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Epidemiology of Malnutrition: Maternal and Child Malnutrition

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Abstract

Malnutrition, though uncommon in developed countries, continues to be a major health burden in developing countries. Malnutrition, consisting of protein-energy malnutrition and micronutrient deficiencies, is globally the most important risk factor for morbidity and mortality. Particularly, hundreds of millions of pregnant women and young children are affected by malnutrition. Forty five percent of all deaths in children fewer than 5 years of age are attributed to under nutrition. In 2012, it was estimated that 26% of the world's children were stunted and about 3% were severely wasted. In the past decade, discourse about the challenge of malnutrition has increased substantially at both national and international levels. Definition, prevalence, causes and challenges associated with reducing malnutrition (undernutrition) in children, pregnant women and the elderly will be covered briefly in this review. Emphasis of this review is on prevalence and prevention of malnutrition in pregnant women and children.

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Introduction

Malnutrition is a significant global health concern, particularly in children under five years of age and pregnant women. The World Health Organization classifies malnutrition world-wide as the greatest threat to public health[1]. Globally malnutrition is the most important risk factor for morbidity and death[2]. According to the latest data available from World Bank, the average per capita income for the low income developing countries was $1,983 in 1990 and $2,830 in 2012, while for the same years the average per capita income for high income developed countries was $3,685 and $12,920 respectively. For the very high income developed countries, the average per capita income for years 1990 and 2012 was reported to be $28,736 and $40,307 respectively (World 2014, World Development Indicators Database).

A detailed discussion of the epidemiology of malnutrition in developed and developing countries is beyond the scope of this article. Therefore, definitions, prevalence, causes and challenges associated with reducing malnutrition (undernutrition) in children, pregnant women and the elderly with emphasis on maternal and child malnutrition will be covered in this review. Though obesity is a form of malnutrition and is a growing problem in both developed and developing countries, it will not be covered in this article.

Definition

Malnutrition means faulty nutrition. Malnutrition is defined as a state of nutrition in which a deficiency or excess (or imbalance) of energy, protein and other nutrients causes measurable adverse effects on tissue/body from body function and clinical outcome[1,2]. Since this means deviation from normal nutrition, it is necessary to establish cutoff points between normal and malnutrition. There are uncertainties and a significant amount of conflict about both the definition and the recognition of malnutrition[3].

Malnutrition in adults and pregnancy

There is an extraordinarily large range of cut-off values

of Body Mass Index (BMI) that are used to identify individuals with chronic protein-energy malnutrition[3]. Table 1 shows the anthropometric cut-off values using Body Mass Index (BMI) which have been used by several researchers[4-13].

Table 1: Anthropometric cut-off values that include Body Mass Index (BMI) for detecting underweight or undernutrition in adults*.

Recommended/type of Anthropometric criteria	study using criteria	Reference
BMI < 17.5	Anorexia nervosa	International classification for World Health Organization, 1992[4]
BMI < 18	Nursing homes	Lowik et al., 1992[5]
BMI < 18.5	Community and hospital	Kelly et al., 2000[6]
BMI < 19.0	Community and hospital	Dietary Guidelines for Americans, 1995[7]
BMI < 20 (< ~90% ideal body weight)	Community and hospital	Vlaming et al., 1999[8]
BMI < 20 (and < 15th centile for MAMC and/or 15th centile for TSF)	Hospital and community studies	McWhirter and Pennington, 1994[9]
BMI < 22	Free-living elders (> 70 years)	Posner et al., 1993[10]
BMI < ~23.5 (25th centile for BMI)	Community and hospital	Potter et al., 1998; Potter, 2001[11]
BMI < 24 (and other criteria)	Community	Gray-Donald et al., 1995[12]
BMI < 24 (and other criteria)		Recipients of 'meals on wheels'Coulston et al., 1996[13]

[1]Based on the mid-point of the Metropolitan Life Insurance tables for mid-point of 'ideal' or 'acceptable' weight range.
MAMC = Mid-Arm Muscle Circumference; TSF = Triceps Skin-Fold Thickness.
*Adapted from Stratton et al[3].

