



Seasonal variation in the proximal determinants of undernutrition during the first 1000 days of life in rural South Asia: A comprehensive review

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ARTICLE INFO

Keywords:

Seasonality
Nutrition
Agriculture
Growth
Thousand days

ABSTRACT

In this review, the influence of seasonal variation on undernutrition during the first 1000 days of life of life in rural South Asia is conceptualized using a modified framework developed under the “Tackling the Agriculture and Nutrition Disconnect in India” project. Evidence for the existence and extent of seasonality is summarized from 14 studies reporting on six proximal determinants of undernutrition. A limited number of studies examine seasonal variation in risk factors for this age group. All available studies, however, report a compelling finding of significant seasonal variation for at least one determinant of undernutrition. Research to clarify mechanisms for potentially adverse effects of seasonal variation on health and nutritional status during the first 1000 days of life is needed.

1. Introduction

Various measures of nutritional status are widely used to define undernutrition. Anthropometric assessment of body size, however, remains one of the most widely used and accepted methods of assessment, particularly in children from low-resource settings (The World Health Organization, 1995). The definition of undernutrition is based on a negative deviation in child growth, or growth faltering, relative to an age appropriate reference. Child undernutrition remains one of the world's most significant public health challenges. South Asia, where an estimated 34.4% of children less than five years of age are stunted (low height-for-age), has the highest number of undernourished children of any region in the world (United Nations Children's Fund (UNICEF) et al., 2016). Due to the high nutritional requirements for rapid growth and development during early life, the first 1000 days (period from conception through approximately two years of age), is a particularly high risk period for undernutrition (Save the Children, 2012). Children who are undernourished in early life are at potentially life-long increased risk of morbidity and mortality, cognitive deficits, and decreased adult productivity and earnings (Victora et al., 2008; Hoddinott et al., 2008; Martorell, 2017). Understanding and addressing undernutrition in early life in South Asia is therefore of critical public health importance.

Agriculture serves as the primary livelihood for over half the population in South Asia, and thus has important potential to be leveraged

for the reduction of child undernutrition (Gillespie et al., 2015). The agricultural cycle in tropical and sub-tropical regions of developing countries is driven by agro-ecological conditions and by annual cycles in the weather. In rural South Asia, different seasons, or periods of the year, are marked by extreme variations in agro-climatic factors (e.g. temperature, rainfall, labor demands, crop cycles, etc.). The climate in South Asia is largely determined by the summer monsoon (southwest monsoon), which runs from approximately June to September. In India, for example, the heavy rainfall associated with the monsoon period typically begins on the western coast at the beginning of June, covers the entire country by mid-July, and withdrawals between September and early October. The monsoon is critical for agriculture and rural livelihoods across South Asia and forms the basis for many of the definitions of seasons employed across the region (Asia Continent: Climate; South Asia: Climate and Vegetation; The World Factbook: South Asia). Many of these definitions, however, remain somewhat arbitrary and are influenced by local and regional climate and agricultural characteristics. To allow for standardization of different seasonal definitions utilized in the literature, we employ a simplified three season framework commonly reported in the South Asian literature: summer/pre-monsoon (March–June; hot and dry), monsoon/rainy (June–September; hot and wet), and winter/post-monsoon (October–March; cool and dry) (Stevens et al., 2017).

Seasonality, or any regularly occurring variation that is correlated with the seasons (e.g. changing agricultural labor demands, food

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supplies, and disease vectors in the environment, etc.), is often associated with negative health and economic consequences for both individuals and populations (Devereux et al., 2012). In rural areas of developing countries, seasonality in infant and young child growth is a fairly well documented phenomenon. In South Asian countries, seasonal differences of greater than 100 g in mean birth weights and 0.5 standard deviations in birth lengths, in favor of the dry, post harvest period have been reported in the published literature (Chodick et al., 2009a, 2009b; Rao et al., 2009; Hort, 1987; Shaheen et al., 2006; Hughes et al., 2014). Seasonal changes in weight and prevalence of wasting (low weight-for-height) have also been observed in children less than two years of age (Brown et al., 1982; Costello, 1989; Panter-Brick, 1997; Gillespie and McNeill, 1994). In Bangladesh, for children 6–60 months of age, the magnitude of these differences was on the order of 3–4 fold, with weight loss occurring during the rainy season (Brown et al., 1982). Seasonal fluctuations in agro-climatic cycles may serve as potentially important indirect determinants of undernutrition and/or a failure to achieve nutritional recovery (Seasonal Dimensions to Rural Poverty, 1983).

