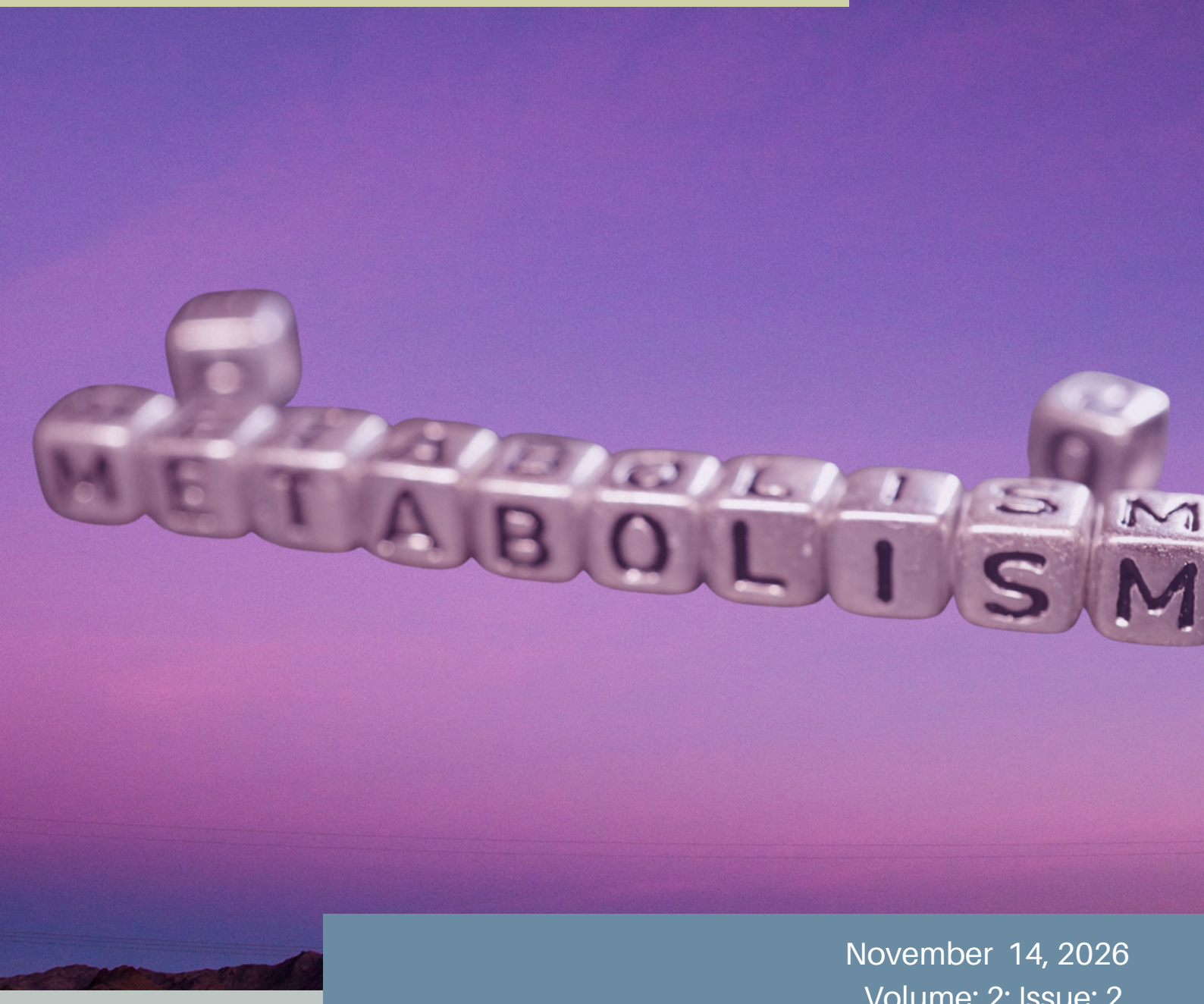
UpDAYtes

ISSN : 2839-6642

International Journal for Multidisciplinary Research and Innovation

Published by 'Diabetes Awareness & You (DAY)' in collaboration with 'Nurture Academy Welfare Trust (NAWT)'

Web: www.updaytes.org Email: updaytesjournal@gmail.com



November 14, 2026

Volume: 2; Issue: 2

Is India Reading General Dietary Guideline? - A Situation Analysis Study of Knowledge, Attitude and Practice Regarding General Dietary Guideline and RDA Among Women of Kolkata, West Bengal, India. P3

Psychodemographic Perspective of Diabetes Stigma: A Cross-Sectional Analytical Study from West Bengal, India. P14

Dietary Diversification and the Changing Burden of Metabolic Disorders in West Bengal: A Century-Long Perspective P26

An initiative of

HOLOS HEALTHCARE FOUNDATION
EMPOWERING HEALTH

ONLINE COURSE

BETTER ART OF LIVING WITH DIABETES

For People Living with Diabetes (PWD) & Caregivers

Academic Partner

DIABETES AWARENESS & YOU
Combat the silent killer

XXXXX
XXXXX

INTRDUCTORY COURSE FEE ₹199

www.holoshealthcare.org

hhf.alwd@gmail.com

+91 8336977344

FOR MORE INFORMATION

CLICK

SCAN OR CLICK ABOVE FOR DETAILS & ENROLLMENT

UpDAYtes

ISSN : 2839-6642

International Journal for Multidisciplinary Research and Innovation

Editorial Board:

Editor-in-Chief:
Prof. (Dr.) Satinath Mukhopadhyay

Editor :
Mr. Indrajit Majumder

Executive Editor:
Dr. Suprakash Pradhan

Associate Editor:
Dr. Arnab Chatterjee
Dr. Atanu Ghosh
Ms. Rimpa Bose

Editorial Board :
Prof. (Dr.) A. K. Azad Khan
Dr. Sujoy Majumdar
Dr. Soumik Goswami
Prof. (Dr.) Rakesh Kumar
Dr. Virendra V. Panpatil
Prof. (Dr.) Edward Jude
Prof. Iryna Vlasenko
Prof. (Dr.) Bishwajit Bhowmick
Dr. Amit Kumar Jana
Dr. Manas Das
Mr. Tanmay Saha
Mr. Sabyasachi Roy
Dr. Nandan Bhunia

Advisory Board :
Prof. (Dr.) Apurba Kumar Mukherjee
Dr. Debdulal Dutta Roy
Dr. Santi Gopal Kar
Dr. Ranajit Das
Prof. Binata Nayak
Dr. Malay Dolai
Ms. Shreya Dutta

Subscription Information:

UpDAYtes, International Journal for Multidisciplinary Research and Innovation, is a peer-reviewed biannual and open access journal.

Copyright & Photocopying:

UpDAYtes: International Journal for Multidisciplinary Research and Innovation licenses all its publications under a Creative Commons Attribution–NonCommercial 4.0 International License (CC BY-NC 4.0). This license permits use, distribution, and reproduction in any medium for non-commercial purposes only, provided that the original author(s) and source are properly credited.

For copyright or permission queries, please contact: updaytes.consent@gmail.com

🔗 https://creativecommons.org/licenses/by-nc/4.0/

Edited By:

Prof. (Dr.) Satinath Mukhopadhyay, Editor-in-Chief, on behalf of 'Diabetes Awareness & You (DAY)'

Published By:

'Diabetes Awareness & You (DAY)' in collaboration with 'Nurture Academy Welfare Trust (NAWT)'. Diabetes Awareness & You, Regd. Office: 109, Ramkrishna Nagar, Kolkata – 700153; Working Office: SACHETANATA BHAVAN, 12/1A/58, Chowbaga Road, Bidhannagar (South), Panchannagram, Kolkata – 700039.

Content:

Sl No	Particulars	Author/s	Page No
1	Editorial		1
2	Is India Reading General Dietary Guideline? - A Situation Analysis Study of Knowledge, Attitude and Practice Regarding General Dietary Guideline and RDA Among Women of Kolkata, West Bengal, India.	Snehasree Saha, Arpita Banerjee, Madhurima Roy, Rimpa Biswas, Rajoshree Roy	3
3	Psychodemographic Perspective of Diabetes Stigma: A Cross-Sectional Analytical Study from West Bengal, India	Kajal Hansda, Sukanya Samanta, Malvika Fulwani, Sneha Das, Debdulal Dutta Roy	14
4	Dietary Diversification and the Changing Burden of Metabolic Disorders in West Bengal: A Century-Long Perspective	Sonali Giri, Sukanta Bhunia, Dr.Suprakash Pradhan, Dr.Amit KumarJana	26
5	Social Media Influence on Dietary Behaviour in Adolescents and Young Adults: An Umbrella Review	Arpita Mondal, Arnab Chatterjee	35
6	Chrono Nutrition and the Regulation of Glucose Transporter 4 in Insulin-Sensitive Tissues: A Narrative Review	Neha Choudhury, Arnab Chatterjee	43
7	Breaking the Metabolic Cycle: From Awareness to Action Against Obesity	Sukanta Bhunia,Sonali Giri, Dr.Suprakash Pradhan	48
8	Gut Microbiome-Informed Precision Nutrition for Cardiometabolic Risk Reduction: A Narrative Review	Paushali Ghosh, Arnab Chatterjee	53
9	Air Pollution, Iron Status and Anaemia: A Narrative Review	Aishee Ghatak[1], Arnab Chatterjee[1]	60

From the Desk of the Editor-in-Chief:

Dear ALL,
GREETINGS from **UpDAYtes** Team!
Diseases and arm conflicts causes loss of human lives and harm the society. Therefore, preventing and avoiding them as far as possible is a shared responsibility. As with war, addressing disease should not be limited to dealing with its consequences after they occur; we must also understand their causes, identify risk factors, and strengthen preventive strategies in advance. Although disease cannot be completely avoided, prevention, early detection, health education, and healthy lifestyle practices must be recognized as fundamental pillars of public health alongside modern medical care.

A significant proportion of today's public health challenges is associated with limited health awareness, inadequate understanding of disease causation, fear and anxiety, reluctance to learn about the human body and health, and neglect of preventive health practices. Diabetes, obesity, cardiovascular disease, kidney disease, cancer, and other non-communicable diseases are placing an increasing burden on individuals, families, and communities. Addressing these challenges requires not only effective medical treatment but also sustained efforts to reduce risk and create supportive environments for healthier lifestyles.

Our traditional food culture has a long history of incorporating local, seasonal, diverse, and culturally appropriate foods. However, rapid urbanization, changing lifestyles, modernization of dietary practices, increasing availability of ultra-processed foods, irregular eating patterns, and physical inactivity are rapidly transforming our food and behavioural environment. Understanding how these transitions influence metabolic health and lifestyle-related diseases requires greater scientific research, public awareness, and evidence-based interventions.

It is within this context that UpDAYtes Journal seeks to promote the concept of a Solution-Based Health Movement. Our purpose is not merely to discuss diseases, their prevalence, or their risk factors, but to use scientific evidence to explore why health problems arise, who is most vulnerable, which behavioural and social determinants contribute to them, and how individuals, families, and communities can move towards practical and sustainable solutions.
Health is deeply interconnected with food, behaviour, education, environment, social structures, and individual choices. Therefore, an effective health movement requires a strong bridge between science and society.

UpDAYtes Journal aims to serve as a platform for the exchange of knowledge, research, and experience among researchers, educators, physicians, nutritionists, public health professionals, students, health workers, and community stakeholders. Our vision is to contribute to the development of a health-conscious, knowledge-driven, evidence-

From the Desk of the Editor-in-Chief:

evidence-informed, and solution-oriented society—where prevention receives as much attention as treatment, where health education becomes a lifelong process, and where scientific evidence is translated into meaningful action for individuals and communities.

We wish you a happy reading to explore this issue and invite you to engage with the research, and be part of this growing academic community.

With warm regards,



Editor-in-Chief
Prof. (Dr.) Satinath Mukhopadhyay
MD, DM (Endocrinology), FRCP (London), FAMS (India)
Ex Professor & Head of Endocrinology & Metabolism
Institute of Post Graduate Medical Education and Research

Original Article: Humanities and Cultural Studies

Is India Reading General Dietary Guideline? - A Situation Analysis Study of Knowledge, Attitude and Practice Regarding General Dietary Guideline and RDA Among Women of Kolkata, West Bengal, India.

Snehasree Saha[1], Arpita Banerjee[2], Madhurima Roy[3], Rimpa Biswas[4], Rajoshree Roy[5]

[1]Assistant Professor, Department of Food & Nutrition, Udaynarayanpur Madhabilata Mahavidyalaya, University of Calcutta, [2]Assistant Professor, Department of Applied Nutrition and Dietetics, School of Health Science and Translational Research, Sister Nivedita University, [2]Clinical Trial Transparency, Data Analyst, Bengaluru, India, [4 & 5]M.Sc (Nutrition), Department of Applied Nutrition and Dietetics, School of Health Science and Translational Research, Sister Nivedita University.

Author for Correspondence: Dr. Snehasree Saha , Assistant Professor and Head, Dept. of Food & Nutrition, Udaynarayanpur Madhabilata Mahavidyalaya, University of Calcutta, Udaynarayanpur, Howrah- 711226 , West Bengal, India

Email: sneha.snehasree16@gmail.com, Mobile: +91 8900285626

Received on: 22.09.2026 **Revised Manuscript:** 07.11.2026 **Accepted on:** 08.11.2026

ABSTRACT: Nutrition status is a key indicator of health and well-being of general population of a country. To uphold nutritional status, Recommended Dietary Allowances and general dietary guideline are designed and released for the population by Indian Council of Medical Research. India, a country suffering from triple burden of nutrition requires robust and credible intervention to combat malnutrition. Nutrition information is a powerful tool to strengthen health related behaviour and modify daily diet. Currently, it is an electronically available and free to access document intended to be used by general population. The guideline encompasses seventeen general dietary guidelines along with objective values of required nutrient for each person per day. In an age of information, it is important to understand the source and credibility of information. RDA is an authentic information source. However, there are hardly any study focusing use of RDA among general population. This study aims to assess knowledge, attitude and practice regarding RDA and general dietary guideline among general population. The study was population included 100 women from city of Kolkata, an eastern capital city of Kolkata. The study was conducted using an interviewer-administered questionnaire. The questionnaire included general knowledge on RDA and its origin, daily dietary practices and intention and attitude to learn RDA. The findingshows 58% of the participants were aware about RDA whereas 42% were not aware of any guideline or national recommendation to guide daily intake. Nearly half of them (43.1%) have come across such information from internet but many of them could correctly identify ICMR has its publishing authority. The study also highlighted despite feeling the need (44%) to modify diet, only 28% were willing to consult a dietician. Half of the study participants also felt personal preference also hinder adhering to dietary guideline over 79% check nutrition label while buying packaged food, but in absence of understanding of caloric contribution required from a product the link of diet and label reading remains questionable. Daily practices included This identifies a clear gap needed to be addressed. Vast majority (94%) of the participants expressed interest to learn about RDA from govt. institution. The study is pilot in nature and in our knowledge, it's one of the first few in this direction. The study is limited by number of participants and gender. The study highlights the need for larger studies in different section of population and intervention to promote understanding and interpretation of RDA and general dietary guideline among Indian.

