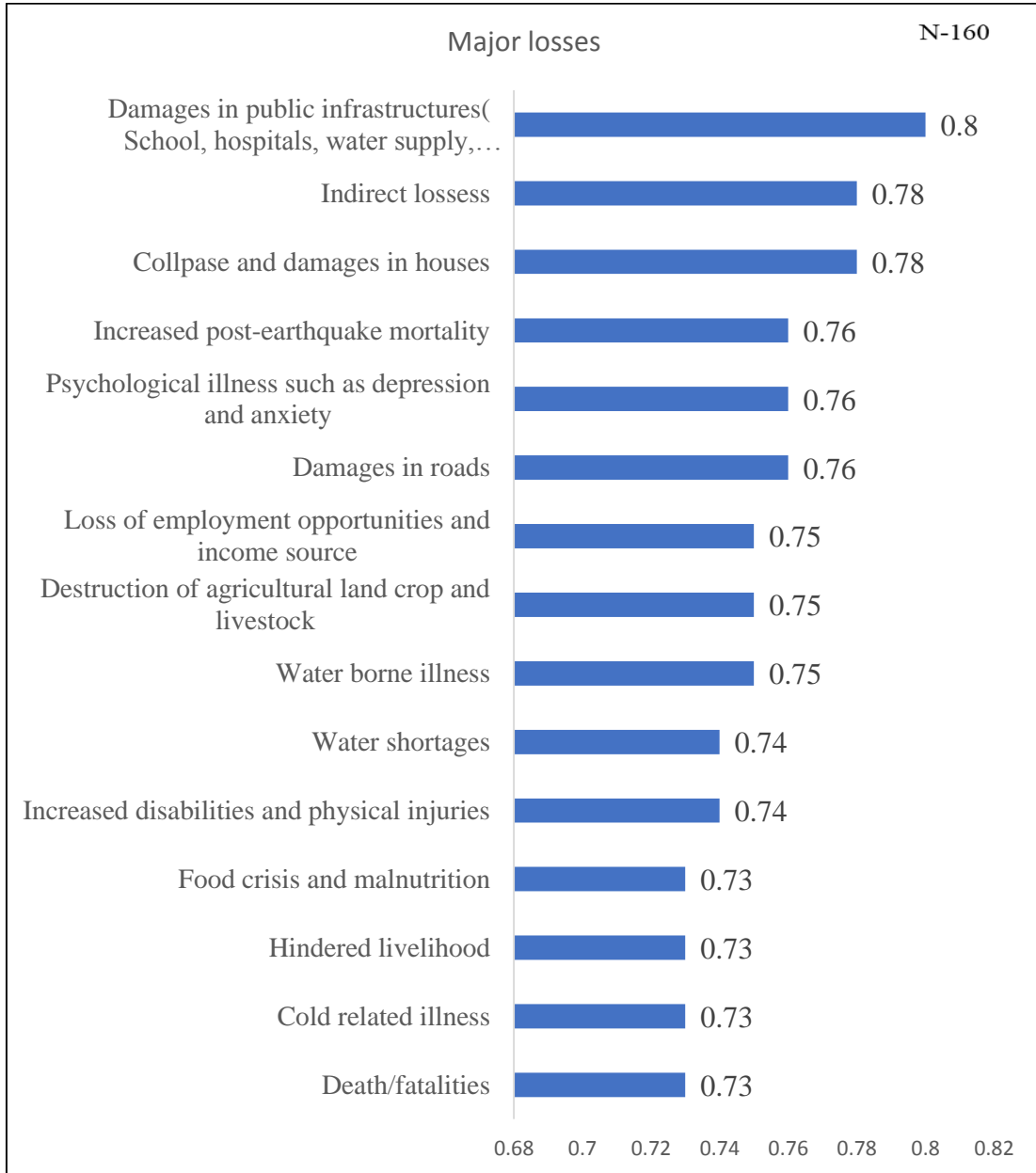
Where W is the weight assigned by respondents (1–5),  $n_1$ – $n_5$  are the number of respondents for each Likert category (strongly disagree to strongly agree), A is the highest weight (5), and N is the total number of respondents. RII values range from 0 to 1, with higher values indicating greater perceived importance or severity. Qualitative data from IDIs and FGDs were analyzed thematically to identify recurring patterns and validate quantitative findings.

