

Stunting and Child Growth Faltering in Gilgit-Baltistan, Pakistan: Prevalence, Risk Factors, and Public Health Intervention

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Abstract

There are growing concerns regarding childhood undernutrition and growth delays in Pakistan and Gilgit-Baltistan (GB), but regional evidence is still lacking. Most available studies are small, non-representative, and cross-sectional. Due to this, evidence on GB's regional determinants including, but not limited to, isolation, maternal nutrition, WASH, health services, dietary risks, and climate-related vulnerabilities are scarce. Recent public health and nutrition programs have addressed the burden of childhood undernutrition through integrated means and context-specific frameworks. Stunting (height-for-age < -2 SD of WHO) is still the leading public health issue in GB, though it is not often acknowledged. A scoping review from 2010-2025 reported stunting prevalence as high as 46.6% in GB, which is higher than the national and regional estimates. Poor child feeding and maternal nutrition practices, food insecurity, poor WASH services, health and climate isolation, and poor health services are the major risks. The Central Asia Stunting Initiative (CASI) addressed undernutrition by increasing the diversity of breastfeeding and other feeding practices, with a moderate reduction in stunting. The still pertinent issues of food insecurity and unequal access to essential, basic services continue to worsen the child stunting problem. There are persisting gaps in research including underdeveloped and climate-related nutritional studies at the district-level and a lack of longitudinal and intervention studies. These findings highlight the need for the implementation of context-specific integrated multi-sector strategies for the first 1,000 days of life, along with food security, maternal and child nutrition, WASH and women's empowerment, and the reduction of stunting and improvement of child growth in Gilgit-Baltistan.

Keywords: Stunting; Gilgit-Baltistan; Pakistan; Child nutrition; Food insecurity; WASH; Public health interventions.

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1 Introduction

Stunted chronic linear growth failure due to chronic nutritional deprivation and recurrent infections in first 1,000 days of life is a worldwide health disaster with unremediable impacts on cognitive development, schooling achievement, economic efficiency, and inter-generational wellbeing. The World Health Organization edition states that the number of children aged under five years in 2024 who were stunted worldwide was about 150.2 million, of which more than half (51.25 million) were in Asia (World Health Organization, [2025](#)). Although the prevalence of stunting worldwide has decreased from 33.0% in 2000 to 22.3% in 2024, this level is dangerously low. Only one-third of countries are currently halting stunting, as required by Sustainable Development Goal (SDG) Target. The burden of stunting is still high in South Asia. The regional prevalence rate is 30.7 and the global prevalence is 22.0, with Pakistan having a national prevalence of stunting of 40.2 in the National Nutrition Survey (NNS) 2018, second after Afghanistan in South Asia (Global Nutrition Report, [2022](#); World Health Organization, [2025](#)). It is estimated that Pakistan has almost 10 million stunted children, which is among the greatest absolute stunting burdens worldwide (World Health Organization, [2025](#)).

Gilgit-Baltistan (GB) is a particularly acute yet long-neglected public health issue in Pakistan. GB is a mountainous region in far north Pakistan, which shares borders with China and Afghanistan, with extreme topography, geographic isolation, underdeveloped health infrastructure, and high socioeconomic vulnerability. In the territory, the GB Multiple Indicator Cluster Survey (GB-MICS) 201617 was the first extensive household survey, which reported a stunting prevalence of 46.6 per cent among children under five with rural regions showing even higher prevalence of 49.1 percent. Although these are worrying statistics, there has been no pre-scoping or systematic review to exhaustively map the evidence on stunting and child growth faltering in this area. The oversight of GB in national and international nutrition research is on record. A systematic review of the academic literature on child malnutrition in Pakistan found that no studies were conducted in Gilgit-Baltistan before 2018, and researchers were mostly involved in Punjab, Sindh, and Khyber Pakhtunkhwa (Abubakar et al., [2013](#)). This lack of evidence has direct policy and resource allocation implications: there can be no targeted interventions, no monitoring of progress, and no accountability of decision-makers without region-specific data.

The current scoping review fills this important gap. It seeks to: (1) map the evidence on the prevalence and time-trend in the incidence of stunting and child growth faltering in GB; (2) determine and classify the stakeholders of stunting in this special mountain setting; (3) assess the evidence of the interventions; and (4) outline important research gaps and policy priorities. It is hoped that this review will provide a baseline document to researchers, nutrition practitioners and policymakers operating in GB and other high-altitude, geographically remote environments.

