Social Science & Medicine 374 (2025) 118047

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Rural-urban migration dynamics and double burden of malnutrition among women across 29 low and middle income countries

Jinseo Kim [a], Seung-Ah Choe [b], Hwa-Young Lee [c,d], S.V. Subramanian [e,f], Rockli Kim [a,g,*]

[a] Interdisciplinary Program in Precision Public Health, Department of Public Health Sciences, Graduate School of Korea University, 145 Anam-ro, Seongbuk-gu, Seoul, 02841, Republic of Korea

[b] Department of Preventive Medicine, Korea University College of Medicine, 73 Inchon-ro, Seongbuk-Gu, Seoul, 02841, Republic of Korea

[c] Graduate School of Public Health and Healthcare Management, The Catholic University of Korea, 222 Banpo-daero, Seocho-gu, Seoul, 06591, Republic of Korea

[d] Catholic Institute for Public Health and Healthcare Management, The Catholic University of Korea, 222 Banpo-daero, Seocho-gu, Seoul, 06591, Republic of Korea

[e] Harvard Center for Population and Development Studies, 9 Bow Street, Cambridge, MA, 02138, USA

[f] Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, 677 Huntington Avenue, Boston, MA, 02115, USA

[g] Division of Health Policy and Management, College of Health Sciences, Korea University, 145 Anam-ro, Seongbuk-gu, Seoul, 02841, Republic of Korea

ARTICLE INFO

Handling editor: Social Epidemiology Office

Keywords:
Undernutrition
Overnutrition
Internal migration
LMICs
Nutritional transition

ABSTRACT

The double burden of malnutrition (DBM) is a significant public health issue in low- and middle-income countries (LMICs), resulting from complex socioeconomic, demographic and nutrition transitions. This study examined the association between internal migration and DBM among women across LMICs, focusing on direction, recency, and age at migration. Using the latest Demographic and Health Survey (2010–2023), data on body mass index, migration status, and covariates were extracted from 232,449 women aged 15–49 years in 29 countries. Migration status was categorised as urban non-migrants, rural non-migrants, urban-to-rural, or rural-to-urban based on prior and current residences. Recency and age at migration were categorised as recent/non-recent (within the last five years or earlier) and childhood/adulthood (before or after age 19). Multinomial multivariable logistic regressions were used to estimate odds ratio for each migrant groups relative to urban and rural non-migrants, respectively. Further analyses examined the association between DBM and recency, and age at migration, among migrants. Overall, 32.1 % of women were overweight/obese while 9.7 % were underweight. Urban-to-rural migrants accounted for 9.5 % of the sample, and rural-to-urban migrants constituted 7.0 %. Rural-to-urban migrants had 21.0 % higher odds of being overweight/obese (95 % CI: 1.15–1.29) compared to rural non-migrants. Urban-to-rural migrants showed 9.0 % lower odds of being underweight (95 % CI: 0.85–0.99) compared to urban non-migrants. Among migrants, recency of migration and age at migration were found to be significantly associated with DBM. This study emphasises the need for targeted public health strategies to enhance immediate and distal determinants of DBM in urban and rural settings in LMICs.

1. Introduction

The emergence of double burden of malnutrition (DBM) presents significant burden on population health and healthcare systems in low- and middle-income countries (LMICs) (Kolčić, 2012). This phenomenon is characterised by the coexistence of undernutrition and overnutrition within the same population due to rapid nutrition transition driven by economic growth and urbanisation, which contribute to shifts in dietary patterns and lifestyles (Escher et al., 2024; Kolčić, 2012). The coexistence of traditional and newer dietary patterns, coupled with socioeconomic and cultural factors, makes women in LMICs particularly vulnerable to DBM. Despite the availability of modern dietary resources, pregnant women in LMICs often adhere to traditional beliefs, which increases their risk of undernutrition. For instance, a systematic review in Ethiopia found that pregnant women often avoid vegetables and fruits due to cultural taboos (Gebregziabher et al., 2023). Additionally, cultural norms prioritising household needs often lead mothers to sacrifice their own nutrition for the benefit of their children, exacerbating the risk of undernutrition (Jung et al., 2017; Matheson and McIntyre, 2014). However, in some regions in sub-Saharan Africa, socio-cultural norms

* Corresponding author. Division of Health Policy and Management, College of Health Sciences, Korea University, 145 Anam-ro, Seongbuk-gu, Seoul, 02841, Republic of Korea.

E-mail address: rocklikim@korea.ac.kr (R. Kim).

https://doi.org/10.1016/j.socscimed.2025.118047
Received 26 December 2024; Received in revised form 1 March 2025; Accepted 28 March 2025
Available online 31 March 2025
0277-9536/

can also increase the risk of overnutrition, where larger body sizes are viewed as indicators of prosperity and fertility (Onyango et al., 2019). Therefore, it is important to understand various drivers of DBM among women and comprehensively manage them.

Internal migration, defined as moving residence to different regions within a country, is a pervasive socio-economic phenomenon in LMICs (McAuliffe and Triandafyllidou, 2021). Despite globalisation, only 3.6 % of the global population are international migrants, indicating that a significant majority of people still reside in their country of birth (McAuliffe and Triandafyllidou, 2021). Shifts in rural and urban living conditions can impact people's health behaviours, exposure to environmental factors, and access to healthcare services, affecting their nutritional health after migration (Abubakar et al., 2018; Fadlallah et al., 2020).

Rapid urbanisation in LMICs, driven by internal migration, is projected to result in 67.0 % of the population residing in urban areas by 2050 (Pheiffer, 2021; Qian et al., 2021; United Nations, 2004). The increase in population density in urban areas has contributed to the creation of obesogenic environments, including lack of green spaces and unhealthy dietary habits (Rahaman et al., 2023). In addition, rapid urbanisation in LMICs, combined with inadequate urban planning and shortage in essential infrastructure, has led to the proliferation of slums (Abdulhadi et al., 2024; Amegah, 2021). In these environments, migrants frequently face limited access to affordable and nutritious food options, resulting in a greater dependence on energy-dense and nutrient-poor foods (Amegah, 2021; Bowen et al., 2011; Gupta et al., 2016). Therefore, this shift towards increased consumption of energy-dense and processed foods can lead to overnutrition among rural-to-urban migrants, compared to rural non-migrants (Sullivan et al., 2011).

While economic factors primarily drive both urban-to-rural and rural-to-urban migrations, the former often involves individuals moving due to escalated urban living costs, indicating the population's relative vulnerability (Karsten, 2020). Food insecurity is more prevalent in rural areas due to limited food diversity and lower incomes (Paştiu et al., 2024). Globally, 33.3 % of adults in rural areas experienced moderate to severe food insecurity in 2022, compared to 26.0 % in urban areas (UNICEF, 2020). In addition, poor water, sanitation, and hygiene (WASH) in rural areas are major risk factors for underweight, contributing to chronic diarrhoea, soil-transmitted helminth infections, and environmental enteric dysfunction (Cumming and Cairncross, 2016). Lastly, insufficient utilisation of healthcare, which are common in rural areas in LMICs, can lead to delays in the diagnosis and treatment of infectious diseases, which contribute to undernutrition (Garchitorena et al., 2021; Stock, 1983). For all these reasons, urban-to-rural migrants are expected to face higher risk of being underweight compared to urban non-migrants.

At the same time, internal migration may affect DBM differentially depending on the varying duration of exposure to new lifestyle factors and environmental risks among migrants. These changes among migrants are often explained by the adaptation and assimilation hypotheses. The adaptation hypothesis suggests that migrants deliberately change their behaviour to adjust to the new environment and to fully take advantage of new opportunities (Assaf, 2023; Hervitz, 1985). On the other hand, the assimilation hypothesis suggests that migrants slowly adopt and internalise the norms of their new community (Assaf, 2023; Hervitz, 1985). Newer migrants may initially retain certain dietary habits, food preferences, and activity patterns from their previous environment, whether rural or urban. However, as they spend more time in their new environment, their health risks become more similar to those of their destination non-migrants (Assaf, 2023; Budyta-Budzyńska, 2011). According to a study conducted in Kenya, migrant women who moved from rural to urban areas for more than ten years had a higher risk of becoming overweight or obese compared to those who experienced migration for five years or less (Peters et al., 2019). This indicates that long-term, accumulated exposure to urban environments can lead to a nutritional transition, shifting away from diverse, nutrient-rich rural diets (Weerasekara et al., 2020).