Keywords: RDA, General dietary guideline, Nutrition knowledge, Dietary Habit, Food label,Women, Kolkata

A well-balanced meal is a key component of maintaining the health and nutritional status of an individual. The estimated disease burden from unhealthy diet is almost 56% among Indian population(ICMR, 2024). Childhood growth stunning, wasting to childhood obesity;

osteoporosis, anemia along with double and triple burden of malnutrition is prevalent among 12 – 50 percent of selected population (Ji N et al, 2024; ICMR-RDA, 2024). Malnutrition can cause reduced productivity, compromised quality of life, transgenerational malnutrition and diminished life expectancy. According to the Indian Council of Medical Research, a balanced diet requires inclusion of cereals, millets, pulses, legumes, flesh foods, fats and oils and nuts and seeds. The proportion of several food groups in a meal is calculated to fulfil the recommended Dietary Allowances. RDA is defined as the average daily intake of all essential nutrients required by the human body each day. It is calculated for a healthy population, and it aims to fulfil almost 97-98% nutrient requirements of any given age, gender and socio-economic strata. The set of RDA and national guideline is published by ICMR-NIN. The country had its first set of published values on 1943(NRC, 1943; RDA, 1989). Since then, there has several been revisions in1958, 1968, 1978, 2010, and most recently in 2020 and 2024. The RDA contains quantitative values of each nutrient required by the human body, categorized for gender, age, and physiological cycle. Beyond the numerical values, the recent document also elaborates seventeen (17) guidelines to help plan and prepare daily meals, management of physical activity to lead a healthy life. It also exemplified the use of portion size, serving size for each meal and the use of food labels for food selection. The combined set of guidelines are referred as national guidelines to be followed by general population in healthy condition or to lead daily dietary habits. RDA has been a crucial tool for the implementation of public health policies, medical nutrition therapy and academic discourse. Although RDA is designed to manage the general population's diet, there is hardly any evidence of RDA usage and understanding by the general population beyond the academic fraternity. The guideline itself has mentioned its aim to reach general population through effective Information, Education and Communication (IEC) strategies. Though nutrition knowledge assessment has been conducted in several occasion, the major questions often revolved around the relationship between nutrient and their physiological benefit and dietary practices(Gavaravarapu et al, 2017;Khandelwal et al, 2012; Moitra et al, 2021). These studies have also explored perceptionlinked to meal patterns and planning. However, very limited information has been documented on quantitative data related understanding and usage and interpretation by general population. RDA can be an important tool to bring data driven, objective information to change knowledge and attitude towards dietary management.

Within the scope of the context the study aimed to pilot an investigation on knowledge, perception regarding RDA and national dietary guideline and general dietary practice.

The Objective of the study was to assess the understanding, knowledge, and perception about Recommended Dietary Allowance (RDA) guidelines among woman living in West Bengal with general dietary practices, perception and attitude towards learning RDA guidelines to improve healthiness of overall food intake.

Methodology:

A cross-sectional survey was conducted among adult women of Kolkata, living in the capital city of the eastern state West Bengal. After obtaining required permission, Board of Research Studies, Sister Nivedita University, Kolkata random sampling method was utilized for the survey. The nature of survey was household interview using an interviewer administered questionnaire. The study included participants from a varied age groups from their natural set-up (workplace or household) based on their convenience. The

minimum age requirement was 18 and there was no upper age limit. The total number of participants was 100 (Teresi et al, 2022). The participants were included only after receiving written consent. Overall, 159 persons were approached, from which willing 102 women were included for the study. Two questionnaires were rejected due to inconsistent details.

Survey Instrument:

The study was conducted using a pre-tested, pre-coded interviewer administered questionnaire containing twenty-five (25) questions. The questionnaire included question on self-reported age, height, weight, occupation followed by seventeen (17) closed-ended questions, and three (03) open-ended questions on knowledge, practice, attitude, intention and perception. Further, each close ended questions had a minimum of four (04)options to select from. The questionnaire was explained in local language, Bengali, if required. The average time to complete the questionnaire was approximately 12-15 minutes. No partially filled questionnaire was entered in final data analysis.

Data collection and Analysis:

The quantitative data were coded and entered into an MS Excel workbook. The statistical software package SPSS Statistics for Windows version 19·00 and R statistical software was used for the analysis of data. Descriptive statistics such as percentages, frequency distribution, as well as cross-tabulations were calculated, and the χ^2 test were performed to assess the significance of associations between variables.

Results:

Demographic profile of the participants:

Among the hundred (100) women who participated in the study were aged between 26 – 78 years. Of the participants, 10 percent were aged between 20-30, whereas 30-60 were predominant age group of the participants. Three (03) participants were above 70 years of age. The age-wise details are provided in **Table 1.**

Educational Qualification:

Based on the self-reported response, the academic qualification was categorized in four groups, i.e. Secondary, higher secondary, graduate and post-graduate and above. The entire study population literate and the minimum educational level were secondary level education. 31% have completed only secondary level of education whereas 34% have graduate degree in **Table 2.**

Occupation of the participants:

Almost of half of the participants were homemaker (51%), followed by in service (35%). A small number of the participant were in business and 01 was retired personnel. The number of participants in each category are given in the **Table 3.**

Body Mass Index (based on self-reported height and weight):

The participants were asked to report their height and weight either based on recent medical reports or the last (not older than 3 months) checked details. Based on the reported measurement, Body Mass Index was calculated using the formula = weight in kilograms / (height in meters)^2.

Using the cut-off,the results were distributed in four categories (WHO,2000). More than half of the study population falls into obese category based on their self-reported values. **Table 4** and **Chart 1** depict the result.

Knowledge of an existing general guideline:

Among the participants, 58% were about existing national dietary guideline, whereas 42% were not aware of any nutrition guideline. Among those who responded positively to knowledge of existing guidelines, the investigator enquired about how they had come across this information. The options

were given from internet search, subject-oriented books or subjective studies, from their dietician or doctor, social media influencer. Of them who were aware of national dietary guideline, 2% could not be certain of their source of knowledge, whereas 43.1% have come across information on Internet search, 24 % have learned from their academic courses, and approximately 22% have heard either from their doctor or dietician. About 7% have learned about the guideline from social media influencer. On response to the question have you ever heard about nutrient requirement for a certain requirement; out of 100 participants, 43% have never came across any such information whereas 26% of the respondent have come across certain values on internet search, 14% came across it from their academic courses, 13% learned about this either from their physician or dietician, and only 4% have heard from social media influencer.

Participants were further asked if they knew or could predict which organization designs and publishes the national dietary guideline. The options were given to select from ICMR, WHO, UNICEF, and the World BANK. 51 % of the respondents could correctly identify ICMR as the publisher of the National Dietary Guideline. The questionnaire also enquired what they think when they hear the national nutrition guideline. The closed-ended question had four (04) options to reply from, those are: it helps to maintain a healthy life, it provides a list of nutrients required by the human body, it provides guidelines for calories, protein and fat, and the last option was it is an overall calorie consumption related guideline. A little over half of the population (52%) correctly chose the response, which provides details of all nutrients required by the human body. Only seventeen per cent perceived their family's dietary pattern was in adherence to RDA; whereas 60% of the study population said they were not certain about it. However, the majority (97%) were certain that there are changes in RDA based on basic physiological needs,age and gender. The study also tried to establish any given condition that may trigger to motivate them to learn nutrition guidelines, like the presence of any condition and advice from a physician or dietician. Though 44% of participants had at least one (1) member of their family requiring dietary modification, only 28% have ever consulted anyone. This identifies a big gap between the requirement to practice in case of dietary behaviour and seeking professional help. To understand practices, the study included questions on checking food labels while purchasing food. A vast majority of the respondent (79% and 83%, respectively) claimed to check nutritional value and ingredient list before purchasing any products.

General Dietary Behaviour:

More than half of the participants included fruits and vegetables in their daily meals, even some (11%) prefer to include them in every meal. Only 2% had a habit of rarely consuming any fruits and vegetables in their daily meal. They reported an average intake of 2-3 liters of water daily. Only very few didn't drink enough water. Over 80% of the study participants cooked protein-rich meals in their house, and only 30% of the participants regularly cooked processed food items as part of daily household cooking. Among the participants, 64% reported that family food preference is a major influence for planning or preparing a meal, also the number is at per with the number of challenges faced during planning a meal to match to nutrient requirements of the family. Only 4% are influenced by social media; this number is consistent with the % of participants who gather information from social media regarding RDA. 56% view that the family's

food preference may often cause a challenge to make a nutrient adequate meal. Almost the entire study population had some or the other diet-related concern for their family and were willing to learn about the recommended guidelines of the country. They insisted nutrition workshop in collaboration with government bodies should be conducted to raise awareness. 20 % of them also think children's study books should have a component on RDA, then the family will also be indirectly benefited. About10% of them think there should be more scientific information available on social media. The result also showed a significant association between knowledge, attitude and practice.

The results were analyzed using cross-tabulation to explore association between two variables. Among those who were aware of existence of national dietary guideline, 48% of them were checking food label in comparison to 31% of participant checked label from the section who were not aware of the RDA and related guideline. Similarly, practice of including fruits and vegetable with each meal or each day were considerably high (64.5 % and 57,1% respectively) in group who knew about RDA compared to participants (35.5% and 42.9% respectively) who were not aware of RDA. The attitude to learn RDA was significantly high in entire study participants, even those who were not sure about meeting RDA with daily diet, 53% of them were willing to learn about it. To understand the association and relation between knowledge, practices and attitude of RDA and dietary habits, chi-square tests were performed using R software.

The result shows significant association between awareness of existing nutrition guideline and adherence of family diet was significantly associated (.000479, $p < .05$). consultation with a doctor or nutritionist for a diet plan were also significantly associated (at 5 percent) when there is an existing health condition within the family. This is also significantly associated with higher frequency inclusion of fruits and vegetable in daily diet. The concern of family health was positively associated with intention to learn about RDA and general dietary guideline. Knowledge of RDA was also significantly associated with reading of ingredient information while purchasing pre-packaged food **(Table – 8).**

The study responses did not indicate any significant results on understanding of nutritional requirements of entire family and variation required at different age and gender. Educational qualification was not strongly associated with knowledge of RDA and General nutrition guideline. Understanding meaning of RDA and perception on meeting up RDA value in daily meal for a family was also not significantly associated. There was also not significant association between understanding RDA and consultation for a diet plan. The choice of media to learn about general guideline did not have any significant association with intention to learn about RDA.

Discussion:

This study assessed the knowledge regarding current recommended dietary allowances and national dietary guideline and general dietary practices. While studies are available on general nutrition knowledge among Indian population, findings on knowledge on objective information like RDA are rarely available. Earlier research investigationwas focused on understanding and improving nutrition knowledge that emphasizes physiological role of nutrient. Currently the discussion revolving nutrient information, portion control, nutrient requirementhas been exploded across the web. World economic forum has marked digital misinformation as one of the major threats of this era (Global Risk Reports, 2025). A review

conducted on internet information found majority of the health-related information is sub-optimal and sometime even misleading (Feili et al, 2020; Zhao et al, 2025). The current study indicates limited knowledge among study population. The limited knowledge was primarilysourced from various internet source rather than authentic and reliable source.Although, RDA and dietary guideline area free and open-source material, availability alone does not necessarily guarantee its use by general population. To understand reliable source, dissemination of scientific knowledge is a pre-requisite condition. As majority of the participants were not aware of publishing agency of RDA, lack of information could lead to gathering information from unreliable sources.

The use of internet and digital platform goes beyond collection of information. The current world is also experiencing diet management using mobile application. The application often focusses on a calorie driven diet. An analysis by Banerjee et al, 2023 showed inclusion of fruits and vegetables, reduction of saturated fatty acids and inclusion of high fibre fruits were encouraged by only eight apps (40%) whereas calorie restriction was primary theme of all the apps. All the apps kept track of weight change, but waist or hip circumferences were recorded by only five apps (25%). This reflects the gap between healthy lifestyle and only calorie driven dietary management. These food app also recommended calorie reduction per week or month, but in absence of knowledge how much calorie is required to maintain overall healthy life, a person can make faulty diet a life choice. Often restricting calorie restrict choice of foods which indirectly impact micronutrient intake. In presence of almost 42 % of triple burden of malnutrition, the dissemination of information on RDA is crucial than ever. Global nutrition report shows only calorie from cereal meets 97% of the recommended allowances. Dietary intake from vegetables, fruits, fish, nuts, legumes only meet 56%, 18%, 34% and 25 % respectively. This identifies a massive gap of understanding inclusion of different food groups in daily diet. The result from the study population shows an encouraging trend of knowledge on RDA and inclusion of fruits and vegetable in daily meal. This trend can be highlighted further to design quantitative and objective data driven communication approach.

The current food environment provides majority of the products in packaged form. Each food pack comes in pack printed with food label. Label information contains nutritive value and portion size. in absence of knowledge regarding distribution of calorie from each food group and required nutrient for each day, one may often underconsume or overconsume. The study participants checked label information, but ability to interpret the nutrient information was beyond scope of this study. The knowledge regarding RDA was positively associated with habit of checking ingredient list. Thus, awareness of RDA and general dietary meal could positively impact use and interpretation of label information. This may also promote healthier food selection among processed and packaged food. Considering the increase in pre-packaged food in food environment, strengthening label interpretation ability can be an impactful public health approach.

Indian disease burden is often contributed by faulty diet. The study population admitted concern over dietary pattern of family members, but consulting a nutritionist was not a popular approach yet. The knowledge on RDA can bring focus on trace elements and micronutrient. The minuscule yet crucial nutrient requirement can also motivate consulting nutritionist. This may help bring

overall changes in dietary practices and thus reducing diet related disease burden. A review by Schwartz&Vernarelli (2019) conducted an analysis of thirty-one (31) studies conducted among USA citizen over a period of 22 years found a clear gap of knowledge regarding national dietary initiative. The food pyramid, my plate concept in available by FDA and meant for public usage. The findings exhibit low use and it advocates promotion and dissemination of national guideline related nutrition communication activity. The similar findings were reported in a cross-sectional analysis conducted among USA (Kinderknecht et al, 2024). The latest guideline by ICMR depicts food plate, food pyramid and easy to understand guideline along with numerical values. Promotion of these materials at household level may bring increase in awareness and positive changes towards inclusion of foods from various food groups. The visual depiction can improve inclusion of food groups in required quantity and adherence to a balanced diet.

The participants felt the need of initiation from govt.agencies in form of workshop to promote the verified information. The study is limited in strength, but the presence of a researcher and a questionnaire can itself generate interest to learn. Hence, more research on this area is highly recommended. The RDA book itself can act as a communication material, with advancement of ICT material, RDA can be promoted via visual tools like movie, 3 -D poster etc. Hands-on training on reliable nutrition related source sites is also a required area of intervention.