## **3. RESULTS AND DISCUSSION**

### **3.1 Major Losses in Chhedagad Municipality**

The RII analysis of questionnaire responses identified a hierarchy of earthquake losses in Chhedagad Municipality. Damage to public infrastructure — including schools, hospitals, water supply systems, hydropower installations, and historical sites — received the highest RII value (0.80), indicating it as the most broadly recognized category of loss. Indirect financial losses, particularly the high cost of rebuilding infrastructure and the economy, and collapse and damage in residential houses each registered RII = 0.78. Increased post-earthquake mortality, psychological illness (depression and anxiety), and road damage were rated equally significant (RII = 0.76). Loss of employment opportunities and income, destruction of agricultural land, crops, and livestock, and waterborne illness each scored RII = 0.75, followed by water shortages and increased physical injuries and disabilities (RII = 0.74). Food crisis and malnutrition, hindered livelihoods, cold-related illness, and direct death toll were all rated at RII = 0.73.

These findings are consistent with broader literature on earthquake impacts in Nepal and similar low-income, rural contexts. The 2015 Gorkha earthquake similarly demonstrated severe damage to public infrastructure and housing, with rural communities bearing disproportionate losses (NPC, 2015). The high indirect cost burden reflects the compounded economic disruption commonly observed in post-disaster settings, where reconstruction diverts resources from healthcare, education, and social services (Aksoy et al., 2024).

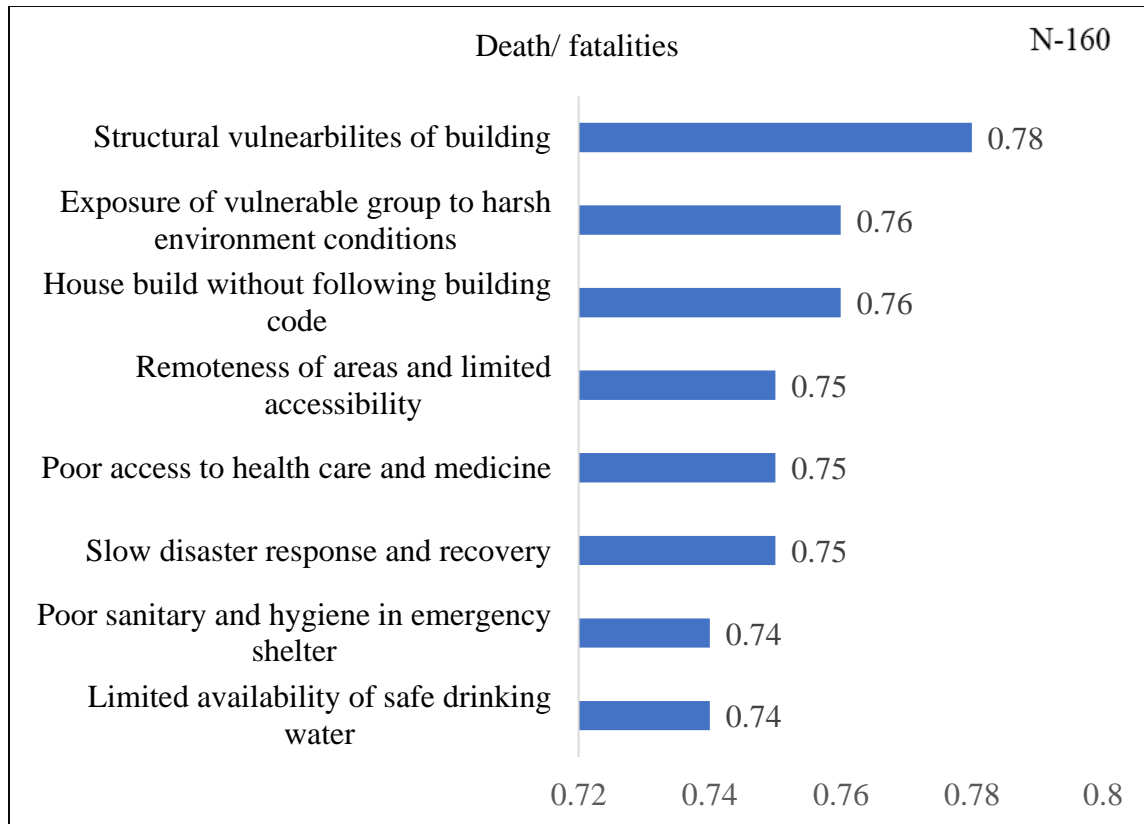


### 3.2 Causes of Death and Fatalities

The primary cause of death and fatalities was identified as structural vulnerability of buildings (RII = 0.78), followed jointly by exposure of vulnerable populations to harsh environmental conditions and construction without compliance to building codes (RII = 0.76). Geographic remoteness and limited accessibility, poor healthcare access, and slow disaster response and recovery each registered RII = 0.75. Inadequate sanitation and

hygiene in emergency shelters and limited availability of safe drinking water were also significant contributory causes (RII = 0.74).

