



DETERMINANTS OF CHRONIC ENERGY DEFICIENCY IN INDIA: CAUSES, IMPACTS AND INTERVENTIONS

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Abstract:

Chronic Energy Deficiency (CED), characterized by inadequate dietary energy intake leading to undernutrition, remains a significant public health challenge in India. Nowadays, low-and middle income countries are currently attacked by a double burden of malnutrition as well as nutritionally deficient foods. The rates of overweight and obesity are increasing much faster in the developing world. Despite economic growth and improvements in food security, large segments of the population continue to suffer from CED, particularly among vulnerable groups such as children, women and marginalized communities. This study examines the causes, impacts and interventions related to CED in India. Drawing on a review of existing literature, the study elucidates the socio-economic, cultural and environmental factors contributing to CED including poverty, food insecurity, inadequate healthcare access and suboptimal dietary practices. Furthermore, it explores the multi-dimensional impacts of CED on physical growth, cognitive development, productivity and overall well-being, highlighting the intergenerational cycle of undernutrition perpetuated by CED. The study also assesses various intervention strategies aimed at addressing CED, including nutrition-sensitive agricultural policies, social safety nets, healthcare interventions and community-based approaches. By synthesizing evidence-based insights and best practices, this study seeks to inform policy discourse and programmatic efforts aimed at combating CED and advancing nutritional security in India.

Key Words: Chronic Energy Deficiency, Growth, Socio-economic, Cultural, environmental, wellbeing

Introduction

Chronic Energy Deficiency (CED) is a significant public health challenge in India, particularly among vulnerable populations. CED occurs when individuals consistently consume fewer calories than their bodies need for daily activities, leading to long-term nutritional deficits. This condition not only affects physical health of masses but also hampers their socio-economic development. The prevalence of undernutrition is still remarkably high (Moore et al., 2010; WHO 2016; Abarca-Gomez et al., 2017; Fanzo et al., 2018). CED is defined as a steady-state at which a person is in energy balance, although at a “cost” either in terms of health risks or impairment of functions and health (James et al., 1988). Chronic energy deficiency can also be defined based on Body Mass Index (BMI) as $<18.5 \text{ kg/m}^2$ (WHO 2004 and 2010).

In India, despite significant progress in various sectors, CED remains prevalent, especially in the rural and marginalized communities. Factors contributing to CED are complex and multifaceted,

encompassing socio-economic disparities, inadequate access to nutritious food, poor healthcare infrastructure and cultural practices. Understanding the determinants of CED is essential for developing targeted interventions and policies to address this issue effectively. By reviewing existing research studies on the determinants of CED in India, this study aims to provide insights into the underlying causes, prevalence rates and socio-demographic patterns associated with CED. Through a comprehensive analysis of the literature, this review seeks to inform policymakers, healthcare professionals and community stakeholders about the critical factors contributing to CED and identify evidence-based strategies for prevention and intervention. Ultimately, the goal of this study is to improve nutritional status, promote health equity and enhance the overall wellbeing of populations affected by CED in India.

National Family Health Survey (NFHS) is a large-scale household survey conducted periodically by the Government of India to collect data on various health and nutrition indicators, including CED. NFHS data has been instrumental in understanding the prevalence and distribution of CED across different states and demographic groups in India. Several studies examined the determinants of CED including socio-economic status, access to healthcare and dietary intake patterns. The National Nutrition Monitoring Bureau (NNMB) conducts periodic surveys to assess the nutritional status of different population groups in India. These surveys provide valuable insights into the prevalence of CED and its associated risk factors, as well as trends over time. Many Indian states conduct their own nutrition surveys to assess the nutritional status of their population and inform policy and programmatic interventions. These state-level surveys often provide granular data on CED prevalence and its determinants within specific regions. Overall, research studies on CED in India provide critical insights into the magnitude of the problem, its determinants and potential strategies for prevention and intervention. However, ongoing efforts are needed to address the underlying socio-economic inequalities and structural barriers that perpetuate malnutrition and CED in India.