In contrast, urban-to-rural migrants initially carry 'urban advantages' such as better awareness and utilisation of healthcare resources (Assaf, 2023; Norris et al., 2022; UNICEF, 2019). However, with longer durations post-migration, these advantages fade, aligning their health outcomes more closely with those of long-term rural residents. For instance, a pooled analysis across 15 LMICs found that recent urban-to-rural migrants had significantly fewer problems accessing healthcare (PAHC) than rural non-migrants (Assaf, 2023). However, when migration from urban to rural areas occurred more than three years ago, there was no significant difference in PAHC between them and rural non-migrants (Assaf, 2023). Over time, challenges related to healthcare in rural areas can lead to delayed diagnosis and treatment of malnutrition or repeated infectious diseases, thereby increasing the risks of underweight among these migrants (Garchitorena et al., 2021; Pheiffer, 2021; Qian et al., 2021; Stock, 1983). Additionally, rural areas in LMICs often experience more significant seasonal variations in food availability than urban areas, resulting in deficiencies of essential nutrients and increasing the risk of chronic malnutrition (Kirk et al., 2019). Therefore, it is important to consider the time since migration to better understand and address these challenges effectively.

The age at which a person migrates can also significantly impact their nutrition-related health trajectories. Migrant children face many challenges when adapting to a new environment, including changes in their diet (Roshania et al., 2008), which are known to shape their dietary choices in later adulthood (Berggreen-Clausen et al., 2022). Adult migrants, on the other hand, may have more resilience to the challenges following migration. With autonomy in decision-making, prior life experiences, and knowledge regarding their dietary habits, adult migrants can make better decisions when adapting to new environments. (Gong et al., 2011; McDonald and Kennedy, 2005). Therefore, migration in adulthood may have less significant impact on DBM compared to childhood migration.

While current evidence generally supports a meaningful association between internal migration and malnutrition, significant knowledge gaps still exist. First, despite the importance of comprehensively addressing DBM in LMICs, research has only focused on overnutrition, and little is known about the association between internal migration and undernutrition. Second, although internal migration occurs in both direction (from rural to urban areas and vice versa), majority of studies define internal migration only in the rural-to-urban aspect. This is problematic since a considerable proportion of adult women migrate from urban to rural areas in LMICs. For instance, in the Philippines, about 10.0 % of adult women moved from urban to rural areas in 2017, compared to 5.2 % moving from rural to urban areas (Assaf, 2023). Third, the duration since migration and age at migration are often overlooked in current literature. Fourth, the complex interplay between migration and nutrition among women remains underexplored. In LMICs, internal migration is highly gendered, with women often migrating for family reasons, which may exacerbate DBM by exposing them to new dietary environments and changing cultural norms (Kanaiaupuni, 2000; Pheiffer, 2021). Lastly, most research has focused on individual countries, making it challenging to generalise the findings across LMICs (Gupta et al., 2016; Qian et al., 2021; Tymejczyk et al., 2019).

To address these gaps, this study provides a comprehensive analysis of the association between internal migration and malnutrition among women across 29 LMICs. Specifically, it aims to use nationally representative data to explore how urban-to-rural and rural-to-urban migration patterns are associated with under and over-nutrition compared to their non-migrant counterparts. Additionally, within each type of migration, this study will comprehensively assess heterogeneity by the recency of migration and age at migration. Through these multifaceted analyses, this study aims to contribute to a better understanding of the complex interplay between internal migration and DBM in LMICs.

2. Methods

2.1. Data source

The Demographic and Health Survey (DHS) are nationally representative cross-sectional surveys, providing data on key population, health, fertility, and nutrition indicators (Corsi et al., 2012). Secondary data analysis was performed using DHS completed between 2010 and 2023 to guarantee consistency in measured variables. A total of 29 LMICs included relevant information on the previous place of residence needed to construct migration status, as well as height and weight measures to calculate body mass index (BMI). In general, DHS follows a two-stage cluster sampling procedure. The details of the survey design are well-documented elsewhere (Corsi et al., 2012).

2.2. Study population

The study population comprised women aged 15–49 years from 29 LMICs (Table 1). This study utilised the inclusion/exclusion criteria illustrated in Fig. 1. The exclusion criteria included visitors, international migrants, and women who were pregnant during the survey, resulting in the exclusion of 28,249 respondents. Then, those with inadequate information for calculating BMI or with extreme BMI values (<12.0 kg/m^2 or >60.0 kg/m^2) were excluded. Consequently, the final sample consisted of 232,449 women across 29 countries.

2.3. Outcome

The primary outcome of this study was categorised BMI (kg/m^2). SECA scales were used to measure weight across most surveys, except for Cambodia, where the UNICEF model was used (Demographic and Health Surveys Program, 2021; National Institute of Statistics et al., 2023). Height was measured with a ShorrBoard® measuring board in most countries, while Armenia and Cambodia used the UNICEF measuring board (Demographic and Health Surveys Program, 2021; National Institute of Statistics et al., 2023; National Statistical Service - NSS/Armenia et al., 2017). According to the World Health Organization definition, BMI measures were classified as underweight (<18.5 kg/m^2), normal weight (18.5–25.0 kg/m^2), overweight (25.0–30.0 kg/m^2), and obese (>30.0 kg/m^2) (World Health Organization Consultation, 2000). For the purpose of our analysis, we combined the category of overweight and obesity. Due to the multi-country nature of this study, we chose to apply these standard cut-offs instead of using population-specific thresholds to maintain comparability across different settings.

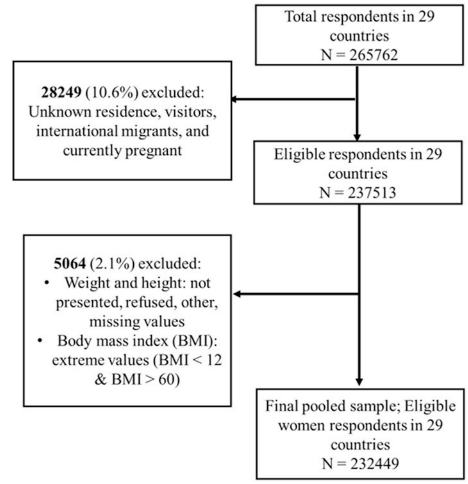

Fig. 1. Flow diagram for the selection of study population.

Table 1
Internal migration status across 29 low- and middle-income countries.