The study also points out even with knowledge; many only prioritize taste over healthiness. Same was reported while choosing package by a study population in Kolkata (Saha et al, 2013). This area needs focus to bring attention towards importance of healthiness and functionality of a meal over taste. The training should focus on selection of food products from each food groups, retention of nutrient in cooking, identification of nutrient inhibitor and facilitator for promotion of balance diet. The ability of interpret RDA values and factual information in reference with dietary guideline can alone serve as verified source and guiding principle of a balance meal.

Way forward:

The study points towards necessity of a study with larger population size among different socio-economic strata. The study reinforces the requirement for knowledge-based intervention to promote identification of validated and authentic source of health information and interpretational skills for making healthier dietary choices.

Limitation:

The study is limited to only 100 sample and conducted only among women. The sample size and inclusion of one gender may limit its generalizability of results across population.

Conflict of Interest:

The authors have no conflicts of interest to disclose.

Reference:

1. ·Banerjee, P., Mendu, V. V. R., Korrapati, D., &Gavaravarapu, S. M. (2020). Calorie counting smart phone apps: Effectiveness in nutritional awareness, lifestyle modification and weight management among young Indian adults. Health informatics journal, 26(2), 816-828.
2. ·Country nutrition profiles. Global Nutrition report. The state of global nutrition. Available at https://globalnutritionreport.org/about/ accessed on 25th September, 2025.
3. ·Denniss E, Lindberg R, McNaughton SA. Quality and accuracy of online nutrition-related information: a systematic review of content analysis studies. Public Health Nutr. 2023 Jul;26(7):1345-1357. doi: 10.1017/S1368980023000873. Epub 2023 May 4. PMID: 37138366; PMCID: PMC10346027.
4. ·Feili tu, Nancy p. Zimmerman. It Is Not Just a Matter of Ethics: A Survey of the Provision of Health Disclaimers, Caveats, and Other Health-related Alerts in Consumer Health Information on Eating Disorders on the Internet, The International Information & Library Review, Volume 32, Issues 3–4, 2000, Pages 325-339, ISSN 1057-2317,

5. Gavaravarapu, S. M., Konapur, A., & Saha, S. (2017). Role of education and communication interventions in promoting micronutrient status in India–what research in the last two decades informs. Journal of Communication in Healthcare, 10(4), 238-249.
6. ·Global Risks Report 2025: Conflict, Environment and Disinformation Top Threats. World Economic forum. Available at https://www.weforum.org/press/2025/01/global-risks-report-2025-conflict-environment-and-disinformation-top-threats/ accessed on 21st September, 2025
7. ·Haack, S. A., & Byker, C. J. (2014). Recent population adherence to and knowledge of United States federal nutrition guides, 1992–2013: a systematic review. Nutrition reviews, 72(10), 613-626.
8. ·ICMR-NIN. Dietary Guidelines for Indians. Indian Council for Medical Research/National Institute of Nutrition (7th May 2024) https://www.nin.res.in/dietaryguidelines/pdfjs/locale/DGI07052024P.pdf (accessed on 17th July, 20245)
9. ·Ji, N., Kumar, A., Joe, W., Kuriyan, R., Sethi, V., Finkelstein, J. L., & Mehta, S. (2024). Prevalence and Correlates of Double and Triple Burden of Malnutrition Among Children and Adolescents in India: The Comprehensive National Nutrition Survey. The Journal of Nutrition, 154(10), 2932-2947.
10. ·Khandelwal, S., Dayal, R., Jha, M., Zodpey, S., & Reddy, K. S. (2012). Mapping of nutrition teaching and training initiatives in India: the need for Public Health Nutrition. Public Health Nutrition, 15(11), 2020-2025.
11. ·Kinderknecht, K. L., The, N. S., &Slining, M. M. (2024). Whose Plate Is It? Awareness of MyPlate Among US Adults Over Time Since Implementation. Journal of the Academy of Nutrition and Dietetics, 124(9), 1214-1221.
12. ·Moitra, P., Madan, J., & Verma, P. (2021). Impact of a behaviourally focused nutrition education intervention on attitudes and practices related to eating habits and activity levels in Indian adolescents. Public Health Nutrition, 24(9), 2715-2726.
13. ·National Research Council (US) Subcommittee on the Tenth Edition of the Recommended Dietary Allowances. Recommended Dietary Allowances: 10th Edition. Washington (DC): National Academies Press (US); 1989. 2, Definition and Applications. Available from: https://www.ncbi.nlm.nih.gov/books/NBK234926/
14. National Research Council, Commission on Life Sciences, & Subcommittee on the Tenth Edition of the Recommended Dietary Allowances. (1989). Recommended dietary allowances.
15. ·NRC (National Research Council). 1943. Recommended Dietary Allowances. Report of the Food and Nutrition Board, Reprint and Circular Series No. 115. National Research Council, Washington, D.C. 6 pp.
16. ·Pai, A., & Sabharwal, A. (2023). Calorie compensation patterns observed in app-based food diaries. Nutrients, 15(18), 4007.
17. ·Roberts, L.J. 1958. Beginnings of the Recommended Dietary Allowances. J. Am. Diet. Assoc. 34: 903–908.
18. ·Schwartz, J. L., &Vernarelli, J. A. (2019). Assessing the public's comprehension of dietary guidelines: use of MyPyramid or MyPlate is associated with healthier diets among US adults. Journal of the Academy of Nutrition and Dietetics, 119(3), 482-489.
19. ·Sharma, M., Kishore, A., Roy, D., & Joshi, K. (2020). A comparison of the Indian diet with the EAT-Lancet reference diet. BMC public health, 20(1), 812.
20. ·Solbrig L, Jones R, Kavanagh D, May J, Parkin T, Andrade J. People trying to lose weight dislike calorie counting apps and want motivational support to help them achieve their goals. Internet Interv. 2017 Mar;7:23–31. doi: 10.1016/j.invent.2016.12.003. https://linkinghub.elsevier.com/retrieve/pii/S2214-7829(16)30039-2. [DOI] [PMC free article] [PubMed] [Google Scholar]
21. ·Teresi, J. A., Yu, X., Stewart, A. L., & Hays, R. D. (2022). Guidelines for designing and evaluating feasibility pilot studies. Medical care, 60(1), 95-103.
22. ·Vanderlee, L., McCRORY, C. A. S. S. O. N. D. R. A., & Hammond, D. (2015). Awareness and knowledge of recommendations from Canada's Food Guide. Canadian Journal of Dietetic Practice and Research, 76(3), 146-149.
23. ·World Economic Forum (2013) Global Risks 2013. Geneva: WHO.
24. ·World Health Organization Western Pacific Region. The Asia-Pacific perspective: redefining obesity and its treatment [Internet] Geneva: World Health Organization; 2000.[2016Nov3].Availablefrom: http://www.wpro.who.int/nutrition/documents/Redefining_obesity/en/ [Google Scholar]
25. ·Zhao, Y., Zhang, L., Zeng, C., Chen, Y., Lu, W., & Song, N. (2025). Factors influencing online health information credibility: a meta-analysis. Aslib Journal of Information Management, 77(4), 701-732.

Is India Reading General Dietary Guideline? - A Situation Analysis Study of Knowledge, Attitude and Practice Regarding General Dietary Guideline and RDA Among Women of Kolkata, West Bengal, India.

Table 1:- Age Distribution of the Participants

Age in Years	Number of Participants
20-30	10
30-40	28
40-50	40
50-60	13
60-70	6
70 and above	3

Table 2: Academic qualification of the study participants

Education qualification	Number of participants
Secondary	31
Higher secondary	16
Graduate	34
Postgraduate & above	19

Table 3:- Major occupation of the participants

Occupation	Number of participants
Student	4
Homemaker	51
Service	35
Business owner	9
Retd personnel	1

Table 4 : - BMI categorization

BMI	Number of participants
Normal	21
Underweight	6
Obese	53
Overweight	20

Chart 1 : Display of distribution of study participants based on BMI classification [Weight Status based on perceived weight of the participant]

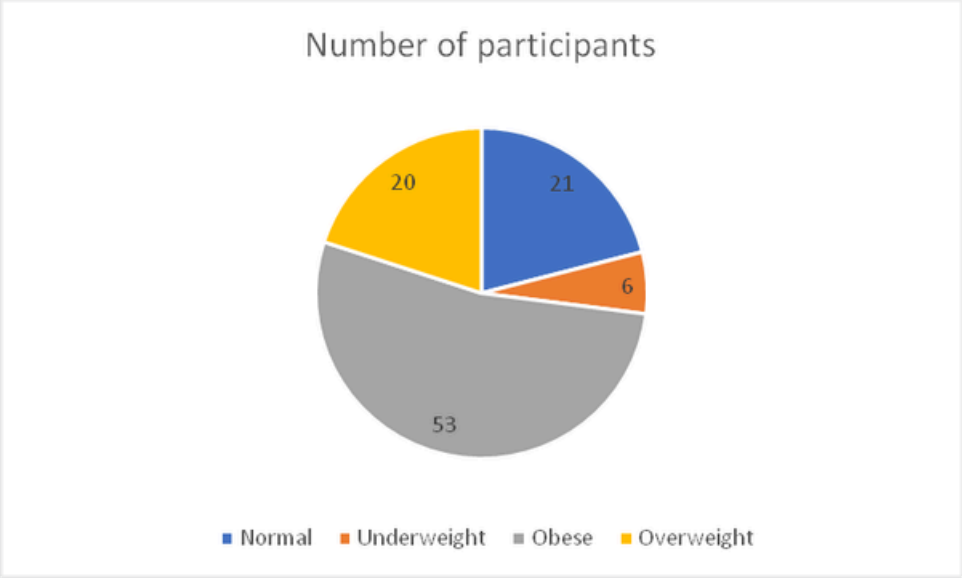


Table 5 :- Knowledge of the Participants (n=100)

Questions	Number of correct / positive responses	Number of incorrect/ negative responses
Are you aware of an existing nutrition guide line for the Indian population?	58	42
Which of the following institutes prepare guidelines for dietary allowances?	51	49
Do you believe nutritional needs vary based on age and gender?	93	7

Table 6 :- Common Practices of the Participants (n=100) [The affirmative response would stand for response according to guideline or desirable public health behaviour]

Questions	Number of positive/ affirmative responses	Number of negative responses (rarely or never)
Have you ever consulted a nutritionist or doctor for a diet plan?	28	72
Do you check the nutritional value of food items before purchasing?	79	21
Do you read ingredients and nutrient declarations on packaged food?	83	17
How often do you prepare processed or packaged foods at home?	33	67
do you include fruits and vegetables in your family's meal daily?	98	2
do you drink 2-3 litre of water each day?	98	2
do you cook protein rich meals daily (lentils, eggs, fish, dairy, meat etc.)?	99	1

Table 7:- Attitude To Learn / Include RDA In Daily Diet

Questions	Response (Yes)	Response (No)
Do you think awareness about RDA guidelines should be increased in ' communities?	100	0
Would you like to learn more about RDA guidelines and balanced nutrition?	94	6

Table 8 : Chi- Square analysis of Knowledge, Practice and Attitude

Variable	*Variable*	*Valid N*	*P_ Value*	*Significance at 5 percent*	*Association strength (based on CramersV)*
Awareness of existing nutrition guideline	Perception on adherence of family diet according to RDA	100	0.000479	Yes	Moderate
Meaning of nutrition guideline	Perception on adherence of family diet according to RDA	100	0.333467	No	Weak
Health requirement of family member	Consultation for diet plan	100	0.000002	Yes	Moderate
Health requirement of family member	Inclusion of fruits and vegetable in daily diet	100	0.010599	Yes	Moderate
Intention to learn RDA	Concern regarding family diet	100	0.0018	Yes	Moderate
Understanding of meeting up RDA value for each member of family	Knowledge on nutritional requirement of different age and gender	100	0.065993	No	Weak
Awareness of existing nutrition guideline	Checking of nutritional value of packaged food	100	1.176	No	Weak
Awareness of existing nutrition guideline	Checking of ingredient list of packaged food	100	0.008757	Yes	Weak

Original Article: Humanities and Cultural Studies

Psychodemographic Perspective of Diabetes Stigma: A Cross-Sectional Analytical Study from West Bengal, India

Kajal Hansda[1], Sukanya Samanta[2], Malvika Fulwani[3], Sneha Das[4], Debdulal Dutta Roy[5]
[1]Dietitian and Senior Diabetes Educator, Diabetes Awareness and You, [2]Dietitian and Diabetes Educator, Diabetes Awareness and You, [3]Clinical Dietitian and Diabetes Educator, Diabetes Awareness and You, [4]International Institute of Population Science, Mumbai, [5]President, Rabindrik Psychotherapy Research Institute Trust
Author for Correspondence: Sneha Das, **Email:** 19sdas04@gmail.com, **Mobile:** +919875521811

Received on:11.08.2026 **Revised Manuscript Received:** 08.11.2026 **Accepted on:** 09.11.2026

ABSTRACT: Psychodemography refers to the study of how demographic characteristics shape psychological processes, perceptions, emotions, attitudes, coping styles, and social behaviors. In this research, psychodemography helps explain why some patients with diabetes perceive greater stigma than others because of demographic differences. Stigma associated with diabetes mellitus represents a significant psychosocial burden that adversely affects treatment adherence, psychological well-being, and health-related quality of life. This cross-sectional analytical study examined the prevalence and socio-demographic correlates of perceived stigma among 137 adults with confirmed diabetes attending a healthcare facility in South 24 Parganas, West Bengal, India. Stigma was assessed using a culturally adapted Bengali version of the validated 19-item Type 2 Diabetes Stigma Assessment Scale (DSAS-2), which demonstrated excellent reliability in this sample (alpha = 0.88). The mean total stigma score was 46.02 9.32. The Shapiro–Wilk test confirmed non-normal score distribution (W = 0.926, p < .001), necessitating non-parametric bivariate tests (Wilcoxon rank-sum; Kruskal–Wallis) and Spearman's correlation. Multivariable binary logistic regression identified independent predictors. Using the sample median (46) as the cut-off, 49.64% of participants (95% CI [41.03%, 58.26%]) were classified as having high perceived stigma; as no validated cut-off exists for the DSAS-2, this classification is relative to the sample. In bivariate analysis, stigma scores differed significantly by sex (W = 1549, p = .001), religion (W = 1446, p = .001), educational status (= 16.53, p = .002), occupational status (= 13.56, p = .019), and disease duration category (= 9.63, p = .022). Age was inversely correlated with stigma (rs = – .285, p = .001). After multivariable adjustment, a disease duration of 10–20 years was identified as the sole significant independent predictor of high perceived stigma (AOR = 3.13, 95% CI [1.08, 9.10], p = .036). Findings indicate that perceived stigma is socially patterned among persons with diabetes in this Indian setting and was highest during the early-to-middle disease phase. Targeted psychosocial interventions, particularly for individuals in the 10–20 year disease duration window, are strongly indicated.