Currently there is neither a consensus on which anthropometric measurement should be used to identify malnutrition or acute malnutrition during pregnancy nor wich cut-off value should be used[14]. Some programs use the normal Body Mass Index (BMI) cut-off value of 18.5 kg/m^2 for adult women assuming it is applicable for pregnant women[3,14]. In response to the unsatisfactory nutritional status findings for women and young children from the United States Ten-States Nutrition Survey, the Center for Disease Control and Prevention (CDC) has developed a system for continuous monitoring of the nutritional status of selected high risk population groups (CDC, 1984) called the Pediatrics and Pregnancy Nutrition Surveillance System (PedNSS) [15]. This agency collects, analyzes and interprets data on health indicators for pregnant women and young children. PedNSS has adapted the Institute for Medicine recommended cut-offs for defining maternal and child malnutrition (Table 2 and Table 3). An overview of cut-off values for maternal BMI in developing countries for low birth weight (LBW), Intra Uterine Growth Retardation (IUGR) and Preterm Birth (PTB) for most studies has indicated a BMI ranging from < 18.5 kg/m^2 to < 20.5 kg/m^2 with statistically significant LBW[16].

Table 2: Maternal pre-pregnancy weight recommended by the Institute of Medicine to define malnutrition adopted by the Pediatrics and Pregnancy Nutrition Surveillance System (PNSS).

Pre-pregnancy Weight	BMI
Underweight	< 18.5
Normal weight	18.5 - 24.9
Overweight	25.0 - 29.9
Obese	≥ 30

Table 3: Maternal weight gain recommended by the Institute of Medicine to define malnutrition adopted by the Pediatrics and Pregnancy Nutrition Surveillance System (PNSS).

Weight	Pre-pregnancy BMI	Total Weight Gain (lb)
Underweight	< 18.5	28 - 40
Normal weight	18.5 - 24.9	25 - 35
Overweight	25.0 - 29.9	15 - 25
Obese	≥ 30	11 - 20

Some researchers after conducting extensive literature searches starting with key terms maternal anthropometry and pregnancy have identified mid-arm circumference (MUAC) as the preferential method of choice because of its relatively strong association with LBW, narrow range of cut-off values, strength of measurement and no need for prior knowledge of gravid as age. The MUAC values below which most adverse effects were identified were < 22 and < 23 cm. A conservative cut-off of < 23 is recommended to include most pregnant women at risk of LBW infants for African-American and Asian women[16].

Malnutrition in young children

The World Health Organization (WHO) and United Nations Children's Fund (UNICEF) define Severe Acute Malnutrition (SAM) in children by weight-for-height index (WHZ) less than -3 Z score or a Mid-Upper Arm Circumference (MUAC) less than 115 mm, or presence of edema (WHO, 2009)[17,18]

WHO has provided standard definitions for underweight, wasting and stunting for children (Table 4).

Table 4: WHO standard definitions for underweight, wasting and stunting for children*.

Classification	Index Used	Moderate	Severe
Underweight	Weight for age	< -2 Z-scores	< -3 Z-scores
Wasting	Weight for length/height	< -2 Z-scores	< -3 Z-scores
Mid upper arm circumference	(6 - 59 months)	< 125 mm	< 115 mm
Stunting	Length/height for age	< -2 Z-scores	< -3 Z-scores

*WHO/UNICEF Joint Statement. WHO child growth standards and identification of severe acute malnutrition (2009)[17].

However, individual country surveys for standard analysis have used low height for age, low weight for height and low weight for age as the anthropometric indicators traditionally to assess child nutritional status[19]. Most investigators have focused on height for age, i.e., stunting, because this indicator best reflects long time cumulative effects resulting from inadequate diet and/or recurrent illness[20,21]. The prevalence of low height for age has been defined as the proportion of children that fall

below -2 Standard Deviations (SD) of the United States National Center for Health Statistics/WHO international reference mode.

Malnutrition in the elderly

For the study of malnutrition in the elderly, standardized nutritional assessments, both in the home and hospital care, Body Mass Index, Malnutrition Universal Screening Tool (MUST), Mini Nutritional Assessment-short form (MNA-sf) are frequently used[5,22,23].