2 Methodology

2.1 Study Design and Framework

The review adheres to the scoping review approach by Arksey and O'Malley ([2005](#)) and optimised by the Joanna Briggs Institute (JBI) (Peters et al., [2020](#)). The reporting is done in accordance with Preferred Reporting Items of Systematic Reviews and Meta-Analyses Extension of Scoping Reviews (PRISMA-ScR) checklist (Tricco et al., [2018](#)). A review design was chosen instead of a systematic review since the major aim was to map the scope and nature of the available evidence as opposed to synthesizing effect estimates of particular interventions.

2.2 Eligibility Criteria

To be eligible, studies had to: (i) be in Gilgit-Baltistan or include GB as a separate region in a Pakistan-wide dataset; (ii) report child stunting, undernutrition, growth faltering, or other nutritional or health outcomes in children 0-59 months or their mothers; (iii) be published or

released between January 2010 and April 2025; and (iv) There were no limitations to study design. Articles where only adult data were reported and conference abstracts did not provide complete data were eliminated.

2.3 Information Sources and Search Strategy

A systematic literature search was conducted in May 2025 across the following databases and repositories: PubMed/MEDLINE, Scopus, Google Scholar, WHO IRIS, UNICEF Data Hub, Pakistan Bureau of Statistics, the Aga Khan Development Network (AKDN) publications portal, and the Global Nutrition Report. Search terms included combinations of: "stunting", "child growth faltering", "malnutrition", "undernutrition", "wasting", "underweight", "child nutrition", "Gilgit-Baltistan", "Gilgit", "Northern Areas Pakistan", "GB-MICS", "NNS Pakistan", "mountain communities Pakistan", "AKDN nutrition", and "CASI". Reference lists of included articles were manually screened for additional sources.

2.4 Source Selection and Data Extraction

All identified records were independently screened by title and abstract. Full texts of potentially eligible sources were retrieved and assessed against the inclusion criteria. Data were extracted into a structured evidence map covering: study location, design, sample size, age group, outcome measures, stunting prevalence, determinants identified, intervention type, and key findings. Extracted data were synthesized narratively and organized thematically into: prevalence and trends, determinants, and interventions.

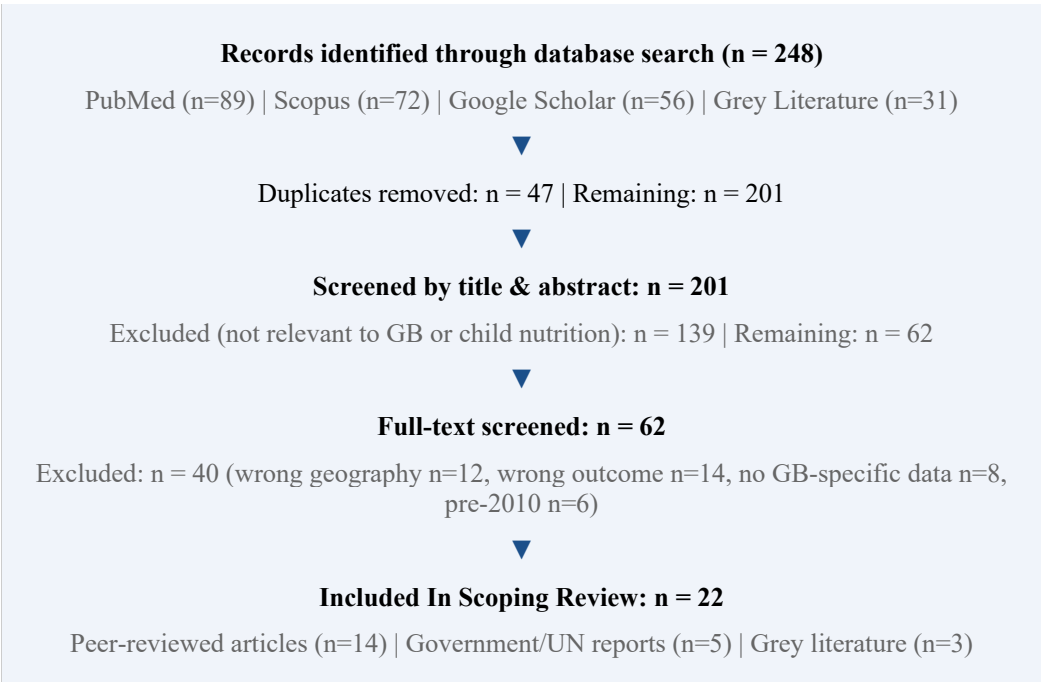


Figure 1. Prisma-ScR flow diagram showing the process of source identification, screening, and inclusion for the scoping review on stunting and child growth faltering in Gilgit-Baltistan (2010-2025).

