Ind. J. Phys. Anthrop & Hum. Genet. Vol. 41, No. 1, (2022) : 37-51

DETERMINANTS OF MALNUTRITION AMONG CHILDREN UNDER FIVE YEAR OF AGE GROUP IN INDIA: A REVIEW

HARSH VATS, RUCHI SAXENA, VIPIN GUPTA, MOHINDER PAL SACHDEVA

ABSTRACT

Malnutrition is a common public health condition among children under five years of age. Nearly half of the global childrens' deaths are attributable to undernutrition. In 2020, 149 million children were stunted (low height-for-age), 45 million were wasted (low height-for-age), and 38.9 million were overweight and obese (weight-for-height) as per global report of World Helath Organization. This critical review aims to effectively address the problem of malnutrition in children under five year by determining its risk factors in India. A comprehensive review of the literature was conducted using PubMed, Google Scholar, Web of Science, Embase, and a manual review of the reference list after selected studies were done to identify relevant published articles. The search was conducted from 01-01-2012 to 20-01-2021. The 28 potential studies have been identified that fulfilled the eligibility criteria. The findings indicate that maternal and paternal education, maternal BMI, breastfeeding and caring practices, socio-economic status, household air pollution, residence location, water and sanitation facilities, birth order, birth weight less than 2500 gram, and sex of the child are a few of the vital determinants of child malnutrition. In conclusion, there is a need to receive a multiple of startergies for state and area level with a thought of community-based approach that straightforwardly targets the prompt, basic, and fundamental determinants of child undernutrition.

Keywords: India, Malnurition, Risk factors, Stunting, Undernutrition, Underweight, Wasting

INTRODUCTION

Malnutrition is a common public health condition among children under five year of age (UNICEF, WHO, 2021). Nearly half of the global children's deaths are attributable to undernutrition (UNICEF, WHO, 2021). In 2020, 149 million

Harsh Vats, Research scholar, Department of Anthropology, University of Delhi, India, Email: vats.harsh.1994@gmail.com; **Dr. Ruchi Saxena,** Associate Professor, Department of Obstetrics and Gynecology, Sardar Patel Medical College, Bikaner, Rajasthan, India, Email: drgajendrasaxena@gmail.com; **Prof. Mohinder Pal Sachdeva** (Corresponding author), Professor, Department of Anthropology, University of Delhi, India, Email: mpsachdeva@rediffmail.com; **Dr. Vipin Gupta** (Corresponding author), Associate Professor, Department of Anthropology, University of Delhi, India, Email: drvipiing@gmail.co

children were stunted (low height-for-age), 45 million were wasted (low height-for-age), and 38.9 million were overweight and obese (weight-for-height) as per global report of World Health Organization (UNICEF, WHO, 2021). The vast majority of these, for the most part, happen in low-and-middle-income countries, particularly in Africa and Asia (UNICEF, WHO, 2021). The National Family Health Survey (NFHS) of India reported the prevalence of stunted (35.5%), underweight (weight-for-age) (32%), and wasted (19.3%) children [(*National Family Health Survey (NFHS-5)*, 2021)]. There has been a considerable decline noticed in the prevalence of childhood stunting, underweight, and wasting, with a plausibility that the number of children with malnutrition increases further in the aftermath of covid-19 global lockdown (Headey *et al*., 2020).

In recent times, India has had so much to deal with in terms of malnutrition burden. In 2020, India accounted for more than 24% of global stunted children.(UNICEF, WHO, 2021) Additionally, in 2021, the prevalence of stunting has increased in 13 out of 22 states and union territories while the overall reduction in the prevalence of stunting, underweight, and wasting was only 2.9% (NFHS-5:32.1%, NFHS-4: 35.8), 3.7% (NFHS-5:32.1%, NFHS-4: 35.8), and 1.7% (NFHS-5:32.1%, NFHS-4: 35.8) respectively (*National Family Health Survey (NFHS-5)*, 2021).

The wholesome status of the children was linked to several direct or indirect factors like maternal nutrition (Kelly *et al*., 1996; Kim *et al*., 2019; Zaveri *et al*., 2020), maternal education (Anjum *et al*., 2011; Chakrabarti *et al*., 2020; Zaveri *et al*., 2020), pre-pregnancy BMI (Vats *et al*., 2021), gestational weight gain (Bird *et al*., 2017; Bouvier *et al*., 2019), maternal anemia (Anjum *et al*., 2011), birth order (Coffey *et al*., 2021; Dhingra and Pingali, 2021), low birth weight (Zaveri *et al*., 2020), birth weight (Kim *et al*., 2019), maternal age (Deshmukh *et al*., 2013; Sk *et al*., 2021), maternal residence (Deshmukh *et al*., 2013; Khan and Das, 2020; Kim *et al*., 2019; Menon *et al*., 2018; Meshram *et al*., 2014), antenatal care (Kim *et al*., 2019), child sex (Das *et al*., 2021; Jose, 2017; Murarkar *et al*., 2020; Patel *et al*., 2013), toilet facility (Aguayo *et al*., 2016; Dearden *et al*., 2017; Ghosh *et al*., 2021; Gupta and Santhya, 2020; Kim *et al*., 2019; Menon *et al*., 2018) and socio-economic profile (Khan and Das, 2020; Kim *et al*., 2019; Sharma and Subramanyam, 2021). These were the main determinant of the anthropometric failure (stunting, underweight, and wasting) among the children. Despite the noticeable progress, health inequalities among the low-and-middle-income countries like India are caused by unequal distribution of power, goods, and services, leading to ill-health, mortality and premature morbidity among children (Guerra *et al*., 2016).

