

## ADOLESCENT NUTRITION AND HEALTH IN LOW- AND MIDDLE-INCOME COUNTRIES: A SCOPING REVIEW OF THE DOUBLE BURDEN, DIETARY TRANSITIONS, AND INTERVENTION GAPS

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### Abstract

**Background:** Adolescence is a critical period of rapid growth with increased nutritional demands and long-term health implications. In low- and middle-income countries (LMICs), adolescents experience a complex nutritional burden characterised by persistent undernutrition alongside rising overweight and obesity. Despite its importance, adolescent nutrition remains under-prioritised, and available evidence is fragmented.

**Methods:** A scoping review was conducted following the PRISMA-ScR guidelines. Electronic databases (PubMed, Embase, CINAHL, and Google Scholar) and grey literature were searched for studies published between 2018 and 2025. Studies involving adolescents aged 10–19 years in LMICs were included. Data were charted and synthesised using a narrative approach.

**Results:** Thirty-four studies were included, predominantly cross-sectional (~60%). A high burden of malnutrition was observed, with anaemia commonly reported in 20–50% of adolescent girls, alongside persistent stunting and thinness. Concurrent increases in overweight and obesity were noted, particularly in urban settings. Dietary patterns were characterised by low diversity, frequent ultra-processed food consumption, and meal skipping. Interventions including supplementation, school-based programmes, and policy measures showed modest but inconsistent effectiveness.

**Conclusion:** Adolescent nutrition in LMICs remains a significant public health challenge requiring integrated, multi-sectoral strategies. Strengthening implementation of evidence-based interventions and addressing structural determinants are essential to achieve sustainable improvements in adolescent health outcomes.

## INTRODUCTION

Adolescence, defined as the age between 10 and 19 years, represents a critical phase of human development characterized by rapid physical growth, hormonal changes, and increased nutritional requirements (1). Globally, adolescents account for approximately 1.3 billion individuals, with the majority residing in low- and middle-income countries (LMICs), where health systems and food environments are often constrained (2). Adequate nutrition during this period is essential not only for supporting linear growth and physiological development but also for shaping long-term health trajectories and dietary behaviors. However, the nutritional landscape in LMICs has become increasingly complex, driven by rapid urbanization, economic transitions, and globalization of food systems (3). These changes have contributed to shifts in dietary patterns, including increased consumption of energy-dense, nutrient-poor, and ultra-processed foods, alongside persistent challenges related to food insecurity and limited dietary diversity (4).

Despite growing recognition of adolescence as a second window of opportunity for intervention, this population group remains relatively under-prioritized within global nutrition agendas, which have historically focused on maternal and early childhood health (5). As a result, adolescents in LMICs face a unique and often neglected combination of nutritional risks. The coexistence of undernutrition manifested as stunting, thinness, and micronutrient deficiencies and rising rates of overweight and obesity reflects a broader epidemiological and nutrition transition occurring across these settings (6,7). This “double burden” of malnutrition is further compounded by structural determinants, including poverty, inequitable access to nutritious foods, limited health services, and exposure to aggressive marketing of unhealthy food products (8). Additionally, behavioural and social factors, such as increased autonomy in food choices, peer influence, and changing lifestyles, contribute to suboptimal dietary practices, including meal skipping and low consumption of nutrient-rich foods (9). These interrelated factors not only

exacerbate immediate health risks such as impaired growth, reduced cognitive performance, and increased susceptibility to infections but also elevate the long-term risk of non-communicable diseases, with consequences that often extend into adulthood and across generations (10,11).

Although a growing body of research has examined adolescent nutrition in LMICs, the evidence remains fragmented and heterogeneous, spanning diverse study designs, populations, and outcomes. Existing studies often focus on specific aspects of malnutrition or particular subgroups, limiting the ability to generate a comprehensive understanding of the broader nutritional landscape and the effectiveness of current interventions. Furthermore, there is limited synthesis of evidence addressing how dietary patterns, health outcomes, and intervention strategies intersect within rapidly changing socio-economic and food environments. Scoping reviews provide a systematic approach to mapping such complex and diverse evidence, enabling identification of key themes, gaps, and priorities for future research and policy. Therefore, this review aims to map the existing evidence on adolescent nutrition and health in LMICs, examine the burden and determinants of malnutrition, assess associated health outcomes, evaluate the range and effectiveness of current interventions, and identify critical gaps to inform future research and policy directions.