Country	Year of Survey	Sample Size	Internal Migration Status			
			Rural non-migrants	Urban non-migrants	Urban-to-rural	Rural-to-urban
Pooled	–	232449	110916 (47.7 %)	83106 (35.8 %)	22127 (9.5 %)	16300 (7.0 %)
Albania	2017–18	10283	3304 (32.1 %)	4666 (45.4 %)	2313 (22.5 %)	-*
Armenia	2015–16	5574	2109 (37.8 %)	2936 (52.7 %)	263 (4.7 %)	266 (4.8 %)
Benin	2017–18	6684	2882 (43.1 %)	2578 (38.6 %)	870 (13.0 %)	354 (5.3 %)
Burkina Faso	2021	7590	4463 (58.8 %)	2188 (28.8 %)	462 (6.1 %)	477 (6.3 %)
Burundi	2016–17	7697	3106 (40.4 %)	1629 (21.2 %)	2962 (38.5 %)	-*
Cambodia	2021–22	9215	5584 (60.6 %)	2738 (29.7 %)	247 (2.7 %)	646 (7.0 %)
Cameroon	2018–19	5970	1956 (32.8 %)	2760 (46.2 %)	748 (12.5 %)	506 (8.5 %)
Cote d'Ivoire	2021	6169	2122 (34.4 %)	2912 (47.2 %)	898 (14.6 %)	237 (3.8 %)
Gabon	2019–21	5324	706 (13.3 %)	3649 (68.5 %)	794 (14.9 %)	175 (3.3 %)
Ghana	2022–23	6886	2339 (34.0 %)	2950 (42.8 %)	1101 (16.0 %)	496 (7.2 %)
Guinea	2018	4772	2711 (56.8 %)	1636 (34.3 %)	300 (6.3 %)	125 (2.6 %)
Haiti	2016–17	8878	4467 (50.3 %)	2928 (33.0 %)	813 (9.2 %)	670 (7.5 %)
Kenya	2022	15426	8420 (54.6 %)	4154 (26.9 %)	1095 (7.1 %)	1757 (11.4 %)
Liberia	2019–20	3616	1645 (45.5 %)	1367 (37.8 %)	493 (13.6 %)	111 (3.1 %)
Madagascar	2021	8840	5777 (65.4 %)	2072 (23.4 %)	619 (7.0 %)	372 (4.2 %)
Malawi	2015–16	7295	5202 (71.3 %)	1141 (15.6 %)	492 (6.7 %)	460 (6.3 %)
Mali	2018	4450	2668 (60.0 %)	1320 (29.7 %)	287 (6.4 %)	175 (3.9 %)
Mauritania	2019–21	6627	3063 (46.2 %)	2842 (42.9 %)	321 (4.8 %)	401 (6.1 %)
Nepal	2018–19	6484	2745 (42.3 %)	1923 (29.7 %)	227 (3.5 %)	1589 (24.5 %)
Nigeria	2018	13213	6437 (48.7 %)	4911 (37.2 %)	1225 (9.3 %)	640 (4.8 %)
Peru	2012	22212	5527 (24.9 %)	12781 (57.5 %)	1749 (7.9 %)	2155 (9.7 %)
Rwanda	2019–20	6766	4755 (70.3 %)	957 (14.1 %)	366 (5.4 %)	688 (10.2 %)
Sierra Leone	2019	6897	3474 (50.4 %)	2367 (34.3 %)	530 (7.7 %)	526 (7.6 %)
Tajikistan	2017	9801	5419 (55.3 %)	3690 (37.6 %)	493 (5.0 %)	199 (2.0 %)
Tanzania	2022	6969	4091 (58.7 %)	2023 (29.0 %)	395 (5.7 %)	460 (6.6 %)
Timor-Leste	2016	11681	7187 (61.5 %)	3416 (29.2 %)	520 (4.5 %)	558 (4.8 %)
Uganda	2016	5356	3515 (65.6 %)	772 (14.4 %)	586 (10.9 %)	483 (9.0 %)
Zambia	2018	3026	1285 (42.5 %)	1282 (42.4 %)	111 (3.7 %)	348 (11.5 %)
Zimbabwe	2015	8748	3957 (45.2 %)	2518 (28.8 %)	847 (9.7 %)	1426 (16.3 %)

*None of the respondents indicated rural as their previous residence in both countries.

2.4. Exposure

Migration status was determined based on the respondent's previous residence (countryside, town, or city/capital regions) and current place of residence (either urban or rural areas). Aligning with previous literature, individuals who answered 'town' or 'city/capital' for their previous residence were classified as having previously lived in an urban area (Assaf, 2023; Global Burden of Diseases 2019 Diseases and Injuries Collaborators, 2020). Anyone who experienced a change in place of residence from rural to urban or urban to rural was classified as an internal migrant. Those who moved within urban areas or within rural areas were classified as urban and rural non-migrants, respectively. This classification was based on the study's assumption that such intra-urban or intra-rural moves involve relatively marginal changes in environments that would not substantially affect nutritional health (Assaf, 2023). Consequently, the exposure variable was categorised as: 1) urban non-migrants, 2) rural non-migrants, 3) rural-to-urban migrants, and 4) urban-to-rural migrants.

The study examined the recency of migration as both a categorical and continuous variable, based on years lived in the current residence. Recent migrants were defined as those who lived in the current residence for less than five years, while non-recent migrants were those who lived in the current residence for at least five years (Chilunga et al., 2019). The continuous variable was utilised to examine the dose-response relationship between exposure to the current residence and malnutrition. Lastly, age at migration was calculated by subtracting the years lived in the current residence from the respondent's current age. Then, it was categorised into childhood (migrated before the age of 19) and adulthood (migrated at the age of 19 and above) migration.

2.5. Covariates

For the regression models, covariates were selected based on previous literature and their consistency in availability across countries: household wealth index (in quintiles), women's education level (no education, primary, secondary, and higher), age group (categorised in ten-year intervals), number of children (zero, one, two, three or more), and marital status (never married, currently married, divorced or widowed).

2.6. Statistical analysis

The study first assessed the distribution of categorised BMI and covariates by four categories of migration status. Chi-square tests were conducted to determine if any differences existed in the distributions by migration status. For the primary analysis, the association between internal migration and malnutrition was examined using multivariable multinomial logistic regression model for the probability of Y = 'Underweight' or 'Overweight or obese' versus the probability of the reference group 'Normal weight':

$$\ln \frac{\Pr(Y_i = j)}{\Pr(Y_i = \text{Normal})} = \beta_0 + \beta_1 \mathit{Migration\ Pattern}_i + \beta_2 X_i$$

$$, j = \text{'}\mathit{Underweight}\text{'}, \text{'}\mathit{Overweight\ or\ obese}\text{'} \quad (1)$$

, where X is a matrix of control variables and country fixed effects. To compare the distinct migration patterns relative to both urban and rural non-migrants, this model was estimated twice: first, specifying urban non-migrants as the reference category, and then using rural non-migrants as the reference category for the exposure variable.

The second stage of analysis was restricted to migrants only, stratified by rural-to-urban and urban-to-rural migrants. In Model 2, we analysed the association between the recency of migration and malnutrition, while controlling for covariates and age at migration. We adjusted for age at migration to assess the independent association between recency of migration and the outcomes.

$$\ln \frac{\Pr(Y_i = j)}{\Pr(Y_i = \text{Normal})} = \beta_0 + \beta_1 \mathit{Recency\ of\ Migration}_i + \beta_2 X_i$$

$$, j = \text{'}\mathit{Underweight}\text{'}, \text{'}\mathit{Overweight\ or\ obese}\text{'} \quad (2)$$

To ensure the robustness of our findings, we examined potential dose-response relationships, by repeating Model 2 while considering the recency of migration as a continuous variable, measured in years lived in the current place.

In Model 3, we analysed the association between age at migration and malnutrition for rural-to-urban and urban-to-rural migrants separately. As our primary interest was age at migration, we adjusted for covariates and recency of migration for the aforementioned reasons.

$$\ln \frac{\Pr(Y_i = j)}{\Pr(Y_i = \text{Normal})} = \beta_0 + \beta_1 \mathit{Age\ at\ Migration}_i + \beta_2 X_i$$

$$, j = \text{'}\mathit{Underweight}\text{'}, \text{'}\mathit{Overweight\ or\ obese}\text{'} \quad (3)$$

Sensitivity analyses were conducted considering the role of demographic and health behaviour factors as both mediators and confounders in the relationship between internal migration and DBM. For example, women's working status, smoking status, health insurance status, and PAHC were excluded from the primary analysis to avoid over-adjustment for their potential mediation effects. In the sensitivity analysis, we further adjusted for these variables to check for robustness of our main findings.

R was used (4.2.2), and all analyses accounted for complex survey design to adjust for clustering among observations and obtain robust standard errors. All results are presented as odds ratio (OR) with 95 % confidence intervals (CI).

3. Results

Among the study population, 47.7 % were rural non-migrants, followed by 35.8 % urban non-migrants, 9.5 % urban-to-rural migrants and 7.0 % rural-to-urban migrants (Table 1). Fifteen countries showed a higher proportion of urban-to-rural migration, ranging from 5.0 % in Tajikistan to 16.0 % in Ghana, when compared to their rural-to-urban counterparts. On the other hand, twelve countries had a greater proportion of rural-to-urban migration, with figures varying from 4.8 % in Armenia and Timor-Leste to 24.5 % in Nepal.