Several studies reported that malnutrition in early childhood could impair psychological and intellectual development (Liu *et al*., 2003; Lozoff *et al*., 2000). The disturbance in both psychological and intellectual development can impair performance at school, overall growth, and behavior (Liu *et al*., 2003; Lozoff *et al*., 2000). Furthermore, malnutrition in early childhood is often related with a reduction

in economic productivity, leading to socio-economic deprivation (Liu *et al*., 2003; Lozoff *et al*., 2000). It has been estimated that 22% of income is lost per annum by an adult who suffers from malnutrition (*Improving Child Nutrition: The Achievable Imperative for Global Progress - UNICEF DATA*, 2021). Therefore, it is very crucial to develop an effective strategy to control child malnutrition in India. However, developing an effective strategy will require the comprehensive consolidation of evidence on the malnutrition burden and its underlying determinants. Overall, understading of the primary determinants of malnutrition is therefore critical for effectively guiding health authorities in developing a country and state-specific policy action plan. As a result, this review was conceived with the goal of identifying the factors of malnutrition in children under the age of five.

MATERIALS AND METHODS

Search Strategy and Outcome:

The review of literature was performed using PubMed, Goggle Scholar, Web of Science, Embase and a manual review of the reference lists from the selected studies was done to identify relevant published articles. The search was conducted from 01-01-2012 to 20-01-2021 (DD-MM-YYYY). The search strategy was developed by using a combination of Medical Subject Heading (MeSH) terms and words in Title/Abstract: (((((((“malnutrition”[Title/Abstract]) OR (“stunting”[Title/Abstract])) OR (“wasting”[Title/Abstract])) OR (“underweight”[Title/Abstract])) OR (“malnutrition”[MeSH Terms])) OR (“nutrition disorders”[MeSH Terms])) AND (((“risk factors”[MeSH Terms]) OR (“risk factor”[Title/Abstract])) OR (“determinant”[Title/Abstract]))) AND ((“india”[Title/Abstract]) OR (“india”[MeSH Terms]). The selected articles were then accessed in full text to check for eligibility criteria. The similar articles were removed by cross-referencing. During the search papers were managed using Mendeley software (Elsevier).

Study Selection

Inclusion criteria

- Children younger than 5 years (0-60 months)
- Studies must report malnutrition/undernutrition (stunting, underweight, and wasting)
- Case-control study
- Cohort study
- Cross-sectional study
- Natural conception
- Studies published in English only

Exclusion criteria

- History of venereal diseases
- Grey literature

Data Extraction

The selected articles were imported to Mendeley library, and if the discrepancies were found in the data, then articles were excluded. The summary of the selected studies was recorded; these include: author's name, year of publication, country/ location of the study, sample size, study period, the study period of malnutrition/ undernutrition, study outcome and adjustment for covariates.

RESULTS AND DISCUSSION

Maternal Factors

Maternal and paternal education

One of the most significant and persistent factor linked to stunting, wasting, and underweight is parental education (Khan and Das, 2020; Meshram *et al*., 2014; Sk *et al*., 2021). The mother's education among the parents plays a much bigger role than fathers' education and is strongly associated with child malnutrition (Miller and Rodgers, 2009). Socio-cultural norms in India direct mothers' role to be more child-rearing and domestic chores oriented. Thus, several pathways affect the child's nutrition as a result of the mother's education. Firstly, mothers with a higher education are more conscious of their children's nutrition, resulting in better child rearing (Fadare *et al*., 2019; Tasnim *et al*., 2018). The mothers who are educated provide a healthy environment for better nourishment among children (Tasnim *et al*., 2018). Educated women are also expected to have better hygienic practices and more availability of structured toilets than uneducated mothers (Kajjura *et al*., 2019). Secondly, higher maternal education is associated with a better awareness of healthcare services in prenatal, antenatal and postpartum care. The educated mothers were found to be more inclined to have adequate antenatal care visits and complete immunization for themselves and their children than the uneducated mother (Ogbo *et al*., 2019). Complete immunization and adequate antenatal care lowers the risk of infectious illness, which play a major role in child malnutrition. Furthermore, educated mothers were more likely to be financially self-sufficent and have a high level of autonomy towards resources (Shroff *et al*., 2009). As a result, mothers can contribute to family income, resulting in equitable gender standards for children's nourishement (Shroff *et al*., 2009). The purchasing power for nutritious food and access to counseling increases maternal and child health. The healthier mother can adequately breastfeed (Horta *et al*., 2007; Scherbaum and Srour, 2016) and deliver children with high birth weight (Uthman, 2009).

However, a higher education level of the father also leads to a higer household income which ensures access and availability to essential food for child nutrition (Khattak *et al*., 2017). This link appears to be stronger, when mother has poor social standing and low decision-making power in the home. An educated father tends to guide his wife to have better understanding about child care methods (Khattak *et al*., 2017; Boah *et al*., 2019). Thus, if both the parent were uneducated, overall family income would be low and has low access to adequate nutrition. Their child is more prone to growth retardation due to lack of adequate amenities and increased risk to diseases (Khattak *et al*., 2017; Boah *et al*., 2019).

Maternal BMI

Maternal body mass index (BMI) is a major indicator of maternal nutrition. The low maternal BMI is caused by insufficient dietary intake, the poor nutritional quality of diet, frequent infections, and short pregnancy intervals (Goudet *et al*., 2011; Mokalla *et al*., 2020; Özaltin *et al*., 2010). The consequences of poor maternal BMI are reflected throughout the pregnancy as they have low gestational weight gain and high infant and maternal morbidity and mortality. Several recent studies have shown maternal BMI to be closely associated with child nutritional status (Subramanian *et al*., 2010; Tigga and Sen, 2016; Vats *et al*., 2021). Tigga and Sen (2016), in their study, showed that BMI of the mother was significantly and highly correlated with height-for-age and BMI. Subramanian *et al*. (2010) in their study observed a mutually adjusted model; an increase in 1 unit of maternal BMI was associated with a lower relative risk for childhood undernutrition (RR:0.957), stunting (RR:0.961), and wasting (RR:0.965).