Keywords: Psychodemography, diabetes mellitus, perceived stigma, DSAS-2, prevalence, socio-demographic correlates, disease duration, psychosocial burden

1. Introduction

Diabetes mellitus has emerged as one of the most pressing non-communicable disease challenges of the 21st century. Approximately 537 million adults worldwide were living with diabetes as of 2021, a figure the International Diabetes Federation (IDF) projects will escalate to 783 million by 2045 [1]. The disease burden is disproportionately concentrated in low- and middle-income countries (LMICs), with India—home to an estimated 74.2 million persons with diabetes (PWD) and an additional 39.4 million undiagnosed cases—often described as the global 'diabetes capital' [1,2]. Diabetes-related complications account for approximately 1.5 million deaths annually [2], and the country's epidemiological trajectory is complicated by delayed treatment-seeking, poor adherence, and persistent socio-cultural misconceptions about the disease.

Beyond its physiological sequelae, diabetes imposes a substantial psychosocial burden that has received comparatively limited empirical attention in the Indian context. Chief among these psychosocial dimensions is health-related stigma. The perception of stigma in diabetes is not merely a medical issue but a psychodemographic phenomenon where social identity and demographic positioning shape emotional interpretation of illness. Diabetes stigma is the devaluation, social rejection, and internalized shame experienced by individuals because of their illness status [3]. Stigma in the context of chronic disease is conceptually multidimensional, encompassing enacted stigma (actual discrimination), felt or perceived stigma (anticipatory fear and internalized shame), and self-stigma (internalization of negative social stereotypes) [4]. In the context of diabetes, stigmatizing attributions commonly reflect beliefs that the disease results from personal failures of dietary discipline or behavioral self-regulation, generating an implicit moral culpability [5,6].

The consequences of diabetes-related stigma extend beyond psychological distress. Empirical literature consistently documents associations between perceived stigma and reduced medication adherence, avoidance of healthcare settings, impaired self-management behaviors, and deteriorated metabolic control [6–8]. Persons living with diabetes who experience high stigma are more likely to delay seeking medical attention until complications become severe [5]. In India, where over 50% of the population reportedly lacks adequate awareness about diabetes [1], social myths and cultural stigma are recognized as significant barriers to timely diagnosis and treatment [9].

Several socio-demographic factors are theorized to modulate the experience and severity of diabetes stigma. Sex differences in stigma have been documented consistently, with women reporting higher levels—potentially reflecting stricter normative expectations around dietary conduct and body image in many cultural settings [5,10]. Younger age has been associated with heightened stigma vulnerability, possibly because of concerns about social acceptance, romantic relationships, and employment implications [7]. Educational attainment and occupational status are understood to confer differential access to health literacy, social capital, and psychological coping resources, thereby shaping both exposure and sensitivity to stigmatizing attributions [11,12]. Cultural and religious contexts further mediate illness attribution processes, particularly in heterogeneous societies such as India [13].

Disease duration represents a theoretically important but understudied, temporal determinant of stigma. It has been posited that the early-to-middle years of chronic disease may represent a critical period for stigma accumulation, during which the diagnosis has been socially metabolized but has not yet been fully normalized through prolonged illness experience [14]. The 10–20 year period may coincide with the emergence of visible disease management requirements (e.g., escalating pharmacotherapy, insulin initiation), increased comorbidity burden, and progressive disclosure to social networks—each of which may intensify stigmatizing social interactions.

Despite the clinical and public health relevance of diabetes stigma in India, published empirical research from the country remains sparse and methodologically limited. The few available studies have not systematically applied validated, diabetes-specific stigma instruments such as the Type 2 Diabetes Stigma Assessment Scale (DSAS-2) [15], have relied on small convenience samples, or have omitted multivariable regression to disentangle independent socio-demographic predictors from confounders. A recent study from Pune by

Kudale et al. [9] examined community-level attitudes toward diabetes stigma among non-diabetic participants using a culturally adapted measure—an important contribution, but one that does not capture the subjective experience of stigma among PWD themselves.

The present study addressed this gap by estimating the prevalence of perceived stigma among PWD and identifying independent socio-demographic predictors using a validated instrument and rigorous multivariable adjustment in a mixed rural–urban population in West Bengal. The specific objectives of this study were: (a) to estimate the overall prevalence of perceived stigma among persons with diabetes; (b) to examine bivariate associations between socio-demographic variables and stigma scores; and (c) to identify independent predictors of stigma through multivariable binary logistic regression. The findings are intended to inform the design of targeted stigma-reduction interventions within primary and secondary diabetes care frameworks in India.

Method:

Study Design and Setting:

A cross-sectional analytical study design was employed. Cross-sectional designs are appropriate for estimating the prevalence of health outcomes and identifying correlates at a single point in time, though they preclude causal inference [16]. Data were collected from patients attending the outpatient department (OPD) of a healthcare facility serving the rural and urban population of South 24 Parganas district, West Bengal, India. The study was conducted over a six-month period.

Participants:

The target population comprised all adults (aged ≥18 years) with a confirmed diagnosis of diabetes mellitus who had been diagnosed for more than one year. Patients with severe cognitive impairment, acute psychiatric illness, or who declined to provide informed consent were excluded. Simple random sampling was used to select participants from the Non-Communicable Disease (NCD) clinic register.

The minimum required sample size was calculated using Cochran's formula:

$$n_0 = \frac{Z^2\, p\, q}{e^2}$$

Based on a prior stigma prevalence (p) estimate of 49% reported among adults with type 2 diabetes who did not use insulin [7], where Z = 1.96 (for a 95% confidence interval), q = 1 - p = 0.51, and an allowable margin of error (e) of 10% (0.10), the baseline required sample size was calculated as 96 and accounting for an anticipated 10% non-response or incomplete data rate yielded a target sample size of 106. The study ultimately enrolled and successfully analyzed 137 eligible participants who provided complete records.

The mean age of the participants was 52.51 ± 10.34 years (range: 26–74 years). Of the 137 participants, 60 (43.8%) were male and 77 (56.2%) were female. The majority identified as Hindu (n = 87, 63.5%) and the remainder as non-Hindu (n = 50, 36.5%). A total of 100 participants (73.0%) were not on insulin therapy, and 81 participants (59.1%) reported one or more comorbidities alongside diabetes.

Measures:

Diabetes Stigma Assessment Scale (DSAS-2):

Perceived stigma was measured using the 19-item DSAS-2 [15], which yields a continuous total score ranging from 19 to 95, with higher scores indicating greater perceived stigma severity. The scale encompasses three subscales: (a) Treated Differently (3 items), (b) Blame and Judgment (7 items), and (c) Self-Stigma (9 items). The DSAS-2 has demonstrated robust psychometric properties across multiple international cultural adaptations.

For the present study, the scale was forward-translated into Bengali by an independent language expert and back-translated into

English by a senior clinical psychologist to ensure semantic equivalence and construct validity. In this sample, the translated Bengali version of the overall scale demonstrated strong internal consistency, yielding a raw Cronbach's alpha (α) coefficient of 0.88 (standardized α = 0.89), with a 95% confidence interval ranging from 0.85 to 0.91 (computed via Feldt / Duhachek methods). Reliable internal consistencies were also obtained for the subscales: Treated Differently (α = 0.76), Blame and Judgment (α = 0.81), and Self-Stigma (α = 0.84).

To conduct multivariable logistic regression analyses, the continuous total score was dichotomized at the sample median (median = 46.00) to yield a binary outcome variable (0 = lower perceived stigma [score < 46]; 1 = higher perceived stigma [score 46]).

A median split was adopted for the following reasons. First, no validated or clinically established cut-off score exists for the DSAS-2, or for other diabetes stigma instruments, to classify stigma as high or low [17]; a sample-based cut-off was therefore the most transparent option available. Second, the median yields two groups of nearly equal size, which gives balanced numbers of participants in each outcome category for the logistic regression model. The median is, however, specific to this sample. 'High perceived stigma' therefore denotes relatively higher stigma within this cohort and does not imply clinically significant stigma, and the proportion classified as high stigma is approximately 50% by construction. This proportion should not be read as an absolute prevalence or compared directly with estimates from studies that used other thresholds. Because dichotomizing a continuous measure reduces statistical power and discards information [18], the continuous total score was also analyzed using non-parametric bivariate tests and Spearman's correlation (see Statistical Analysis).

Socio-Demographic and Clinical Covariates

Structured face-to-face interviews were conducted to collect data on:

- Age: Continuous variable in years.
- Sex: Categorical variable (1 = male, 2 = female).
- Religion: Categorical variable (1 = Hindu, 2 = non-Hindu).
- Educational Status: Ordered categorical variable (1 = illiterate/primary, 2 = secondary, 3 = higher secondary, 4 = graduate, 5 = postgraduate).
- Occupational Status: Categorical variable (1 = housewife, 2 = retired, 3 = service, 4 = business, 5 = farmer, 6 = others).
- Marital Status: Categorical variable (1 = widow/er, 2 = married, 3 = unmarried).
- Addiction Status: Binary lifestyle indicator (1 = present, 2 = absent). "Addiction" was operationally defined as the daily, self-reported consumption of tobacco (smoking or smokeless chewing forms) and/or habitual alcohol use.
- Monthly Income: Ordinal bands (seven progressive categories).
- Family Size: Continuous variable capturing total household members.
- Disease Duration: Categorized into four groups according to the empirical distribution of the data (1 = < 10 years, 2 = 10–20 years, 3 = 20–30 years, 4 = > 30 years).
- Clinical Factors: Insulin use (1 = yes, 2 = no) and presence of any diagnosed chronic comorbidities (e.g., hypertension, cardiovascular disease, chronic kidney disease).

Statistical Analysis:

All statistical analyses were executed using R (version 4.3.0) [19]. Continuous variables were summarized using means and standard deviations; categorical variables were presented as frequencies and proportions alongside 95% confidence intervals (CIs) estimated via the Wilson score method. The normality of the total

stigma score distribution was evaluated using the Shapiro–Wilk test. Given the confirmed non-normal distribution, non-parametric tests were deployed: the Wilcoxon rank-sum test (Mann–Whitney U) for dual-group comparisons, the Kruskal–Wallis H test for multi-group categorical variables, and Spearman's rank correlation coefficient (rs) to evaluate the relationship between continuous age and stigma.

Multivariable binary logistic regression was performed using the dichotomized stigma status as the dependent outcome. To prevent selective reporting bias and fully account for confounding structures, all collected socio-demographic and clinical covariates were simultaneously entered into the regression model. Adjusted odds ratios (AORs) with their corresponding 95% CIs are presented.

Multicollinearity among the predictors was systematically evaluated using Variance Inflation Factors (VIF); VIF values strictly below 2.5 were considered indicative of acceptable, non-problematic collinearity. The overall calibration and goodness of fit of the logistic regression model were formally verified using the Hosmer–Lemeshow test. All statistical assessments were two-tailed, with significance established at a threshold of $p < .05$.

Ethical Considerations:

The study was reviewed and approved by an Institutional Ethics Committee. All procedures conformed to the ethical principles of the World Medical Association Declaration of Helsinki (2013). Written informed consent was obtained from every participant prior to data collection. Participant anonymity and data confidentiality were maintained throughout the study.

Results:

Sample Characteristics and Prevalence of Stigma:

The analytic cohort comprised 137 patients.

The mean total DSAS-2 stigma score across the entire sample was 46.02 9.32 (range: 25–81). Evaluation of the subscale scores revealed that the highest proportional endorsement occurred within the Blame and Judgment domain (M = 18.24, SD = 4.11), followed by Self-Stigma (M = 17.15, SD = 4.62), and Treated Differently (M = 10.63, SD = 2.44). The Shapiro–Wilk test verified that the distribution of total stigma scores was significantly non-normal ($W = 0.926$, $p < .001$).

Using the sample median as the threshold (see Measures), 49.64% of participants (95% CI [41.03%, 58.26%]) were classified as having high perceived stigma. Because this cut-off is derived from the sample, the proportion is close to 50% by construction and describes relative rather than absolute stigma levels. Descriptive details of the subgroups and the distribution of high stigma within each are presented in **Table 1.**

Bivariate Analysis:

Bivariate analyses revealed significant differences in stigma scores across several socio-demographic groups. Total perceived stigma scores differed significantly across sex ($W = 1549$, $p = .001$), religious affiliation ($W = 1446$, $p = .001$), educational background (= 16.53, df = 4, $p = .002$), occupational status (= 13.56, df = 5, $p = .019$), and disease duration groupings (= 9.63, df = 3, $p = .022$).

Conversely, no significant differences were observed for marital status (= 1.70, df = 2, $p = .426$), lifestyle addiction status (= 0.92, df = 1, $p = .338$), monthly income category (= 10.30, df = 7, $p = .172$), insulin usage ($W = 1640$, $p = .390$), or comorbid profiles ($W = 2122$, $p = .541$). Spearman's rank correlation indicated a significant inverse relationship between chronological age and perceived stigma scores ($r_s = -.285$, $p = .001$), showing that younger patients reported higher perceived stigma levels.

Table 1:Socio-Demographic Characteristics of Study Participants (N = 137)

Characteristic	n (%)	High Stigma, % (95% CI)
Sex		
Male	60 (43.8)	35 (24–48)
Female	77 (56.2)	61 (49–71)
Religion		
Hindu	87 (63.5)	41 (31–52)
Non-Hindu	50 (36.5)	64 (50–76)
Educational Status		
Illiterate/Primary	36 (26.3)	53 (37–68)
Secondary	63 (46.0)	63 (51–74)
Higher Secondary	15 (10.9)	20 (6–47)
Graduate	21 (15.3)	29 (13–51)
Postgraduate	2 (1.5)	—
Disease Duration		
< 10 years	65 (47.4)	45(33,57)
10–20 years	51 (37.2)	63(49,75)
20–30 years	13 (9.5)	46(22,72)
> 30 years	8 (5.8)	13(1.7,54)
Insulin Use		
Yes	37 (27.0)	54(38,69)
No	100 (73.0)	48(38,58)
Any Comorbidity		
Yes	81 (59.1)	51(39,61)
No	56 (40.9)	48(35,61)
Total Stigma Score: M (SD)	46.02 (9.32)	—

Note. 95% CIs were estimated using the Wilson score method. High stigma is defined as a total DSAS-2 score sample median (46). Dashes (—) signify sub-cohorts where n < 15, rendering localized percentage estimates statistically u

Table 2: Bivariate Analysis: Differences in Total Stigma Scores Across Socio-Demographic Variables

Variable	Test Statistic	df	p-value	Significance
Sex	W = 1549	—	0.001	**
Religion	W = 1446	—	0.001	**
Educational Status	χ^2 = 16.53	4	0.002	**
Occupational Status	χ^2 = 13.56	5	0.019	*
Disease Duration	χ^2 = 9.63	3	0.022	*
Marital Status	χ^2 = 1.70	2	0.426	ns
Addiction Status	χ^2 = 0.92	1	0.338	ns
Income Category	χ^2 = 10.30	7	0.172	ns
Age (Spearman)	rs = − .285	—	0.001	**

Note. W denotes the Wilcoxon rank-sum test; represents the Kruskal–Wallis H test; rs denotes Spearman's rank correlation coefficient. ns = not significant (p .05); * p < .05; ** p < .01.