3 Results

3.1 Overview of Included Sources

Twenty-two sources met the eligibility criteria. These included fourteen peer-reviewed journal articles, five official government and United Nations reports (GB-MICS 2016–17, NNS 2018, Pakistan Maternal Mortality Survey 2019, Pakistan Adolescent Nutrition Strategy 2020–25, WHO Pakistan Nutrition Reports), and three grey literature publications from the Aga Khan Development Network (AKDN) and the Central Asia Stunting Initiative (CASI). Study designs included cross-sectional surveys ($n=9$), program evaluation reports ($n=5$), secondary data analyses ($n=5$), and narrative or policy reviews ($n=3$). The majority of primary studies were conducted between 2016 and 2024, reflecting the relative recency of nutrition surveillance in GB.

3.2 Prevalence and Trends of Stunting in Gilgit-Baltistan

3.2.1 Regional and District-Level Prevalence

The GB-MICS 2016–17, the first comprehensive population-level survey ever conducted in the territory, documented a stunting prevalence of 46.6% among children under five years, with rural areas recording 49.1% compared to 32.4% in urban areas. These figures exceeded the national average of 44% (NNS 2011) and 40.2% (NNS 2018) (Soofi et al., [2023](#)), and were substantially higher than both the South Asian regional average of 30.5% and the global average of 22.3% (World Health Organization, [2025](#)). District-level data remain critically sparse. The most substantive district-level study was conducted in Diamer one of GB's ten districts, by Khan ([2023](#)) using a nutritional survey across four tehsils (Goharabad, Chilas, Darel, and Tangir) involving 320 children aged under five in 2021 (Khan, [2023](#)). This study confirmed high-severity malnutrition, including stunting, wasting, underweight, and anemia across all surveyed tehsils. No comparable district-level data exist for the remaining nine GB districts, representing a critical surveillance gap.

Data from the Pakistan Demographic and Health Survey (PDHS) 2017–18 provided GB-specific estimates at the regional level, confirming that, while stunting in GB declined significantly between 2012–13 and 2017–18, it remained among the highest in Pakistan's regions (Raza et al., [2021](#)). The coexistence of stunting with underweight was evident in more than 10% of GB children.

3.2.2 Temporal Trends and Intervention Impact

The Central Asia Stunting Initiative (CASI), implemented by the Aga Khan Development Network (AKDN), comprising the Aga Khan Foundation (AKF), Aga Khan University (AKU), and Aga Khan Health Services (AKHS) targeted approximately 387,500 people across 475 remote communities in Gilgit-Baltistan, Chitral (GBC), and Badakhshan, Afghanistan (Aga Khan Development Network, [2025](#)). A pre-post evaluation study published in 2024/2025 documented a decline in stunting prevalence from 40.9% at baseline to 35.4% at midline among children aged 0–59 months a statistically significant reduction ($p = 0.02$) (Jahangir et al., [2025](#)). Severe stunting fell more dramatically, from 17.8% to 10.9% ($p < 0.001$). These findings represent the most recent and robust evidence of stunting trends in GB.

Nationally, Pakistan recorded a decline in stunting prevalence from 44% in 2011 to 40% in 2018, as reported in successive national nutrition surveys (Government of Pakistan, [2011](#); World Health Organization, [2025](#)). Evidence from large-scale nutrition programs indicates that community-based and multisectoral interventions have contributed to further reductions in stunting, with estimates declining from approximately 45% in 2012 to 37.6% in 2019 (Bhutta et al., [2020](#); Headey et al., [2020](#)). However, the rate of decline in Gilgit-Baltistan remains insufficient to meet United Nations Sustainable Development Goal Target 2.2 by 2030, highlighting persistent regional disparities in nutrition outcomes.

Table 1. Stunting Prevalence in Gilgit-Baltistan: Comparison with National and Global Benchmarks

District / Region	Survey / Source	Year	Stunting Prevalence	Age Group
Gilgit-Baltistan (Overall)	GB-MICS	2016–17	46.6%	< 5 years
Gilgit-Baltistan (Rural)	GB-MICS	2016–17	49.1%	< 5 years
Gilgit-Baltistan (Urban)	GB-MICS	2016–17	32.4%	< 5 years
District Diamer	JHRR Survey	2021–23	High severity	< 5 years
GBC (Baseline – CASI)	AKDN/CASI	2022–24	40.9%	0–59 months
GBC (Midline – CASI)	AKDN/CASI	2024	35.4%	0–59 months
Pakistan (National)	NNS	2018	40.2%	< 5 years
South Asia (Regional)	UNICEF/WHO/WB JME	2022	30.5%	< 5 years
Global	UNICEF/WHO/WB JME	2024	22.3%	< 5 years

Note: GBC = Gilgit-Baltistan and Chitral; NNS = National Nutrition Survey; JME = Joint Malnutrition Estimates; CASI = Central Asia Stunting Initiative.