Breastfeeding and caring practices

Breastfeeding and caring practices play a pivotal role in child malnutrition (Scherbaum and Srour, 2016). Breastfeeding promotes healthy growth and development of the infants providing a physiological and psychological advantage for a child and a mother (Horta *et al*., 2007). Several studies have found that children who were exclusively breastfed had a lower risk of stunting, wasting, and underweight. The odds of undernourishment were very high if children were not exclusively breastfed (David *et al*., 2020; Dodos *et al*. (2018). The child's nutritional status also depends on the nature and duration of feeding practices. The child rearing practices are critical during the early months of an infant as growth is faster, and protection against illness and infection is most needed during this crucial period. Singhal *et al*. (2013) and Prerna Singhal (2013) in their study observed that children who were bottle-fed, despite being breastfed, had a higher prevalence of stunting, wasting, and underweight as bottle feeding is a source of gastrointestinal infections which leads to macro- and micronutrient deficiency.

Household and Community-level Factors

Socio-economic status

Socio-economic status contributes significantly towards malnutrition in children under the age of five (Khan and Das, 2020; Kim *et al*., 2019). Socio-economic status affects utilization of health care services for mother and the child. The economic capital influences the spending power for food and hygiene standards (Baharvand *et al*., 2021). Providing food and hygiene such as a high-quality nutritious diet, toilet facility, and good household air quality are crucial for child's developement. A family with low socio-economic standing will be unable to achieve these requirements. Children from lower socioeconomic background were more likely to be stunted, wasted, and underweight than those from higher socioeconomic background (Khan and Das, 2020; Kim *et al*., 2019; Sharma and Subramanyam, 2021). The low SES family has less money so they spend less on helath care services, and as a result mothers have limited knowledge of child feeding methods (Baharvand *et al*., 2021). Furthermore, low SES households are unable to offer clean water, adequate sanitation, or quality housing (Chakrabarti *et al*., 2020). This condition, both directly and indirectly, raises the prevalence of chronic infection in children under the age of five, resulting in a rise of malnutrition (Gupta and Santhya, 2020).

Household air pollution

Household air pollution is mainly comprised of smoke from the burning of unclean cooking fuel and indoor tobacco smoking (*WHO Guidelines for Indoor Air Quality: Selected Pollutants*, 2018) (WHO, 2018). Several studies in India have examined the effect of different components of household air pollution in relation with the infant mortality, respiratory diseases, anemia and low birth weight that lead to child undernutrition (Balietti and Datta, 2017; Islam *et al*., 2021; Kurata *et al*., 2020; Kyu *et al*., 2009; Mishra and Retherford, 2007; Patel *et al*., 2015; Upadhyay *et al*., 2021). For instance, Upadhyay *et al*. (2020), in their longitudinal data from young lives study, found that children living in a household where unclean cooking fuel is used were more prone to have lower height-for-age scores compared with living in a household where clean fuel is used. Balietti and Dutta , (2017) in their study, also observed the same association using the data from NFHS-3. Isalm *et al*. (2020) in their study supported the above association and showed the absence of separate kitchen and exposure of environmental tobacco as a strong gradient for undernutrition.

Place of residence

The children living in an urban location are taller than other children of their age (Charmarbagwala *et al*., 2004). The reason behind this may be that there is a better healthcare provision in cities than in rural areas. The study conducted by Bharti *et al*. (2008) found that the consequences of spatial differences,

especially rural-urban, along with other socio-economic factors, was significant regarding the health status of the children. While, when the age and socio-economic variable were controlled, spatial effect decreased. In their study, Ghosh *et al*. (2011) supported that urban lifestyle and lack of physical activity irrespective of child sex make urban children more obese than their rural counterparts.

Water and Sanitation facilities

Diarrhea is the leading cause of malnutrition in children under the age of five, leading to higher morbidity and mortality (Ghosh *et al*., 2021; Nguendo-Yongsi, 2008). The main cause of diarrhea is unhygienic food preparation, feeding method, sanitation, and stool disposal management (Kim *et al*., 2019). This unhygienic behavior is more acute when there is inadequate access to clean water. The reduced immunity among the children is directly caused by diarrhea (Pongou *et al*., 2006). Diarrhea also leads to other infectious diseases which cause malnutrition. Furthermore, contaminated water resources, inadequate sanitation places, unsafe stool disposal systems, increased parasitic infection, and overall contamination in the food and water will directly increase infection load among children (Johri *et al*., 2019). Several studies have reported that increased toilet coverage will reduce exposure, prevent contamination, and reduce malnutrition in the long run (Aguayo *et al*., 2016; Dearden *et al*., 2017; K. Ghosh *et al*., 2021; Gupta and Santhya, 2020; Kim *et al*., 2019; Menon *et al*., 2018). In fact, Chakrabarti *et al*. (2020) in their study also observed that access to safe drinking water improves height-for-age.

Child Factors

Birth order

The birth order of the child refers to the sequence of birth. Behram *et al*. (1988a, 1988b) in their study created a model to estimate the key factors of parental preferences for the distribution of nutrients among their children. When productivity equity was a trade-off, then the estimate of latent variable in rural south india revealed that parent prefered older children. This implies that if a parent cannot afford enough food, they will feed their elder children first. The reason behind this is an assumption of early wage-earning by older children and as a result they expose their younger sibling at a risk of malnutrition. Several other studies supported the above-mentioned findings of positive correlation between malnutrition with birth order (Charmarbagwala *et al*., 2004; Coffey *et al*., 2021; Dhingra and Pingali, 2021; Ghosh, 2011).

Sex of the child

The sex of the child is a major determinant of malnutrition (Murarkar *et al*., 2020). Several studies found that societal preferences map more towards sons getting better nutrition than their daughters (Das *et al*., 2021; Jose, 2017;

Murarkar *et al*., 2020; K. A. Patel *et al*., 2013). The study conducted by Patel *et al*. (2013) in an urban slum found that female children were with a remarkably high incidence of stunting and malnutrition. Jose *et al*. (2017) in their study found that there was considerable heterogeneity existing in nutrient intake across both genders in the various state of India. This study also showed that child-specific household and exogenous factors play a crucial role in the determination of gender disparity in health. This malnutrition among females doesn't only lead to child malnutrition, but it also led to undernourished reproductive women, who were more prone to bad obstetric history (Kushwaha *et al*., 2021), cardiovascular (Kushwaha and Mishra, 2019) and cardiometabolic diseases (Kushwaha *et al*., 2021) and as a result, the new generation has a higher probability of being undernourished (Griffiths *et al*., 2002).