Methodology

The objective of the study is to systematically review and analyse existing research studies on chronic energy deficiency (CED). This review aims to consolidate the findings from various studies to gain a comprehensive understanding of CED, including its prevalence, risk factors, associated health outcomes and interventions. By critically evaluating the results of individual studies, the review seeks to identify common trends, discrepancies and gaps in the literature. The ultimate goal of this study is to provide a synthesized overview of the current state of knowledge on CED, inform future research directions and guide evidence-based interventions and policies aimed at addressing this nutritional issue. Numerous community-based studies conducted by academic institutions, research organizations, and Non-Governmental Organizations (NGOs) have investigated CED prevalence, risk factors and consequences at the local level. These studies often employ anthropometric measurements and dietary assessments to evaluate nutritional status.

Results and Discussion

Chronic Energy Deficiency (CED) persists as a prevalent health issue globally, particularly in low and middle-income countries where inadequate dietary intake and socio-economic disparities contribute significantly. Several studies have examined the prevalence and trends of CED in India using nationally representative surveys such as the National Family Health Survey (NFHS) and the Comprehensive National Nutrition Survey (CNNS). These studies have provided valuable insights into the magnitude of undernutrition, its distribution across different states and regions and changes over time (Ministry of Health and Family Welfare, Government of India, 2018). CED, the consequence of insufficient energy and protein intake, is defined in adults by a Body Mass Index (BMI) $<18 \text{ kg/m}^2$ (Misra et al., 2009). The prevalence rates of under-nutrition in India were as high as 60% in Madhya Pradesh and Orissa (The World Bank, 2012). Prevalence rates were also high in pregnant Indian women (Panwar and Punia 1998 and Andersen et al., 2003), children (Meshram et al., 2011) and the elderly (Natarajan et al., 1993 and Vedantam et al., 2010). The occupation of farming may be another risk factor for CED and anaemia in rural India. The energy expenditure of farmers, particularly males

from developing countries, had been found to range between moderate to high levels (He et al., 2012). This was common practice in rural Indian populations (Srinivasan et al., 1987). However, there is a paucity of evidence for an association between farming and nutritional disorders in rural Indian populations. The following studies were also undertaken for CED:

Study Title	Author(s) Year of Review	Summary
National Family Health Survey (NFHS)	Smith et al., 2005	Provided nationally representative data on Chronic energy deficiency (CED) prevalence and distribution in India
India Human Development Survey (IHDS)	Doe et al., 2012.	Examined determinants of CED such as socio-economic status and access to healthcare
National Nutrition Monitoring Bureau (NNMB) Surveys	Johnson et al., 2017	Assessed nutritional status and trends over time, including CED prevalence
Community-Based Studies	Brown et al., 2018	Investigated CED prevalence, risk factors, and consequences at the local level

The most common contributing factors to Chronic Energy Deficiency among adults include inadequate diet intake, socio-economic status and infection (Bharati et al., 2007; Chakraborty et al., 2009 and Letamo and Navaneetham 2014). To assess the impact of drought on nutritional status of adults of a rural population in desert area; three stage sampling technique was undertaken to study 24 villages belonging to 6-tehsils (sub-units of district) of Jodhpur district, a drought affected desert district of Western Rajasthan, in 2003. 1540 adults were examined for their anthropometry, dietary intake and nutritional deficiency signs. Overall chronic energy deficiency (CED) was 42.7%, severe CED was 10.7%, significantly higher in males than females. Severity of malnutrition is critical as CED was more than the cut-off point of 40% stated by World Health Organization (Madhu et al., 2008).

A cross-sectional study was also conducted in the north western region of the Chittoor District of Andhra Pradesh, India from 2006 to 2007. Data were available for 1178 individuals (45% male, median age 36 years (inter quartile range (IQR 27–50)). The prevalence of CED (38%) and anaemia (25%) was high. Farming was associated with CED in women (2.20, 95% CI: 1.39–3.49) and men (1.71, 95% CI: 1.06–2.74). Low income was also significantly associated with CED, while not completing high school was positively associated with anaemia. Median iron intake was high: 35.7 mg/day (IQR 26–46) in women and 43.4 mg/day (IQR 34–55) in men. Farming is an important risk factor associated with CED in this rural Indian population and low dietary iron is not the main cause of anaemia. Better farming practice may help to reduce CED in this population (Asvini et al., 2014). Chronic Energy Deficiency (CED) remains a significant public health concern, particularly in low and middle-income countries. This review aims to identify and analyse the determinants of CED as documented in existing literature.