3.3 Determinants of Stunting in Gilgit-Baltistan

The determinants of child growth faltering in GB operate at multiple levels individual, household, community, health system, and environmental and interact synergistically to produce the high stunting burden observed. Drawing on the UNICEF conceptual framework for malnutrition and evidence from included studies, the following key determinants were identified.

3.3.1 Inadequate Infant and Young Child Feeding Practices

Suboptimal infant and young child feeding (IYCF) practices represent the most proximal and modifiable determinant of stunting in GB. The CASI baseline survey documented exclusive breastfeeding rates of only 71.3%, below optimal levels for a region where breastfeeding is culturally supported, and dietary diversity scores so low that only 4.0% of children aged 6–23 months were receiving the WHO-recommended minimum of four food groups (Jahangir et al., 2025). Following CASI interventions, breastfeeding rates improved to 88.3% and dietary diversity to 26.8%, though the latter remained far below acceptable thresholds (Jahangir et al., 2025). These findings align with national evidence. Pakistan has historically had the lowest rates of early breastfeeding initiation in South Asia (18% at birth), the lowest exclusive breastfeeding rates (38% at 6 months), and some of the poorest complementary feeding diversity in the region (Das et al., 2016). In GB specifically, cultural practices such as prelacteal feeding, the discard of colostrum based on its appearance, and reliance on cereal-only weaning diets are compounding factors, though these remain unstudied in peer-reviewed literature for this specific territory.

3.3.2 Maternal Nutrition and Health

Maternal undernutrition, low education, and poor antenatal health are established proximal determinants of child stunting through mechanisms including intrauterine growth restriction, low birth weight, and compromised breastmilk composition. Evidence from the PDHS 2017–18 analysis by Siddiqua et al. (2023) confirmed that higher maternal education was significantly protective against stunting, wasting, and underweight in Pakistan, with GB-specific findings consistent with this national pattern (Siddiqua et al., 2023).

In GB, 50% of ever-married women have no formal education (National Institute of Population Studies, [2020](#)), and adolescent anaemia reaches 55.6% which is one of the highest rates nationally. Anaemia in reproductive-age women, affecting an estimated 48.4% of women in South Asia, directly impairs fetal growth and infant nutritional status (Sridhar, [2025](#)). Despite this, no GB-specific study has quantified the relationship between maternal nutritional biomarkers and child stunting.

3.3.3 Household Food Insecurity

Food insecurity is both a cause and a consequence of stunting in GB. The CASI evaluation reported a dramatic decline in food security from 95.2% to 11.9% between baseline and midline, and an alarming deterioration occurred simultaneously with improvements in nutritional behaviors (Jahangir et al., [2025](#)). This paradoxical finding underscores how economic shocks, climatic disruptions, and inflationary pressures can erode dietary quality even when knowledge and practices improve. GB-MICS 2016–17 documented that food insecurity affected an estimated 60% of households in the region. Traditional dietary patterns in GB historically provided a protective nutritional quality. The Hunza Valley, for example, had a well-documented heritage of apricot oils, dried fruits, and diverse whole foods that provided essential micronutrients. However, AKDN researchers observe that these traditional food practices are increasingly being lost as communities shift toward CPEC-driven market economies, imported processed foods, and cash crop monocultures (Aga Khan Development Network, [2025](#)).

3.3.4 Geographic Isolation and Healthcare Access

GB's unique geography creates structural barriers to healthcare access that have no parallel in Pakistan's other regions. Communities are separated by high mountain passes, accessible only via serpentine roads that may be blocked for months by snowfall, landslides, or flooding. The GB health system is critically under-resourced: only one psychiatrist serves the entire territory (Sridhar, [2025](#)). Rural health centers have significant infrastructure deficits, and the Comprehensive Emergency Obstetric and Neonatal Care (CEmONC) services package remains critically inadequate (Asif, [2017](#)).

The Lady Health Worker (LHW) program is the primary mechanism for delivering community-level maternal and child nutrition services. A cross-sectional survey of over 10,000 households in GB conducted by Farrar et al. (2024) as part of a cluster randomized controlled trial baseline found that LHW coverage was significantly associated with maternal and neonatal outcomes, though geographic barriers remained limiting factors for the most remote communities (Farrar et al., [2024](#)).

3.3.5 Water, Sanitation, Hygiene (WASH) and Infectious Disease Burden

The WASH-nutrition link is particularly salient in GB. GB-MICS data and health expert reports document a worm infestation prevalence of 64% across the population and access to soap in only 17% of children creating a high-burden enteropathogenic environment that directly impairs gut integrity, nutrient absorption, and linear growth. Recurrent diarrheal illnesses and acute respiratory infections, compounded by GB's high under-five mortality rate of 92 per 1,000 live births, create a vicious cycle of infection and growth faltering that dietary interventions alone cannot break.