Multivariable Logistic Regression Analysis:

To establish independent predictors, a simultaneous multivariable binary logistic regression model was constructed. Diagnostic evaluation yielded mean VIF values of 1.34 (all individual VIFs < 1.90), confirming the absence of problematic multicollinearity. The Hosmer–Lemeshow goodness-of-fit test confirmed that the model was well-calibrated ((8) = 6.42, p = .599$).

After controlling for all socio-demographic and clinical characteristics, disease duration remained the sole independent predictor of high perceived stigma. Patients within the 10–20 year disease duration category exhibited more than three times higher odds of experiencing elevated stigma compared to individuals diagnosed for less than 10 years (Reference) (AOR = 3.13, 95% CI [1.08, 9.10], p = .036).

Higher secondary educational attainment demonstrated a borderline protective association (AOR = 0.13, 95% CI [0.02, 1.01], p = .050). Variables that displayed highly prominent associations in the bivariate tests—including sex, religion, and age—failed to maintain statistical significance within the fully adjusted model (p > .05), suggesting confounding among these variables. Full model outputs are presented in **Table 3.**

Discussion:

The present study estimated the proportion of participants with high perceived stigma and identified socio-demographic correlates of perceived stigma among 137 persons with diabetes in South 24 Parganas, West Bengal—one of the few studies to examine these questions in India using a validated, diabetes-specific instrument (DSAS-2) and multivariable regression methodology.

Table 3: Multivariable Binary Logistic Regression: Independent Predictors of Perceived Stigma (N = 137)

Variable	AOR	95% CI	p-value	Sig.
Disease Duration (ref: < 10 years)				
10-20 years	3.13	[1.08, 9.10]	0.036	*
20-30 years	1.81	[0.41, 8.06]	0.434	ns
> 30 years	1.27	[0.19, 8.42]	0.807	ns
Educational Status (ref: Category 1)				
Category 2 (Secondary)	1.64	[0.72, 3.75]	0.236	ns
Category 3 (Higher Secondary)	0.13	[0.02, 1.01]	0.05	†
Category 4 (Graduate)	0.51	[0.13, 1.96]	0.326	ns
Sex (ref: Male)	1.88	[0.84, 4.20]	0.124	ns
Religion (ref: Hindu)	2.15	[0.88, 5.24]	0.092	ns
Age (per year)	0.98	[0.94, 1.02]	0.309	ns

Note. AOR = adjusted odds ratio; CI = confidence interval. The model simultaneously incorporates all tabulated predictors to obtain adjusted estimates. ns = not significant (p .05); † borderline significance (p = .050); * p < .05.

Approximately half of the participants (49.64%) were classified as having high perceived stigma relative to the sample median, and disease duration emerged as the sole independent predictor after full socio-demographic adjustment.

Proportion With High Perceived Stigma:

Because high stigma was defined relative to the sample median, the observed proportion of 49.64% reflects the cut-off rather than an absolute prevalence, and it cannot be compared directly with estimates based on other instruments or thresholds. For context, a large online survey in the United States found that 52% of respondents with type 2 diabetes reported diabetes-related stigma [7], and an international consensus statement concluded that, on average, four in five adults with diabetes experience diabetes stigma [8]. Reported proportions vary widely according to the instrument and thresholds used [7,20]. The mean score observed here suggests that perceived stigma is a relevant concern among persons with diabetes in this setting, which

may reflect specific socio-cultural dynamics, including the attribution of diabetes to lifestyle 'indulgence' and the intersection of chronic illness with caste, religion, and socioeconomic disadvantage in this region [6,9].

It is also notable that the mean DSAS-2 score in this sample (46.02 9.32) is comparable to that reported in a Turkish cross-sectional study (46.56 14.44) [21] and lower than that reported in a Chinese working-age sample (56.14 8.05) [22], despite contextual and instrument variations. These comparisons suggest that the overall severity of perceived stigma observed here lies within the range reported for other outpatient diabetic populations. Subscale evaluations reinforce this view, as the high scores in Blame and Judgment underscore how heavily patients perceive external moral condemnation regarding self-care and disease etiology.

Sex Differences in Stigma:

Female participants demonstrated a substantially higher proportion of high stigma (61%) than males (35%), with a statistically significant bivariate difference (W = 1549, p = .001). This finding replicates patterns documented by Browne et al. [5], who identified female sex as a significant predictor of higher stigma, and by Liu et al. [7], who reported higher stigma-related distress in women with diabetes across multiple national samples. From a theoretical perspective, social role theory [10] suggests that women in many cultural contexts face stricter normative expectations regarding dietary conduct, body image, and self-care performance; perceived deviations from these norms generate disproportionate blame attributions. In the Indian context, the domestic labor burden and reduced agency in healthcare decision-making faced by many women may further amplify stigma vulnerability. That sex did not retain significance after multivariable adjustment suggests that its crude association with stigma is partly mediated by educational and occupational variables that are themselves strongly patterned by gender.

Age and Stigma:

The inverse correlation between age and stigma score (rs = – .285, p = .001) is consistent with findings by Liu et al. [7], who reported that younger adults with diabetes face heightened concerns about social acceptance, employment discrimination, and romantic relationship implications of their diagnosis. Older adults may develop greater equanimity and reduced identity threat through accumulated illness experience, desensitization to stigmatizing interactions, and the establishment of illness-incorporating social narratives [3,4]. Alternatively, cohort effects may operate: younger generations may have higher awareness of diabetes stigma as a concept and thus greater sensitivity to its occurrence. Sińska et al. [23] similarly reported that perceived stigma decreased with age among adults with type 1 diabetes.

Religion and Socioeconomic Correlates:

Participants from non-Hindu religious backgrounds demonstrated a markedly higher proportion of high stigma (64%) than Hindu participants (41%), with a significant bivariate difference (W = 1446, p = .001). This pattern is consistent with conceptual frameworks emphasizing how minority religious identity intersects with chronic illness to produce compound stigma—both disease-related and identity-related—reducing access to social support and increasing psychological vulnerability [12,13]. In India, religious minority communities frequently experience material disadvantage and reduced access to quality healthcare, which may reinforce rather than alleviate disease-related stigma. However, the attenuation of this association after multivariable adjustment—though religion showed a trend toward significance (AOR = 2.15, p = .092) —suggests substantial confounding by socioeconomic iables.

Similarly, the significant bivariate associations of educational status and occupational status with stigma are interpretable through the lens of fundamental cause theory [11], which posits that socioeconomic resources shape access to information, coping capital, and structural protections against stigmatizing attributions. The borderline protective association of higher secondary education (AOR = 0.13, p = .050) in the adjusted model—while not definitive at conventional thresholds —is theoretically consistent with health literacy acting as a buffer against internalized stigma [20].

Disease Duration as the Dominant Independent Predictor:

The most substantively significant finding of this study is that a disease duration of 10–20 years was the sole independent predictor of high stigma after full multivariable adjustment (AOR = 3.13, 95% CI [1.08, 9.10], p = .036). This finding extends emerging evidence on the temporal dynamics of chronic illness stigma. Footh et al. [14] proposed that stigma may peak during the early-to-middle years of chronic disease, when the diagnosis has been sufficiently integrated into social identity to generate stigmatizing interactions, yet has not been fully normalized through prolonged illness experience and adaptive coping.

The 10–20 year window in diabetes may correspond to several clinically significant transitions: the escalation of pharmacotherapy (including insulin initiation in some patients), increasing comorbidity burden, and progressive social disclosure of the disease, each of which may heighten social visibility and invite judgment. The absence of significant associations for longer duration categories (20–30 years: AOR = 1.81, p = .434; > 30 years: AOR = 1.27, p = .807) is consistent with stigma attenuation through illness chronicity —possibly via desensitization, social network adaptation, or the development of a consolidated illness identity that incorporates rather than resists the diabetic diagnosis. It should be noted, however, that the small cell sizes for these longer-duration groups (n = 13 and n = 8, respectively) substantially limit statistical power for these comparisons, and these observed null findings should be interpreted with caution. Future longitudinal research with larger samples is needed to disentangle the mechanisms underlying this temporal pattern.

Methodological Considerations:

The loss of significance for several bivariate predictors—notably sex, age, and religion—after multivariable adjustment is expected and reflects the complex collinearity among socio-demographic variables in epidemiological data. Post-estimation diagnostics showed that severe multicollinearity did not destabilize the model's parameters (all VIF < 1.90). The use of a dichotomized outcome for logistic regression, while useful for establishing a clear prevalence boundary, may have reduced statistical power relative to a continuous approach and may have obscured weaker independent associations. In addition, because the cut-off was derived from the sample median, the high-stigma classification is relative rather than clinically defined, and the proportion classified as high stigma should not be interpreted as an absolute prevalence or compared directly with estimates based on other thresholds [17,18]. Wide confidence intervals for some odds ratio estimates reflect sparse data in certain socio-demographic subcategories—a known limitation of cross-sectional studies with moderate sample sizes—and preclude definitive conclusions about those specific predictors.

Several limitations should be acknowledged. First, the cross-sectional design precludes causal inference; temporal relationships between variables cannot be firmly established. Second, the moderate sample size (N = 137), though exceeding the a priori calculation, limits power for detecting weak independent

associations among highly stratified subcategories. Third, stigma was assessed through self-report in face-to-face interview settings, which may introduce social desirability bias and lead to underreporting. Fourth, the single-facility design and geographic restriction to South 24 Parganas limits the generalizability of findings to broader Indian populations. Fifth, important psychosocial and clinical covariates—including depression, anxiety, objective social support scales, self-efficacy, and HbA1c values—were not captured, precluding assessment of their confounding or mediating roles.

Conclusion:

The findings indicate that perceived stigma in diabetes is socially patterned and psycho-demographically mediated. Demographic variables not only represent population characteristics but also shape psychological vulnerability, self-concept, and illness-related social identity.

This study provides empirical evidence that a substantial proportion of persons with diabetes in West Bengal, India, report relatively high perceived stigma (approximately one in two participants scored at or above the sample median). While multiple socio-demographic factors—including sex, age, religion, educational status, and occupational status—were significantly associated with stigma in bivariate analyses, disease duration category emerged as the sole robust independent predictor after multivariable adjustment. Individuals in the 10–20 year disease duration window faced more than three times the odds of high perceived stigma compared to those with shorter disease duration, representing a critical psychosocial risk period.

These findings carry meaningful implications for clinical practice and public health. Healthcare providers, particularly those managing patients in the early-to-middle stages of diabetes, should proactively screen for perceived stigma using validated instruments such as the DSAS-2 and refer affected individuals to appropriate psychosocial support. Community-level stigma-reduction campaigns targeting lay misconceptions about diabetes causation, insulin use, and behavioral blame—particularly in minority religious communities and among women—are warranted. Integration of brief, evidence-based psychosocial counseling modules addressing stigma into existing diabetes care programs, including peer support models and culturally adapted patient education, could meaningfully reduce the psychosocial burden of the disease in this setting. Future research should employ longitudinal designs with larger, multi-site samples and validated stigma instruments to map the temporal trajectory of stigma across the disease course, investigate the mechanisms by which disease duration amplifies stigma risk, and evaluate the effectiveness of stigma-reduction interventions in the Indian context.

Declaration of generative AI in scientific writing: Generative AI tools (Gemini, Google) were used for the purpose of enhancing readability and refining language, particularly structural refinement of the discussion section, and for English-language editing of the whole manuscript. No AI technologies were used to generate primary data, produce scientific interpretations, originate clinical insights, or conduct the literature search and appraisal. The last author verified all AI-assisted outputs for accuracy and clinical relevance, and all authors reviewed and approved the final manuscript.

Author Note:

The authors declare no conflicts of interest. This study was approved by an Institutional Ethics Committee and conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent prior to data collection.

Acknowledgement: This research work is supported by 'Ila Majumder Memorial Research Grant' provided by the DIABETES AWARENESS & YOU (DAY) during 2024–25 vide Research Grant Sanction No. DAY/ADMN/236/2024–25 dated 8th September, 2024. We thank Ms Adrita Sanyal, MSc Nutrition & CDE, Diabetes Educator of DAY for helping in data collection and Mr. Indrajit Majumder, Secretary of DIABETES AWARENESS & YOU (DAY) for his continuous support.

References:

1. International Diabetes Federation. IDF diabetes atlas. 10th ed. Brussels: International Diabetes Federation; 2021. Available from: https://www.diabetesatlas.org
2. World Health Organization. Diabetes [Internet]. Geneva: World Health Organization; 2022 [cited 2026 Nov 9]. Available from: https://www.who.int/news-room/fact-sheets/detail/diabetes
3. Goffman E. Stigma: notes on the management of spoiled identity. Englewood Cliffs (NJ): Prentice-Hall; 1963.
4. Corrigan PW, Watson AC. Understanding the impact of stigma on people with mental illness. World Psychiatry. 2002;1(1):16-20.
5. Browne JL, Ventura A, Mosely K, Speight J. 'I call it the blame and shame disease': a qualitative study about perceptions of social stigma surrounding type 2 diabetes. BMJ Open. 2013;3(11):e003384. doi:10.1136/bmjopen-2013-003384
6. Schabert J, Browne JL, Mosely K, Speight J. Social stigma in diabetes: a framework to understand a growing problem for an increasing epidemic. Patient. 2013;6(1):1-10. doi:10.1007/s40271-012-0001-0
7. Liu NF, Brown AS, Folias AE, Younge MF, Guzman SJ, Close KL, et al. Stigma in people with type 1 or type 2 diabetes. Clin Diabetes. 2017;35(1):27-34. doi:10.2337/cd16-0020
8. Speight J, Holmes-Truscott E, Garza M, Scibilia R, Wagner S, Kato A, et al. Bringing an end to diabetes stigma and discrimination: an international consensus statement on evidence and recommendations. Lancet Diabetes Endocrinol. 2024;12(1):61-82. doi:10.1016/S2213-8587(23)00347-9
9. Kudale AM, Ghawat MD, Gopale AV, Phutane MS, Joseph S. Cultural aspects of type-2 diabetes-related social stigma: a cultural epidemiological study among general community members in urban Pune, India. Indian J Community Med. 2025;50(1):234-41. doi:10.4103/ijcm.ijcm_894_22
10. Eagly AH, Wood W. The origins of sex differences in human behavior: evolved dispositions versus social roles. Am Psychol. 1999;54(6):408-23. doi:10.1037/0003-066X.54.6.408
11. Link BG, Phelan JC. Social conditions as fundamental causes of disease. J Health Soc Behav. 1995;35(Extra Issue):80-94. doi:10.2307/2626958
12. Link BG, Phelan JC. Conceptualizing stigma. Annu Rev Sociol. 2001;27:363-85. doi:10.1146/annurev.soc.27.1.363
13. Kleinman A. The illness narratives: suffering, healing, and the human condition. New York: Basic Books; 1988.
14. Footh K, Browne JL, Speight J. The role of illness duration and management complexity in diabetes stigma: a mixed methods study. Diabet Med. 2019;36(4):456-63.
15. Browne JL, Ventura A, Mosely K, Speight J. Measuring the stigma surrounding type 2 diabetes: development and validation of the Type 2 Diabetes Stigma Assessment Scale (DSAS-2). Diabetes Care. 2016;39(12):2141-8. doi:10.2337/dc16-0117
16. Rothman KJ, Greenland S, Lash TL. Modern epidemiology. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2008.
17. Eitel KB, Pihoker C, Barrett CE, Roberts AJ. Diabetes stigma and clinical outcomes: an international review. J Endocr Soc. 2024;8(9):bvae136. doi:10.1210/jendso/bvae136
18. MacCallum RC, Zhang S, Preacher KJ, Rucker DD. On the practice of dichotomization of quantitative variables. Psychol Methods. 2002;7(1):19-40. doi:10.1037/1082-989X.7.1.19
19. R Core Team. R: a language and environment for statistical computing [Internet]. Version 4.3.0. Vienna: R Foundation for Statistical Computing; 2023 [cited 2026 Nov 9]. Available from: https://www.R-project.org/
20. Subramaniam M, Abdin E, Bhuvaneswari S, AshaRani PV, Devi F, Roystonn K, et al. Prevalence and correlates of social stigma toward diabetes: results from a nationwide survey in Singapore. Front Psychol. 2021;12:692573. doi:10.3389/fpsyg.2021.692573
21. Inkaya B, Karadag E. Turkish validity and reliability study of Type 2 Diabetes Stigma Assessment Scale. Turk J Med Sci. 2021;51(3):1302-6.
22. Sińska BI, Kucharska A, Panczyk M, Matejko B, Traczyk I, Harton A, et al. Identification of sociodemographic and clinical factors influencing the feeling of stigmatization in people with type 1 diabetes. Healthcare (Basel). 2023;11(15):2185. doi:10.3390/healthcare11152185

