

## BURDEN OF MALNUTRITION IN ASIA: A SYSTEMATIC REVIEW

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### **Abstract**

Malnutrition is universal and has various forms. Excess and deficit, generally, are the two directions of malnutrition. Nutritional deficiency in early life increases susceptibility to infection and illness and can cause reduced adult physical stature, and impaired cognitive abilities which affect their learning abilities. As a result, they are less prepared when they enter the job market and tend to earn lower wages than those without childhood stunting. The current analysis was inspired by the publication of several studies on burden of the malnutrition. Several research on the burden and problems due to malnutrition prompted the current study. A Pubmed, EMBASE, and Web of Science online database search was conducted, and relevant studies were included with language restrictions to English. Following that, databases were accessed in order to conduct a more in-depth search of the literature utilising key terms and Boolean operators to create articles pertinent to the issue. These papers were screened using inclusion/exclusion criteria to reduce the number of articles to a manageable eight. These eight publications were examined, and the findings revealed that burden of malnutrition in the Asia-Pacific region is alarmingly high and is tilted toward obesity. The significant coexisting of both undernutrition and overweight/obesity suggests that future interventions/policy targeting to maintain a healthy population weight should not just focus on prevention and treatment toward one direction. The available national data showed that the prevalence of overweight/obesity has been increasing in Asian countries, whereas the prevalence of undernutrition has been declining. National economic development, changes in the food supply, urbanization, and lack of adequate physical activity are positively associated with increasing overweight/obesity

**Key words:** malnutrition, prevalence, burden, problem

### **Introduction**

Nutritional deficiency in early life increases susceptibility to infection and illness and can cause reduced adult physical stature, and impaired cognitive abilities which affect their learning abilities. As a result, they are less prepared when they enter the job market and tend to earn lower wages than those without childhood stunting. Their lifetime earnings are estimated to be 10 percent less than their counterparts. Stunting also increases the risk of children developing obesity, diabetes, and heart problems later in life. Overall, childhood stunting has long-term negative consequences both for the child and society (APIYCNA, n.d.). The challenge of providing optimal infant and young child nutrition is complex and multi-faceted. Some of the best solutions include protecting and promoting exclusive breastfeeding for the first six months of a child's life. Fortunately, UNICEF reports that breastfeeding rates are no longer declining at the global level, with many countries experiencing "significant increases" in the last decade

(Briend et al., 2013). Malnutrition is universal and has various forms. Excess and deficit, generally, are the two directions of malnutrition. Double Burden of Malnutrition (DBM) means co-occurring burdens of under- and over nutrition, characterized by the coexistence of undernourishment along with overweight, obesity, or diet-related Non-communicable Diseases (NCDs). This coexistence of double burden has been recognized as a global trend (Black et al., 2013). In 2018, 2.01 billion adults were overweight and obese globally. By contrast, 150.8 million children were stunted. Meanwhile, 50.5 and 38.3 million children were wasted and overweight, respectively. Furthermore, Burden of Malnutrition is also an important point for intervention and action to achieve the target of ending all forms of malnutrition. To tackle the issue of Burden of Malnutrition properly, it is necessary to understand the scope of Burden of Malnutrition (Lutter et al., 2013).

More than half of the world's children impacted by wasting (26.9 million) live in South Asia. Of the three countries that are home to almost half (47.2%) of all stunted children, two are in Asia: India (46.6 million) and Pakistan (10.7 million).

Of the 38.3 million children globally overweight, 5.4 million and 4.8 million are in South and East Asia respectively (26.6% of the total). The prevalence of adult obesity in Hong Kong rose from 10.4% in 2015 to 10.6% in 2016 (overweight from 40.5% to 40.9%). The whole region is undergoing significant growth in the consumption of packaged foods.(UNICEF, 2018) Significant steps are being made to address malnutrition. Asia experienced the largest regional reduction in stunting prevalence from 2000 to 2017 – from 38% to 23%. Nepal alone has seen stunting decline from 57.1% to 36% over the same period. Additionally, at a global-regional level, adult overweight levels are least prevalent in Asian men and women (30%) compared to the rest of the world (UNICEF, 2018) But progress to date is not enough. At the global level, none of the countries with sufficient data are on course to meet all nine targets on malnutrition. Asia is no exception.