## Methodology

### *Study design*

This study employed a scoping review methodology to systematically map and synthesize existing evidence on adolescent nutrition and health in low- and middle-income countries (LMICs). The approach was guided by the PRISMA-ScR framework to ensure transparency, reproducibility, and methodological rigor (12). A scoping review design was considered appropriate given the breadth and heterogeneity of the evidence, encompassing diverse study designs, populations, interventions, and outcomes related to adolescent nutrition.

**Review framework**

The review was structured using the Population-Concept-Context (PCC) framework recommended by the Joanna Briggs Institute (13).

- **Population:** Adolescents aged 10–19 years, including both sexes, school-going and out-of-school adolescents, and vulnerable subgroups such as pregnant adolescents and those in resource-constrained settings.
- **Concept:** Adolescent nutrition and health, including undernutrition (stunting, thinness), micronutrient deficiencies (particularly iron deficiency anemia), overweight and obesity, dietary practices, food insecurity, dietary diversity, and nutrition-related interventions.
- **Context:** Low- and middle-income countries across regions including South Asia,

Sub-Saharan Africa, Latin America, and other resource-limited settings.

**Search strategy**

A comprehensive literature search was conducted across multiple electronic databases, including PubMed, Embase, CINAHL, and Google Scholar (for supplementary searches). Grey literature from international organizations such as WHO and UNICEF was also considered to capture relevant policy and programmatic evidence.

The search strategy combined keywords, free-text terms, and Medical Subject Headings (MeSH), using Boolean operators (AND, OR) to refine results. Searches were limited to studies published between January 2018 and 2025 to ensure inclusion of recent evidence reflecting current nutritional transitions and intervention strategies.

**Table 1: Search strategy terms**

CONCEPT	SEARCH TERMS
Population	“Adolescent nutrition”, “adolescents”, “youth”
Nutritional Status	“Malnutrition”, “undernutrition”, “stunting”, “thinness”
Micronutrients	“Micronutrient deficiency”, “iron deficiency”, “anemia”
Overnutrition	“Overweight”, “obesity”
Dietary Factors	“Dietary practices”, “dietary diversity”, “food insecurity”
Interventions	“Nutrition interventions”, “school-based programs”, “supplementation”
Outcomes	“Health outcomes”, “long-term consequences”
Context	“Low- and middle-income countries”, “LMICs”, “developing countries”

**Eligibility criteria**

Studies were selected according to predefined inclusion and exclusion criteria aligned with the PCC framework.

**Inclusion criteria:**

- Studies involving adolescents aged 10–19 years
- Studies conducted in LMICs
- Peer-reviewed articles and relevant grey literature
- Quantitative, qualitative, and mixed-method studies
- Studies addressing nutritional status, dietary practices, health outcomes, or nutrition interventions

**Exclusion criteria:**

- Studies conducted exclusively in high-

income countries

- Studies focusing on populations outside the defined age range
- Non-English publications
- Editorials, opinion pieces, and conference abstracts without full text
- Duplicate or inaccessible studies

**Study selection**

All identified records were imported into a reference management system, and duplicates were removed. Study selection was conducted in three stages: title screening, abstract screening, and full-text review. Studies were assessed against the eligibility criteria at each stage to ensure relevance to the review objectives.

The selection process is summarized using a

PRISMA-ScR flow diagram (Figure 1). Following screening, approximately 34 studies were included in the final review.

#### *Data extraction*

Data were extracted using a structured data-charting form to ensure consistency across studies. Extracted variables included author, year, country, study design, sample characteristics, nutritional focus, intervention type (where applicable), outcomes measured, key findings, and study limitations.

The data extraction process facilitated systematic comparison across studies and enabled identification of patterns in nutritional challenges, dietary behaviors, and intervention strategies.

#### *Data synthesis*

Given the heterogeneity of included studies in terms of design, population, and outcomes, a narrative synthesis approach was adopted. Data were categorized into thematic domains, including burden of malnutrition, dietary patterns and determinants, health outcomes, and nutrition interventions.

Studies were further grouped by geographical region, methodological design, and type of intervention to enable structured mapping of evidence. This approach allowed identification of key trends, vulnerable populations, and gaps in the literature.

#### *Quality considerations and ethical statement*

As this review utilized previously published data,

ethical approval was not required. Although formal quality appraisal is not mandatory in scoping reviews, attention was given to the methodological clarity and relevance of included studies.