As per the outcome distribution, of the total 232,449 women, only 9.7 % were underweight whereas 32.1 % were overweight/obese (Table 2). A higher prevalence of underweight was observed among rural non-migrants (12.0 %) and urban-to-rural migrants (8.4 %), compared to urban non-migrants (7.6 %) and rural-to-urban migrants (6.6 %). Conversely, the prevalence of overweight/obesity was higher among women living in urban areas, particularly among urban non-migrants (41.9 %). Among urban-to-rural migrants, 44.0 % were recent migrants (migrated within the last five years) and 64.6 % were adulthood migration. Among rural-to-urban migrants, 41.2 % were recent migrants and 56.7 % were adulthood migration.

Table 3 shows the association between internal migration status and DBM. When accounting for all covariates and country fixed effects, rural-to-urban migrants exhibited 7.0 % lower odds of being underweight compared to rural non-migrants, although this association was not statistically significant (95 % CI: 0.85–1.02). On the other hand, rural-to-urban migrants had a significantly higher odds of being overweight/obese (OR: 1.21, 95 % CI: 1.15–1.29). Furthermore, when compared to urban non-migrants, women who migrated from urban to rural areas had a significantly lower odds of being underweight (OR: 0.91, 95 % CI: 0.85–0.99). Their risk of being overweight/obese, however, was not significantly different from that of urban non-migrants (OR: 0.98, 95 % CI: 0.93–1.03).

Table 4 presents the association between recency of migration and

Table 2
Distribution of nutritional status and covariates by internal migration status.

	Overall	Non-migrants		Migrants		P-value*
		Rural	Urban	Urban-to-Rural	Rural-to-Urban	
	232449	110915 (47.7 %)	83106 (35.8 %)	22127 (9.5 %)	16300 (7.0 %)	
Nutritional Status†						
Normal	135250 (58.2 %)	71823 (64.8 %)	42018 (50.6 %)	12820 (57.9 %)	8589 (52.7 %)	p < 0.001
Underweight	22548 (9.7 %)	13303 (12.0 %)	6301 (7.6 %)	1862 (8.4 %)	1082 (6.6 %)	
Overweight or Obese	74651 (32.1 %)	25790 (23.3 %)	34787 (41.9 %)	7445 (33.6 %)	6629 (40.7 %)	
Age						
15–24	87012 (37.4 %)	42869 (38.7 %)	32028 (38.5 %)	6574 (29.7 %)	5541 (34.0 %)	p < 0.001
25–34	68253 (29.4 %)	30836 (27.8 %)	24784 (29.8 %)	7513 (34.0 %)	5120 (31.4 %)	
35–44	55226 (23.8 %)	26372 (23.8 %)	18936 (22.8 %)	5788 (26.2 %)	4130 (25.3 %)	
45–49	21958 (9.4 %)	10839 (9.8 %)	7358 (8.9 %)	2252 (10.2 %)	1509 (9.3 %)	
Marital Status						
Currently in Union	141064 (60.7 %)	70745 (63.8 %)	43828 (52.7 %)	16251 (73.4 %)	10240 (62.8 %)	p < 0.001
Formerly in Union	19100 (8.2 %)	8206 (7.4 %)	7459 (9.0 %)	1796 (8.1 %)	1639 (10.1 %)	
Never in Union	72285 (31.1 %)	31965 (28.8 %)	31819 (38.3 %)	4080 (18.4 %)	4421 (27.1 %)	
Number of Living Children						
Zero	70673 (30.4 %)	31766 (28.6 %)	30333 (36.5 %)	4175 (18.9 %)	4399 (27.0 %)	p < 0.001
One	34770 (15.0 %)	14484 (13.1 %)	13794 (16.6 %)	3701 (16.7 %)	2791 (17.1 %)	
Two	39347 (16.9 %)	16621 (15.0 %)	15124 (18.2 %)	4327 (19.6 %)	3275 (20.1 %)	
Three or More	87659 (37.7 %)	48045 (43.3 %)	23855 (28.7 %)	9924 (44.9 %)	5835 (35.8 %)	
Highest Education Level						
No Education	48157 (20.7 %)	31620 (28.5 %)	9223 (11.1 %)	4899 (22.1 %)	2415 (14.8 %)	p < 0.001
Primary	66220 (28.5 %)	39007 (35.2 %)	14928 (18.0 %)	7403 (33.5 %)	4882 (30.0 %)	
Secondary	94307 (40.6 %)	36247 (32.7 %)	42340 (50.9 %)	8279 (37.4 %)	7441 (45.7 %)	
Higher	23765 (10.2 %)	4042 (3.6 %)	16615 (20.0 %)	1546 (7.0 %)	1562 (9.6 %)	
Wealth						
Poorest	46114 (19.8 %)	35704 (32.2 %)	3908 (4.7 %)	5562 (25.1 %)	940 (5.8 %)	p < 0.001
Poorer	45101 (19.4 %)	30390 (27.4 %)	7142 (8.6 %)	5681 (25.7 %)	1888 (11.6 %)	
Middle	46830 (20.1 %)	24680 (22.3 %)	14479 (17.4 %)	4782 (21.6 %)	2889 (17.7 %)	
Richer	47599 (20.5 %)	15074 (13.6 %)	23833 (28.7 %)	3726 (16.8 %)	4966 (30.5 %)	
Richest	46805 (20.1 %)	5068 (4.6 %)	33744 (40.6 %)	2376 (10.7 %)	5617 (34.5 %)	
Recency of Migration						
Recent	–	–	–	9734 (44.0 %)	6708 (41.2 %)	p < 0.001
Non-recent	–	–	–	12393 (56.0 %)	9592 (58.8 %)	
Age at Migration						
Childhood	–	–	–	7843 (35.4 %)	7058 (43.3 %)	p < 0.001
Adulthood	–	–	–	14284 (64.6 %)	9242 (56.7 %)	

*P-value from chi-square tests.
†Classified nutritional status as follows: underweight (<18.5 kg/m^2), normal weight (18.5–25 kg/m^2), and overweight/obese (>25 kg/m^2).

DBM among migrants. The categorised recency of migration was not significantly associated with malnutrition status among urban-to-rural migrants. On the other hand, for rural-to-urban migrants, the categorised recency of migration was significantly associated with overweight/obesity. Specifically, non-recent migrants had 31.0 % higher odds of being overweight/obese (95 % CI: 1.16–1.48) compared to their recently migrated counterparts. In terms of continuous measure of recency, for each additional year since migration among urban-to-rural migrants, the odds of being underweight increased by 1.0 % (95 % CI: 1.00–1.02). For every additional year since migration among rural-to-urban migrants, there was a 2.0 % increase in the odds of being overweight/obesity (95 % CI: 1.01–1.03).

Table 5 presents the association between age at migration and DBM among migrants. The associations between age at migration and malnutrition status were not statistically significant among urban-to-rural migrants. However, among rural-to-urban migrants, age at migration was significantly associated with overweight/obesity. Adulthood migration among rural-to-urban migrants had 13.0 % increased odds of being overweight/obese (95 % CI: 1.00–1.28), compared to their childhood counterparts.

The sensitivity analyses demonstrated the robustness of our main findings. After adjusting for working status and comprehensive health-related variables, rural-to-urban migrants exhibited 21.0 % higher odds of being overweight/obese (95 % CI: 1.15–1.29) compared to rural non-migrants. In addition, urban-to-rural migrants had 8.0 % lower odds of being underweight (95 % CI: 0.85–0.99) than urban non-migrants (Supplementary Table 1). Furthermore, significant associations were consistently reported between the recency of migration, both categorical and continuous, and overweight/obesity among migrants (Supplementary Table 2). However, the association observed for age at migration among rural-to-urban migrants became insignificant after adjusting for additional covariates (Supplementary Table 3).

Table 3
Associations between internal migration status and double burden of malnutrition (reference: normal weight).