### **Justification**

Asia-Pacific region with the largest population worldwide is a place where the DBM issue should be prioritized. Countries in this region accounted for most of the global burden of stunting (Briend et al., 2013). At the same time, overweight and obesity prevalence in the area is also rising, with China, India, Pakistan, and Indonesia taking four places of the top 10 countries with the highest populations of obesity in the world . As a result, the economic and medical consequences of DBM in the Asia-Pacific countries are of great significance. It has been reported that malnutrition and infant stunting have resulted in losses in marked gross national product for Asian countries . Simultaneously, the negative impact of the increasing prevalence of obesity is also rising (Barquera et al., 2016). Urbanization, poorly managed diet and lifestyle, obesity, and related noncommunicable chronic diseases have escalated with increased risks of many adverse health outcomes, including serious cardio metabolic diseases and certain types of cancers. Reducing the DBM is fundamental to managing health outcomes in the Asia-Pacific region.

Early life under nutrition may result in increased odds of childhood mortality, reduced capacity for physical work, lower school performance, and greater susceptibility to infectious diseases. Adult overweight/obesity has been extensively associated with higher risk of non-communicable diseases such as hypertension, diabetes, cancer, stroke, and ischemic heart disease. These diverse

forms of ill health contribute to lower wages, loss of productivity and higher medical costs. Thus, the double burden of malnutrition introduces considerable global health challenges that need to be urgently addressed (Gao et al., 2019). The 2030 Agenda for Sustainable Development and the United Nations Decade of Action on Nutrition 2016–2025 aim to mobilise action and accelerate progress towards ending malnutrition in all its forms. Double-duty actions seek to tackle both forms of malnutrition simultaneously and therefore have the potential to improve nutrition globally and promote health at all life stages across LMIC (Baker et al., 2018)

In the South Asian context, the prevalence of undernutrition in children and adolescents remains considerably high compared to other regions, despite a decline over the past three decades. In addition, South Asia is currently facing the challenge of overnutrition which is exacerbating the double burden of malnutrition. Recent epidemiological studies on the double burden of malnutrition in South Asia have focused on women of reproductive age and mother-child pairs. However, only a few studies quantified the double burden of malnutrition among adolescents in India, overlooking the rest of the South Asian countries (Querol et al., 2021). These publications identified factors contributing to malnutrition such as socioeconomic status, hygiene behaviour, maternal education and urban/rural residence

### **Aim**

Therefore, the objective of this systematic review and meta-analysis was offer insight into the pertinent stakeholders regarding the trend and magnitude of different forms of malnutrition existing in the Asia-Pacific region.

### **Review of Literature**

#### ***Current Scenario and Prevalence***

Reducing malnutrition globally depends on reducing malnutrition in Asia, which has the highest prevalence and greatest numbers of children under 5 years of age who are stunted, wasted, and underweight. USAID's renewed focus and commitment to nutrition is an opportunity to critically examine the nutrition situation in Asia to identify nutrition priorities to reduce malnutrition in the region, which would ultimately impact and reduce the global prevalence of malnutrition. FANTA conducted a critical review of the nutrition situation in 11 countries in Asia, which is presented by region (South-Central Asia and Southeast Asia) and by country (The Food and Nutrition Technical Assistance III Project (FANTA) [2012-2018, 2014)

it is a more acute problem specifically in the Asian region. According to a report by the World Health Organisation (WHO), United Nations Children's Fund (UNICEF) and World Bank Group, more than half of all stunted children, almost half of all overweight children and more than two-thirds of all wasted children live in the region (Post, n.d.).

Stunting is defined by the WHO as a failure to grow both, physically and cognitively due to chronic or recurrent malnutrition. Physically, stunted children are usually too short for their age. On the other hand, wasting, or acute malnutrition, is the result of recent rapid weight loss or the failure to gain weight. A child who is moderately or severely wasted has an increased risk of death. (Pavithra et al., 2019)

Looking at Southeast Asia, the results are unfortunately, not too surprising. 25.8 percent of children under five are stunted, while 8.4 percent and 7.2 percent of children under five are wasting and overweight, respectively. The 2017 report finds that stunting prevalence is highest in Cambodia, Lao PDR and Myanmar, as well as in parts of Indonesia and the Philippines. (Post,

n.d.)