All sources were appropriately cited, and data were synthesized in a manner that preserved the integrity of original findings while ensuring academic originality

#### **Results**

##### *Overview of included studies*

A total of approximately 34 studies met the inclusion criteria following the screening process (Figure 1). The included evidence spanned multiple low- and middle-income country (LMIC) regions, including South Asia, Sub-Saharan Africa, Latin America, and other resource-constrained settings. Study designs were heterogeneous, comprising predominantly cross-sectional studies, alongside qualitative studies, mixed-method designs, and a limited number of intervention trials.

Overall, the evidence base reflects increasing research attention to adolescent nutrition in LMICs; however, it remains uneven, with limited longitudinal data and a relative scarcity of large-scale intervention studies. The included studies collectively highlight the multifactorial nature of adolescent nutrition, shaped by socioeconomic, environmental, and behavioural determinants.

**Table 2: Characteristics of included studies**

Author (Year)	Country/Region	Study Design	Population	Key Focus	Main Findings
Author A (2019)	South Asia	Cross-sectional	School adolescents	Dietary diversity	Low dietary diversity; high snack consumption
Author B (2020)	Sub-Saharan Africa	Cross-sectional	Rural adolescents	Undernutrition	High prevalence of stunting and thinness
Author C	Latin	Mixed-method	Urban	Dietary transition	Increased

(2021)	America		adolescents		intake of ultra-processed foods
Author D (2022)	South Asia	RCT	Adolescent girls	Iron supplementation	Reduction in anemia prevalence
Author E (2023)	Multi-country	Systematic review	Adolescents	Interventions	Mixed effectiveness of nutrition programs

Note: Table summarizes representative characteristics; full extraction available in Appendix.

**Burden of malnutrition**

The included studies consistently demonstrate a substantial and multifaceted burden of malnutrition among adolescents in LMICs. Undernutrition remains highly prevalent, particularly in rural and socioeconomically disadvantaged populations, with stunting and thinness reflecting chronic nutritional deprivation.

Micronutrient deficiencies, particularly iron deficiency anaemia, among the most frequently reported conditions, disproportionately affecting adolescent girls due to increased physiological demands and, in some settings, early pregnancy.

Concurrently, there is a rising prevalence of overweight and obesity, particularly in urban and peri-urban areas. This shift reflects broader nutrition transitions characterized by increased consumption of energy-dense, nutrient-poor foods and reduced physical activity. The coexistence of undernutrition and overnutrition across settings underscores the persistence of the double burden of malnutrition within LMIC populations.

**Dietary patterns and determinants**

Across studies, adolescent dietary patterns were characterized by low dietary diversity, inadequate intake of fruits, vegetables, and protein-rich foods, and increasing consumption of ultra-processed foods and sugar-sweetened beverages.

Meal skipping particularly breakfast was frequently reported and associated with poorer dietary quality and reduced academic performance. These patterns were influenced by multiple determinants, including socioeconomic status,

household food security, cultural practices, and urban food environments.

Urbanisation emerged as a key driver of dietary change, increasing access to processed foods and exposure to unhealthy food marketing. At the same time, adolescents from low-income households often faced structural barriers to accessing diverse and nutritious diets, reinforcing inequalities in nutritional outcomes.

**Health outcomes associated with poor nutrition**

The reviewed evidence highlights significant short- and long-term health consequences of inadequate nutrition during adolescence. Undernutrition was associated with impaired physical growth, delayed maturation, and increased susceptibility to infectious diseases.

Micronutrient deficiencies, particularly anemia, were linked to reduced cognitive performance, fatigue, and decreased academic achievement. In contrast, overweight and obesity were associated with increased risk of non-communicable diseases, including type 2 diabetes and cardiovascular conditions, with implications extending into adulthood.

Importantly, several studies emphasized intergenerational effects, particularly among adolescent girls, where poor nutritional status contributes to adverse maternal and neonatal outcomes.

**Nutrition interventions**

A range of intervention strategies targeting adolescent nutrition in LMICs were identified, varying in scope, delivery platforms, and

effectiveness.

**Table 3: Types of nutrition interventions**

Intervention Type	Description	Reported Outcomes	Key Limitations
School-based programs	Feeding, nutrition education	Improved dietary intake, attendance	Limited coverage, sustainability
Micronutrient supplementation	Iron, folic acid, multiple micronutrients	Reduced anemia prevalence	Adherence, supply issues
Policy interventions	Taxation, food regulation	Improved food environment	Implementation variability
Community-based programs	Behaviour change, awareness	Improved knowledge and practices	Resource-intensive
Digital interventions	mHealth, social media	Increased engagement	Limited evidence

**School-based interventions**

School-based interventions were the most commonly reported strategy, including school feeding programs, nutrition education, and health promotion activities. These interventions demonstrated improvements in dietary intake, nutritional status, and school attendance, particularly when implemented as integrated programmes.