3.3.6 Micronutrient Deficiencies

Micronutrient deficiencies compound the stunting burden in GB. The National Nutrition Survey 2011 documented urinary iodine concentrations (UIC) of 64 µg/L in mothers and 68 µg/L in children from GB both well below the WHO adequate range of 100–199 µg/L confirming continued iodine deficiency despite universal salt iodization programs (Fordyce et al., [2021](#)). Iodine deficiency during pregnancy impairs fetal brain development and contributes to postnatal growth failure. Selenium deficiency, vitamin D deficiency, and inadequate zinc intake are also

documented in GB populations but remain poorly quantified. UNICEF Pakistan estimates that more than 40% of Pakistani children are deficient in both zinc and vitamin D, and nearly 62% are anemic figures likely exceeded in GB given its heightened vulnerability (World Health Organization, [2025](#)).

3.3.7 Climate, Ecology, and the Environmental Determinants

A landmark study published in the American Journal of Clinical Nutrition (January 2025) by Soofi et al. examined drivers of stunting and wasting in children under two across Pakistan using linked ecological and household survey data from NNS 2011 and NNS 2018, explicitly including GB (Soofi et al., [2025](#)). The study confirmed that environmental factors including heat stress, precipitation variability, agricultural outputs, and food security were significant determinants of linear growth faltering particularly in high-altitude settings. GB, which experiences nearly double the warming rate of lower elevation regions of Pakistan, faces heightened climate-nutrition risks as glacial melt disrupts agricultural water availability and seasonal food production.

Table 2: Key Determinants of Stunting and Child Growth Faltering in Gilgit-Baltistan

Category	Specific Determinants	Evidence / Reference
Dietary & Feeding	Low dietary diversity, inadequate complementary feeding and poor exclusive breastfeeding rates	(Soofi et al., 2023 ; World Health Organization, 2025)
Maternal Factors	Low maternal education, poor maternal nutrition, short birth intervals, early marriage and maternal anaemia	Siddiqi et al., 2023
Socioeconomic	Household poverty, food insecurity, low wealth quintile	(World Health Organization, 2025)
Geographic & Access	Mountain terrain, poor road infrastructure, limited health facility access, seasonal isolation	Agha Khan Development Network, 2025 ; Farrar et al., 2024
WASH & Infection	Worm infestation (64%), poor sanitation, unsafe water, recurrent diarrhea and respiratory infections	(World Health Organization, 2025)
Micronutrient Status	Iodine deficiency (UIC < 100 µg/L), zinc and vitamin D deficiency, anemia	(Fordyce et al., 2021)
Healthcare System	Low skilled birth attendance, limited community health worker coverage, inadequate facility-based nutrition services	(World Health Organization, 2025)
Climate & Ecology	High-altitude seasonal food scarcity, flash floods, glacial melt disrupting agriculture	Soofi et al., 2025

Note: WASH = Water, Sanitation, and Hygiene; UIC = Urinary Iodine Concentration; GB-MICS = Gilgit-Baltistan Multiple Indicator Cluster Survey.

3.4 Interventions to Reduce Stunting in Gilgit-Baltistan

3.4.1 Central Asia Stunting Initiative (CASI)

The most substantial evidence of stunting intervention in GB comes from the AKDN's Central Asia Stunting Initiative (CASI). CASI is a long-term, multi-sectoral program targeting 387,500 individuals across 475 remote and marginalized communities in GB, Chitral, Badakhshan (Afghanistan), and GBAO (Tajikistan). The program prioritizes the first 1,000 days of life and integrates nutrition-specific components (micronutrient supplementation for pregnant and lactating women, breastfeeding support, complementary feeding counseling, management of acute malnutrition) with nutrition-sensitive interventions (agriculture, WASH, gender equity, income support, and health system strengthening).

A 2024–2025 pre-post evaluation documented significant improvements across all primary outcomes [14]. Stunting declined from 40.9% to 35.4% ($p = 0.02$), severe stunting from 17.8% to 10.9% ($p < 0.001$), and wasting and underweight showed marked reductions. Exclusive breastfeeding improved from 71.3% to 88.3% and dietary diversity improved dramatically from 4.0% to 26.8%. CASI's theoretical model is supported by Bhutta and colleagues' analysis of countries that successfully reduced stunting at scale, which concluded that approximately half of stunting reductions are attributable to non-health-sector interventions, a finding that underpins AKDN's multi-sectoral approach (Aga Khan Development Network, 2025). However, limitations of the CASI evaluation must be acknowledged. The study employed a single-group pre-post design without a concurrent control arm, limiting causal attribution. The simultaneous sharp decline in food security (from 95.2% to 11.9%) represents a concerning trend that, if sustained, may reverse nutritional gains. The evaluation captured midline data only; endline results are pending.