It is a that these issues of malnutrition especially, stunted growth, is still prevalent in most countries in the region, even in those that are seen to be enjoying positive economic growth. In addition to poverty, other contributing factors include traditional diets that lack food with sufficient nutrients, poor infant feeding practices, inadequate clean water and sanitation, and limited agricultural crops

### ***Burden at Glance***

In the Asia region, there has been modest progress towards achieving global nutrition targets. The global target for overweight among children under 5 years of age has 29 countries on course to meet it, stunting among children under 5 years of age has 21 countries on course, wasting among children under 5 years of age has 14 countries on course, exclusive breastfeeding among infants aged 0 to 5 months has ten countries on course, while low birth weight and diabetes among women each have three countries on course. However, not a single country in the region is on course to meet the targets for anaemia in women of reproductive age (aged 15 to 49 years), diabetes among men, obesity among men, and obesity among women. 27 countries in the region have insufficient data to comprehensively assess their progress towards these global targets. (Global Nutrition Report, 2020)

Undernutrition represents a set of adverse health outcomes that are caused by imbalances in diet and their interactions with infection. For European and North American countries the twentieth century saw an orderly transition from problems of undernutrition such as underweight, stunting and micronutrient deficiency diseases to problems of overnutrition, such as overweight, obesity and diet-related non-communicable chronic diseases such as diabetes, high blood pressure and coronary heart disease. In the twenty-first century, the countries of South East (SE) Asia and the Pacific have had less time than others to make this transition (Mason et al., 2010)

### **Approaches to fill gaps**

UNICEF supports action to improve nutrition for young children, adolescents and mothers in the Europe and Central Asia Region, aiming to ensure that every child has the best possible nutritional start in life. This requires a focus on the systems that are in place – or that need to be created – to safeguard the nutrition of each child. UNICEF’s systems approach in the Region aims to strengthen the capacity of national and sub-national systems to deliver nutrition-specific interventions to children from birth to adulthood and build programmes that are sensitive to their nutritional needs at every stage of life. The approach prioritizes four delivery systems that are crucial for the achievement of Sustainable Development Goal 2 – End Hunger – by 2030 (UNICEF, 2022)

UNICEF supports large-scale food fortification programmes, such as Universal Salt Iodization (USI) and Flour Fortification to control micronutrient deficiencies among children and women, aiming for safer pregnancies and healthier children. We push for the enforcement of USI as well as legislation and programmes to boost the quality and consumption of iodized salt (UNICEF, 2022)

### **Methodology**

The systematic review was undertaken by following the guideline of recording results followed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement

All relevant articles published on PubMed, EMBASE, Web of Science database were searched from the time the database was established until 2023. Search strategies were developed based on PICO model, A manual search was also conducted to include any relevant studies that may not have been identified in the original search.

### **Data Collection Strategies**

For this inquiry, three databases were chosen and used throughout the data gathering process. PubMed, EMBASE, Web of Science were all searched. To minimize data saturation, keywords were searched, and logical operators were utilised inside the search. As a result, it is critical to demonstrate that a complete, extended, and broad search was carried out.

#### **Inclusion /exclusion criteria.**

The included studies were: (1) Cohort and Observation studies, (2) Studies emphasised on Malnutrition (3) children and adult samples, (4) studies conducted in the Asia-Pacific region defined geographically, including East Asia and Pacific and South Asia defined by World Bank, (5) reported both prevalence of under- and over nutrition of the same population at the same time point; (6) provided data for individual country or population; (7) studies published in the last 10 years, (8) Studies published in English language .