Prevalence of malnutrition

Global trends indicate a decrease in diseases of undernutrition, while over nutrition is increasing. On the community level, economic status seems to influence the dual burden's extent, with obesity increasingly affecting the already malnourished poor[24]. The co-existence of under and over nutrition, a phenomenon known as "dual burden", poses a new public health challenge[25]. Significant worldwide challenges are posed by the various forms of under nutrition (stunting, wasting, micronutrient deficiencies) in children under five, pregnant women and the elderly. In 2010, an estimated 171 million children under five years of age were stunted, with almost all occurring in developing countries[21]. Although, the global prevalence of stunting has declined from 39.7% in 1990 to 26.7% in 2010, this trend has not been consistent in all regions of the world. Stunting in Africa has remained relatively unchanged around approximately 40%[24]. Projections for 2020 indicate that the situation in Africa will not improve much, whereas prevalence in Asia and Latin America will continue to improve[24]. Also, micro-nutrient deficiencies in children under five years of age continue to be problematic, 47% are reported to be anemic and 33% are vitamin A deficient[25]. Table 5 shows the countries where chronic malnutrition in children is highest[26].

Table 5: Countries with highest chronic malnutrition (stunting in children under 5 years of age)*.

Country	Highest Chronic Malnutrition
Korea, Dem. People's Rep.	60
Zambia	59
Burundi	57
Nepal	54
Afghanistan	52
Yemen	52
Ethiopia	51
Madagascar	49
Malawi	49
Cambodia	46
Guatemala	46
India	46
Nigeria	46
Bangladesh	45
Congo, Dem. Rep.	45
Lesotho	44
Mauritania	44
Tanzania	44
Rwanda	43
Comoros	42
Lao PDR	41
Bhutan	40
Niger	40

*Child Malnutrition Child Malnutrition - Unicef

Table 6: A summary of trends in maternal health indicators according to the Pediatric and Pregnancy Nutrition Surveillance System (PNSS)*

Year	Pre-pregnancy BMI			Weight Gain			Anemia (Low Hb/Hct)			
	Number	Under weight %	Over weight %	Number	< Ideal %	> Ideal %	Number	3rd Trimester %	Number	Postpartum %
2011	953,682	4.5	53.7	718,099	21.0	48.0	142,563	33.8	282,614	28.3
2010	1,106,370	4.5	53.4	835,927	21.5	48.0	164,201	33.9	346,981	28.1
2009	1,226,875	4.5	52.9	917,032	21.2	48.2	189,944	33.9	412,633	28.8
2008	1,225,236	4.7	52.2	963,520	21.4	48.3	187,077	33.9	417,631	29.6
2007	1,174,620	4.7	51.3	920,893	21.4	48.6	180,198	33.5	414,771	9.8
2006	1,079,529	4.8	50.5	870,778	21.3	48.8	161,684	32.2	359,268	29.2
2005	800,470	5.0	50.7	660,824	22.2	48.9	125,185	31.2	278,272	29.4
2004	792,024	5.2	49.9	641,639	22.1	49.1	128,870	30.8	263,784	28.8
2003	697,032	5.3	49.6	593,956	21.7	49.6	102,837	30.6	260,650	29.4
2002	658,273	5.7	48.7	551,422	22.2	49.0	102,684	31.3	243,271	28.2
2001	667,876	5.9	48.0	555,294	22.4	48.6	97,910	29.4	253,283	29.2
2000	682,995	6.2	46.9	554,674	22.4	48.3	110,322	29.7	262,307	28.0
1999	626,160	6.4	46.3	504,916	24.8	46.5	99,312	29.9	245,079	27.1
1998	555,492	6.6	45.2	481,647	29.5	42.4	84,916	29.3	226,374	27.4
1997	482,952	6.8	44.1	410,736	30.9	40.8	80,380	28.1	203,395	26.5

*Adapted from[15].

Maternal malnutrition contributes to fetal growth restriction, which increases the risk of neonatal death and for survivors, of stunting by 2 years of age[27]. Prevalence of low BMI (< 18.5 kg/m^2) in adult women has decreased in Africa and Asia since 1980, but remains higher than 10 % in these two large developing regions. On the other hand, by 2008 the prevalence of overweight and obesity has risen in all regions, together reaching more than 70 and 40 % in the Americas, the Caribbean and Africa respectively[27]. Table 6 reports a summary of trends in maternal health indicators according to the Pediatric and Pregnancy Nutrition Surveillance System (PNSS). This summary shows that from 1997 to 2011 the percentage of underweight has decreased from 6.8% to 4.5% in the U.S., while during the same period the percentage of overweight has increased from 44.1% to 53.7%. Also the percentage of women in the U.S. gaining less than ideal weight (according to IOM guidelines) during pregnancy has decreased from 30.9 % down to 21%, while the percentage of gravid as gaining more than ideal weight has remained essentially the same (40.8% to 48.0%). For another nutritional status indicator, anemia, in the U.S. the prevalence of anemia in the 3rd trimester has increased from 28.1% in 1997 to 33.8% in 2011[15].