**Micronutrient supplementation**

Micronutrient supplementation, particularly iron-folic acid programmes, showed effectiveness in reducing anemia among adolescent girls. However, outcomes varied depending on programme coverage, adherence, and health system capacity.

**Policy-level interventions**

Policy approaches, including taxation of sugar-sweetened beverages, food labelling, and regulation of unhealthy food marketing, aimed to modify broader food environments. Evidence suggests these strategies have potential population-level impact, although implementation remains inconsistent across LMICs.

**Behavioural and community-based interventions**

Community-based and behavioural interventions focused on improving dietary practices through education, social support, and behaviour change communication. Emerging approaches using digital platforms and mobile technologies

demonstrated potential for engaging adolescents, although evidence remains limited.

**Discussion**

This scoping review synthesizes current evidence on adolescent nutrition in low- and middle-income countries (LMICs), highlighting the persistent coexistence of undernutrition, micronutrient deficiencies, and rising overweight and obesity. The findings indicate that adolescent nutrition is shaped by a complex interplay of socioeconomic, environmental, and behavioural determinants, with interventions demonstrating variable effectiveness across contexts.

A key insight from this review is the persistence of the double burden of malnutrition as a structural and sustained public health challenge rather than a transient phase. This aligns with findings reported by Salam and colleagues (14), who emphasized that nutritional inequalities in LMICs are increasingly driven by systemic factors, including poverty, food insecurity, and unequal access to health services. Similarly, a multi-country analysis by Keats et al. (15) demonstrated that adolescents in LMICs are simultaneously exposed to risks of both undernutrition and excess weight gain due to rapid dietary transitions. These findings suggest that the double burden is not merely a consequence of individual behaviors but is embedded within broader transformations in food systems and urban environments.

The review further underscores the role of dietary transitions characterized by increased

consumption of ultra-processed foods and reduced dietary diversity. This pattern is consistent with evidence presented by Popkin et al. (16), who described a global shift towards energy-dense, nutrient-poor diets in LMICs, driven by urbanization and market integration. Similarly, findings from Pries et al. (17) highlight the growing penetration of ultra-processed foods in adolescent diets, particularly in urban settings, contributing to both micronutrient deficiencies and excess caloric intake. These studies reinforce the need to address food environments as a central determinant of adolescent nutrition rather than focusing solely on individual-level interventions.

Socioeconomic disparities emerged as a critical determinant of nutritional outcomes, with adolescents from low-income households facing limited access to diverse and nutritious foods. This observation is supported by Akseer et al. (18), who identified poverty and food insecurity as key drivers of malnutrition in LMICs. Furthermore, Neufeld et al. (19) emphasized that structural inequities, including gender norms and educational disparities, disproportionately affect adolescent girls, increasing their vulnerability to micronutrient deficiencies such as anemias. However, the current evidence base remains skewed towards female populations, with limited attention to adolescent boys and out-of-school adolescents. This imbalance has also been noted by Norris et al. (20), who argue for more inclusive research frameworks that capture the diversity of adolescent experiences.

In terms of health outcomes, the findings of this review corroborate existing evidence linking poor adolescent nutrition to both immediate and long-term consequences. Black et al. (21) demonstrated that undernutrition during adolescence is associated with impaired growth and reduced human capital development, while Afshin et al. (22) highlighted the increasing contribution of dietary risk factors to the global burden of non-communicable diseases. The coexistence of these risks within the same populations underscores the need for integrated approaches that address multiple forms of malnutrition simultaneously.

The effectiveness of current interventions appears

to be mixed, reflecting challenges in implementation, coverage, and sustainability. While micronutrient supplementation programmes, particularly iron-folic acid interventions, have shown benefits in reducing anemia, their broader impact on health outcomes remains limited. This finding is consistent with evidence reported by Tam et al. (23), who noted that supplementation alone is insufficient to address the multifactorial nature of malnutrition. Similarly, school-based interventions, although widely implemented, demonstrate variable effectiveness depending on programme quality and contextual factors. A systematic review by Best et al. (24) found that school feeding programmes can improve dietary intake and educational outcomes, but their long-term sustainability remains uncertain.