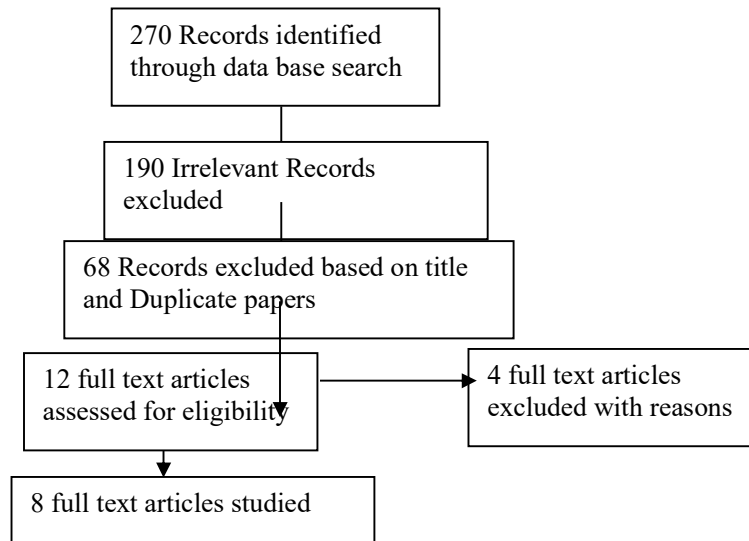
The exclusion criteria were: (1) pilot study or protocols; (2) Studies not conducted in the Asia-Pacific region; (3) not an original study (e.g., reviews, meta-analysis); (4) population lack generalizability (e.g., refugees, pregnant women, infants under 2 years old only, indigenous population); (4) no precise reporting on either under- or over nutrition; (5) only reported data on the prevalence of double burden at household level but not at individual level.

### **Data Extraction**

A Boolean search for relevant phrases was performed, followed by filtering them using various filters based on inclusion criteria. This restricted the number of records to 122 in Web of Science, 88 in Embase, and 70 in PubMed.

Data extraction was performed according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines by two of the authors independently. Disagreements were solved through discussion. Data extracted included the authors, publication year, country/area the study was conducted, study setting, prevalence of under- and over nutrition, and criteria used for the evaluation of nutritional status. PRISMA flow diagrams were created. Several items were removed owing to their insignificance to the subject of the study. Duplicates were removed, and the abstracts of each article were examined. Additionally, papers were excluded that include meta - analytic review, leaving a total of eight publications that fit the inclusion criteria for this systematic review.

## PRISMA FLOWCHART



## Results

The finished compositions will be subjected to critiques and analysis. Eight studies are included in the study. The use of a conceptual framework (The C.A.S.P. tool, 2018) enabled the assessment of the overall and understanding of the literature. The table below summarises each article.

Author and Year	study design	Sample size	Key findings
Kang et al 2018 (Bhutan)	Survey	2020	Despite a WHZ distribution comparable with the World Health Organization reference (with ~2.6% vs. an expected 2.5% of children beyond 2 z in each tail), stunting persists in one fifth of preschool Bhutanese children
Zhang et al (2016) China	Survey	11630	Young girls appeared to have higher risk of under-nutrition, and the risk decreased with age more markedly than for boys
Pell et al (2017) Malaysia	Survey	5319	varied patterns of obesity and overweight at the different age groups
Khan et al (2017) Pakistan	Cross Sectional Survey	1321	The proportion exhibiting comorbidity increased with increasing levels of fatness in a dose-response relationship
Seo et al (2016) Korea	Survey	3979	The risk of microalbuminuria was significant in the underweight group

Sengupta et al (2015) India	Survey	89199	overweight problem has started expanding from urban and well-off women to the poor and rural people, while the rural-urban and rich-poor difference has disappeared
Gaur et al (2013) India	Survey	19488	High prevalence of overweight women across both slum and non-slum areas.
Agho et al (2018) Nepal	Survey	14857	Key modifiable factors that were strongly associated with prehypertension and hypertension in both genders included overweight and obesity,

**Kang et al (2018)** assessed in 1,506 children nutritional status (by z-scores of height-for-age [HAZ], weight-for-height [WHZ], and weight-for-age [WAZ]), estimating prevalence, adjusted for survey design, of stunting, wasting, underweight, and overweight (<-2 for HAZ, WHZ, and WAZ and >2 for WHZ). Children were also assessed for pedal oedema. They conducted multivariable linear/logistic regression analysis to identify child, maternal, and household risk factors for childhood undernutrition and overweight, excluding children with oedema (1.7%). Mean (SE) HAZ, WHZ, and WAZ were -0.82 (0.13), 0.10 (0.04), and -0.42 (0.05), respectively. Prevalence of stunting, wasting, underweight, and overweight were 21.2%, 2.6%, 7.4%, and 2.6%, respectively. In multivariable regressions, risk of stunting significantly increased by age: 5.3% at <6 months (reference), 16.8% at 6-23 months (OR = 3.06, 95% CI [0.63, 14.8]), and 25.0% at 24-59 months (OR = 5.07, [1.16, 22.2]). Risk of stunting also decreased in a dose-response manner with improved maternal education. None of the examined variables were significantly associated with wasting or overweight. Despite a WHZ distribution comparable with the World Health Organization reference (with ~2.6% vs. an expected 2.5% of children beyond 2 z in each tail), stunting persists in one fifth of preschool Bhutanese children, suggesting that other nutrient deficits or no nutritional factors may be constraining linear growth for a substantial proportion of children (Kang et al., 2018)

