

Double Burden of Malnutrition and Parasitic Infections in the Low-Middle Income Countries: An Emerging Triple Burden of Malnutrition in South Asia.

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Double Burden of Malnutrition and Parasitic Infections in the Low-Middle Income Countries: An Emerging Triple Burden of Malnutrition in South Asia.

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Abstract

The lifestyle pattern has changed drastically in recent decades. There is a huge change from few decades ago to the present day. This review study is done to know the change of lifestyle pattern manifested in the form of malnutrition and obesity/overweight (Double Burden of Malnutrition, DBM) and its link with the parasitic infection, both culminating into a Triple Burden of Malnutrition in the Low-Middle Income Countries (LMICs). DBM, a challenging issue, in today's context is one of the major problem in south Asia. This review aims at showing the real picture of today's scenario of DBM accompanied with high prevalence of parasitic infections. Data used in this review are taken from the research articles through google search engine, different journals, websites, national surveys and other sources. References to the original source are strictly given to be safe from plagiarism and academic dishonesty. Gender differences in the prevalence of Overweight and Obesity (OWOB) and underweight is not considerable in this review but rural-urban differences is notable in this review, urban areas based people with higher prevalence of OWOB and rural areas people with higher prevalence of underweight. This study finds no significant difference in parasitic infections among OWOB and underweight population. Entamoeba coli and adenovirus -36 infection may contribute to fat deposition but still further studies required. This review study finds that DBM along with parasitic infections result into a Triple Burden of Malnutrition which is currently a disastrous condition for low-middle income countries. Simple concept of search, compile, analyze and interpret is used in this study. This can be a limitation in this study. The findings of this review cannot be neglected as it is very important in present context for low-middle income countries in south Asia.

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Original Manuscript

A Narrative Review

Double Burden of Malnutrition and Parasitic Infections in the Low-Middle Income Countries: An Emerging Triple Burden of Malnutrition in South Asia

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Abstract

The lifestyle pattern has changed drastically in recent decades. There is a huge change from few decades ago to the present day. This review study is done to know the change of lifestyle pattern manifested in the form of malnutrition and obesity/overweight (Double Burden of Malnutrition, DBM) and its link with the parasitic infection, both culminating into a Triple Burden of Malnutrition in the Low-Middle Income Countries (LMICs). DBM, a challenging issue, in today's context is one of the major problem in south Asia. This review aims at showing the real picture of today's scenario of DBM accompanied with high prevalence of parasitic infections. Data used in this review are taken from the research articles through google search engine, different journals, websites, national surveys and other sources. References to the original source are strictly given to be safe from plagiarism and academic dishonesty. Gender differences in the prevalence of Overweight and Obesity (OWOB) and underweight is not considerable in this review but rural-urban differences is notable in this review, urban areas based people with higher prevalence of OWOB and rural areas people with higher prevalence of underweight. This study finds no significant difference in parasitic infections among OWOB and underweight population. *Entamoeba coli* and adenovirus -36 infection may contribute to fat deposition but still further studies required. This review study finds that DBM along with parasitic infections result into a Triple Burden of Malnutrition which is currently a disastrous condition for low-middle income countries. Simple concept of search, compile, analyze and interpret is used in this study. This can be a limitation in this study. The findings of this review cannot be neglected as it is very important in present context for low-middle income countries in south Asia.

Keywords: Double Burden of Malnutrition (DBM), Overweight and Obesity (OWOB), Underweight, Parasites, Infections, Prevalence, Low-Middle Income Countries

1. Background

The double burden of malnutrition (DBM) is characterized by the coexistence of undernutrition along with overweight and obesity, or diet-related non communicable diseases, within individuals, households and populations, and across the life course. A parasite is an organism that lives on or in a host organism and gets its food from or at the expense of its host. Parasites are found in the human body, mostly in the Gastrointestinal (GI) tract. They alter the digestive system, hampers the nutrition absorption and leads to micronutrient deficiencies. The co-occurrence of undernutrition (wasting and stunting), micronutrient deficiencies (commonly referred to as hidden hunger), and overnutrition (overweight and obesity) is known as the "triple burden of malnutrition." Many low-income groups, including single families, have all three

components of the triple burden of malnutrition at the same time.

In the context of a changing global nutrition landscape, influenced by economic and income growth, urbanization, demographic change and globalization, diet-related epidemiology has seen a significant shift in recent decades [1]. In 2014, as reported by World Health Organization (WHO), more than 1.9 billion adults worldwide, 18 years and older, were overweight while 462 million were underweight. More than 600 million were obese [2]. In the same year, 42 million children under the age of five were overweight or obese but 156 million were affected by stunting; low height-for-age. While 50 million children were affected by wasting; low weight-for-height [3].