Malnutrition status (Adjusted* OR (95 % CI))					
	Underweight	Overweight /Obesity		Underweight	Overweight /Obesity
Migration Status (Reference: Rural non-migrants)			**Migration Status** (Reference: Urban non-migrants)		
Urban non-migrants	1.11 (1.05, 1.17)	1.31 (1.26, 1.36)	Rural non-migrants	0.90 (0.85, 0.96)	0.76 (0.73, 0.80)
Urban-to-rural	1.01 (0.95, 1.08)	1.28 (1.23, 1.34)	Urban-to-rural	0.91 (0.85, 0.99)	0.98 (0.93, 1.03)
Rural-to-urban	0.93 (0.85, 1.02)	1.21 (1.15, 1.29)	Rural-to-urban	0.84 (0.77, 0.92)	0.93 (0.88, 0.98)

OR, odds ratio; CI, confidence intervals.
*Survey-structure adjusted multinomial logistic regressions were conducted, adjusting for covariates (categorised age, marital status, number of living children, education level, wealth) and country fixed effects.

Table 4
Associations between recency of migration and double burden of malnutrition (reference: normal weight) among migrants*.

	Malnutrition status (Adjusted* OR (95 % CI))			
	Underweight		Overweight or Obese	
	Urban-to-Rural	Rural-to-Urban	Urban-to-Rural	Rural-to-Urban
Categorical				
Recent [Ref]				
Non-recent	1.10 (0.95, 1.28)	1.10 (0.89, 1.36)	1.03 (0.94, 1.13)	1.31 (1.16, 1.48)
Continuous				
Years since migration	1.01 (1.00, 1.02)	1.00 (0.99, 1.02)	1.01 (1.01, 1.02)	1.02 (1.01, 1.03)

OR, odds ratio; CI, confidence intervals.
*Survey-structure adjusted multinomial logistic regressions were conducted, adjusting for covariates (categorised age, marital status, number of living children, education level, wealth), categorised age at migration, and country fixed effects.

Table 5
Associations between age at migration and double burden of malnutrition (reference: normal weight) among migrants*.

	Malnutrition status (Adjusted* OR (95 % CI))			
	Underweight		Overweight or Obese	
	Urban-to-Rural	Rural-to-Urban	Urban-to-Rural	Rural-to-Urban
Age at Migration				
Childhood [ref]				
Adulthood	0.90 (0.78, 1.04)	0.86 (0.71, 1.05)	1.10 (0.99, 1.22)	1.13 (1.00, 1.28)

OR, odds ratio; CI, confidence intervals.
*Survey-structure adjusted multinomial logistic regressions were conducted, adjusting for covariates (categorised age, marital status, number of living children, education level, wealth), categorised recency of migration, and country fixed effects.

4. Discussion

To the best of our knowledge, this is the first study to comprehensively analyse the association between internal migration and DBM across LMICs, considering multifaceted nature of internal migration, including direction, recency, and age at migration. Our analysis identified four key findings. First, we found that rural-to-urban migrants had significantly higher odds of being overweight/obese compared to their rural non-migrant counterparts. This association is consistent with earlier studies in LMICs (Peters et al., 2019; Wang et al., 2020), indicating the influence of urban environments, where processed foods high in fats and sugars are more accessible, and fresh produce is limited. For example, a study in India revealed that rural-to-urban migration is associated with negative dietary changes, characterised by higher energy intake and increased consumption of fats and sugars (Bowen et al., 2011). Additionally, deprived urban areas, including slums, often act as food deserts with limited access to fresh produce due to availability and transportation issues (Battersby, 2012; Kimani-Murage et al., 2014). Concurrently, these neighbourhoods are often food swamps, characterised by an abundance of calorie-dense foods and sugar-sweetened beverages (Andretti et al., 2023; Rose et al., 2009). A study in Brazil showed that both food deserts and swamps are predominantly found in the most deprived urban areas (Bridle-Fitzpatrick, 2015). While urban environments in LMICs generally offer more stable food availability than rural areas, food quality varies significantly, especially in slums, where poor migrants face a higher risk of obesity due to their obesogenic surroundings (Awumbila, 2014).

Second, in contrary to our initial hypothesis, we found that urban-to-rural migrants had a reduced odds of being underweight compared to urban non-migrants. This could potentially be explained by the protective effects of moving to rural areas, where there is greater access to fresh produce and diets that include more minimally processed foods (USAID Advancing Nutrition, 2022). Urban-to-rural migration often reduces living costs, allowing migrants to allocate more resources towards nutritious food options (UNICEF, 2023). Additionally, even though the availability of food in rural areas can vary by season, these regions often offer better access to fresh, locally-produced foods (Popkin et al., 2012). Coupled with higher purchasing power and urban advantages regarding health-seeking behaviours, these nutritional transitions can shift individuals toward healthier lifestyles, decreasing the likelihood of being underweight for urban-to-rural migrants.

Third, significant association between recency of migration and DBM was observed among rural-to-urban migrants. The increased odds of overweight/obesity among non-recent rural-to-urban migrants may be due to rapid adoption of urban dietary and lifestyle habits that occur within a relatively short amount of time (Losada-Rojas et al., 2021; Wang et al., 2017). Among urban-to-rural migrants, analysis utilising continuous variable for the duration since migration showed statistical significance with marginally increased odds of underweight, while categorical variables did not. The escalated odds of being underweight over time among urban-to-rural migrants may be due to challenges such as food insecurity or exposures to infectious diseases, which may take longer time to manifest their significant effects on BMI. Taken together, these findings support adaptation and assimilation theories, suggesting that the longer migrants reside in a new environment, the more their dietary and health behaviours reflect those of the destination community. Furthermore, our study suggests that the time required for assimilation could vary between urban and rural contexts.

Lastly, we found increased odds of overweight/obesity among adulthood rural-to-urban migrants, even after adjusting for the recency of migration, compared to their childhood counterparts. Although this finding contradicts our initial expectation that childhood rural-to-urban migrants may have a higher risk of overweight/obesity, it aligns with previous research in LMICs (Bernabe-Ortiz et al., 2010; Wang et al., 2020). One possible explanation is that adults who move from rural to urban areas may intentionally assimilate more rapidly to take advantage of urban opportunities, compared to childhood rural-to-urban migrants. It is well-known that in many LMICs, higher socioeconomic positions (SEP) are positively associated with overweight/obesity among women due to socio-cultural norms (Jäger et al., 2022; Onyango et al., 2019). Therefore, faster assimilation to urban lifestyles to actively achieve higher SEP can contribute to the increased odds of overweight/obesity among adulthood rural-to-urban migrants.

The findings of our study highlight the significance of understanding the causes and consequences of migration patterns to address DBM at the population level. Our study highlights the need for policies that promote equitable access to nutritious and affordable dietary options, particularly in deprived urban areas. Low-income urban areas have limited access to nutritious foods due to the scarcity of fresh fruits and vegetables, as well as inadequate transportation for grocery shopping (Battersby, 2012; Kimani-Murage et al., 2014). Ensuring affordability and accessibility of healthy food options can be done by supporting small and medium enterprises (SMEs) to serve as vital links between primary producers and consumers in urban areas of LMICs (UNICEF, 2023). Modernising the agrifood sector and subsidising logistics infrastructure can enhance the distribution of fresh produce in urban areas at reduced costs, ultimately improving food security and nutrition outcomes (UNICEF, 2023).

At the same time, it is important to note that environmental factors in rural areas may increase the risk of underweight among urban-to-rural migrants over time, despite their initial urban advantages. Therefore, in rural areas, it is crucial to address the distal factors of DBM while promoting healthy diets. Improving WASH infrastructure and healthcare accessibility can prevent diseases and treat them in a timely manner, thus mitigating risks associated with undernutrition (Watson et al., 2019). Furthermore, it is crucial to invest in infrastructure like storage facilities and transportation, as well as to promote local food production to stabilise food availability in rural areas.