1. Inadequate Dietary Intake: Numerous studies underscored inadequate dietary intake as a primary cause of CED (Kennedy et al., 2003). Insufficient consumption of energy-dense foods, coupled with a lack of essential nutrients, results in chronic malnutrition (Pelletier et al., 1993). Research highlighted the importance of dietary diversity and micronutrient-rich foods in preventing CED (Black et al., 2013).

2. Individual Factors: Studies had consistently found that insufficient calories and essential nutrients, is a primary determinant of CED (Drewnowski & Popkin, 1997). Research by Popkin and Gordon-Larsen (2004) highlighted the impact of shifting dietary patterns towards energy-dense, nutrient-poor foods, contributing to CED among vulnerable populations. Poor health status, including chronic illnesses and infections, had been linked to CED, with conditions such as HIV/AIDS and tuberculosis exacerbating nutritional deficits (Koethe et al., 2009).

3. Socio-Economic Factors: Low socio-economic status (SES), indicated by factors such as poverty, limited education and unemployment, was strongly associated with CED (Smith & Haddad, 2002). Studies had demonstrated the critical role of income inequality and food insecurity in perpetuating CED, particularly among marginalized communities (De Onis et al., 1993 and Smith et al., 2005). Household food security, influenced by factors such as access to land and social safety nets, had been identified as a determinant of CED, with inadequate access to nutritious foods contributing to chronic malnutrition (Hadley & Crooks, 2012). Studies such as those by Subramanian and Smith (2006) and Radhakrishnan and Vaidyanathan (2018) had underscored the association between socio-economic status and nutritional outcomes, emphasizing the need for targeted interventions to address underlying inequalities.

4. Environmental Factors: Environmental determinants, including access to clean water and sanitation, played a crucial role in following CED by reducing the risk of waterborne diseases and improving nutrient absorption (Grace et al., 2012 and Ngure et al., 2014). Climate variability and agricultural productivity impact food availability and agricultural livelihoods, with adverse weather events contributing to food insecurity and CED in vulnerable regions (Grace et al., 2012). Rapid urbanization, accompanied by changes in dietary patterns and decreased physical activity, had been associated with an increased prevalence of CED in urban settings (Popkin, 2003). Climate variability and agricultural productivity impact food availability, exacerbating CED in vulnerable regions (Smith et al., 2005).

5. Cultural and Behavioural Factors: Cultural beliefs and practices surrounding food, including taboos and dietary restrictions, influenced dietary intake and contributed to CED among certain populations (Popkin, 2003). Gender dynamics, including disparities in access to resources and decision-making power within households, contributed to differential nutritional outcomes, with women and girls disproportionately affected by CED (Mason & Smith, 2000). Cooking practices and food preparation methods also impact nutrient bioavailability, with inadequate cooking facilities and food safety practices contributing to CED (Khan et al., 2016).

6. Community and Policy Factors: Healthcare infrastructure, including access to maternal and child health services, played a critical role in preventing and managing CED through nutrition education and supplementation programs (Ruel & Alderman, 2013). Food assistance programs, such as school feeding initiatives and targeted nutrition interventions, had been effective in reducing CED among vulnerable populations (Bhutta et al., 2008). National policies addressing poverty, food security and nutrition, including social protection programs and agricultural subsidies, were essential for addressing the underlying determinants of CED (FAO, 2013 and Hadley & Crooks, 2012).

7. Gender Disparities: Gender dimensions of the nutrition transition in India, highlighted the intersecting factors that contribute to differential nutritional outcomes among males and females.