Low birth weight

Low birth weight is defined as birth weight less than 2500 gram (Cutland *et al*., 2017). The causes of low birth weight are not clearly understood. The complex interaction of several direct or indirect factors such as mother's malnutrition, low socio-economic status, previous cesarean section, and poor utilization of health care facilities manifests into low birth weight (Anjum *et al*., 2011; Sutan *et al*., 2014; Zaveri *et al*., 2020). Low birth weight babies were more prone to feeding difficulties, pneumonia, cardiovascular diseases, respiratory diseases, illness due to infection, and malnutrition (Al Hazzani *et al*., 2011; Hack *et al*., 1995; Hilaire *et al*., 2021). The LBW are also correlated to cough and diarrhea (Lira *et al*., 1996) as these are the leading cause of childhood malnutrition in India. Several studies support that the LBW is highly correlated with childhood stunting, wasting, and being underweight as compared to infants with normal weight (Ansuya *et al*., 2018; Huey *et al*., 2019).

CONCLUSIONS

In conclusion, the factors associated with undernutrition were maternal and paternal education, maternal BMI, breastfeeding and caring practices, socio-economic status, household air pollution, place of residence, water and sanitation facilities, birth order, low birth weight and sex of the child (Figure 1). There is a need to adopt a multiple startergy for state and area level with a thought of community-based approach that straightforwardly targets the prompt, basic, and fundamental determinants of child undernutrition. The approach should be supported with counselling sessions, and supplementary food to improve overall maternal and child health. Public health campaigns should grow in numbers to increase awareness regarding breastfeeding practices, proper sanitation, and hygiene practices. Further, nutritional intervention could be implemented on mothers and children with an initiative to address proper diet, access to good food, and poverty. These aforementioned possible strategies will yield a more sustainable improvement in child nutrition in India, which will help us to achieve the WHO global nutrition target by 2025.

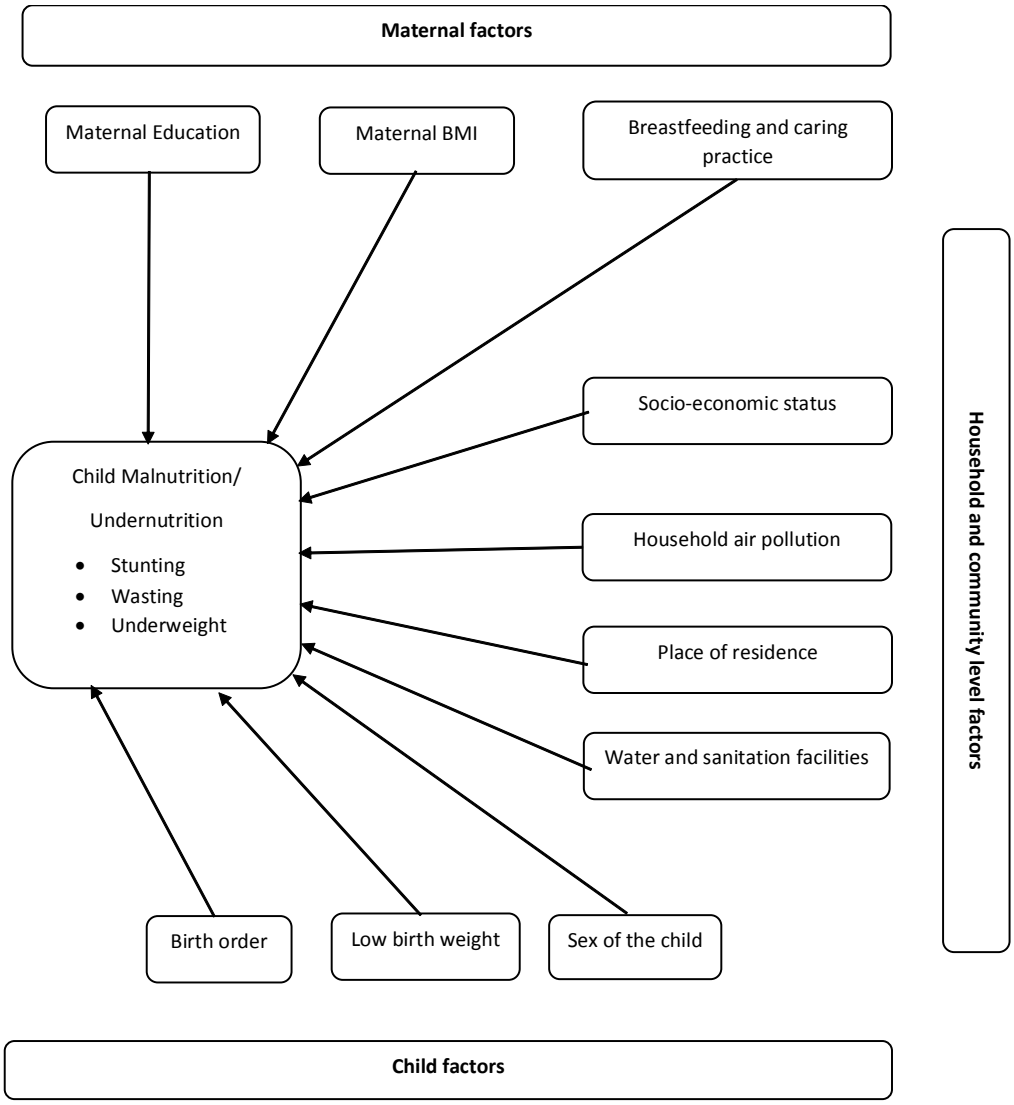

Figure 1: The determinants of the child malnutrition

Disclosure Statement

The authors report no conflict of interest.