The findings of this study should be interpreted in light of a few data-related limitations. First, due to the cross-sectional nature of DHS data, we cannot discern long-term nutritional changes before and after migration. Additionally, there may be unmeasured or residual confounding factors like genetic predisposition, early-life health status, or SEP prior to migration that may importantly affect both internal migration and women's nutritional status. Furthermore, the potential for selection bias associated with the healthy migrant hypothesis must be considered. This hypothesis suggests that migrants are often a self-selected group with better initial health than non-migrants, which could influence the observed associations (Abraído-Lanza et al., 1999; Ruiz et al., 2013). Second, except for BMI (height and weight) and the wealth index, all other variables included in this study were self-reported. While some misreporting may have occurred, it is highly unlikely to have introduced systematic bias affecting the study's findings.

Third, the measure of internal migration was constructed based solely on the previous and current residence and fails to account for multiple movements over the course of life. Also, peri-urban and rural areas are common in LMICs, but we used a dichotomous classification that does not account for the degree of urbanicity. Limited data on primary reason for migration (i.e., family-related, seeking better education, or employment opportunities) prevented further exploration of the health effects of internal migration dynamics. While it is important to recognise that individuals who move within urban or rural areas may be exposed to different social and economic conditions that can impact their health-related behaviours, we treated intra-urban and intra-rural movements as 'non-migrants' in this study given the primary interest in assessing change in exposure between rural and urban environments.

Fourth, our decision to apply international BMI cutoffs to define nutritional status may not adequately reflect body fat levels and health risks associated with obesity across different ethnic groups (Guo et al., 2021; Hudda et al., 2017; Kopinska et al., 2024; Patel et al., 2022). Nevertheless, the WHO international BMI cutoffs remain as a practical anthropometric indicator in large-scale population studies (WHO expert consultation, 2004). Future research can benefit from using alternative anthropometric measures, such as waist-to-height ratio or body fat percentage, to better capture obesity-related health risks in diverse populations.

Fifth, the COVID-19 pandemic may have restricted mobility within countries. In our study sample, ten countries had survey timelines that overlapped with the COVID-19 outbreak, which may have substantially disrupted movements of people and their nutritional intake. Sixth, across the 29 LMICs included in this study, substantial variations within- and between-countries are expected in terms of cultural norms, nutritional habits, and access to healthcare. For example, cultural factors influencing women's perceptions of the ideal body size and the acceptability of physical activity can differ significantly even within the same country (Trübswasser et al., 2021). Future studies should examine these nuances in country-specific investigations. Lastly, data on the male population was omitted due to limited availability of BMI measures in only 9 countries, as well as gender-based differences in primary reasons for migration and biological mechanisms affecting DBM (de Juras et al., 2022; Pheiffer, 2021).

5. Conclusion

From this comprehensive assessment of the association between internal migration and DBM across LMICs, we show that rural-to-urban migrants have an increased odds of overweight/obesity compared to rural non-migrants and urban-to-rural migrants have a reduced odds of being underweight compared to urban non-migrants. The recency of migration and the age at which migration occurred were significantly associated with nutritional outcomes of migrants. Longer stays tended to make migrants' health profiles more similar to their destination native population, while migrating later in life to urban areas was found to facilitate a more profound level of assimilation to their destination than childhood migrants.

These findings are crucial for the development of targeted public health interventions. Policymakers should prioritise making healthy foods more affordable and accessible in urban areas by supporting SMEs and subsidising healthy food options. Investments in infrastructure such as transportation systems, along with subsidies for healthy food outlets, can mitigate barriers to accessing nutritious foods, especially in disadvantaged neighbourhoods. At the same time, addressing the root causes of undernutrition in rural areas is important to improve the overall living conditions and increase access to healthcare. In conclusion, as factors like urbanisation and economic opportunities are expected to make urban-rural dynamics more complex in LMICs, understanding the causes and consequences of internal migration patterns is crucial for both addressing and managing DBM at the population level.

CRediT authorship contribution statement

Jinseo Kim: Writing – original draft, Investigation, Formal analysis, Data curation. **Seung-Ah Choe:** Writing – review & editing, Investigation. **Hwa-Young Lee:** Writing – review & editing, Investigation. **S.V. Subramanian:** Writing – review & editing, Investigation. **Rockli Kim:** Writing – review & editing, Supervision, Investigation, Conceptualization.

Ethical standards disclosure

This project used publicly accessible secondary data obtained from the DHS website. DHS data are available at https://dhsprogram.com (requiring a simple application). The DHS data are not collected specifically for this study and no one on the study team has access to identifiers linked to the data. These activities do not meet the regulatory definition of human subject research. As such, an Institutional Review Board (IRB) review is not required.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

The authors report no conflicts of interest.

Appendix. ASupplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2025.118047.

Data availability

The authors do not have permission to share data.

References

Abdulhadi, R., Bailey, A., Van Noorloos, F., 2024. Access inequalities to WASH and housing in slums in low- and middle-income countries (LMICs): a scoping review. Glob. Public Health 19 (1), 2369099. https://doi.org/10.1080/17441692.2024.2369099.

Abraído-Lanza, A.F., Dohrenwend, B.P., Ng-Mak, D.S., Turner, J.B., 1999. The Latino mortality paradox: a test of the "salmon bias" and healthy migrant hypotheses. Am. J. Publ. Health 89 (10), 1543–1548. https://doi.org/10.2105/ajph.89.10.1543.

Abubakar, I., Aldridge, R.W., Devakumar, D., Orcutt, M., Burns, R., Barreto, M.L., Dhavan, P., Fouad, F.M., Groce, N., Guo, Y., Hargreaves, S., Knipper, M., Miranda, J. J., Madise, N., Kumar, B., Mosca, D., McGovern, T., Rubenstein, L., Sammonds, P., Zimmerman, C., 2018. The UCL-Lancet Commission on Migration and Health: the health of a world on the move. Lancet 392 (10164), 2606–2654. https://doi.org/10.1016/s0140-6736(18)32114-7.

Amegah, A.K., 2021. Slum decay in Sub-Saharan Africa: context, environmental pollution challenges, and impact on dweller's health. Environ. Epidemiol. 5 (3), e158. https://doi.org/10.1097/ee9.0000000000000158.

Andretti, B., Cardoso, L.O., Honório, O.S., de Castro Junior, P.C.P., Tavares, L.F., da Costa Gaspar da Silva, I., Mendes, L.L., 2023. Ecological study of the association between socioeconomic inequality and food deserts and swamps around schools in Rio de Janeiro, Brazil. BMC Public Health 23 (1), 120. https://doi.org/10.1186/s12889-023-14990-8.

Assaf, S., Raj Thapa, Naba, Edmeades, Jeff, 2023. Internal Adult Women Migrants' Use and Access to Health Services in 15 DHS Countries. DHS Analytical Studies. Issue. https://www.dhsprogram.com/pubs/pdf/AS87/AS87.pdf.

Awumbila, M., 2014. Linkages between urbanization, rural-urban migration and poverty outcomes in Africa. Int. Organ. Migr. 3–24.

Battersby, J., 2012. Beyond the food desert: finding ways to speak about urban food security in South Africa. Geogr. Ann. Ser. B, Hum. Geogr. 94 (2), 141–159. http://www.jstor.org/stable/23254572.

Berggreen-Clausen, A., Hseing Pha, S., Mölsted Alvesson, H., Andersson, A., Daivadanam, M., 2022. Food environment interactions after migration: a scoping review on low- and middle-income country immigrants in high-income countries. Public Health Nutr. 25 (1), 136–158. https://doi.org/10.1017/s1368980021003943.

Bernabe-Ortiz, A., Gilman, R.H., Smeeth, L., Miranda, J.J., 2010. Migration surrogates and their association with obesity among within-country migrants. Obesity 18 (11), 2199–2203. https://doi.org/10.1038/oby.2010.92.

Bowen, L., Ebrahim, S., De Stavola, B., Ness, A., Kinra, S., Bharathi, A.V., Prabhakaran, D., Reddy, K.S., 2011. Dietary intake and rural-urban migration in India: a cross-sectional study. PLoS One 6 (6), e14822. https://doi.org/10.1371/journal.pone.0014822.