3.4.2 National Programs with GB Relevance

The Government of Pakistan's Nashonuma program (2020–2023), supported by the World Bank, implemented conditional cash transfers linked to the use of lipid-based nutrient supplements and maternal and child health services. Evidence suggests that integrated nutrition interventions, including cash transfers and supplementation, contribute to reductions in child stunting in low- and middle-income countries (Keats et al., 2021; Muhammad et al., 2025). National estimates in Pakistan show a decline in stunting from 45% in 2012 to approximately 37.6% in 2019, partly attributed to such multisectoral programs (Headey et al., 2020). However, the extent of the Nashonuma program coverage in Gilgit-Baltistan remains unclear due to limited regionally disaggregated implementation data. The Lady Health Worker Cluster Randomized Controlled Trial (cRCT) in GB (Farrar et al., 2024) enrolled over 27,000 pregnant women across 2022–2024, examining whether delivery of a preventive newborn care kit through LHWs reduced neonatal mortality and infection (Farrar et al., 2024). While this trial's primary outcomes were mortality-focused rather than nutritional, it generated the most recent and high-quality household survey data from GB and confirmed the significant unmet need for community-level maternal and child health services.

3.4.3 WHO SAM Management Capacity Building

WHO Pakistan supported the establishment of two Severe Acute Malnutrition (SAM) stabilization centers in GB and provided capacity building for health workers on SAM treatment guidelines (World Health Organization, 2025). While these initiatives represent critical service provision, they address severe acute malnutrition rather than the chronic undernutrition underlying stunting. Reviews of Pakistan's infant and young child feeding policy landscape confirm that complementary feeding arguably the most important modifiable determinant of stunting after 6 months of age has never been the subject of a concerted national program, let alone a GB-specific one (Nguyen et al., 2017).

Table 3: Summary of Interventions Addressing Stunting in Gilgit-Baltistan

Intervention	Implementing Agency	Key Outcome	Limitation / Gap
Central Asia Stunting Initiative (CASI)	AKDN (AKF, AKU, AKHS)	Stunting 40.9%→35.4%; EBF 71.3%→88.3%; Dietary diversity 4%→26.8%	No control group; food security declined sharply
Nashonuma Program (National)	World Bank / Government of Pakistan	Conditional cash transfer + lipid-based nutrient supplement;	Limited GB coverage

LHW-delivered Maternal & Newborn Kits	PLOS cRCT / LHW Programme	reduced stunting 45%→37.6% Enrolled >27,000 pregnant women 2022–24; preventive newborn infection focus	Nutritional outcomes are not the primary endpoint
WHO SAM Stabilization Centers	WHO Pakistan / DoH GB	Two centers established in GB; SAM management guidelines implemented	Capacity building is insufficient; coverage gaps remain
Maternal Complementary Feeding Education (CHW-delivered)	Community-based trials, Pakistan	10% proportionate stunting reduction; significant weight and length gain	Not implemented at scale in GB

Note: AKDN = Aga Khan Development Network; AKF = Aga Khan Foundation; AKU = Aga Khan University; AKHS = Aga Khan Health Services; LHW = Lady Health Worker; SAM = Severe Acute Malnutrition; EBF = Exclusive Breastfeeding.

Table 5: Adapted multi-level conceptual framework illustrating distal, intermediate, and immediate determinants of stunting and child growth faltering in Gilgit-Baltistan, Pakistan, based on the UNICEF Malnutrition Conceptual Framework. HAZ = Height-for-Age Z-score; HH = Household; LHW = Lady Health Worker; CMW = Community Midwife; UIC = Urinary Iodine Concentration; RHC = Rural Health Centre; WASH = Water, Sanitation, and Hygiene.