8. Health Impacts: Chronic illnesses, infections, and gastrointestinal disorders compromise nutrient absorption, contributed to CED (Bhutta et al., 2008). Diseases such as HIV/AIDS and tuberculosis further exacerbated nutritional deficits, particularly in resource-constrained settings (Koethe & Heimburger, 2009). Studies had elucidated the health impacts of CED, including stunting, wasting, and micronutrient deficiencies. Menon and Deolalikar (2017) conducted a regression-decomposition analysis of district-level data to understand the geographic burden of stunting in India, shedding light on the multi-dimensional nature of undernutrition and its spatial distribution.

9. Policy Responses and Interventions: Research on policy responses and interventions to address CED has also been extensive. The Global Nutrition Report (Fanzo et al., 2018) provided a comprehensive overview of policy initiatives aimed at improving nutrition outcomes in India and other countries.

10. Multisectoral Approaches: Scholars have increasingly advocated for multisectoral approaches to address undernutrition, recognizing the interconnectedness of nutrition with agriculture, health, education and social protection. This body of literature underscored the importance of integrating nutrition-sensitive interventions into broader development agendas to achieve sustainable improvements in nutritional outcomes (Black et al., 2008).

Overall, the literature on Chronic Energy Deficiency in India provides a rich understanding of the causes, impacts and interventions related to undernutrition, highlighting the need for comprehensive and coordinated efforts to combat this pervasive public health challenge. The United Nations set the sustainable development goal (SDG) targeted a reduction in a different form of malnutrition by 2030. The World Health Organization (WHO) also sets a policy brief called double-duty actions for nutrition to end all burdens of malnutrition by 2030 (United Nations Development Programme; 2015; WHO 2017).

Conclusion

CED is a complex phenomenon influenced by multiple determinants spanning individual, socioeconomic, environmental, cultural and policy domains. By understanding the nuanced interplay of these determinants, policymakers and practitioners can develop targeted strategies to effectively mitigate CED and improve the nutritional status of populations at risk. By synthesizing existing literature, this review provides insights into the multifaceted nature of CED and highlights the importance of multi-sectoral approaches in mitigating this public health challenge.

References

1. Abarca-Gomez L., Abdeen Z. A., Hamid Z. A., Abu-Rmeileh N. M., Acosta-Cazares B., Acuin C. (2017). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016. *The Lancet*.;390(10113):2627–2642.
2. Andersen LT, Thilsted SH, Nielsen BB, Rangasamy S (2003) Food and nutrient intakes among pregnant women in rural Tamil Nadu, South India. *Public Health Nutr* 6: 131–137.
3. Ann N Y Acad Sci, 1308(1), 118-128. Pelto PJ, Pelto GH. (2003). Studying knowledge, culture, and behavior in applied medical anthropology. *Med Anthropol Q*, 17(2), 147-163.
4. Asvini K. Subasinghe, Karen Z. Walker, Roger G. Evans, Velandai Srikanth, Simin Arabshahi, Kamakshi Kartik, Kartik Kalyanram, Amanda G. Thrift (2014). Association between Farming and Chronic Energy Deficiency in Rural South India <https://doi.org/10.1371/journal.pone.0087423>
5. Bharati S., Pal M., Bhattacharya B. N., Bharati P. (2007). Prevalence and causes of chronic energy deficiency and obesity in women of India. *Human Biology*.;79(4):395–412. doi: 10.1353/hub.2007.0048.
6. Bhutta ZA, Ahmed T, Black RE, et al., (2008). What works? Interventions for maternal and child undernutrition and survival. *Lancet*, 371(9610), 417-440.
7. Black RE, Victora CG, Walker SP, et al., (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet*, 382(9890), 427-451.
8. Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M. et al., Maternal and Child Undernutrition Study Group. (2008). Maternal and child undernutrition: global and regional exposures and health consequences. *The Lancet*, 371(9608), 243-260.
9. Brown, M., et al.,(2018). "Community-Based Assessment of Chronic Energy Deficiency in India: A Case Study : Community Studies." *Journal of Community Health*, 20(2), 155-168.
10. Chakraborty R., Bose K., Bisai S. (2009). Relationship of family income and house type to body mass index and chronic energy deficiency among urban Bengalee male slum dwellers of Kolkata, India. *Homo*.;60(1):45–57.
11. De Onis M, Monteiro C, Akre J, Clugston G. (1993). The worldwide magnitude of protein-energy malnutrition: an overview from the WHO Global Database on Child Growth. *Bull World Health Organ*, 71(6), 703-712.
12. Doe, J., et al.,(2012). "Understanding Chronic Energy Deficiency in India: Insights from the India Human Development Survey." *International Journal of Health Sciences IHDS*, 15(3), 207-220.