Review Article: Humanities and Cultural Studies

Dietary Diversification and the Changing Burden of Metabolic Disorders in West Bengal: A Century-Long Perspective

Sonali Giri[1], Sukanta Bhunia[2], Dr. Suprakash Pradhan[3], Dr. Amit Kumar Jana[4]

[1]M. Sc. in Food and Nutrition, Department of Home science, University of Calcutta. [2] Community Nutritionist, Nurture Nutrition Solution, NAWT. [3]SACT-1, Department of Nutrition, Prabhat Kumar College (Affiliated to Vidyasagar University, Contai, PurbaMedinipur, West Bengal-721401. [4]SACT-1, Department of Nutrition (UG & PG), Debra Thana SahidKshudiramSmritiMahavidyalaya (Autonomous)

Author for Correspondence: Sonali Giri, Email: girisonali204@gmail.com, Mobile: +918972011694

Received on: 18.08.2026 **Revived Manuscript Received:** 07.11.2026 **Accepted on:** 08.11.2026

ABSTRACT: Dietary diversification is a key determinant of nutritional adequacy, as different food groups provide complementary essential nutrients. Over the past century, West Bengal has experienced substantial changes in dietary patterns, shaped by ecology, agriculture, food availability, migration, urbanization, economic development, and evolving food markets. This paper reviews the historical evolution of dietary diversification in West Bengal, with particular emphasis on the consumption of cereals, pulses, vegetables, fruits, milk and milk products, eggs, fish, and meat. Rice has remained the principal staple, while fish, pulses, vegetables, and seasonal foods have traditionally contributed to dietary variety. Major historical events, including the Bengal Famine of 1943 and the Partition of Bengal in 1947, profoundly influenced food availability, food security, and culinary practices. During the latter half of the twentieth century, agricultural development, improved market access, urbanization, and economic growth increased the availability and consumption of wheat-based foods, dairy products, poultry, fruits, vegetables, and commercially processed foods. Contemporary dietary patterns are consequently more heterogeneous, reflecting both nutritional opportunities and emerging challenges. Evidence from NFHS-5 indicates relatively frequent consumption of leafy vegetables and pulses, while consumption of fruits and milk or curd remains comparatively less regular among women aged 15–49 years. The changing dietary landscape also parallels the growing burden of obesity, type 2 diabetes, hypertension, dyslipidemia, and cardiovascular diseases. Overall, promoting affordable, diverse, culturally appropriate, and nutritionally balanced diets, while preserving beneficial traditional food practices, is essential for improving population nutrition and addressing the evolving burden of metabolic disorders in West Bengal.

Keywords: Dietary diversification; West Bengal; Dietary patterns; Food habits; Nutritional transition; Food security; Dietary diversity; Metabolic disorders.

1.Introduction

Dietary diversification refers to the inclusion of a variety of foods from different food groups in the usual diet. A diverse diet is important because no single food can provide all essential nutrients in adequate amounts. Consumption of cereals, pulses, vegetables, fruits, milk and milk products, eggs, fish, meat, nuts and seeds in appropriate combinations can improve the overall nutrient quality of the diet. In nutritional research, dietary diversity is therefore considered an important component of diet quality and micronutrient adequacy.

West Bengal provides an interesting setting for studying dietary diversification because food habits in the state have been shaped by its geography, agriculture, rivers, cultural practices, migration,urbanization and economic changes. Rice has historically remained the principal food of bengali, while fish, pulses, vegetables and mustard oil have formed important components of traditional Bengali meals. Historical evidence also indicates that food and cooking practices in Bengal were closely connected with cultural identity and social life, particularly during the late nineteenth and early twentieth centuries.

The traditional Bengali diet cannot, however,

be described simply as a rice-and-fish diet. Different varieties of leafy vegetables, roots and tubers, pulses, seasonal fruits, fish, eggs, milk products and other locally available foods have contributed to dietary variety. The availability of these foods has differed according to season, geography, socioeconomic status and community. The food culture of Kolkata has developed through interactions with other regional and international cuisines, which gradually introduced new ingredients, cooking methods and snack foods.

The first half of the twentieth century was marked by considerable food insecurity and nutritional challenges. The Bengal famine of 1943 demonstrated the vulnerability of a rice-dominated food system to disruption. The Famine Inquiry Commission described the typical Bengali diet of that period as heavily dependent on rice and emphasized the importance of complementary foods such as fish, meat, eggs, pulses, milk, vegetables and fruits for improving the nutritional quality of the diet . Thus, the history of dietary diversification in Bengal is also closely connected with the history of food availability and food security.

The Partition of Bengal in 1947 brought another major change. Large-scale migration altered household composition, food availability and culinary practices. Refugee communities carried their traditional recipes and food preferences to West Bengal while simultaneously adapting them to the ingredients and markets available in their new surroundings. Food consequently became both a means of maintaining cultural identity and a field of adaptation.

During the later twentieth century, improvements in agricultural production, expansion of markets, urbanization increasing incomes and changes in occupational patterns gradually modified food choices. Rice continued to dominate the staple diet, but wheat-based foods, commercially prepared snacks, dairy products, poultry, eggs and a wider range of vegetables and fruits became increasingly available, particularly in urban areas. Agricultural diversification has also received increasing attention in West Bengal, with initiatives encouraging pulses, oilseeds, vegetables and other crops alongside rice-based systems.

Recent research shows that West Bengal still has a strong cereal-based dietary pattern, but considerable diversity exists within meals. Studies of food choice in eastern India have identified combinations of rice, pulses, vegetables and non-vegetarian foods such as fish, egg, chicken and meat, with lunch and dinner generally showing greater food-group diversity than breakfast and snacks . At the same time, diversity does not necessarily mean nutritional adequacy. Certain population groups continue to have limited access to fruits, dairy products and other nutrient-rich foods.

The NFHS-5 data for West Bengal provide an important picture of recent dietary practices. Among women aged 25-45 years 77.0% reported consuming dark green leafy vegetables daily, while 48.7% consumed pulses or beans daily. In contrast, only 9.6% consumed fruits daily and 22.6% consumed milk or curd daily. Fish and eggs were commonly consumed weekly, but daily consumption was considerably lower . These findings indicate that although dietary variety is present, the frequency and regularity of consumption of individual food groups remain uneven.

Therefore, the dietary history of West Bengal over approximately the last century represents a transition from a predominantly traditional, locally dependent food system towards a more commercially connected and heterogeneous dietary environment. However, this transition has not been uniform. Traditional foods continue to coexist with modern, processed and convenience foods, while differences between

socioeconomic groups remain important.

1. Aims and Objective:

·To study the evolution of dietary diversification in West Bengal over approximately the last 100 years and to examine its major nutritional, socioeconomic and environmental determinants.

·To describe the traditional dietary pattern of West Bengal during the early twentieth century.

·To examine changes in the consumption of major food groups over the study period.

·To assess changes in the contribution of cereals, pulses, vegetables, fruits, fish, meat, eggs and milk to the diet.

·To examine the transition from a predominantly rice-based dietary pattern towards a more diversified dietary pattern.

·To identify the influence of agricultural development and food availability on dietary diversification.

3.Methodology:

3.1 Study Design:

The present study was designed as a narrative review of the historical and contemporary changes in dietary diversification in West Bengal over approximately the last 100 years. The review focused on changes in food availability, dietary patterns, consumption of major food groups, agricultural practices, socioeconomic conditions and the emerging nutritional transition in the state.

3.2 Scope of the Review:

The review covered major food groups commonly consumed in West Bengal, including cereals, pulses, vegetables, fruits, milk and milk products, eggs, fish and meat. Particular attention was given to the continuing importance of rice as a staple food and the changing contribution of complementary food groups to dietary diversity.

The historical component considered important periods and events that influenced food systems and dietary practices, particularly the Bengal Famine of 1943 and the Partition of Bengal in 1947. The review also examined subsequent changes associated with agricultural development, urbanization, migration, market expansion, improved food availability and changing socioeconomic conditions.

3.3 Sources of Information:

Information was compiled from published research articles, historical documents, government reports, nutrition surveys, agricultural sources and relevant scientific literature concerning West Bengal's food and nutrition environment.

The Famine Inquiry Commission Report on Bengal was considered for understanding food availability and dietary conditions during the 1940. Contemporary dietary information was examined using findings from the National Family Health Survey-5 (NFHS-5), 2019–21, particularly information relating to the frequency of consumption of selected food groups among women aged 25 – 45 years in West Bengal.

Published studies concerning food choice, dietary diversity, food security, nutritional status, child feeding practices, elderly nutrition and dietary patterns among different population groups in West Bengal were also considered. Agricultural literature was reviewed to understand the relationship between crop diversification, food availability and dietary diversity.

3.4 Data and Evidence Considered:

The review considered both qualitative and quantitative evidence. Historical evidence was used to describe changes in food systems and dietary practices, while contemporary survey findings were used to assess the frequency and distribution of consumption of selected food groups.

NFHS-5 data included in the manuscript were used to describe the reported consumption of milk or curd, pulses or beans, dark green leafy

vegetables, fruits, eggs, fish and chicken/meat among women aged 25-45 years West Bengal. The review also considered evidence concerning differences in dietary practices according to socioeconomic conditions, geographical location and population characteristics.

3.5 Analytical Approach:

The available evidence was organized chronologically and thematically. The historical evidence was examined to identify major factors influencing dietary patterns, while contemporary evidence was compared across food groups and population groups.

The analysis focused on the relationship between food availability, agricultural production, socioeconomic conditions, cultural practices, urbanization and dietary diversification. Particular attention was given to the distinction between increased food variety and actual improvement in dietary quality.

The evidence was subsequently synthesized to describe the broad transition from a predominantly rice-centertraditional food system towards a more heterogeneous dietary environment. The potential nutritional benefits and challenges associated with this transition were also considered.

4. Results:

4.1 Traditional dietary pattern of West Bengal:

The dietary pattern of Bengal historically developed in close relationship with its ecological environment. Rivers, wetlands, fertile agricultural land and seasonal availability of vegetables and fruits contributed to a varied food culture. Rice became the major staple, while fish became an important source of animal protein. Pulses, leafy vegetables, roots, tubers, seasonal vegetables and fruits complemented the staple cereal.

Historical studies of Bengal indicate that food was not simply a physiological requirement but also carried strong social and cultural meanings. Cooking and eating practices became connected with ideas of household identity, social status and cultural belonging during the colonial period.

The traditional meal structure could therefore provide considerable food-group diversity even though the quantity and frequency of individual foods varied among households. A typical traditional meal could include rice, leafy or other vegetables, dal, fish or egg, and chutney or seasonal fruit. This combination provided different sources of carbohydrate, protein, fat, fibre, vitamins and minerals. However, the presence of several food items in a meal should not automatically be interpreted as adequate dietary diversity. Poor households could consume several dishes in small quantities while still receiving a diet dominated by cereals.

4.2 Rice dominance and the importance of complementary foods:

Rice has remained central to the food culture of West Bengal. The historical importance of rice was particularly evident during the Bengal famine of 1943. The Famine Inquiry Commission reported that rice could contribute approximately 80–90% of total calories in typical Bengali diets at that time.

This dependence created a nutritional vulnerability because a cereal-dominated diet requires adequate complementary foods to supply nutrients that may be limited in cereals. The Commission specifically[K1] recognized the importance of fish, meat, eggs, pulses, milk, vegetables and fruits as supplementary or “protective” foods .Thus, one important theme emerging from the last century is that dietary diversification has been necessary not only for cultural variety but also for nutritional adequacy.

4.3 Bengal famine and disruption of dietary diversity:

The Bengal famine of 1943 represents one of the

most severe disruptions to the food system of Bengal. Food availability was affected by several interacting factors, including disruption of rice imports from Burma, wartime conditions, crop problems, market disturbances and failures in food distribution .

The crisis was not simply a reduction in the amount of food available. It also affected the ability of poorer households to obtain different types of food. Historical evidence indicates shortages not only of rice but also of wheat, pulses, mustard, sugar and salt . The famine therefore demonstrated that a nutritionally adequate diet depends upon adequate food production, stable markets, purchasing power, distribution systems and access to diverse food groups.

4.4 Partition of Bengal and transformation of food culture:

The Partition of Bengal in 1947 caused large-scale population movement. Refugees arriving in West Bengal brought food traditions, cooking methods and preferences from their former homes. At the same time, they had to adapt to the availability and affordability of ingredients in their new surroundings.

Food consequently became a mechanism for maintaining cultural identity. Research on the food history of Partition describes rice, fish, vegetables and sweets as important elements of culinary memory among displaced Bengali communities . At the same time, migration contributed to diversification. New food combinations, ingredients and cooking practices entered households and markets. The distinction between traditional and modern food therefore became increasingly fluid.