Distal determinants	Intermediate determinants	Immediate determinants
Geographic isolation & terrain	Food insecurity (60% HH affected)	Low dietary diversity (only 4% met the minimum)
Poverty & low household income	Inadequate WASH (64% worm infestation)	Suboptimal exclusive breastfeeding
Low maternal education	Traditional dietary erosion	Cereal-based weaning without protein/micronutrient
Weak health system (1 psychiatrist; limited RHCs)	Maternal anaemia & micronutrient deficiency	Iodine deficiency (UIC 64-68 µg/L; threshold 100)
Constitutional ambiguity & low public spending	Early marriage & short birth intervals	Recurrent infections & high disease burden
Climate change & glacial melt (double warming rate)	Limited LHW & CMW coverage	Low birth weight & preterm birth

4 Discussion

4.1 Summary of Key Findings

This scoping review provides the first comprehensive synthesis of evidence on stunting and child growth faltering in Gilgit-Baltistan. Three overarching findings emerge. First, GB carries a disproportionate and persistent stunting burden with prevalence rates of 35.4% to 46.6% that far exceed national and regional averages and are inconsistent with any trajectory that would achieve SDG targets by 2030. Second, this burden is driven by a uniquely complex constellation of determinants operating simultaneously across multiple ecological, socioeconomic, nutritional, and

health-system levels many of which interact synergistically and cannot be addressed by single-sector interventions. Third, the intervention evidence base for GB is nascent and critically underpowered: only one major region-specific program (CASI) has produced quantified outcome data, and even this lacks a randomized control arm.

4.2 Context Within the Broader Pakistan and South Asian Literature

GB's stunting burden must be understood within the broader epidemiological context of Pakistan, which has the second-highest absolute number of stunted children in South Asia. National studies using PDHS 2017–18 data confirm that child age, maternal education, household wealth, birth order, and feeding practices are the dominant predictors of stunting at the national level (Siddiqua et al., 2023). However, Pakistan-wide analyses consistently inadequately represent GB due to its historically excluded or insufficiently powered sampling in surveys before 2017 (Abubakar et al., 2013; Raza et al., 2021).

Comparison with other high-altitude, geographically isolated populations globally offers instructive parallels. Stunting rates of 40–50% have been documented in the Nepal highlands, remote communities of Afghanistan's Badakhshan province (which shares ecological and socioeconomic characteristics with GB), and the Ethiopian highlands all contexts where geographic inaccessibility, seasonal food insecurity, and weak health systems interact to sustain high burden despite national improvements (Aga Khan Development Network, 2025). The AKDN's own experience in Badakhshan provides the closest published comparator for CASI's work in GB, and indicates that multi-year multi-sectoral approaches can achieve meaningful stunting reductions even in highly constrained contexts, provided they are sustained and properly resourced.

4.3 The 1,000 Days Imperative in Gilgit-Baltistan

Evidence consistently confirms that stunting before age two predicts poorer cognitive and educational outcomes in later childhood, higher susceptibility to diet-related non-communicable diseases in adulthood, and perpetuation of the intergenerational cycle of malnutrition (Victora et al., 2021). The first 1,000 days from conception through age two therefore represent the most critical and time-sensitive window for intervention. In GB, this window is compromised at every stage: poor preconception and maternal nutrition (50% of women with no education; 55.6% adolescent anemia), inadequate antenatal care (low LHW and CMW coverage), suboptimal breastfeeding initiation and exclusivity, and catastrophically low dietary diversity during complementary feeding.

Pakistan's stunting prevention strategy is widely aligned with the critical 1,000-day window from conception to a child's second birthday, which is strongly supported in the global evidence base as the most effective period for nutrition interventions (Bhutta et al., 2013; Keats et al., 2021). However, the application of this approach in Gilgit-Baltistan remains constrained by the absence of region-specific data, limited culturally adapted behavior change communication, and infrastructural barriers that restrict access to geographically isolated populations (Soofi et al., 2023). Evidence from Pakistan-based community nutrition interventions, including cluster-randomised trials led by Bhutta et al. (2013) demonstrates that integrated approaches combining behavior change communication with nutritional supplementation can significantly improve infant and young child feeding practices and growth outcomes; however, these gains are often attenuated in contexts where food insecurity persists (Keats et al., 2021). This suggests that behavior-focused interventions alone are insufficient without parallel improvements in household food security and broader socioeconomic conditions.

4.4 Research Gaps and Priority Agenda

This review identifies six critical research gaps that must be addressed urgently to strengthen the evidence base for stunting prevention in GB. Nutritional surveillance at the district level is absent in nine of GB's 10 districts. A systematic, district-representative nutritional survey similar in design to the GB-MICS is needed to characterize the geographic heterogeneity of stunting burden and identify the most nutritionally deprived sub-populations. However, there were no study has examined the longitudinal association between stunting in early childhood and neurodevelopmental, cognitive, and educational outcomes specifically in GB's high-altitude population. This evidence is critical for mobilizing political will and resource allocation.