References

Aguayo, V. M., Nair, R., Badgaiyan, N. and V. Krishna, , 2016. Determinants of stunting and poor linear growth in children under 2 years of age in India: An in-depth analysis of Maharashtra's comprehensive nutrition survey. Maternal and Child Nutrition, 12: 121–140. https://doi.org/10.1111/mcn.12259

Al Hazzani, F., Al-Alaiyan, S., Hassanein, J., and E. Khadawardi, 2011. Short-term outcome

of very low-birth-weight infants in a tertiary care hospital in Saudi Arabia. Annals of Saudi Medicine, 31(6), 581–585. https://doi.org/10.4103/0256-4947.87093

Anjum, F., Javed, T., Afzal, M. F., and G.A.Sheikh, 2011. Maternal Risk Factors Associated with Low Birth Weight: A Case Control Study. Annals of King Edward Medical University, 17(3): 223–223. https://doi.org/10.21649/AKEMU.V17I3.338

Ansuya, Nayak, B. S., Unnikrishnan, B., George, A., Shashidhara, N. Y., Mundkur, S. C., and V. Guddattu, 2018. Risk factors for malnutrition among preschool children in rural Karnataka: A case-control study. BMC Public Health, 18(1): 1–8. https://doi.org/10.1186/S12889-018-5124-3/TABLES/5

Baharvand, P., Nejad, E. B., Karami, K., Amraei, M., Baharvand, P., Nejad, E. B., Karami, K., and M. Amraei , 2021. A Review Study of the Role of Socioeconomic Status and its Components in Children's Health. Global Journal of Medical, Pharmaceutical, and Biomedical Update, 16, 9. https://doi.org/10.25259/GJMPBU_10_2021

Balietti, A., and S. Datta, 2017. The impact of indoor solid fuel use on the stunting of Indian children. Elsevier. https://www.sciencedirect.com/science/article/pii/S0272775715000473

Behrman, J. R. , 1988a. Nutrition, health, birth order and seasonality: Intrahousehold allocation among children in rural India. Journal of Development Economics, 28(1): 43–62. https://doi.org/10.1016/0304-3878(88)90013-2

Behrman, J. R. , 1988b. Intrahousehold Allocation of Nutrients in Rural India: Are Boys Favored? Do Parents Exhibit Inequality Aversion? Oxford Economic Papers, 40(1): 32–54. https://ideas.repec.org/a/oup/oxecpp/v40y1988i1p32-54.html

Bharati, S., Pal, M., and P. Bharati, 2008. Determinants of nutritional status of pre-school children in India. Journal of Biosocial Science, 40(6): 801–814. https://doi.org/10.1017/S0021932008002812

Bird, A. L., Grant, C. C., Bandara, D. K., Mohal, J., Atatoa-Carr, P. E., Wise, M. R., Inskip, H., Miyahara, M., and S. M. B.Morton, 2017. Maternal health in pregnancy and associations with adverse birth outcomes: Evidence from Growing Up in New Zealand. The Australian and New Zealand Journal of Obstetrics and Gynaecology, 57(1):16–24. https://doi.org/10.1111/ajo.12557

Boah, M., Azupogo, F., Amporfro, D. A., and L. A. Abada, 2019. The epidemiology of undernutrition and its determinants in children under five years in Ghana. PLoS ONE, 14(7): 1–23. https://doi.org/10.1371/journal.pone.0219665

Bouvier, D., Forest, J.-C., Dion-Buteau, E., Bernard, N., Bujold, E., Pereira, B., and Y.Giguère, 2019. Association of Maternal Weight and Gestational Weight Gain with Maternal and Neonate Outcomes: A Prospective Cohort Study. Journal of Clinical Medicine, 8(12): 2074. https://doi.org/10.3390/jcm8122074

Chakrabarti, S., Singh, P., and T. Bruckner, 2020. Association of Poor Sanitation With Growth Measurements Among Children in India. JAMA Network Open, 3(4): e202791–e202791. https://doi.org/10.1001/JAMANETWORKOPEN.2020.2791

Charmarbagwala, R., Ranger, M., Waddington, H., and H.White, 2004. The Determinants of child health and nutrition: a meta-analysis. America, 60.

Coffey, D., Spears, D., Afridi, F., Behrman, J., Black, S., Case, A., Cummins, J., Currie, J., Deaton, A., Elo, I., Foster, A., Geruso, M., Guillot, M., Kolk, M., Kuziemko, I., Lawson, N., Masters, W., Miller, G., Oettinger, G., … T.Vogl, 2021. Neonatal Death in India: Birth Order in a Context of Maternal Undernutrition. The Economic Journal, 131(638): 2478–2507. https://doi.org/10.1093/EJ/UEAB028

Cutland, C. L., Lackritz, E. M., Mallett-Moore, T., Bardají, A., Chandrasekaran, R., Lahariya, C., Nisar, M. I., Tapia, M. D., Pathirana, J., Kochhar, S., and F. M.Muñoz, 2017. Low birth weight: Case definition and guidelines for data collection, analysis, and presentation of maternal immunization safety data. Vaccine, 35(48Part A): 6492. https://doi.org/10.1016/

J.VACCINE.2017.01.049

Das, P., Roy, R., Das, T., and T. B.Roy, 2021. Prevalence and change detection of child growth failure phenomena among under-5 children: A comparative scrutiny from NFHS-4 and NFHS-5 in West Bengal, India. Clinical Epidemiology and Global Health, 12: 100857. https://doi.org/10.1016/J.CEGH.2021.100857

David, S., Pricilla, R., Paul, S., George, K., Bose, A., and J.Prasad, 2020. Risk factors for severe acute malnutrition among children aged 6-59 months: A community-based case-control study from Vellore, Southern India. Journal of Family Medicine and Primary Care, 9(5): 2237. https://doi.org/10.4103/JFMPC.JFMPC_211_20

Dearden, K. A., Schott, W., Crookston, B. T., Humphries, D. L., Penny, M. E., and J. R.Behrman, 2017. Children with access to improved sanitation but not improved water are at lower risk of stunting compared to children without access: a cohort study in Ethiopia, India, Peru, and Vietnam. BMC Public Health, 17(1): 1–19. https://doi.org/10.1186/S12889-017-4033-1/TABLES/6