4.5 Urbanization and changing food choices:

Urbanization has been one of the important drivers of dietary change in West Bengal. Kolkata, in particular, has historically acted as a centre of cultural and culinary exchange. Research on eastern India has shown that foods originating outside the traditional Bengali repertoire became incorporated into everyday urban food practices.

Modern urban diets increasingly include wheat-based foods, bread, noodles, biscuits, packaged snacks, fast foods, restaurant foods, poultry, dairy products and a wider variety of vegetables and fruits. This has increased the number of foods available, but availability and nutritional quality are not necessarily equivalent.

4.6 Agricultural diversification and its relationship with dietary diversity:

Agriculture plays an important role in determining the availability and affordability of food. West Bengal remains strongly associated with rice cultivation, while potato, mustard, pulses and horticultural crops are also important agricultural commodities .

Recent agricultural initiatives in the state have promoted crop diversification, particularly in rice-fallow areas. ICAR programmes have encouraged the cultivation of pulses, oilseeds and vegetables alongside rice-based systems. This has nutritional significance because agricultural diversification can potentially improve the availability of pulses and legumes, vegetables, oilseeds, fruits and other nutrient-rich foods.

However, increased production of a crop does not automatically guarantee increased consumption of that food by producing households. Market prices, household income, cultural preferences and whether the crop is sold or consumed at home all influence dietary outcomes.

4.7 Dietary diversity in contemporary West Bengal:

Recent research provides a more detailed picture of present-day food habits. A study examining food choices in low- and middle-income households in West Bengal found that rice remained an important component of lunch and dinner. These meals frequently combined rice with pulses, vegetables and non-vegetarian dishes. Fish, egg, chicken and mutton were

among the animal-source foods reported in daily meal patterns .

The same research identified substantial variation according to eating occasion. Lunch and dinner were generally more diverse than breakfast and snack occasions. Breakfasts often contained starch-based foods such as muri, potato-based preparations or wheat-based snacks, while fruits and other nutrient-rich foods were less consistently represented . This suggests that dietary diversification in West Bengal has not occurred equally across the entire day.

4.8 Current food-group consumption among women:

NFHS-5 provides useful recent information on the frequency of consumption of selected food groups among women aged 25-45 years in West Bengal. Green leafy vegetables and pulses are consumed relatively frequently, while fruits and milk/curd are consumed less regularly. Fish and eggs are relatively common but are predominantly consumed on a weekly rather than daily basis . Thus, the present dietary pattern can be described as diverse but unevenly distributed across food groups.

4.9 Rural–urban and socioeconomic differences:

Dietary diversification is not uniform throughout West Bengal. Income, education, occupation, market accessibility and geographical location influence food choice. Research conducted among women in a slum area of Hooghly found that approximately 90% of participants followed a non-vegetarian dietary pattern, while only 52.7% achieved adequate dietary diversity according to the Minimum Dietary Diversity for Women measure.

The same study found that cereals, pulses and animal-source foods were relatively common, whereas dairy products and fruits were consumed less frequently. This demonstrates that being non-vegetarian does not necessarily mean that the overall diet is sufficiently diverse.

Research among households in Bankura has similarly demonstrated an association between food security, nutrient adequacy and dietary diversity. Food-insecure households were more vulnerable to inadequate nutrient intake and poorer nutritional outcomes among children. Therefore, socioeconomic improvement is an important potential pathway through which dietary diversification can be achieved, but cultural and behavioural factors must also be considered.

4.10 Dietary diversification among children:

Childhood is a particularly important period for dietary diversification because nutritional requirements increase during growth. Research among Santal communities in Birbhum district showed that complementary feeding practices were heavily cereal-based. Rice and other cereals were common, while fruits, dairy products, eggs and meat were less consistently provided. Although vegetables and pulses were also consumed, the overall quantity of several food groups was below recommended levels.

This indicates that the transition from breastfeeding to family foods does not automatically produce a diverse diet. A child may receive sufficient quantity of cereal-based food but still have inadequate dietary diversity if foods such as pulses, vegetables, fruits, eggs, fish or dairy products are not regularly included.

4.11 Emerging influence of modern foods:

One major change during the later decades of the twentieth century and the beginning of the twenty-first century has been the increasing availability of commercially prepared foods. Urban and semi-urban populations now have easier access to packaged snacks, fried foods, bakery products, sweetened beverages, fast foods, instant foods and restaurant meals.

These foods have contributed to dietary diversification in terms of food choice but may also increase the intake of refined carbohydrates, added sugar, sodium and unhealthy fats when

consumed frequently. NFHS-5 reported that 18.4% of women aged 25-45 years in West Bengal consumed fried foods daily, while 44.1% consumed them weekly. Aerated drinks were consumed daily by 1.7% and weekly by 11.3%.

Therefore, the contemporary dietary transition has a dual character: greater food variety on one hand, but increasing exposure to energy-dense processed foods on the other.

4.12 Dietary diversity and nutritional outcomes:

Dietary diversity is important because different food groups contribute different nutrients. Diets dominated by cereals can provide substantial energy but may not provide adequate amounts of several micronutrients unless complemented by pulses, vegetables, fruits and animal-source foods.

A study among elderly people in Budge Budge II, West Bengal, found a mean dietary diversity score of 6.07 ± 0.65 and reported a positive relationship between greater dietary diversity and nutritional status. Similarly, research among women in West Bengal has identified dietary patterns characterized by vegetables, fruits and pulses as one distinct pattern, alongside patterns characterized by higher intakes of fats, refined grains, fish, sweets and high-fat foods. These findings indicate that the dietary transition cannot simply be described as traditional versus modern. Modern diets contain both potentially beneficial and potentially less desirable changes.

5. Discussion:

The present review indicates that dietary diversification in West Bengal has developed through a combination of historical, cultural, agricultural and socioeconomic changes. Rice has remained the principal staple, but traditional meals have generally included complementary foods such as pulses, vegetables, fish, eggs and seasonal foods. Thus, the traditional Bengali diet was not completely uniform, although the quantity and frequency of different food groups varied between households and socioeconomic groups.

Historical events played an important role in shaping dietary diversity. The Bengal famine of 1943 demonstrated the nutritional vulnerability associated with dependence on a cereal-dominated food system and highlighted the importance of complementary foods. The Partition of Bengal in 1947 further changed food practices through migration, cultural exchange and adaptation to new food environments.

During the later twentieth century, urbanization, improved transport, agricultural development and market expansion increased the availability of a wider range of foods. Contemporary diets therefore include traditional foods alongside wheat-based products, poultry, dairy foods, packaged snacks and fast foods. However, greater food availability does not always indicate better dietary quality.

Recent NFHS-5 findings also show that dietary diversity remains uneven. Leafy vegetables and pulses are consumed relatively frequently, whereas fruits and milk or curd are consumed less regularly. Studies among vulnerable groups further indicate differences related to food security, income and access to nutrient-rich foods.

Overall, West Bengal has moved towards a more heterogeneous dietary environment, but the transition is not uniform. Future nutrition strategies should promote affordable and regular consumption of diverse nutrient-rich foods while preserving beneficial traditional food practices and limiting excessive reliance on highly processed foods.

6. Summery and Conclusion:

The present study examined the evolution of dietary diversification in West Bengal and explored the historical, agricultural, socioeconomic and cultural factors influencing dietary patterns. Traditionally, rice formed the

major dietary component, complemented by pulses, vegetables, fish, eggs and seasonal foods. Over time, agricultural development, urbanization, economic changes, improved transportation and market expansion have contributed to greater food availability and dietary diversity.

The findings indicate that dietary diversification has not been uniform across all population groups, as socioeconomic conditions, geographical location and food accessibility continue to influence food choices. The increasing availability of processed foods also reflects the changing food environment.

In relation to the study objectives, the findings demonstrate that dietary change in West Bengal is closely linked with historical and socioeconomic transformation. However, increased dietary variety does not necessarily ensure better nutritional quality. Promoting affordable nutrient-rich foods, maintaining healthy traditional dietary practices, improving nutrition awareness and limiting excessive consumption of highly processed foods are therefore important for improving dietary quality and nutritional well-being in West Bengal.

Table 1. Frequency of Selected Food Consumption among Women Aged 25–45 Years in West Bengal, NFHS-5, 2019–21

Food group	Daily (%)	Weekly (%)	Occasionally (%)	Never (%)
Milk or curd	22.6	30.6	33.1	13.8
Pulses or beans	48.7	44.2	5.7	1.4
Dark green leafy vegetables	77	20.5	2.3	0.2
Fruits	9.6	34.6	51.4	4.4
Eggs	12.2	70.8	13.1	3.9
Fish	23.3	64.5	10.4	1.8
Chicken/meat	3.3	60.1	33.2	3.3

Source: NFHS-5, West Bengal, 2019–21 [8].

Table 2. Broad Historical Transition in Dietary Patterns

Period	Dominant characteristics	Major influences
Early 20th century	Rice-centred diet with fish, pulses, vegetables and seasonal foods	Local agriculture, ecology, culture
1940s	Severe disruption of food availability and dietary quality	Bengal famine, wartime conditions
1947–1970s	Traditional foods continued with new regional influences	Partition, migration, refugee settlement
1980s–1990s	Increasing market-based food choices	Urbanization, economic change, improved transport
2000s–2010s	Greater availability of poultry, dairy, fruits, vegetables and processed foods	Globalization, supermarkets, media, rising incomes
2020s	Highly heterogeneous dietary pattern	Urbanization, digital food markets, convenience foods, nutrition awareness

References:

1. Achaya KT. The Story of Our Food. Hyderabad: Universities Press; 2000.
2. Ashok S, Nguyen PH, Singh SK, Sarwal R, Bhatia N, Johnston R, et al. State Nutrition Profile: West Bengal. POSHAN Data Note 56. New Delhi: International Food Policy Research Institute; 2021.
3. Chatterjee S, Ray R. Changes in food consumption patterns and nutritional transition in India. Economic and Political Weekly. 2009.
4. Chattopadhyay B, Paul B, Bandyopadhyay L, Bhattacharyya M. Nutritional status and intra-household food distribution among reproductive-age-group women in a slum area of Hooghly District, West Bengal: A mixed-methods approach. Cureus. 2022;14(4):e24225.
5. Custodio MC, Ynion J, Samaddar A, Cuevas RP, Mohanty SK, Ray Chakravarti A, Demont M. Unraveling heterogeneity of consumers' foodchoice: Implications for nutrition interventions in eastern India. Global Food Security. 2021;28:100497.
6. Custodio MC, Ynion J, Samaddar A, Cuevas RP, Mohanty SK, Ray Chakravarti A, Demont M. Unraveling heterogeneity of consumers' food choice: Implications for nutrition interventions in eastern India. Global Food Security. 2021;28:100497.
7. De B. Imperial Governance and the Challenges of War: Management of Food Supplies in Bengal, 1943–44. Indian Economic and Social History Review. 2006.
8. De B. Imperial governance and the challenges of war: Management of food supplies in Bengal, 1943–44. Studies in History. 2006;22(1):1–43.
9. Dietary patterns and psychosocial health status among elderly in West Bengal, India. Journal of Dietary Supplements. 2024.
10. Dietary practices of children and adolescents residing in an area of Chakdaha Block, Nadia district, West Bengal. Journal of Family Medicine and Primary Care. 2024.
11. Famine Inquiry Commission. Report on Bengal. Government of India; 1945.
12. Famine Inquiry Commission. Report on Bengal. Government of India. New Delhi: Manager of Publications; 1945.
13. Ganguli D, Das N, Saha I, Biswas P, Datta S, Mukhopadhyay B, et al. Major dietary patterns and their associations with cardiovascular risk factors among women in West Bengal, India. British Journal of Nutrition. 2011;105(10):1520–1529.
14. Gupta K, Dutta S, Mandal M, Chakrabarti S, Bysack RK. Nutritional status and dietary diversity: A community-based assessment among elderly residents of Budge Budge II Block, West Bengal. International Journal of Applied & Basic Medical Research. 2025;15(2):109–115.
15. Huang J, Bouis HE. Structural changes in the demand for food in Asia: Empirical evidence from the Philippines. International Food Policy Research Institute; 1996.
16. ICAR-NBSS & LUP Regional Centre, Kolkata. ICAR-NBSS & LUP RC Kolkata launched Crop Diversification Project in Tribal Village of Jhargram, West Bengal. Kolkata: ICAR; 2023.
17. Indian Council of Agricultural Research. West Bengal: Crop diversification and agricultural development initiatives. ICAR.
18. International Institute for Population Sciences (IIPS). National Family Health Survey (NFHS-5), 2019–21: State Fact Sheet—West Bengal. Mumbai: IIPS; 2021.
19. International Institute for Population Sciences (IIPS). National Family Health Survey (NFHS-5), 2019–21: West Bengal. Ministry of Health and Family Welfare, Government of India.
20. Kisku D, Ghosh S. Crop diversity and farmers' livelihood in an agriculturally prosperous district of West Bengal. Indian Journal of Extension Education. 2017;53(1):15–20.
21. Kisku D, Ghosh S. Spatio-temporal variation in status of crop diversification and its impact on farming in West Bengal. Journal of Community Mobilization and Sustainable Development. 2016;11(1):29–38.
22. Major dietary patterns and their associations with cardiovascular risk factors among women in West Bengal, India. British Journal of Nutrition. 2011.
23. Maternal nutritional status and child feeding practices: A retrospective study in Santal communities, Birbhum District, West Bengal, India. BMC Nutrition. 2020.
24. Mottaleb KA, Rahut DB, Ali A. An overview of food consumption and dietary diversity in South Asia. Food Security. 2018.
25. Nutritional Status and Dietary Diversity: A Community-based Assessment among Elderly Residents of Budge Budge II Block, West Bengal. 2025.
26. Nutritional Status and Intra-household Food Distribution Among Reproductive-Age-Group Women in a Slum Area of Hooghly District, West Bengal: A Mixed-Methods Approach. Cureus. 2022.
27. Ray SK, Biswas AB, Kumar S. A study of dietary pattern, household food security and nutritional profile of under-five children of a community of West Bengal. Journal of Indian Medical Association. 2000;98(9):517–519, 522–523.
28. Saha B, Barik AK, Mandal N. Crop diversification for enhancing productivity, profitability and resource use efficiency of rice-based systems in red and lateritic soils of eastern region. Indian Journal of Agricultural Sciences. 2022;92(8):974–977.
29. Samaddar A, et al. Unraveling heterogeneity of consumers' food choice: Implications for nutrition interventions in eastern India. Food Security. 2021.
30. Sen A, Sarkar S, Ghosh S. Gastro-Political Archives of Partition: Bengal 1947–1971. Loreto College Journal of Humanities and Social Sciences. 2026.
31. Sen A, Sarkar S, Ghosh S. Gastro-political archives of Partition: Bengal 1947–1971. Loreto College Journal of Humanities and Social Sciences. 2026;2(1):154–165.
32. Sengupta J. Nation on a Platter: The Culture and Politics of Food and Cuisine in Colonial Bengal. Modern Asian Studies. 2010;44(1):81–98.
33. Stiller CK, Golembiewski SKE, Golembiewski M, Mondal S, Biesalski HK, Scherbaum V. Maternal nutritional status and child feeding practices: A retrospective study in Santal communities, Birbhum District, West Bengal, India. International Breastfeeding Journal. 2020;15:5•
34. Ynion J, et al. Capturing diversity and cultural drivers of food choice in eastern India. Global Food Security. 2020.
35. Ynion J, Samaddar A, Custodio MC, Cuevas RP, Mohanty SK, Ray Chakravarti A, et al. Expert elicitation database capturing diversity and cultural drivers of food choice and nutritional implications in eastern India. Data in Brief. 2020.
36. Ynion J, et al. Expert elicitation database capturing diversity and cultural drivers of food choice and nutritional implications in eastern India. Data in Brief. 2020.