**Zhang et al (2016)** aimed to explore underlying mechanisms of under-and over-nutrition among children in rural China. This study used a nationwide longitudinal dataset of children ( $N = 5,017$ ) from 9 provinces across China, with four exclusively categories of nutritional outcomes including under-nutrition (stunting and underweight), over-nutrition (overweight only including obesity), paradox (stunted overweight), with normal nutrition as reference. Multinomial logit models (Level-1: occasions; Level-2: children; Level-3: villages) were fitted which corrected for non-independence of observations due to geographic clustering and repeated observations of individuals. A mixture of risk factors at the individual, household and neighborhood levels predicted under-and over-nutrition among children in rural China. Improved socioeconomic status and living in more urbanized villages reduced the risk of stunted overweight among rural children in China. Young girls appeared to have higher risk of under-nutrition, and the risk decreased with age more markedly than for boys up to age 5. From age 5 onwards, boys tended to have higher risk of under-nutrition than girls. Girls aged around 12 and older were less likely

to suffer from under-nutrition, while boys' higher risk of under-nutrition persisted throughout adolescence. Children were less likely to suffer from over-nutrition compared to normal nutrition. Boys tended to have an even lower risk of over-nutrition than girls and the gender difference widened with age until adolescence (Zhang et al., 2016)

**Pell et al (2016)** described obesity and overweight amongst adolescents and young adults in a multi-ethnic population. Data were collected at the South East Asia Community Observatory (SEACO) in Segamat District, Johor. In this dynamic cohort of approximately 40,000 people, 5,475 were aged 16-35 in 2013-2014. The population consists of Malay, Chinese, Indian and Indigenous (Orang Asli) families in proportions that reflect the national ethnic diversity. Data were collected through health profiles (Body Mass Index [BMI] measurements in homes) and self-report questionnaires. Age and ethnicity were associated with overweight (BMI 25.0-29.9Kg/m<sup>2</sup>) and obesity (BMI ≥ 30Kg/m<sup>2</sup>). The prevalence of overweight was 12.8 % at ages 16-20 and 28.4 % at ages 31-35; obesity was 7.9 % and 20.9 % at the same age groups. The main ethnic groups also showed varied patterns of obesity and overweight at the different age groups with Chinese at lowest and Orang Asli at highest risk. Level of education, employment status, physical activity and frequency of eating out were poorly predictive of overweight and obesity (Pell et al., 2016)

Khan et al (2017) stated that association of fatness with chronic metabolic diseases is a well-established fact, and a high prevalence of risk factors for these disorders has increasingly been reported in the third world. In order to incorporate any preventive strategies for such risk factors into clinical practice, decision-makers require objective evidence about the associated burden of disease. A cross-sectional study of 1321 adults from one of the districts of Baluchistan, among the most economically challenged areas of Pakistan, was carried out for the measures of fatness and self-reported comorbidities. Body mass index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR) were measured and demographic information and self-reported comorbidities were documented. The prevalence of obesity was 4.8% (95% CI: [3.8, 6.1]) and 21.7% (95% CI: [19.5, 24.0]), as defined by the World Health Organization (WHO) international and Asia/Asia-Pacific BMI cut-offs, respectively. The proportion exhibiting comorbidity increased with increasing levels of fatness in a dose-response relationship (*p* value < .001). An interaction of weight status with gender was observed to produce a significantly (*p* = .033) higher comorbidity among overweight women (odds ratio (OR) = 6.1 [1.2, 31.7]) compared with overweight men (OR = 1.1 [0.48, 2.75], *p* = .762). (Khan et al., 2017)