Field observation confirmed that 2,256 of 7,895 houses in Chhedagad Municipality suffered complete collapse — approximately 28.6% of the total housing stock — with 319 requiring major retrofitting and 2,501 needing minor repairs. These figures are commensurate with patterns observed elsewhere: the primary cause of earthquake-related death globally is trauma from building collapse, with traditional earthen or stone construction substantially increasing fatality risk (Doocy et al., 2013). The concentration of post-earthquake mortality — rather than immediate deaths — is particularly notable and reflects the cascading health consequences of inadequate shelter, healthcare disruption, and food insecurity following the event.



### 3.3 Infrastructure Damage

#### 3.3.1 Public Infrastructure

Structural vulnerability in public infrastructures was the leading cause of damage (RII = 0.80), followed by failure to meet design standards (RII = 0.78) and use of substandard construction materials (RII = 0.75). Additional causes included poor infrastructure resilience, challenging topography, and landslide-induced collapses (all RII = 0.74). Of 92 school buildings, five collapsed completely and were under reconstruction at the time of study, while approximately 45 exhibited minor structural cracks. Health posts and government offices also sustained significant damage, with some older structures completely collapsed and under reconstruction, though renovation remained incomplete due to limited budget allocations.

#### 3.3.2 Residential Housing

Traditional houses with inherently weak structures were the dominant cause of residential damage (RII = 0.80), followed by inefficient settlement patterns and structural vulnerability in houses (RII = 0.76 each), and construction without adherence to building codes (RII = 0.75). Use of substandard materials (RII = 0.74) and unskilled labor (RII = 0.73) were additional causative factors. In-depth interviews confirmed that even reinforced concrete (RCC) buildings in the municipality were built with substandard materials and without professional engineering supervision, resulting in structural deformities that were exposed under seismic loading.

### **3.3.3 Road Infrastructure**

Earthen roads susceptible to landslide were the highest-rated cause of road damage (RII = 0.80), followed by haphazard road construction without proper engineering standards (RII = 0.78). Roads without proper drainage, absence of retaining or gabion walls in landslide-prone areas, and high slope gradients also contributed significantly (RII = 0.74). Landslides triggered by the earthquake caused road blockages that severely impeded access for emergency responders and supply convoys, prolonging recovery timelines.

## **3.4 Health Impacts**

### **3.4.1 Waterborne Illness**

Open defecation and contamination of water sources was the primary cause of waterborne illness (RII = 0.80), followed by untimely availability of medicine and healthcare and inadequate access to safe drinking water (both RII = 0.78), and poor sanitation in emergency shelters (RII = 0.75). Landslides contaminated water sources and damaged supply infrastructure, creating conditions conducive to waterborne disease outbreaks.

### **3.4.2 Cold-Related Illness**

Exposure of vulnerable populations to extreme cold in emergency shelters was the leading cause of cold-related illness (RII = 0.78), exacerbated by heavy monsoon rainfall (RII = 0.76), poor living conditions, and untimely medical facilities (both RII = 0.75). Infant, child, elderly, and pregnant women populations were most affected. These findings corroborate evidence from similar mountain-region disaster contexts where temporary shelter inadequacy significantly increases post-disaster morbidity and mortality.

### **3.4.3 Psychological Illness**

Loss of family members and destruction of people's homes were the highest-rated causes of depression and anxiety (both RII = 0.78), followed by collapse of houses, wide community trauma (RII = 0.76), destruction of home businesses, loss of social bonds, and income loss (all RII = 0.75). Destruction of agricultural land, disrupted education, and death of livestock also contributed to psychological distress (RII = 0.74). These patterns are consistent with documented long-term psychological consequences of earthquakes in similar rural settings, where livelihood disruption and social disintegration compound direct trauma (Fu et al., 2019).