Deshmukh, P. R., Sinha, N., and A. R.Dongre, 2013. Social determinants of stunting in rural area of Wardha, Central India. Medical Journal Armed Forces India, 69(3): 213–217. https://doi.org/10.1016/j.mjafi.2012.10.004

Dhingra, S., and P. L.Pingali, 2021. Effects of short birth spacing on birth-order differences in child stunting: Evidence from India. Proceedings of the National Academy of Sciences of the United States of America, 118(8): 2017834118. https://doi.org/10.1073/PNAS.2017834118/-/DCSUPPLEMENTAL

Dodos, J., Altare, C., Bechir, M., Myatt, M., Pedro, B., Bellet, F., Lapegue, J., Peeters, J., and M.Altmann, 2018. Individual and household risk factors of severe acute malnutrition among under-five children in Mao, Chad: A matched case-control study. Archives of Public Health, 76(1): 1–9. https://doi.org/10.1186/S13690-018-0281-5/TABLES/3

Fadare, O., Amare, M., Mavrotas, G., Akerele, D., and A.Ogunniyi, 2019. Mother's nutrition-related knowledge and child nutrition outcomes: Empirical evidence from Nigeria. PLoS ONE, 14(2). https://doi.org/10.1371/JOURNAL.PONE.0212775

Ghosh, A. , 2011. Rural-urban comparison in prevalence of overweight and obesity among children and adolescents of Asian Indian origin. Asia-Pacific Journal of Public Health, 23(6): 928–935. https://doi.org/10.1177/1010539511428697

Ghosh, K., Chakraborty, A. S., and M.Mog, 2021. Prevalence of diarrhoea among under five children in India and its contextual determinants: A geo-spatial analysis. Clinical Epidemiology and Global Health, 12: 100813.https://doi.org/10.1016/J.CEGH.2021.100813

Goudet, S., Griffths, P., B. A.and Bogin, 2011. Mother's body mass index as a predictor of infant's nutritional status in the post-emergency phase of a flood. Disasters, 35(4): 701–719. https://doi.org/10.1111/J.1467-7717.2011.01238.X

Griffiths, P., Matthews, Z., and A.Hinde, 2002. Gender, family, and the nutritional status of children in three culturally contrasting states of India. Social Science and Medicine , 1982), 55(5): 775–790. https://doi.org/10.1016/S0277-9536(01)00202-7

Guerra, G., Borde, E., and V. N. Salgado De Snyder, 2016. Measuring health inequities in low and middle income countries for the development of observatories on inequities and social determinants of health. International Journal for Equity in Health, 15(1): 1–10. https://doi.org/10.1186/S12939-016-0297-9/TABLES/3

Gupta, A. K., and K. G.Santhya, 2020. Proximal and contextual correlates of childhood stunting in India: A geo-spatial analysis. PLoS ONE, 15(8 August). https://doi.org/10.1371/journal.pone.0237661

Hack, M., Klein, N. K., and H. G.Taylor, 1995. Long-term developmental outcomes of low birth weight infants. The Future of Children, 5(1): 176–196.https://doi.org/10.2307/ 1602514

Headey, D., Heidkamp, R., Osendarp, S., Ruel, M., Scott, N., Black, R., Shekar, M., Bouis, H., Flory, A., Haddad, L., and N.Walker, 2020. Impacts of COVID-19 on childhood malnutrition and nutrition-related mortality. The Lancet, 396(10250): 519–521. https://doi.org/10.1016/S0140-6736, 20)31647-0/ATTACHMENT/215C6030-7D63-4918-ACA6-96966AC7983B/MMC1.PDF

Hilaire, M., Andrianou, X. D., Lenglet, A., Ariti, C., Charles, K., Buitenhuis, S., Van Brusselen, D., Roggeveen, H., Ledger, E., Denat, R. S., and L.Bryson, 2021. Growth and neurodevelopment in low birth weight versus normal birth weight infants from birth to 24 months, born in an obstetric emergency hospital in Haiti, a prospective cohort study. BMC Pediatrics, 21(1): 1–16. https://doi.org/10.1186/S12887-021-02605-3/FIGURES/8

Horta, B., Bahl, R., Martines, J., and C.Victora, 2007. Evidence on the long-term effects of breastfeeding: systematic reviews and meta-analyses. World Health Organization, pp. 1–52.

Huey, S. L., Finkelstein, J. L., Venkatramanan, S., Udipi, S. A., Ghugre, P., Thakker, V. M., Thorat, A., Potdar, R. D., Chopra, H. V., Kurpad, A. V., Haas, J., and S.Mehta, 2019. Prevalence and covariates of undernutrition in young children living in urban slums of Mumbai, India: A cross sectional study. Frontiers in Public Health, 7(JUN): 191. https://doi.org/10.3389/FPUBH.2019.00191/BIBTEX

Improving Child Nutrition: The achievable imperative for global progress - UNICEF DATA. (2013 Retrieved January 24, 2022, from https://data.unicef.org/resources/improving-child-nutrition-the-achievable-imperative-for-global-progress/

Islam, S., Rana, M. J., and S. K.Mohanty, 2021. Cooking, smoking, and stunting: Effects of household air pollution sources on childhood growth in India. Indoor Air, 31(1): 229–249. https://doi.org/10.1111/ina.12730

Johri, M., Sylvestre, M. P., Koné, G. K., Chandra, D., and S. V.Subramanian, 2019. Effects of improved drinking water quality on early childhood growth in rural Uttar Pradesh, India: A propensity-score analysis. PLOS ONE, 14(1): e0209054. https://doi.org/10.1371/JOURNAL.PONE.0209054

Jose, S. , 2017. Decomposition of gender differential in malnutrition in Indian children. Journal of Social and Economic Development, 19(2): 299–322. https://doi.org/10.1007/s40847-017-0047-x

Kajjura, R. B., Veldman, F. J., and S. M.Kassier, 2019. Effect of Nutrition Education on Knowledge, Complementary Feeding, and Hygiene Practices of Mothers With Moderate Acutely Malnourished Children in Uganda. Food and Nutrition Bulletin, 40(2): 221–230. https://doi.org/10.1177/0379572119840214