Poor nutrition continues to cause nearly half of deaths in children under five in the south Asian low-middle income countries and in the meantime these countries are also witnessing a simultaneous rise in childhood overweight and obesity – increasing at a rate 30% faster than in richer nations [4]. Both type of population, Overweight and Obesity (OWOB) and underweight, are at equal risk of parasitic infection. Not only Body Mass Index (BMI) but hygiene habit and co-morbidities underlying disease also play role on parasitic infection [5].

2. Methods

2a. *Secondary data/information analysis*: Various research articles related with keywords like “double burden of malnutrition, health burden, Gastrointestinal (GI) parasites, overweight and obesity, underweight, stunting, challenging issue, helminthes infection, BMI, Intestinal Parasitic Infections (IPIs), low-middle income countries, triple burden of malnutrition” etc. were thoroughly read and analysed during this review study.

2b. *Search, compile, analyze, and interpret*: This simple concept of search, compile, analyse, interpret and present was used during this study. Searches were done using google, journals and different websites. Compilation was done on zotero for the ease of citations and references. Analysis was mostly done on the basis of ratios and percentages. Interpretation was solely done on the basis of what was found during this study. No biasness is done in this study. Interpretation can be minimally wrong but no any biasness during the interpretation.

2c. *Measures of risk factors*: Information on different risk factors like economics, demographics, social etc. were obtained using multiple sources like World Bank, United Nations (UN), WHO etc. websites and fact sheets. National and international survey reports were one of the key source of information during the measures of risk factors.

2d. *Exclusion/Inclusion criteria*: Date, considering 2013 A.D. as initiative landmark, is one of the major criteria. Full article availability is another important criteria. Similarly other important criteria considered during this review are topic matching, language barrier, journal impact, and journal ranking in SJR (Scimago Journal). Only research papers from low-middle income countries are considered in this review study.

3. Review

3.1. Global review of low-middle income countries

A study done in Venezuela shows that 26.8% households has DBM and also DBM households significantly linked with *Giardia lamblia* and Geohelminths [6]. This is manifestation of triple burden of disease, a very perturbing problem found from this household study. A study done in Peru shows that the homely environment and children in family setting thrive better than the children in orphanage. Same study also shows that GI infection is high in orphanage than in family [7]. A study in Mexico rural area shows that *Entamoeba coli* infection may contribute to fat deposition [8]. Same study shows that *Ascaris lumbricoides* as the most prevalent Soil-Transmitted Helminths (STHs) (16%) followed by hookworm. *Entamoeba coli* was the predominant protozoa (20%) followed by *Endolimax nana*, *Balantidium coli*, *Entamoeba histolytica/dispar*, *Iodamoeba bütschlii* and *Giardia lamblia*.

A research study in school children in Ethiopia concludes that roundworm, hookworm and whipworm (STHs) has no association with BMI i.e nutritional status [9]. Another study conducted among Ethiopian primary school students, children with illiterate mothers and fathers, children with

fathers who could read and write, children who did not regularly wash their hands before meals, and a lack of awareness about WASH are all significantly linked to intestinal parasitosis [10]. Similar study among school children in Northwest Ethiopia shows that GI parasites infection is high among underweight children of below 13 yrs age, severe stunting is high among girls than among boys, and hygienic factors along with literacy are associated with the parasitic infections [11]. These hygienic and literacy factors are highly prevalent in low-middle income countries which make them more vulnerable to parasitic infections.

3.2. Review of China, India, and Nepal – South Asia

In China the prevalence of OWOB is much higher than that of underweight and some large rural-urban differences in the prevalence of these outcomes are found in both school children and childbearing women [12]. Stunting in school children is more prevalent in rural areas than in urban areas. Gender differences in the prevalence of OWOB and underweight are not significant in school children [13]. Overall, the prevalence of OWOB is higher in urban than in rural populations, except among child bearing age women in China where there is a little difference seen. This is possibly because urban people are more likely to be exposed to obesogenic factors (e.g. foods with higher energy density and a more sedentary lifestyle). Interestingly, in China, OWOB is similar in childbearing women in urban and rural areas, according to recent national data [14]. In the recent decades China has gone an impressive increasing economy, now the second largest economy after the USA, with 10% GDP growth annually [15]. Along with the economy leap in the China, it has witnessed a considerable declination in endemic STHs, schistosomiasis, and malaria. But the prevalence of some food-borne trematode infections and cysticercosis has significantly increased in recent years [16]. Clonorchiasis and paragonomiasis are two prominent food-borne trematode infections in China. With regard to the former, approximately 15 million people are infected nationwide [16, 17]. This is contributing to major health issues currently in China.