Emerging evidence suggests that multi-component and context-specific interventions are more effective in addressing adolescent malnutrition. For instance, Ruel et al. (25) emphasized the importance of integrating nutrition-specific and nutrition-sensitive approaches, including education, social protection, and food system interventions. Additionally, digital and community-based strategies have shown potential for improving dietary behaviors among adolescents, although robust evidence on their long-term impact is still limited (26).

Importantly, this review highlights a significant gap in longitudinal and implementation research. Most studies focus on short-term outcomes, such as dietary intake or biochemical indicators, with limited assessment of sustained impacts on health, education, and economic productivity. This limitation has also been identified by Patton et al. (27), who advocate for a life-course approach to adolescent health, emphasizing the long-term benefits of early nutritional interventions.

From a policy perspective, the findings underscore the need for multi-sectoral strategies that address the structural determinants of adolescent nutrition. As highlighted by the World Health Organization (28), effective interventions must integrate health, education, agriculture, and social protection systems to create supportive

environments for healthy dietary behaviors. Regulatory approaches, including taxation of unhealthy foods and restrictions on marketing, are increasingly recognized as essential components of such strategies.

Overall, the evidence suggests that addressing adolescent nutrition in LMICs requires a shift from fragmented, single-component interventions towards comprehensive, systems-based approaches. Without such a shift, existing inequalities and the dual burden of malnutrition are likely to persist, undermining long-term health and development outcomes.

### Limitations

This review has few limitations. The inclusion of studies published between 2018 and 2025 may have excluded earlier evidence relevant to long-term trends in adolescent nutrition. The heterogeneity of study designs, populations, and outcome measures limited direct comparability and precluded quantitative synthesis. A large proportion of included studies were cross-sectional, restricting causal inference. Additionally, reliance on self-reported dietary data may introduce recall and reporting bias. Geographical representation across LMICs was uneven, potentially affecting generalisability. Although grey literature was considered, publication bias cannot be ruled out. Finally, formal quality appraisal was not undertaken, consistent with scoping review methodology, and variations in study rigor were not systematically assessed.

### Conclusion

Adolescent nutrition in low- and middle-income countries remains a complex and under-addressed public health challenge, characterized by the coexistence of undernutrition, micronutrient deficiencies, and rising overweight and obesity. This review highlights the influence of rapidly changing food environments, socioeconomic inequalities, and behavioural factors in shaping adolescent dietary patterns and health outcomes. Current interventions, including

supplementation, school-based programmes, and policy measures, demonstrate potential but remain limited by variability in implementation, coverage, and sustainability. The findings underscore the need for integrated, multi-sectoral strategies that address both immediate nutritional needs and the broader structural determinants of malnutrition. Adolescence represents a critical window of opportunity to improve health trajectories and break intergenerational cycles of malnutrition. Strengthening evidence-based interventions, enhancing policy coherence, and prioritizing inclusive research are essential to achieving sustainable improvements in adolescent nutrition across LMICs.

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**Ethical Approval:** Not required, as this study is based on secondary data from published literature.