Causes and interventions

A detailed discussion of causes of malnutrition is beyond the scope of this article. These causes are well documented and have been covered extensively elsewhere[3,28-30]. Very briefly, both maternal and child malnutrition are much more common in developing countries which are less industrialized with low per capita income. Young children, pregnant women and the elderly are particularly vulnerable to undernutrition. The causes of disease related malnutrition are multiple and include insufficient food /nutrient intake, impaired digestion, absorption and increased requirements due to losses, i.e., from malabsorption, parasites, wounds and infections[2]. Principally insufficient food intake is the main cause of malnutrition. This insufficient food intake could be due to anorexia, taste disturbances, nausea, vomiting and drug related side effects, swallowing difficulties and other social factors like problems with shopping or meal preparation[3]. Anxiety, depression, bereavement, poverty and other factors related to poverty may also reduce food intake, leading to malnutrition.

Malnutrition is not uncommon among the elderly even in developed countries. Prevalence of malnutrition in hospitalized patients was first reported by Butterworth[31]. Since then there have been numerous investigations and reports of a rather high prevalence of malnutrition in hospitals[32]. Several studies across many diagnostic groups have documented energy, protein and micronutrient intake, particularly, iron and calcium to be insufficient to meet the nutritional requirements. Malnutrition is particularly a problem in institutionalized patients. Studies have shown that between 30 and 60% of hospital food is not consumed, sometimes because of catering practices do not meet the needs of the sick elderly[2,32]. Malnutrition in elderly populations can result from many factors other than reduced income and loneliness due to a lack of companionship. A number of factors including sensory loss, chewing due ill-fitting dentures and swallowing problems, anorexia together with acute or chronic diseases, may compromise dietary intake and lead to nutritional deficiencies[33].

A major shift in the nutrition landscape has occurred since the publication of the first Lancet Series on Maternal and Child Undernutrition in January 2008[28]. Since then almost every developmental agency has published a policy document dealing with causes and intervention of malnutrition in mothers and children[28-30,34]. Due to the Scaling Up Nutrition (SUN) movement started in 2010, there has been increased interest in nutrition. By middle 2013 this movement had grown considerably and 35 countries have committed to scale up direct nutrition interventions and advancement of nutrition-sensitive development[34].

Conclusions

As stated in the Global Nutrition Report 2015(International Food Policy Research Institute 2015), as we move into the post-2015 era of the Sustainable Development Goals (SDGS), malnutrition unfortunately is still a public health problem of tremendous magnitude, and major national and international initiatives are needed to improve both the prevention and treatment of malnutrition at global and regional levels (developed and developing countries). Undernutrition, which is the emphasis of this article, most commonly associated with disease is a costly but very treatable problem. Malnutrition not only affects young children and pregnant women, but is a universally significant problem, particularly in health care settings (e.g., hospitals, home care and outpatients), occurring in patients with a wide variety of acute and chronic illnesses. Routine screening for risk of undernutrition in individuals in hospitals, care homes and in outpatient clinics and general practice is essential[2]. A universal, simple uniform, evidence based screening tool to detect both under and over nutrition is recommended for use in all adults, including pregnant women as well as in young children. Many international and national organizations have developed detailed targets, nutrition outcomes and initiatives to achieve a sustainable decrease in maternal and child malnutrition[35,36]. The International Food Policy Institute has worked not only to develop goals and methods to achieve these goals; it has also published information on progress in meeting nutritional status target by various countries[36]. As indicated earlier, it is apparent that many countries have significantly decreased maternal and child malnutrition, but unfortunately many other countries still lack progress in meeting the targets set by themselves as well as international goals. Effective interventions are available to reduce stunting, micronutrient deficiencies and child death. If implemented at a sufficient scale they would reduce all child deaths by about one fourth in the short term[34]. The high mortality and disease burden resulting from these nutrition-related factors make a compelling case for the urgent implementation of interventions to reduce their occurrence and amelioration of their consequences.

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