Seo et al (2016) evaluated the prevalence of microalbuminuria according to body mass index (BMI) and abdominal obesity criteria. The study subjects included 3,979 individuals aged 30 years or older who did not have diabetes, hypertension, renal failure, or overt proteinuria, from among those who participated in The Korean National Health and Nutrition Examination Survey in 2013, a cross-sectional, nationally representative, stratified survey. The prevalence of microalbuminuria was found to be 5.1%. In the norm albuminuria group, 3.4%, 41.7%, 24%, 27.6%, and 3.2% of participants were included in the underweight, normal, overweight, obesity 1, and obesity 2 groups, respectively. These percentages in the microalbuminuria group were 7.1%, 34.5%, 19.2%, 28.6%, and 10.6%, respectively (*P*<0.001). The waist circumference in men was 21.4% in the norm albuminuria group and 36.5% in the microalbuminuria group (*P*=0.004). Logistic regression analyses were performed to evaluate the relationship between the presence of microalbuminuria and BMI or waist circumference groups. The risk of



microalbuminuria was significant only in the underweight group (odds ratio, 13.22; 95% confidence interval, 2.55-68.63; P=0.002) after adjusting for confounding factors, abdominal obesity was not significantly associated with microalbuminuria (Seo et al., 2016)

**Sengupta et al (2015)** investigated the evolution over time of overweight and obesity among ever-married Indian women (15-49 years) from selected 'underweight states' (Bihar, Orissa and Madhya Pradesh, where underweight proportion is predominant) and 'overweight states' (Kerala, Delhi and Punjab, where overweight is the prime concern), in relation to a few selected socio-economic and demographic indicators. This study analysed National Family Health Surveys- NFHS-2 (1998-99) and NFHS-3 (2005-06) following Asian population specific BMI cut-offs for overweight and obesity. The results confirm that within India itself the relationship of overweight and obesity with place of residence and SES cannot be generalized. Results from 'overweight states' show that the overweight problem has started expanding from urban and well-off women to the poor and rural people, while the rural-urban and rich-poor difference has disappeared. On the other hand in 'underweight states' overweight and obesity have remained socially segregated and increasing strongly among urban and richer section of the population. The rate of rise of overweight and obesity has been higher in rural areas of 'OW states' and in urban areas of 'UW states'. Indian policymakers thus need to design state-specific approaches to arrest the rapid growth of overweight and its penetration especially towards under-privileged section of the society. (Sengupta et al., 2015)

**Gaur et al (2013)** examines the intra-city distribution of women's nutritional status across eight Indian mega-cities with a specific focus on slum-non-slum divide. The analysis is based on the National Family Health Survey (2005-06) of India and highlights the dual burden of malnutrition among urban women. The results show that one in every two women in mega-cities is malnourished (either undernourished or over nourished), but a biased, analytical focus on citywide averages conceals the nature of the problem. Over nutrition among women is notably higher in non-slum areas whereas underweight persists as a key concern among slum dwellers. Cities located in the Central India (Nagpur and Indore) have the highest proportion of underweight women whereas the cities in South India (Chennai and Hyderabad) show a high prevalence of overweight women across both slum and non-slum areas. The intensity of income-related inequalities in underweight outcome is much greater for non-slum areas, whereas inequalities in overweight outcomes are higher among slums. Furthermore, regression analysis indicates that place of residence as such has no significant impact on women's nutritional status and that this elementary association is primarily a ramification mediated through other key socioeconomic correlates. Results suggest that, it would be rational to develop a comprehensive urban nutritional plan that focuses on dietary planning and behaviour change to address both type of malnutrition at the same time (Gaur et al., 2013)

Agho et al (2018) aimed to investigate gender differences in factors associated with prehypertension and hypertension in Nepal using the 2016 Nepal Demographic and Health Survey (NDHS). Sociodemographic, behavioural, anthropometric and health status data and information on hypertension were obtained from 14,857 (males: 6,245 and females: 8,612) individuals aged 15 years or above from the biomarker sample of the 2016 NDHS. The overall prevalence of prehypertension and hypertension was 26.9% [95% confidence interval (CI): 25.7, 28.1] and 17.2% (95% CI 16.1, 18.3), respectively. Prehypertension was present in 30.4% (95%CI: 28.7, 32.2) of males and 24.3% (95% CI: 23.1, 25.6) of females, while hypertension

was present in 20.4%, (95% CI 18.9, 22.0) of males and 14.8% (95% CI: 13.7, 16.0) of females. Key modifiable factors that were strongly associated with prehypertension and hypertension in both genders included overweight and obesity, caffeine intake, tobacco use, no schooling, previously informed of hypertension in a health facility, and alcohol consumption (for males). Other significant factors associated with prehypertension and hypertension included increasing age (> 30 years), ecological zone (Hill), Developmental zone (Western) and being married. (Agho et al., 2018)