Kelly, A., Kevany, J., De Onis, M., and P. M.Shah, 1996. A WHO Collaborative Study of Maternal Anthropometry and Pregnancy Outcomes. International Journal of Gynecology and Obstetrics, 53(3): 219–233. https://doi.org/10.1016/0020-7292(96)02652-5

Khan, J., and S. K.Das, 2020. The burden of anthropometric failure and child mortality in India. Scientific Reports, 10(1): 1–16. https://doi.org/10.1038/s41598-020-76884-8

Khattak, U. K., Iqbal, S. P., and H.Ghazanfar, 2017. The Role of Parents' Literacy in Malnutrition of Children Under the Age of Five Years in a Semi-Urban Community of Pakistan: A Case-Control Study. Cureus, 9(6. https://doi.org/10.7759/CUREUS.1316

Kim, R., Rajpal, S., Joe, W., Corsi, D. J., Sankar, R., Kumar, A., and S. V.Subramanian, 2019. Assessing associational strength of 23 correlates of child anthropometric failure: An econometric analysis of the 2015-2016 National Family Health Survey, India. Social Science and Medicine, 238(June 2019): 112374.https://doi.org/10.1016/j.socscimed.2019.112374

Kurata, M., Takahashi, K., and A.Hibiki, 2020. Gender differences in associations of household and ambient air pollution with child health: Evidence from household and satellite-based data in Bangladesh. World Development, 128:104779. https://doi.org/10.1016/J.WORLDDEV.2019.104779

Kushwaha, S., and Mishra, J. , 2019. Association between Age at Menarche and Cardiovascular Risk Factors/ : International Journal of Innovative Knowledge Concepts, 7(6), 103–107. https://doi.org/10.6084/m9.figshare.8378579

Kushwaha, S., Mishra, J., and P. R.Mondal, 2021. Obstetric history and its association with cardiometabolic risk factors/ : a case-control study among Bhil Women of Rajasthan , India. Anthropological Review, 84(1): 75–85. https://doi.org/10.2478/anre-2021-0004

Kyu, H. H., Georgiades, K., and M.Boyle, 2009. Maternal smoking, biofuel smoke exposure and child height-for-age in seven developing countries. International Journal of Epidemiology, 38(5): 1342–1350. https://doi.org/10.1093/IJE/DYP253

Lira, P. I. C., Ashworth, A., and S. S.Morris, 1996. Low birth weight and morbidity from diarrhea and respiratory infection in northeast Brazil. The Journal of Pediatrics, 128(4): 497–504. https://doi.org/10.1016/S0022-3476(96)70360-8

Liu, J., Raine, A., Venables, P. H., Dalais, C., and S. A.Mednick, 2003. Malnutrition at Age 3 Years and Lower Cognitive Ability at Age 11 Years: Independence From Psychosocial Adversity. Archives of Pediatrics and Adolescent Medicine, 157(6): 593–600. https://doi.org/10.1001/ARCHPEDI.157.6.593

Lozoff, B., Jimenez, E., Hagen, J., Mollen, E., and A. W. Wolf, 2000. Poorer behavioral and developmental outcome more than 10 years after treatment for iron deficiency in infancy. Pediatrics, 105(4. https://doi.org/10.1542/PEDS.105.4.E51

Menon, P., Headey, D., Avula, R., and P. H.Nguyen, 2018. Understanding the geographical burden of stunting in India: A regression-decomposition analysis of district-level data from 2015–16. Maternal and Child Nutrition, 14(4): 1–10. https://doi.org/10.1111/mcn.12620

Meshram, I. I., Balakrishna, N., Arlappa, N., Rao, K. M., Laxmaiah, A., and G. N. V.Brahmam, 2014. Prevalence of undernutrition, its determinants, and seasonal variation among tribal preschool children of Odisha state, India. Asia-Pacific Journal of Public Health, 26(5): 470–480. https://doi.org/10.1177/1010539512441492

Miller, J. E., and Y. V.Rodgers, 2009. Mother's Education and Children's NutritionalStatus: New Evidence from Cambodia. Asian Development Review, 26(1): 131–165. https://think-asia.org/handle/11540/1682

Mishra, V., and R. D.Retherford, 2007. Does biofuel smoke contribute to anaemia and stunting in early childhood? International Journal of Epidemiology, 36(1): 117–129. https://doi.org/10.1093/IJE/DYL234

Mokalla, T. R., Mendu, V. V. R., Mokalla, T. R., and V. V. R.Mendu, 2020. Risk factors and socioeconomic inequalities in undernutrition among children 0-59 months of age in India. International Journal of Population Studies, 5(2). https://doi.org/10.18063/IJPS.V5I2.1125

Murarkar, S., Gothankar, J., Doke, P., Pore, P., Lalwani, S., Dhumale, G., Quraishi, S., Patil, R., Waghachavare, V., Dhobale, R., Rasote, K., Palkar, S., and N.Malshe, 2020. Prevalence and determinants of undernutrition among under-five children residing in urban slums and rural area, Maharashtra, India: a community-based cross-sectional study. BMC Public Health, 20(1): 1–9. https://doi.org/10.1186/S12889-020-09642-0/TABLES/4

National Family Health Survey (NFHS-5. (2021 Retrieved January 24, 2022, from http://rchiips.org/nfhs/factsheet_NFHS-5.shtml

Nguendo Yongsi, H. B. , 2008. Pathogenic Microorganisms Associated With Childhood Diarrhea

in Low-and-Middle Income Countries: Case Study of Yaoundé – Cameroon. International Journal of Environmental Research and Public Health, 5(4): 213. https://doi.org/10.3390/IJERPH5040213

Ogbo, F. A., Dhami, M. V., Ude, E. M., Senanayake, P., Osuagwu, U. L., Awosemo, A. O., Ogeleka, P., Akombi, B. J., Ezeh, O. K., and K. E.Agho, 2019. Enablers and Barriers to the Utilization of Antenatal Care Services in India. International Journal of Environmental Research and Public Health, 16(17). https://doi.org/10.3390/IJERPH16173152