The climate-nutrition nexus in GB is virtually unstudied at the community level despite compelling ecological evidence of double warming rates, glacial lake outburst flood risks, and agricultural disruption. Linked longitudinal data on climate variables and child growth outcomes are urgently needed. The traditional food systems of GB including the nutritionally rich Hunza Valley dietary heritage have never been systematically documented or evaluated for their protective role against stunting. As these systems erode under CPEC-driven dietary transition, an opportunity for culturally appropriate nutrition promotion is being lost. Furthermore, the controlled trial has been conducted in GB to evaluate a stunting-specific intervention. The CASI evaluation's lack of a control group limits causal inference. Pragmatic cluster RCTs with adequate power and longer follow-up are feasible given AKDN's existing infrastructure. Sixth, there are no published data on the double burden of malnutrition in GB specifically the coexistence of stunting with overweight or obesity at the individual or household level despite CPEC-driven dietary transitions making this an emerging concern.

Table 4: Priority Research Gaps in Stunting and Child Growth Faltering in Gilgit-Baltistan

Research Gap	Why Critical	Recommended Study Design
District-level stunting prevalence data for all 10 GB districts	Only Diaper and aggregate GB data available	Cross-sectional nutritional survey
Adolescent girls' nutritional status and stunting risk	Anemia at 55.6% but no growth/stunting data for adolescents in GB	Population-based survey, anthropometry + biomarkers
Climate-nutrition nexus: glacial melt/floods and child growth	Ecological drivers of stunting not studied in GB's unique terrain	Longitudinal cohort linked to climate data
Traditional food systems and diet quality	Hunza Valley historical healthy diets being lost; no documentation	Ethnographic + dietary diversity assessment
Cost-effectiveness of CASI and other GB-specific interventions	No economic evaluation of community interventions in GB	Health economic analysis / RCT with control arm
Stunting and neurodevelopmental outcomes in GB children	Long-term cognitive consequences of stunting unstudied in GB	Cohort study; cognitive + school performance follow-up

Note: RCT = Randomized Controlled Trial.

5 Conclusion

Gilgit-Baltistan bears one of the highest and most persistent stunting burdens in South Asia, driven by a unique convergence of geographic isolation, poverty, maternal undernutrition, inadequate infant and young child feeding, micronutrient deficiencies, poor WASH conditions, weak health

systems, and increasingly, climate-driven agricultural and food insecurity. Despite this critical public health challenge, GB remains among the least-studied regions for child nutrition in Pakistan, with no prior systematic or scoping review synthesizing available evidence. This scoping review demonstrates that while some evidence on stunting prevalence and determinants exists primarily from the GB-MICS 2016-17, national nutrition surveys, and the CASI evaluation major gaps remain at every level: district-level surveillance, mechanistic and longitudinal studies, adequately designed intervention trials, and climate-nutrition linkage research. The evidence that does exist confirms that single-sector nutrition interventions are insufficient; multi-sectoral approaches addressing the full range of distal, intermediate, and immediate determinants particularly during the first 1,000 days, are the only evidence-based pathway to meaningful stunting reduction.

The Aga Khan Development Network's CASI program provides a promising proof of concept, demonstrating that community-driven, multisectoral nutrition programs can achieve significant reductions in stunting, even in GB's challenging context. However, its impact is constrained by worsening food insecurity, the absence of robust evaluation designs, and limited geographic coverage. Scaling and sustaining effective interventions in GB will require substantially increased investment, political commitment, integration of nutrition into the CPEC development agenda, and dedicated research partnerships between universities, international organizations, and the Government of Gilgit-Baltistan. The elimination of stunting in Gilgit-Baltistan is not only a moral imperative, it is an economic, developmental, and intergenerational necessity. Every year of delay compounds the cognitive, educational, and productivity losses borne by a generation of GB children who deserve the same nutritional rights as children anywhere in the world.

Author Contributions

Ali Abbas, Muhammad Anas, Nadeem Mehdi, Wajhat Hassan, and Muhammad Hasnain contributed to the conceptualization, development of the review methodology, literature searching, screening of sources, data extraction, evidence synthesis, interpretation of findings, and preparation of the manuscript. All authors contributed to writing—original draft and writing—review and editing. All authors read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Conflict of Interest

The authors declare that they have no financial, professional, institutional, or personal conflicts of interest that could have influenced the review process, interpretation of evidence, or conclusions presented in this article.

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Data Availability

All data used in this scoping review were obtained from published journal articles, government reports, United Nations reports, institutional publications, and publicly available grey literature cited in the manuscript. The structured evidence-extraction material may be obtained from the corresponding author upon reasonable request.

Informed Consent

Not applicable. No human participants were directly recruited for this review and no primary personal data were collected.

Use of Generative AI

The authors declare that no generative artificial intelligence tools were used to screen the studies, extract or analyse the evidence, generate the scholarly content, or formulate the findings and conclusions presented in this article.

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