## **3.5 Socioeconomic and Livelihood Impacts**

The economic impact analysis revealed that direct costs of repairing and replacing damaged houses and public infrastructure received the highest RII (0.80), followed by costs associated with house collapse (RII = 0.79). Disruption of transportation infrastructure and damage to hospitals, schools, and public buildings (RII = 0.76), and sharp declines in household income, loss of employment, and irrigation system damage (all RII = 0.75) were also significant. Displacement due to house collapse was the primary cause of livelihood disruption (RII = 0.79), followed by employment loss (RII = 0.78), damage to home businesses and agricultural fields (RII = 0.76), and blocked resource access (RII = 0.74).

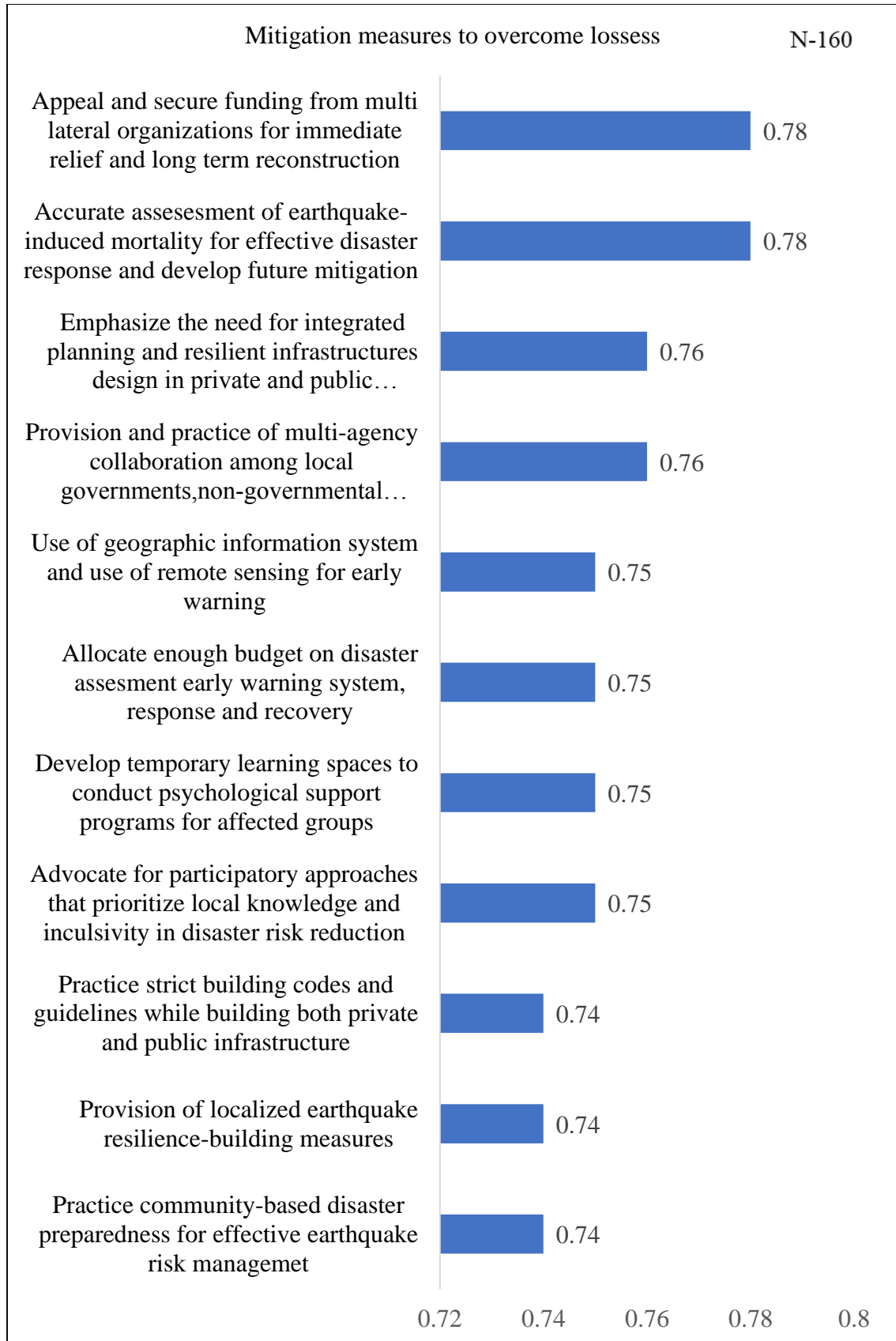
Social impacts included disproportionate effects on marginalized and outcaste groups and widespread non-adherence to modern building codes (both RII = 0.79), alongside socioeconomic disparities, mass displacement,