In the context of India, a recent study shows that being overweight or obese was linked to older age, more education, affluence, living in an urban area, and belonging to a backward class or other groups [18]. Similarly, a prior study in India indicates that other backward communities has a much higher likelihood of being overweight or obese. Among the scheduled tribe groups, the study discovered a lower rate of overweight/obesity and a higher prevalence of underweight [19]. OWOB and underweight, both population of India are at equal risk to intestinal parasitic infections in India. BMI alone is not determinant to the infection risk but hygiene and co-morbidities are playing role [20].

A Nepal's study done to see the prevalence of STHs in 5 major community reveals that STH infection was associated with individual hygiene behavior, but not with nutritional status or socio-demographic characteristics [21]. A study from Nepal among school going children finds that individual variations in behaviour, such as "not using soap for hand washing," are the cause of the risk of Intestinal parasite infections (IPIs) [22]. The burden of enteric parasite infection may be lessened by better health services and a more favourable opinion of the local population [23]. Intestinal parasite infections (IPIs) and various nutritional profiles/statuses were found to be inconsistently associated in numerous previous research. In the context of Nepal, situated between India and China, there are limited policies that have been established to focus on the prevention and control of DBM [24]. They have been inadequate in controlling the rapid increase in DBM over the past 2 decades. There is a lack of prevention and control efforts for key factors related to obesogenic environments. There is also a need to consider genetic and psychological factors in developing policies and programs to fight the DBM epidemic [25].

4. Discussion

Young age children and mostly girls are at more risk to stunting as well as GI parasites infection [26]. A meta-analysis reveals that protozoans like *Cryptosporidium*, *Giradia* and *Entamoeba* are the leading causes to stunting in children in low-middle income countries [27]. A study done among obese population shows that parasites like adenovirus -36 exerts adipogenic action via effect on adipose tissue in animal models [28]. Interestingly, a very recent cross sectional study done among

obese population shows that parasites not correlate with nutritional deficiencies and body composition, but correlate to metabolic syndrome [29]. Malnutrition in its many forms has previously been understood and approached as a separate public health issue, but the new emergent reality is that undernutrition and over nutrition are interconnected and, therefore, double-duty actions that simultaneously address more than one dimension must be implemented for policy solutions to be effective. Accompanied with the parasitic infections, DBM turns into Triple Burden of Malnutrition which is the most important contributing factor for economic burden in low-middle income countries [30].

4.1. Economic and Demographic comparison of China, India, and Nepal

China had the highest per capita income, which was 10 times that of Nepal, and 4.5 times that of India. In addition, China's life expectancy was the highest (76.5 y), followed by Nepal (70.2 y) and India (68.2 y). Under 5-y mortality had a similar pattern, but in the reverse order, i.e. China had the lowest rate, followed by Nepal and India. China also had the largest proportion of urban population. The availability of domestically produced food was highest in India.

TABLE 1; Economic and demographic characteristics of China, India, and Nepal.

Country	Income level	GDP per capita (US \$)	Life expectancy (year)	Population (thousand)	Urban Population (%)	Food production index	Under-5 mortality
China	Upper-middle	8827.0	76.5	1386,395.0	58.0	139.0	9.2
India	Lower-middle	1942.1	68.2	1339,180.1	33.6	144.4	38.7
Nepal	Low	849.0	70.2	29,305.0	19.3	137.8	33.4

Data source; World Development Indicators and World Bank, 2017 [31]

4.2. Prevalence of undernutrition and OWOB among children in China, India, and Nepal

Undernutrition was least prevalent in China (wasting = 2.0%, underweight = 2.5%), Nepal (wasting = 9.7%, underweight = 27.0%), and India (wasting = 21.0%, underweight = 35.7%). Stunting was highly prevalent in all countries except China, with slightly over one-third of children being affected. However, the rural/urban difference was higher in China and almost negligible in the other countries. As opposed to undernutrition, OWOB was more common among school children in China (11.5%), India (2.1%), and Nepal (1.2%).

TABLE 2; Prevalence (%) of under- and over nutrition among children with their urban/rural and gender (boy/girl) differences.