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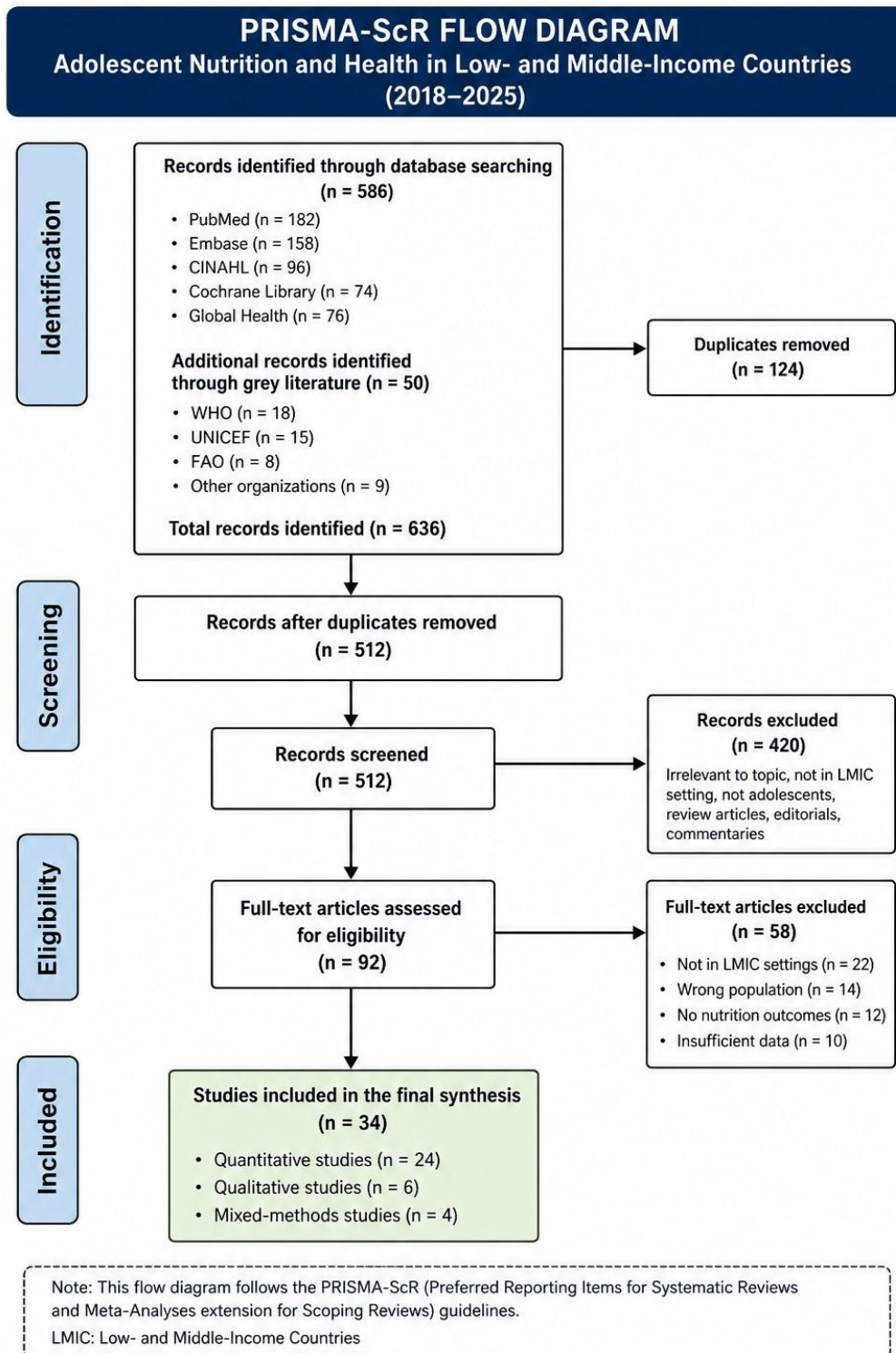


Figure 1: PRISMA Flow Chart

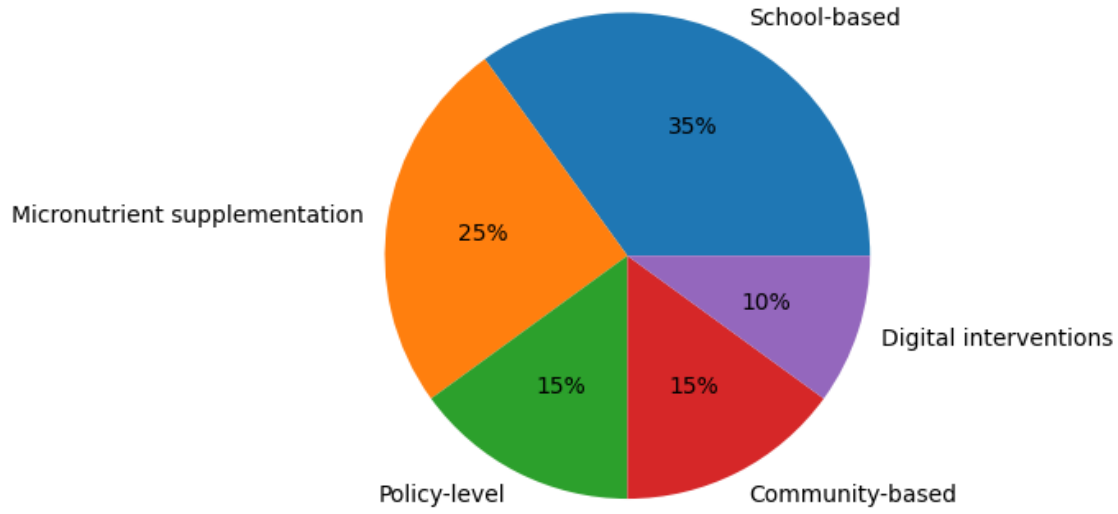


Figure 2: Distribution of nutrition interventions targeting adolescents in low- and middle-income countries (LMICs)