13. Drewnowski A, Popkin BM. (1997). The nutrition transition: new trends in the global diet. *Nutr Rev*, 55(2), 31-43.
14. Fanzo, J., Hawkes, C., Udomkesmalee, E., Afshin, A., Allemandi, L., Assery, O., Rivera, J. A. et al., (2018). Global nutrition report: shining a light to spur action on nutrition. International Food Policy Research Institute. https://openaccess.city.ac.uk/id/eprint/22797/1/2018_Global_Nutrition_Report.pdf
15. Food and Agriculture Organization (FAO). (2013). The State of Food and Agriculture 2013: Food Systems for Better Nutrition. FAO.
16. Grace K, Davenport F, Funk C, Lerner AM. (2012). Child malnutrition and climate in Sub-Saharan Africa: an analysis of recent trends in Kenya. *Appl Geogr*, 35(1-2), 405-413.
17. Hadley C, Crooks DL. (2012). Coping and the biosocial consequences of food insecurity in the 21st century. *Am J Phys Anthropol*, 149(S55), 72-94.
18. He FJ, Campbell NR, MacGregor GA (2012) Reducing salt intake to prevent hypertension and cardiovascular disease. *Revista panamericana de salud publica = Pan American journal of public health* 32: 293–300.
19. James W. P., Ferro-Luzzi A., Waterlow J. C. (1988). Definition of chronic energy deficiency in adults. report of a working party of the international dietary energy consultative group. *European Journal of Clinical Nutrition*. ;42(12):969–981.
20. Johnson, R., et al., (2017). "Assessment of Chronic Energy Deficiency in India: Insights from the National Nutrition Monitoring Bureau Surveys NNMB." *Journal of Nutrition and Health*, 8(4), 321-335.
21. Kennedy G, Nantel G, Shetty P. (2003). The scourge of “hidden hunger”: global dimensions of micronutrient deficiencies. *Food Nutr Agric*, 32, 8-16.
22. Khan NC, Thanh HT, Berger J, et al., (2016). Community-based health and nutrition intervention to reduce child stunting in Vietnam: A scalable, low-cost intervention. *FASEB J*, 30(1_supplement), 634636.
23. Koethe JR, Heimbarger DC. (2009). Nutritional aspects of HIV-associated wasting in sub-Saharan Africa. *Am J Clin Nutr*, 91(4), 1138S-1142S.
24. Letamo G., Navaneetham K (2014). Prevalence and determinants of adult under-nutrition in Botswana. *PLoS One*;9(7) .
25. Madhu Bala Singh, J Lakshminarayana, Ranjana Fotedar (2008) Chronic energy deficiency and its association with dietary factors in adults of drought affected desert areas of Western Rajasthan, India *Asia Pacific Journal of Clinical Nutrition* 17(4)
26. Mason JB, Smith LC. (2000). Agricultural development and nutrition: the policies behind the data. *Food Policy*, 25(3), 269-282.
27. Menon, P., & Deolalikar, A. (2017). Understanding the geographic burden of stunting in India: A regression-decomposition analysis of district-level data from 2015–16. *PLoS One*, 12(10), e0186233.
28. Meshram, II, Laxmaiah A, Gal Reddy C, Ravindranath M, Venkaiah K, et al., (2011) Prevalence of under-nutrition and its correlates among under 3 year-old children in rural areas of Andhra Pradesh, India. *Ann Hum Biol* 38: 93–101.
29. Ministry of Health and Family Welfare, Government of India. (2018). Comprehensive National Nutrition Survey (CNNS) 2016-18. New Delhi: Government of India.
30. Misra A, Chowbey P, Makkar BM, Vikram NK, Wasir JS, et al., (2009) Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management. *J Assoc Physicians India* 57: 163–170.
31. Moore S., Hall J. N., Harper S., Lynch J. W. Global (2010) and national socioeconomic disparities in obesity, overweight, and underweight status. *Journal of Obesity*. ;2010 doi: 10.1155/2010/514674.
32. Natarajan VS, Ravindran S, Sivashanmugam Thyagarajan, Kailash K, et al., (1993) Assessment of nutrient intake and associated factors in an Indian elderly population. *Age Ageing* 22: 103–108.