Bridle-Fitzpatrick, S., 2015. Food deserts or food swamps?: a mixed-methods study of local food environments in a Mexican city. Soc. Sci. Med. 142, 202–213. https://doi.org/10.1016/j.socscimed.2015.08.010.

Budyta-Budzyńska, M., 2011. Adaptation, integration, assimilation: An attempt at a theoretical approach. In: Budyta-Budzyńska, M. (Ed.), Integration or assimilation: Poles in Iceland. Wydawnictwo Naukowe Scholar, Warsaw, pp. 43–63.

Chilunga, F.P., Musicha, C., Tafatatha, T., Geis, S., Nyirenda, M.J., Crampin, A.C., Price, A.J., 2019. Investigating associations between rural-to-urban migration and cardiometabolic disease in Malawi: a population-level study. Int. J. Epidemiol. 48 (6), 1850–1862. https://doi.org/10.1093/ije/dyz198.

Corsi, D.J., Neuman, M., Finlay, J.E., Subramanian, S., 2012. Demographic and health surveys: a profile. Int. J. Epidemiol. 41 (6), 1602–1613. https://doi.org/10.1093/ije/dys184.

Cumming, O., Cairncross, S., 2016. Can water, sanitation and hygiene help eliminate stunting? Current evidence and policy implications. Matern. Child Nutr. 12 (S1), 91–105. https://doi.org/10.1111/mcn.12258.

de Juras, A.R., Hsu, W.C., Cheng, Y.Y., Ku, L.E., Yu, T., Peng, C.J., Hu, S.C., 2022. Sex differences in dietary patterns of adults and their associations with the double burden of malnutrition: a population-based national survey in the Philippines. Nutrients 14 (17). https://doi.org/10.3390/nu14173495.

Demographic and Health Surveys Program, 2021. *Biomarker manual: Demographic and health survey* (training Program for measuring and testing for biomarkers. Issue. https://dhsprogram.com/pubs/pdf/DHSM7/DHS8_Biomarker_Manual_English_27Sep2021.pdf.

Escher, N.A., Andrade, G.C., Ghosh-Jerath, S., Millett, C., Seferidi, P., 2024. The effect of nutrition-specific and nutrition-sensitive interventions on the double burden of malnutrition in low-income and middle-income countries: a systematic review. Lancet Global Health 12 (3), e419–e432. https://doi.org/10.1016/S2214-109X(23)00562-4.

Fadlallah, M.A., Pal, I., Chatterjee, J.S., 2020. Health disparities: a perspective on internal migration and health behavior in Sudan. Ann. Glob. Health 86 (1), 48. https://doi.org/10.5334/aogh.2589.

Garchitorena, A., Ihantamalala, F.A., Révillion, C., Cordier, L.F., Randriamihaja, M., Razafinjato, B., Rafenoarivamalala, F.H., Finnegan, K.E., Andrianirinarison, J.C., Rakotonirina, J., Herbreteau, V., Bonds, M.H., 2021. Geographic barriers to achieving universal health coverage: evidence from rural Madagascar. Health Pol. Plann. 36 (10), 1659–1670. https://doi.org/10.1093/heapol/czab087.

Gebregziabher, H., Kahsay, A., Gebrearegay, F., Berhe, K., Gebremariam, A., Gebretsadik, G.G., 2023. Food taboos and their perceived reasons among pregnant women in Ethiopia: a systematic review, 2022. BMC Pregnancy Childbirth 23 (1), 116. https://doi.org/10.1186/s12884-023-05437-4.

Global Burden of Diseases 2019 Diseases and Injuries Collaborators, 2020. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet 396 (10258), 1204–1222. https://doi.org/10.1016/s0140-6736(20)30925-9.

Gong, F., Xu, J., Fujishiro, K., Takeuchi, D.T., 2011. A life course perspective on migration and mental health among Asian immigrants: the role of human agency. Soc. Sci. Med. 73 (11), 1618–1626. https://doi.org/10.1016/j.socscimed.2011.09.014.

Guo, J., Bakshi, A., Wang, Y., Jiang, L., Yengo, L., Goddard, M.E., Visscher, P.M., Yang, J., 2021. Quantifying genetic heterogeneity between continental populations for human height and body mass index. Sci. Rep. 11 (1), 5240. https://doi.org/10.1038/s41598-021-84739-z.

Gupta, V., Downs, S.M., Ghosh-Jerath, S., Lock, K., Singh, A., 2016. Unhealthy fat in street and snack foods in low-socioeconomic settings in India: a case study of the food environments of rural villages and an urban slum. J. Nutr. Educ. Behav. 48 (4), 269–279.e261. https://doi.org/10.1016/j.jneb.2015.11.006.

Hervitz, H.M., 1985. Selectivity, adaptation, or disruption? A comparison of alternative hypotheses on the effects of migration on fertility: the case of Brazil. Int. Migr. Rev. 19 (2), 293–317. https://doi.org/10.2307/2545774.

Hudda, M.T., Nightingale, C.M., Donin, A.S., Fewtrell, M.S., Haroun, D., Lum, S., Williams, J.E., Owen, C.G., Rudnicka, A.R., Wells, J.C.K., Cook, D.G., Whincup, P.H., 2017. Body mass index adjustments to increase the validity of body fatness assessment in UK Black African and South Asian children. Int. J. Obes. 41 (7), 1048–1055. https://doi.org/10.1038/ijo.2017.75.

Jäger, P., Beyer, K., Claassen, K., 2022. Obesity in the context of migration and socio-economic risk factors – a multivariate epidemiologic analysis. Ann. Epidemiol. 76, 108–113. https://doi.org/10.1016/j.annepidem.2022.09.008.

Jung, N.M., de Bairros, F.S., Pattussi, M.P., Pauli, S., Neutzling, M.B., 2017. Gender differences in the prevalence of household food insecurity: a systematic review and meta-analysis. Public Health Nutr. 20 (5), 902–916. https://doi.org/10.1017/s1368980016002925.

Kanaiaupuni, S.M., 2000. Reframing the migration question: an analysis of men, women, and gender in Mexico. Soc. Forces 78 (4), 1311–1347.

Karsten, L., 2020. Counterurbanisation: why settled families move out of the city again. J. Hous. Built Environ. 35 (2), 429–442.

Kimani-Murage, E.W., Schofield, L., Wekesah, F., Mohamed, S., Mberu, B., Ettarh, R., Egondi, T., Kyobutungi, C., Ezeh, A., 2014. Vulnerability to food insecurity in urban slums: experiences from Nairobi, Kenya. J. Urban Health 91 (6), 1098–1113. https://doi.org/10.1007/s11524-014-9894-3.

Kirk, B., Melloy, B., Iyer, V., Jaacks, L.M., 2019. Variety, price, and consumer desirability of fresh fruits and vegetables in 7 cities around the world. Curr. Dev. Nutr. 3 (9), nzz085. https://doi.org/10.1093/cdn/nzz085.

Kolčić, I., 2012. Double burden of malnutrition: a silent driver of double burden of disease in low- and middle-income countries. J. Glob. Health 2 (2), 020303. https://doi.org/10.7189/jogh.02.020303.

Kopinska, J., Atella, V., Bhattacharya, J., Miller, G., 2024. The changing relationship between bodyweight and longevity in high- and low-income countries. Econ. Hum. Biol. 54, 101392. https://doi.org/10.1016/j.ehb.2024.101392.

Losada-Rojas, L.L., Ke, Y., Pyrialakou, V.D., Konstantina, G., 2021. Access to healthy food in urban and rural areas: an empirical analysis. J. Transport Health 23, 101245. https://doi.org/10.1016/j.jth.2021.101245.

Matheson, J., McIntyre, L., 2014. Women respondents report higher household food insecurity than do men in similar Canadian households. Public Health Nutr. 17 (1), 40–48. https://doi.org/10.1017/s136898001300116x.

McAuliffe, M., Triandafyllidou, A. (Eds.), 2021. World Migration Report 2022: Chapter 2, Migration and Migrants: A Global Overview. International Organization for Migration (IOM). https://publications.iom.int/books/world-migration-report-2022-chapter-2.