In South Asia, the majority of undernourished children continue to reside in rural areas where subsistence and semi-subsistence agriculture serve as the primary livelihoods (Kadiyala et al., 2014). The importance of agriculture for livelihoods and nutrition is increasingly recognized, and various publications have described the potential causal pathways linking agriculture and nutrition (Gillespie et al., 2015, 2012; Kadiyala et al., 2014; The World Bank, 2007; Ruel and Alderman, 2013). The potential influence of seasonality, a central feature of agrarian lives, on these pathways, however, is not widely considered, especially for the vulnerable first 1000 days life. Given the large magnitude of the undernutrition problem in South Asia, the importance of agriculture for livelihoods and nutrition, and the potential for seasonality to act as an indirect determinant of undernutrition, a better understanding of the existence and extent of seasonality in agriculture-nutrition pathways during early life in South Asia is needed. The objectives of this paper are three-fold: 1) To conceptualize the potential influence of seasonality on the proximal determinants of early child nutrition in agriculture-nutrition pathways, 2) to explore the PubMed literature for evidence of the existence and extent of seasonality in the proximal determinants of undernutrition during the first 1000 days of life in rural South Asia and, 3) To identify gaps in the existing literature for which hypotheses can be generated for future research on seasonality and young child undernutrition.

2. Conceptual framework

2.1. Approach

The TANDI framework was chosen for the purposes of this review because it was developed for the South Asian context, provides a concise picture of a causal network linking agriculture and nutrition, and is one of the few available frameworks that consider the concept of seasonality (Devereux et al., 2012). This framework (Fig. 1) illustrates seven key pathways through which agricultural livelihoods affect the nutritional status of mothers and children that have been described in detail elsewhere (Headey et al., 2012; Gillespie et al., 2012). In brief, the key pathways are: agriculture as a source of food, agriculture as a source of income, the link between agricultural policy and food prices, income derived from agriculture and how it is actually spent, women's socioeconomic status and ability to influence household decisions, women's ability to manage the care, feeding and health of young children, and women's own nutrition status (Headey et al., 2012; Gillespie et al., 2012). Due to expectations regarding the organization of the literature in PubMed, the TANDI framework was modified to reflect the underlying and immediate causes of undernutrition terminology as originally described in the UNICEF conceptual framework and expanded in various subsequent nutrition frameworks (United Nations

Children Fund (UNICEF), 1998). The underlying causes of undernutrition in young children include food (food security) health (health status, access and availability of health care and the health environment) and care (child feeding and care practices). The immediate causes of undernutrition include diet (dietary intake) and infection (infectious disease status). Because the nutritional status of pregnant and lactating women is integrally related to the nutritional status of children during the first 1000 days of life, the potential seasonality of these determinants (with the addition of maternal energy expenditure) were also examined in pregnant and lactating women.

3. Pathways: proximal determinants of undernutrition

We examined the pathways illustrated in the TANDI framework to conceptualize the potential mechanisms for adverse effects of seasonality on young child undernutrition. First, underlying agro-climatic conditions and production potential determine the suitability of a farming system. Second, seasonal patterns of temperature and rainfall drive the agricultural cycle, which in turn drives patterns of food production, agricultural income and agricultural labor demands for women and other members of the household. Household (e.g. socio-economic status, non-farm income, etc.) and community factors (e.g. food policies, social protection schemes, etc.) are also likely to exhibit complex seasonal patterns and relationships that will determine the likelihood, extent and ways in which seasonality is experienced by individuals and households. Adverse effects of seasonality on nutrition outcomes may then feed back to further negatively affect household assets and strategies, and thus increase risk for additional detrimental seasonal effects, or other external negative shocks.

Regardless of the pathway examined, the influence of seasonality (including any adverse effects) on young child and maternal undernutrition converges at the levels of the underlying and immediate, or the most proximal determinants, of undernutrition. For example, the time that women spend in agricultural labor is expected to change depending on the season of the year (e.g. higher during sowing and harvest periods) such that women's time for child care and feeding will be more constrained during periods of heavy labor demands. One could thus hypothesize that young infant care and feeding practices would also follow seasonal patterns related to the agricultural cycle (pathway of women's ability to manage the care, feeding and health of young children in the TANDI framework). Based on this conceptualization of the potential impact of season on the proximal undernutrition determinants outlined in the TANDI framework, we conducted a comprehensive search of PubMed in order to identify and assess published literature for the existence and extent of seasonality in the proximal determinants of undernutrition during the first 1000 days of life in rural South Asia.

4. Literature review methodology

4.1. Search strategy

Key concepts for the proximal determinants of undernutrition were extracted from components of the modified TANDI framework, and PubMed was comprehensively searched in January 2017. The following concepts were included in the search: "Immediate determinant of undernutrition" (diet, infection, maternal energy expenditure) OR "Underlying determinant of undernutrition" (food, health, care) OR "Seasonality" OR "South Asia" (Online Supplemental Table 1). Although a systematic search process informed our review, a strict systematic review protocol was not followed, and thus it should be considered as a rigorous literature review rather than a systematic review (Hagan-Zanker and Mallett, 2013).

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