Özaltin, E., Hill, K., and S. V. Subramanian, 2010. Association of maternal stature with offspring mortality, underweight, and stunting in low- to middle-income countries. JAMA, 303(15): 1507–1516. https://doi.org/10.1001/JAMA.2010.450

Patel, A. B., Meleth, S., Pasha, O., Goudar, S. S., Esamai, F., Garces, A. L., Chomba, E., McClure, E. M., Wright, L. L., Koso-Thomas, M., Moore, J. L., Saleem, S., Liechty, E. A., Goldenberg, R. L., Derman, R. J., Hambidge, K. M., Carlo, W. A., and P. L.Hibberd, 2015. Impact of exposure to cooking fuels on stillbirths, perinatal, very early and late neonatal mortality - a multicenter prospective cohort study in rural communities in India, Pakistan, Kenya, Zambia and Guatemala. Maternal Health, Neonatology and Perinatology, 1(1). https://doi.org/10.1186/S40748-015-0019-0

Patel, K. A., Langare, S. D., Naik, J. D., and S. S. Rajderkar, 2013. Gender inequality and bio-social factors in nutritional status among under five children attending anganwadis in an urban slum of a town in Western Maharashtra, India. Journal of Research in Medical Sciences/ : The Official Journal of Isfahan University of Medical Sciences, 18(4): 341. / pmc/articles/PMC3793383/

Pongou, R., Ezzati, M., and J. A.Salomon, 2006. Household and community socioeconomic and environmental determinants of child nutritional status in Cameroon. BMC Public Health, 6(1): 1–19. https://doi.org/10.1186/1471-2458-6-98/TABLES/8

Prerna Singhal, P. S. , 2013. Status of Infant and Young Child Feeding Practices With Special Emphasis on Breast Feeding in an Urban Area of Meerut. IOSR Journal of Dental and Medical Sciences, 7(4): 7–11. https://doi.org/10.9790/0853-0740711

Scherbaum, V., and M. L. Srour, 2016. The Role of Breastfeeding in the Prevention of Childhood Malnutrition. World Review of Nutrition and Dietetics, 115: 82–97. https://doi.org/10.1159/000442075

Sharma, A. J., and M. A.Subramanyam, 2021. Intersectional role of paternal gender-equitable attitudes and maternal empowerment in child undernutrition: A cross-sectional national study from India. BMJ Open, 11(8): 1–7. https://doi.org/10.1136/bmjopen-2020-047276

Shroff, M., Griffiths, P., Adair, L., Suchindran, C., and M.Bentley, 2009. Maternal autonomy is inversely related to child stunting in Andhra Pradesh, India. Maternal and Child Nutrition, 5(1): 64–74. https://doi.org/10.1111/J.1740-8709.2008.00161.X

Sk, R., Banerjee, A., and M. J.Rana, 2021. Nutritional status and concomitant factors of stunting among pre-school children in Malda, India: A micro-level study using a multilevel approach. BMC Public Health, 21(1): 1–13. https://doi.org/10.1186/s12889-021-11704-w

Subramanian, S. V., Ackerson, L. K., and G. D.Smith, 2010. Parental BMI and childhood undernutrition in India: an assessment of intrauterine influence. Pediatrics, 126(3). https://doi.org/10.1542/PEDS.2010-0222

Sutan, R., Mohtar, M., Mahat, A. N., Tamil, A. M., Sutan, R., Mohtar, M., Mahat, A. N., and A. M.Tamil, 2014. Determinant of Low Birth Weight Infants: A Matched Case Control Study. Open Journal of Preventive Medicine, 4(3): 91–99. https://doi.org/10.4236/OJPM.2014.43013

Tasnim, T., Mwanri, L., and G. L.Dasvarma, 2018. Mother ' s child feeding knowledge and

practices associated with underweight in children under-five years/ : A study from rural Konawe , Indonesia MOTHER ' S CHILD FEEDING KNOWLEDGE AND PRACTICES ASSOCIATED WITH UNDERWEIGHT IN CHILDREN UNDER-FIVE YEARS/ : A. April.

Tigga, P. L., and J.Sen, 2016. Maternal Body Mass Index Is Strongly Associated with Children Z -Scores for Height and BMI . Journal of Anthropology, 2016: 1–10. https://doi.org/10.1155/2016/6538235

UNICEF, WHO, W. B. G. , 2021. Joint Child Malnutrition Estimates. Who, 24(2), 51–78. https://www.who.int/publications/i/item/9789240025257

Upadhyay, A. K., Srivastava, S., and V.Mishra, 2021. Does use of solid fuels for cooking contribute to childhood stunting? A longitudinal data analysis from low- and middle-income countries. Journal of Biosocial Science, 53(1): 121–136. https://doi.org/10.1017/S0021932020000097

Uthman, O. A. , 2009. Using extended concentration and achievement indices to study socioeconomic inequality in chronic childhood malnutrition: the case of Nigeria. International Journal for Equity in Health, 8. https://doi.org/10.1186/1475-9276-8-22

Vats, H., Saxena, R., Sachdeva, M. P., Walia, G. K., and V. Gupta, 2021. Impact of maternal pre-pregnancy body mass index on maternal, fetal and neonatal adverse outcomes in the worldwide populations: A systematic review and meta-analysis. Obesity Research and Clinical Practice, 15(6): 536–545. https://doi.org/10.1016/J.ORCP.2021.10.005

WHO., 2018. Air Pollution and Child Health. Who, 113, 32. http://pediatrics.aappublications.org/content/113/Supplement_3/1037.full.html

WHO guidelines for indoor air quality: selected pollutants. (2013 Retrieved January 24, 2022, from https://apps.who.int/iris/handle/10665/260127

Zaveri, A., Paul, P., Saha, J., Barman, B., and P. Chouhan, 2020. Maternal determinants of low birth weight among Indian children: Evidence from the National Family Health Survey-4, 2015-16. PLOS ONE, 15(12): e0244562.https://doi.org/10.1371/JOURNAL.PONE.0244562