McDonald, J.T., Kennedy, S., 2005. Is migration to Canada associated with unhealthy weight gain? Overweight and obesity among Canada's immigrants. Soc. Sci. Med. 61 (12), 2469–2481. https://doi.org/10.1016/j.socscimed.2005.05.004.

National Institute of Statistics, Ministry of Health, & The DHS Program, 2023. Cambodia demographic and health survey 2021–22. https://www.dhsprogram.com/pubs/pdf/FR377/FR377.pdf.

National Statistical Service - NSS/Armenia, Ministry of Health - MOH/Armenia, & ICF, 2017. Armenia demographic and health survey 2015-16. http://dhsprogram.com/pubs/pdf/FR325/FR325.pdf.

Norris, M., Klabbers, G., Pembe, A.B., Hanson, C., Baker, U., Aung, K., Mmweteni, M., Mfaume, R.S., Beňová, L., 2022. A growing disadvantage of being born in an urban area? Analysing urban-rural disparities in neonatal mortality in 21 African countries with a focus on Tanzania. BMJ Glob. Health 7 (1). https://doi.org/10.1136/bmjgh-2021-007544.

Onyango, A.W., Jean-Baptiste, J., Samburu, B., Mahlangu, T.L.M., 2019. Regional overview on the double burden of malnutrition and examples of Program and policy responses: African region. Ann. Nutr. Metab. 75 (2), 127–130. https://doi.org/10.1159/000503671.

Paştiu, C.A., Maican, S.Ş., Dobra, I.B., Muntean, A.C., Haţegan, C., 2024. Food insecurity among consumers from rural areas in Romania [Original Research]. Front. Nutr. 10. https://doi.org/10.3389/fnut.2023.1345729.

Patel, M., Abatcha, S., Uthman, O., 2022. Ethnic differences between South Asians and White Caucasians in cardiovascular disease-related mortality in developed countries: a systematic literature review [Article]. Syst. Rev. 11 (1), 207. https://doi.org/10.1186/s13643-022-02079-z.

Peters, R., Amugsi, D.A., Mberu, B., Ensor, T., Hill, A.J., Newell, J.N., Elsey, H., 2019. Nutrition transition, overweight and obesity among rural-to-urban migrant women in Kenya. Public Health Nutr. 22 (17), 3200–3210. https://doi.org/10.1017/s1368980019001204.

Pheiffer, C.F., 2021. Internal migration, urban living, and non-communicable disease risk in South Africa. Soc. Sci. Med. 274, 113785. https://doi.org/10.1016/j.socscimed.2021.113785.

Popkin, B.M., Adair, L.S., Ng, S.W., 2012. Global nutrition transition and the pandemic of obesity in developing countries. Nutr. Rev. 70 (1), 3–21. https://doi.org/10.1111/j.1753-4887.2011.00456.x.

Qian, C.X., Zhao, Y., Anindya, K., Tenneti, N., Desloge, A., Atun, R., Qin, V.M., Mulcahy, P., Lee, J.T., 2021. Non-communicable disease risk factors and management among internal migrant in China: systematic review and meta-analysis. BMJ Glob. Health 6 (9). https://doi.org/10.1136/bmjgh-2020-003324.

Rahaman, M.A., Kalam, A., Al-Mamun, M., 2023. Unplanned urbanization and health risks of Dhaka City in Bangladesh: uncovering the associations between urban environment and public health. Front. Public Health 11. https://doi.org/10.3389/fpubh.2023.1269362 [Review].

Rose, D., Bodor, J.N., Swalm, C.M., Rice, J.C., Farley, T.A., Hutchinson, P.L., 2009. Deserts in New Orleans? Illustrations of Urban Food Access and Implications for Policy. University of Michigan National Poverty Center/USDA Economic Research Service Research, Ann Arbor, MI.

Roshania, R., Narayan, K.M.V., Oza-Frank, R., 2008. Age at arrival and risk of obesity among US immigrants. Obesity 16 (12), 2669–2675. https://doi.org/10.1038/oby.2008.425.

Ruiz, J.M., Steffen, P., Smith, T.B., 2013. Hispanic mortality paradox: a systematic review and meta-analysis of the longitudinal literature. Am. J. Publ. Health 103 (3), e52–e60.

Stock, R., 1983. Distance and the utilization of health facilities in rural Nigeria. Soc. Sci. Med. 17 (9), 563–570. https://doi.org/10.1016/0277-9536(83)90298-8.

Sullivan, R., Kinra, S., Ekelund, U., V, B.A., Vaz, M., Kurpad, A., Collier, T., Srinath Reddy, K., Prabhakaran, D., Ben-Shlomo, Y., Davey Smith, G., Ebrahim, S., Kuper, H., 2011. Socio-demographic patterning of physical activity across migrant groups in India: results from the Indian migration study. PLoS One 6 (10), e24898. https://doi.org/10.1371/journal.pone.0024898.

Trübswasser, U., Verstraeten, R., Salm, L., Holdsworth, M., Baye, K., Booth, A., Feskens, E.J.M., Gillespie, S., Talsma, E.F., 2021. Factors influencing obesogenic behaviours of adolescent girls and women in low- and middle-income countries: a qualitative evidence synthesis. Obes. Rev. 22 (4), e13163. https://doi.org/10.1111/obr.13163.

Tymejczyk, O., McNairy, M.L., Petion, J.S., Rivera, V.R., Dorelien, A., Peck, M., Seo, G., Walsh, K.F., Fitzgerald, D.W., Peck, R.N., 2019. Hypertension prevalence and risk factors among residents of four slum communities: population-representative findings from Port-au-Prince, Haiti. J. Hypertens. 37 (4), 685–695.

UNICEF, 2019. Advantage or Paradox? the Challenge for Children and Young People of Growing up Urban. United Nations.

UNICEF, 2020. The State of Food Security and Nutrition in the World 2020.

UNICEF, 2023. The State of Food Security and Nutrition in the World 2023: Urbanization, Agrifood Systems, Transformation and Healthy Diets across the Rural-Urban Continuum.

United Nations, 2004. World Urbanization Prospects: the 2003 Revision. UN.

USAID Advancing Nutrition, 2022. Food processing for improved diets. In: Arlington, VA: USAID Advancing Nutrition.

Wang, H., Liu, C., Fan, H., Tian, X., 2017. Rising food accessibility contributed to the increasing dietary diversity in rural and urban China. Asia Pac. J. Clin. Nutr. 26 (4), 738–747. https://doi.org/10.6133/apjcn.052016.03.

Wang, Y., Pan, L., Wan, S.P., Yi, H.W., Yang, F., He, H.J., Li, Z., Zhang, J., Yong, Z.P., Shan, G.L., 2020. Association between age at arrival, duration of migration, and overweight/obesity in Chinese rural-to-urban migrants: the Yi migrant study. Chin. Med. J. (Engl.) 134 (1), 60–67. https://doi.org/10.1097/cm9.0000000000000973.

Watson, J., D'Mello-Guyett, L., Flynn, E., Falconer, J., Esteves-Mills, J., Prual, A., Hunter, P., Allegranzi, B., Montgomery, M., Cumming, O., 2019. Interventions to improve water supply and quality, sanitation and handwashing facilities in healthcare facilities, and their effect on healthcare-associated infections in low-income and middle-income countries: a systematic review and supplementary scoping review. BMJ Glob. Health 4 (4), e001632. https://doi.org/10.1136/bmjgh-2019-001632.

Weerasekara, P.C., Withanachchi, C.R., Ginigaddara, G.A.S., Ploeger, A., 2020. Understanding dietary diversity, dietary practices and changes in food patterns in marginalised societies in Sri Lanka. Foods 9 (11). https://doi.org/10.3390/foods9111659.

WHO expert consultation, 2004. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 363 (9403), 157–163. https://doi.org/10.1016/S0140-6736(03)15268-3.

World Health Organization Consultation, 2000. Obesity: Preventing and Managing the Global Epidemic. World Health Organization technical report series, 894, pp. 1–253. Geneva.