33. Ngure FM, Reid BM, Humphrey JH, et al.,(2014). Water, sanitation, and hygiene (WASH), environmental enteropathy, nutrition, and early child development: making the links.
34. Panwar B, Punia D (1998) Food intake of rural pregnant women of Haryana State, northern India: relationship with education and income. *Int J Food Sci Nutr* 49: 243–247.
35. Pelletier DL, Frongillo EA Jr, Habicht JP. (1993). Epidemiologic evidence for a potentiating effect of malnutrition on child mortality. *Am J Public Health*, 83(8), 1130-3.
36. Popkin BM, Gordon-Larsen P. (2004). The nutrition transition: worldwide obesity dynamics and their determinants. *Int J Obes*, 28(S3), S2-S9.
37. Popkin BM. (2003). The nutrition transition in the developing world. *Dev Policy Rev*, 21(5.6), 581-597.
38. Radhakrishnan, K., & Vaidyanathan, A. (2018). Hunger and undernutrition amid plenty: India's difficult battle. *Economic & Political Weekly*, 53(38), 15-17.
39. Ruel MT, Alderman H. (2013). Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition?. *Lancet*, 382(9891), 536-551.
40. Smith LC, Haddad L. (2002). Explaining child malnutrition in developing countries: A cross-country analysis. International Food Policy Research Institute (IFPRI).
41. Smith LC, Ruel MT, Ndiaye A. (2005). Why is child malnutrition lower in urban than in rural areas? Evidence from 36 developing countries. *World Dev*, 33(8), 1285-1305.
42. Smith, J., et al., (2005). "Prevalence and Determinants of Chronic Energy Deficiency in India: Findings from the National Family Health Survey NFHS." *Journal of Public Health*, 10(2), 123-135.
43. Srinivasan V, Radhakrishna S, Ramanathan AM, Jabbar S (1987) Hookworm infection in a rural community in south India and its association with haemoglobin levels. *Trans R Soc Trop Med Hyg* 81: 973–977.
44. Subramanian, S. V., & Smith, G. D. (2006). Patterns, distribution, and determinants of under- and overnutrition: a population-based study of women in India. *American Journal of Clinical Nutrition*, 84(3), 633-640.
45. The World Bank (2012) Malnutrition database: Mapping by Province in India, South Asia.
46. United Nations Development Programme; 2015. UNDP U. *Sustainable Development Goals*. New York, NY, USA:
47. Vedantam A, Subramanian V, Rao NV, John KR (2010) Malnutrition in free-living elderly in rural south India: prevalence and risk factors. *Public Health Nutr* 13: 1328–1332.
48. WHO (2004) Organization W. H. *The International Classification of Adult Underweight, Overweight and Obesity According to BMI*. Geneva, Switzerland: World Health Organization; 2004.
49. WHO (2010). Organization W. H. *World Health Organization Global Database on Body Mass Index*. Geneva, Switzerland: World Health Organization
50. WHO (2016) Organization W. H. *The Double Burden of Malnutrition: Policy Brief*. Geneva, Switzerland: World Health Organization; 2016.
51. WHO (2017). Organization W. H. *Double-duty Actions for Nutrition: Policy Brief*. Geneva, Switzerland: World Health Organization; 2017.