Country	Population	Stunting (%)	Wasting (%)	Underweight (%)	OWOB (%)
China	Overall	8.1	2.0	2.5	11.5
	Rural/urban	2.7	1.6	1.8	1.0
	Boy/girl	1.2	1.0	1.1	1.3
India	Overall	38.4	21.0	35.7	2.1
	Rural/urban	1.3	1.1	1.3	0.6
	Boy/girl	1.0	1.1	1.0	1.0
Nepal	Overall	35.8	9.7	27.0	1.2
	Rural/urban	1.3	1.1	1.3	0.6
	Boy/girl	1.0	1.0	1.0	1.4

Data source; National Health and Demographics Survey Report: China [12], India [20], and Nepal

[24].

4.3. Prevalence of OWOB among childbearing age women in China, India, and Nepal

In all three countries, the prevalence of OWOB among women (Table 3) was much higher than in children (Table 2). The prevalence was highest in China (34.6% for women and 11.5% for children). The prevalence was much lower in Nepal (22.2% for women and 1.2% for children) and India (20.6% for women and 2.1% for children).

TABLE 3; Prevalence (%) of overweight/obesity among women of child bearing age(15–49 years) and their differences in rural/urban region.

Country	Population	Overweight (%)	Obesity (%)	OWOB (%)
China	Overall	25.4	9.2	34.6
	Rural/urban	1.0	1.0	1.0
India	Overall	15.5	5.1	20.6
	Rural/urban	0.5	0.3	0.5
Nepal	Overall	17.1	5.1	22.2
	Rural/urban	0.7	0.3	0.6

Data source; National Health and Demographics Survey Report: China [12], India [20], and Nepal [24].

In general, undernutrition was less common in nations with stronger economic standing, but OWOB was more common in children [12, 20, 24, 31]. This was especially true in China, which had the greatest income level of the three, where the prevalence of OWOB was significantly higher than that of underweight [12]. School going children and childbearing age women showed some significant rural-urban disparities in the incidence of these outcomes [12, 13]. School children in rural regions were more likely than those in urban environments to be stunted and did not exhibit gender differences in the incidence of underweight and OWOB. In general, countries with higher per capita incomes had higher rates of OWOB among school children and childbearing age women than did those with lower incomes. This supports the body of research showing a link between obesity and higher income [14, 19]. With the exception of childbearing women in China, where there was minimal variation, the frequency of OWOB was generally higher in urban than in rural populations. This may be due to the fact that obesogenic variables, such as meals with a higher energy density and a more sedentary lifestyle, are more likely to be encountered by metropolitan dwellers [13, 18]. Remarkably, recent national data in China showed that the prevalence was same for birthing women in rural and urban settings [12].

The effectiveness of the few policies that have been put in place to concentrate on the prevention and control of obesity has not yet been assessed. China has more obesity-related regulations and intervention initiatives than any of the other three nations combined, yet it also has the worst obesity problem [12, 13]. But over the past 20 years, they haven't been able to keep up with the sharp rise in OWOB. Key factors associated with obesogenic environments are not adequately prevented or controlled in China. When creating policies and initiatives to combat the obesity epidemic, undernutrition and parasitic infections, genetic and psychological elements must also be taken into account for the effective implementation and outcome [25].

5. Limitations

This study also has some limitations. First, the topic is narrow, specific and less researched so, limited research articles were obtained during the study. Another major limitation in this review study is the language barrier. Many research articles related to Double Burden of Malnutrition and parasitic infections are published in other than English language which is not appropriate for our review study. This limits us from access to large number of research articles and publications related to DBM and parasitic infections in low-middle income countries.

6. Conclusion

The available literature and data showed that the prevalence of DBM has been increasing worldwide

with more rapid incline in south Asia. National economic development, changes in the food supply, urbanization, and lack of adequate physical activity are positively associated with increasing DBM. Lack of awareness regarding the hygiene and sanitation, lack of policies regarding wastage management and dumping are possible cause of high parasitic infections in low-middle income countries. These all factors must be considered when formulating and implementing national policies and programs to fight DBM and parasitic infection simultaneously. DBM along with parasitic infections can lead to a devastating condition called Triple Burden of Malnutrition in low-middle income countries. This condition can add more economic burden and in the same time lack of active healthy population can further deteriorate the overall economic development of the south Asian' low-middle income countries.

7. Abbreviations

DBM	Double Burden of Malnutrition
OWOB	Overweight and Obesity
WHO	World Health Organization
LMICs	Low-Middle Income Countries
BMI	Body Mass Index
GI	Gastrointestinal
IPIs	Intestinal Parasitic Infections
UN	United Nations
SJR	Scimago Journal
STHs	Soil-Transmitted Helminths

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