high infant and child mortality, physical injuries, and increased disease risk (RII = 0.75–0.78). Environmental impacts were characterized by prolonged rural economic recovery timelines (RII = 0.79), high disparities in resource access (RII = 0.78), and landslide-compounded devastation (RII = 0.75). Agricultural losses were attributable primarily to landslides in terrace crop fields (RII = 0.78) and collapse of livestock sheds during the earthquake.

### **3.6 Mitigation Measures**

Respondents identified a range of priority mitigation measures. Securing multilateral funding for immediate relief and long-term reconstruction, and accurate assessment of earthquake-induced mortality received the highest priority (both RII = 0.78). Integrated planning and resilient infrastructure design, and multi-agency collaboration among local governments, NGOs, and international bodies for shelter, rehabilitation, and recovery followed (RII = 0.76). Use of GIS and remote sensing for early warning, adequate budget allocation for disaster assessment and recovery, and participatory approaches prioritizing local knowledge in disaster risk reduction were also highly ranked (all RII = 0.75). Strict enforcement of building codes for private and public construction, localized earthquake resilience measures, and community-based disaster preparedness practices were rated at RII = 0.74.

These findings align well with global disaster risk reduction frameworks. The Sendai Framework's four priorities — understanding disaster risk, strengthening disaster governance, investing in resilience, and enhancing preparedness — all correspond to measures identified by respondents (United Nations, 2015). The emphasis on multi-agency collaboration is particularly salient given the documented institutional fragmentation in Nepal's disaster response system (Adhikari et al., 2017 as cited in Giri et al., 2024). The prioritization of accurate mortality assessment reflects recognition that underreporting in remote areas undermines effective disaster response and long-term planning.



### **3.7 Qualitative Findings**

Field observation, in-depth interviews, and focused group discussions corroborated and enriched the quantitative findings. Municipal engineers confirmed that reconstruction has been slow due to budget constraints, with many damaged public buildings still awaiting repair nearly two years after the earthquake. Community members reported that even post-earthquake housing reconstruction continued without seismic resilience considerations, with unskilled labor used without engineering supervision. Minimal awareness of building codes among communities, contractors, and local government officers was a recurring theme. NGO and municipal stakeholders emphasized the need for multi-agency fundraising, training of local manpower, and community-based disaster risk management as essential components of future resilience building.

## **4. CONCLUSION**

This study provides a systematic, community-level assessment of the losses, their causes, and mitigation priorities arising from the 2080/2023 Jajarkot earthquake in Chhedagad Municipality, Nepal. The findings demonstrate that the most severe losses were concentrated in public infrastructure and residential housing, driven predominantly by structural vulnerabilities inherent in traditional construction methods and widespread non-compliance with seismic building codes. Geographic remoteness compounded these losses by delaying disaster response and recovery, increasing post-earthquake mortality through cascading health and livelihood impacts including cold-related illness, waterborne disease, food crisis, and psychological distress.

The study highlights a critical gap between existing building code requirements and actual construction practices in Chhedagad Municipality, a gap that reflects both limited technical awareness among stakeholders and insufficient institutional enforcement by local and national authorities. Economic disruption was severe and multidimensional, encompassing direct infrastructure repair costs, agricultural and livestock losses, disrupted livelihoods, and loss of employment — all of which disproportionately affected marginalized populations.

To reduce future earthquake losses in Chhedagad Municipality and similar remote Nepalese municipalities, the following actions are recommended: establish rapid response teams with trained personnel and pre-positioned resources; enforce seismic building codes for both private and public construction through regular inspection regimes; train local engineers, laborers, and foremen in earthquake-resilient construction techniques; develop community-based disaster preparedness programs including early warning utilization; secure multi-agency funding for reconstruction and long-term resilience investments; implement GIS and remote sensing for hazard mapping and early warning; and ensure accurate, systematic earthquake mortality and impact data collection to inform evidence-based policy.

These measures, if implemented through coordinated collaboration among local government, national agencies, NGOs, and international organizations, can substantially reduce the human, structural, and economic toll of future seismic events in Jajarkot District and across Nepal's vulnerable mountain regions.

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