### **Discussion**

Overall, the likelihood of being overnutrition was three times more than being undernourished in Asia-Pacific region. Prehypertension and hypertension were more prevalent among males (30.4% and 20.4%) than females (24.3% and 14.8%), respectively, consistent with other reports from Nepal. Higher income countries reported larger overnutrition versus undernutrition ratio, while LMICs had similar chance of being overnutrition as well as undernutrition. Children and adolescents more than 5 years old were five times more likely being overnutrition than undernutrition, whereas among adults, the chance increased to 6.6 times.. Common key modifiable factors that were strongly associated with prehypertension and hypertension in both genders included overweight and obesity (Agho et al., 2018). The findings of the review revealed coexistence of under- and overnutrition in Asia-Pacific region, with higher prevalence of overweight/obesity than that of underweight. This common existence of DBM was in line with a previous investigation assessing the global DBM (Min et al., 2018). However, more overweight and obesity was shown in our study, compared to earlier findings that the majority of (55%) LMICs had a lower prevalence of obesity than undernutrition . This is reconciled by the inclusion of more recent publications in our analysis and the overall secular trends of increased overweight/obesity and decreased undernutrition worldwide. prevalence for Southeast Asia was 21.9% showing the much lower burden of undernutrition in this area. Consequently, a high over- and undernutrition ratio was revealed in the Oceania. Despite the general high over- and undernutrition ratio in the Pacific islands, the coexistence of under- and overnutrition was not rare in this region, which distinguishes them from the HICs with little burden of undernutrition (Peng & Berry, 2018). For example, as reported by a previous study of adolescents in Fiji, the prevalence of combined overweight and obesity was 19.6% and 27.8% in boys and girls, while the prevalence of underweight was also as high as 11.4% and 5.4% in boys and girls, respectively (Novotny et al., 2017). Another study conducted in Pacific islands also suggested the dual burden of malnutrition. The secular trend of undernutrition reduction and overweight/obesity increase in Asian countries followed by rapid dietary and lifestyle transition, is leading the direction of dual burden toward overnutrition increase and diet-related NCDs, despite the present over- and undernutrition ratio in Asia is lower than others (BM, 2002). The simultaneous epidemiological transition from infectious diseases to the chronic disease, together with the nutrition transition, calls on more efforts on the policy initiatives and lifestyle changes

### **Limitations**

The limitations in the included a potential variability due to the types of settings, and modality (individualised programmes or by groups). It only included peer-reviewed literature, which reported both undernutrition and overweight/obesity that may have narrowed the scope of studies on population nutritional status. However, this restriction guarantees that numbers for both prevalences were comparable. Second, stratification by social economic determinants at

individual level was not applied in the meta-analysis, since the variables indicating such factors were not consistent across studies (e.g., rural and urban, slum and non-slum, and education). In addition, the studies were conducted at different time points, which means that this meta-analysis was not a pure “cross-sectional” study at a time point, but a study across a certain time span. This limitation is unavoidable in the systematic review of prevalence studies

### Conclusion

Burden of malnutrition in the Asia-Pacific region is alarmingly high and is tilted toward obesity. The significant coexisting of both undernutrition and overweight/obesity suggests that future interventions/policy targeting to maintain a healthy population weight should not just focus on prevention and treatment toward one direction. The available national data showed that the prevalence of overweight/obesity has been increasing in Asian countries, whereas the prevalence of undernutrition has been declining. National economic development, changes in the food supply, urbanization, and lack of adequate physical activity are positively associated with increasing overweight/obesity. These factors must be considered when formulating and implementing national policies and programs to fight obesity. Countries with a high prevalence of overweight/obesity like China, India, and Pakistan need to take timely and effective actions to fight the epidemic, whereas Nepal, where the overweight/obesity prevalence remains low, needs to take action to prevent this epidemic.

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