Review Article: Humanities and Cultural Studies

Social Media Influence on Dietary Behaviour in Adolescents and Young Adults: An Umbrella Review

Arpita Mondal[1], Arnab Chatterjee[1]

[1]Department of Food & Nutrition, Asansol Girls' College, Asansol, India

Author for Correspondence: Arnab Chatterjee, Assistant Professor, Department of Food & Nutrition, Asansol Girls' College, Asansol, India, Email: arnabchatterjeenin@gmail.com, Mobile: +918801544129

Received on:19.09.2026 **Accepted on:** 30.10.2026

ABSTRACT: Adolescents and young adults are the most active users of social media and are therefore particularly exposed to its nutritional influences. This umbrella review synthesises systematic review evidence on how social media exposure and social media-delivered interventions affect dietary behaviour, food choices and disordered eating in people aged 13–35 years.

Systematic reviews and meta-analyses were searched for and quality-appraised. Seven reviews published between 2018 and 2025 were included, covering observational, mixed-methods, randomised controlled, neuroimaging and qualitative studies from Europe, North America, Asia and Australia.

Passive use, particularly exposure to food marketing, peer food content and fitspiration imagery, was consistently associated with higher intake of energy-dense, nutrient-poor foods, preference for fast food and sugar-sweetened beverages, and higher odds of disordered eating. One meta-analysis reported a non-significant pooled correlation of 0.35 with disordered eating, based on only two studies, and a significant correlation of 0.36 with poor sleep quality. Interventions built on behaviour-change theory, social support and personalised content produced mixed but generally favourable dietary effects.

Social media both drives unhealthy eating and offers a promising channel for dietary interventions in young people. Regulation of digital food marketing, media literacy education and longitudinal, platform-specific research are needed.

Keywords: Adolescent; Feeding behaviour; Advertising; Feeding and eating disorders; Body image; Health promotion

1.Introduction:

Adolescence and young adulthood, spanning approximately 13 to 35 years of age, are critical periods in which lifelong eating patterns and health trajectories are established. Diets in this age group are typically high in ultra-processed foods and low in fruits, vegetables and whole grains, contributing substantially to the global burden of obesity, type 2 diabetes and cardiovascular disease [1]. At the same time, social media has become integral to young people's daily lives. In many countries more than 90% of people aged 16–24 years use social media weekly, often for several hours a day, and platforms such as Instagram, YouTube, Facebook, Snapchat and Reddit achieve exceptionally high engagement in this age group [2].

Social media and eating behaviour intersect through two related processes. First, platforms carry food advertising, influencer content and peer-generated nutrition information that can shape food preferences, purchase decisions and eating habits, often without conscious awareness. Food companies have moved much of their marketing online and use algorithmic targeting to reach young audiences with advertisements for energy-dense, nutrient-poor products [3]. Second, nutrition and public health professionals have adopted social media as a channel for dietary interventions, health promotion campaigns and behaviour-change programmes, taking advantage of near-universal smartphone

use and the ways in which young people already engage with digital content [4,5].

Despite growing research interest, the evidence remains fragmented. Individual systematic reviews have examined food marketing and the social and physiological mechanisms of influence [3], the effectiveness of social media-based nutrition interventions [6–8] and the association between social media use and disordered eating [9]. To our knowledge, no overview has yet integrated these strands. An umbrella review is well placed to do so, identifying where the literature converges and diverges and highlighting priorities for further research.

The primary research question was: what does the body of systematic review evidence show about how social media affects the eating habits, food preferences and nutritional outcomes of adolescents and young adults? Secondary objectives were to (1) characterise the mechanisms through which social media influences diet; (2) assess the effectiveness of social media-based dietary interventions; (3) evaluate the association between social media use and disordered eating; and (4) identify methodological gaps in the existing review literature.

2. Methods:

2.1 Study Design:

An umbrella review, that is, a systematic review of existing systematic reviews and meta-analyses, was conducted. This approach provides a higher-level synthesis of the evidence and highlights patterns, convergence and divergence across separate bodies of literature. Reporting follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [10].

2.2 Eligibility Criteria:

Systematic reviews and meta-analyses were included if they (1) reported a clearly defined systematic search, including databases, search terms and eligibility criteria; (2) focused primarily on social media and its influence on dietary behaviour, nutritional outcomes, food consumption or eating-related behaviour; (3) included adolescents (13–19 years) and/or young adults (18–35 years); (4) were published in English in a peer-reviewed journal; and (5) were published from 2014 onwards, to reflect the current social media landscape. Narrative reviews, scoping reviews, protocols without data synthesis and reviews addressing physical activity without dietary outcomes were excluded.

2.3 Included Systematic Reviews:

Seven systematic reviews met the inclusion criteria after full-text screening [2,3,6–9,11]. Their populations, databases searched, numbers of primary studies and main areas of focus are summarised in Table 1.

2.4 Quality Appraisal and Synthesis:

The methodological quality of each review was assessed with AMSTAR-2 (A MeaSurement Tool to Assess systematic Reviews, version 2) [12], and risk of bias with the ROBIS (Risk Of Bias In Systematic reviews) tool [13]. These instruments evaluate the comprehensiveness of the search, independent duplicate screening, assessment of risk of bias in primary studies and transparency of reporting. Two reviewers completed the assessments independently and resolved disagreements by discussion. Findings were synthesised narratively and grouped into thematic domains.

3. Results:

3.1 Overview of the Evidence Base:

Together, the seven reviews covered a large body of primary research, including randomised controlled trials (RCTs), quasi-experimental studies, cross-sectional and longitudinal cohort studies, qualitative investigations, and neuroimaging studies using functional magnetic resonance imaging (fMRI) and eye-tracking. Primary studies were conducted in the United States, the United Kingdom, Australia, South

Korea, Spain, Poland, Turkey, Canada, Brazil, Vietnam, Iraq, Japan, the Netherlands and other European countries, so the evidence captures both cross-cultural variation and patterns that hold across settings. The reviews addressed two broad domains: (1) observational associations between social media exposure and dietary outcomes, including food preferences, consumption patterns, marketing effects and disordered eating; and (2) the effectiveness of social media as a channel for dietary behaviour-change interventions.

3.2 Social Media Exposure and Dietary Patterns

The observational literature presents a consistent picture: habitual social media use is associated with poorer eating habits. Three reviews reported that higher use was associated with greater consumption of fast food, sugar-sweetened beverages (SSBs), caffeinated drinks, high-fat and high-sugar snacks and instant noodles, and with lower consumption of fruits, vegetables and dairy products [2,3,9].

Cal-Herrera et al. also found that social media use was associated with restrictive patterns, including avoidance of new foods, fear of food expiry and meal skipping, particularly of breakfast [9]. In large samples of Korean adolescents, smartphone use for communication and social media was associated with higher odds of fast-food consumption (odds ratio [OR] 1.37 to 1.46 across sexes) and of SSB intake (OR 1.42 to 1.51) [9,14]. Exposure to online culinary content and eating shows was likewise associated with consumption of fast food and caffeinated beverages, and inversely with healthy food intake [15,16].

Moffitt and Thomas described several pathways through which social media affects diet quality: exposure to advertisements and influencer content promoting energy-dense foods; social comparison and body-image concerns that lead to restrictive or compensatory eating; normative modelling through peer-shared food content; and algorithmic amplification that disproportionately surfaces unhealthy food content [2]. The adverse outcomes most often reported were SSB consumption, preference for fast food and breakfast skipping.

Sina et al. added a neurobiological dimension [3]. Evidence from fMRI and eye-tracking studies showed that food images activate reward-related regions in children and adolescents, including the left precuneus, the left hippocampus and the right temporal and occipital cortex. Images of high-energy foods increased activity in the medial and dorsomedial prefrontal cortex, regions linked to reward and self-control, and reduced activity in the left hypothalamus, which regulates satiety. These responses may undermine self-regulated eating, particularly when young people are hungry or about to eat. Peer influence was the main social mechanism among adolescents, while celebrity and brand-sponsored content strongly influenced food preferences and brand recall.

3.3 Platform-Specific Effects on Dietary Behaviour:

Although the overall evidence links social media use with poorer dietary outcomes, the size and nature of the effects differ by platform, content type and individual susceptibility. Cal-Herrera et al. reported that heavy Facebook use was associated with disordered eating attitudes, Instagram use with more severe eating disorder symptoms, Snapchat use with later bedtimes and disrupted meal schedules, and TikTok use with lower well-being and greater bedtime procrastination, which may indirectly affect meal timing and food choice [9,17,18].

The same review emphasised that the content a user encounters matters more than the platform itself [9,19]. Exposure to culinary content, such as eating shows, “mukbang” videos, food-influencer channels and recipe-sharing sites, was strongly associated with

consumption of fast food and unhealthy drinks [15]. Content promoting balanced nutrition and physical activity could have a beneficial effect, but interventional evidence of such benefit remains limited.

Moffitt and Thomas noted that TikTok and YouTube are the most popular platforms among adolescents in the United States. Their autoplay algorithms and short-video formats generate disproportionately high engagement and foster parasocial relationships between users and food-content creators, which increases the persuasiveness of nutrition-related messages, whether healthy or unhealthy [2].

3.4 Social Media, Body Image and Disordered Eating:

The association between social media use and disordered eating was a recurring theme across the reviews. Several cross-sectional studies summarised by Cal-Herrera et al. found strong associations between social media use and an increased risk of meeting diagnostic criteria for an eating disorder [9,20]. Their meta-analysis estimated a pooled correlation of r = 0.35 (95% confidence interval [CI] −0.13 to 0.70) between social media use and indicators of disordered eating. This estimate was not statistically significant, probably because only two studies were eligible for quantitative synthesis; the association with poor sleep quality was more robust (r = 0.36, p = 0.005). Qualitatively, the direction of the association with disordered eating was consistent across populations and countries.

Moffitt and Thomas found that social media exposure promoted both binge eating, by normalising indulgent food content and eating challenges, and restrictive eating, through diet culture, thin-ideal imagery and "fitspiration" content [2]. Orthorexia nervosa, an obsessive focus on healthy eating, was identified as an emerging concern among young adults exposed to wellness and "clean eating" influencers. Body dissatisfaction, driven by continual comparison with idealised images and closely linked to self-esteem, was a key mediator between exposure and disordered eating [21].

Photo-based behaviours typical of Instagram were particularly associated with eating disorder risk. Using beauty filters, scrutinising other people's photographs and editing one's own photographs before posting were each linked to greater risk [9,22]. Secondary school students appeared to be at higher risk than university students, suggesting that early adolescence, when identity formation is most active, may be a period of particular vulnerability [9].

Sina et al. also highlighted the commercial dimension of this influence. Unhealthy food brands promoted through celebrity and corporate accounts were recalled and recognised more often than healthy brands, indicating that the dietary influence of social media extends well beyond peer-generated content [3].

3.5 Social Media-Based Dietary Interventions

Three reviews specifically examined social media as a channel for dietary behaviour-change interventions among young people [6–8]. Together they summarised 55 primary studies, although some overlap between reviews is present.Klassen et al. reviewed 21 studies of young adults aged 18–35 years [6]. Only one of nine RCTs found a statistically significant effect on nutrition outcomes when social media was one component of a multicomponent intervention. Engagement with the social media component varied widely, from 3% to 69% of participants. Young adults welcomed recipes and healthy-eating advice delivered through social media but were reluctant to share weight-related information on public or semi-public networks, a recognised barrier to participation.

Chau et al. found that 11 of 16 studies in adolescents and young adults reported at least one significant nutrition-related behavioural or clinical outcome [7]. Intervention features

were grouped into functional families: platform (Facebook, Twitter, WhatsApp and purpose-built applications), communication (discussion boards, blogs and group messaging), health tracking (food diaries, goal logging and automated feedback), education (nutrition content, meal planning and recipes), social support (peer interaction and peer coaching) and gamification (quizzes, challenges and rewards). Social Cognitive Theory, the Transtheoretical Model and Self-Determination Theory were the most commonly used frameworks. Few studies isolated the contribution of social media features from other intervention components, and many relied on older features such as blogs and discussion boards rather than the full capabilities of modern platforms.

Goodyear et al. updated the evidence with 18 studies published mainly between 2017 and 2020, including RCTs, mixed-methods studies, controlled before-and-after studies and cross-sectional designs [8]. Interventions improved diet-related behaviours and physical activity, particularly when they combined gamification (challenges and rewards), tailored information and interaction (social support and peer counselling). Facebook was the most frequently used platform, with Instagram, Twitter, Reddit and WeChat appearing in more recent studies. Reported improvements included higher intake of fruits, vegetables, milk and dairy products, lower intake of junk food and favourable changes in weight. Newer features, such as integration with wearable activity trackers, image sharing and group chats, were identified as promising for increasing engagement and effectiveness, consistent with earlier meta-analytic evidence on social networking interventions [4].

Across the three reviews, consistent design principles emerged for effective interventions: peer-to-peer interaction for social support, tailored content, feedback and self-monitoring tools, gamification to sustain engagement, and a clear theoretical basis. Declining engagement over time was a common problem, underlining the need for continued innovation in platform design and content strategy.

3.6 Mechanisms of Influence: An Integrated Model:

Taken together, the findings suggest that social media influences young people's diets through four interacting pathways, each moderated by individual vulnerability. The first is direct content exposure. Algorithms curate and amplify food content according to user engagement, exposing users to a disproportionate volume of energy-dense food advertising, unhealthy food trends and sponsored influencer content. Neuroimaging evidence suggests that even brief exposure to images of energy-dense foods activates reward circuitry and weakens prefrontal inhibitory control, favouring impulsive food choices [3].

The second pathway is social comparison and normative influence. Idealised body images and curated depictions of "clean eating" or indulgent eating promote continuous upward comparison, which can trigger restrictive or disordered eating. Peer norms conveyed through shared food photographs and interactions with food posts also shape what young people consider acceptable or desirable to eat.

The third pathway is the information environment. Social media has become a major source of nutrition information for young people, often competing with or replacing advice from health professionals. Because evidence-based educators, health influencers and commercial brands coexist on the same platforms, the quality of information varies widely and nutritional confusion and misinformation are common.

The fourth pathway is intervention and health promotion. When used deliberately and in line with evidence-based design principles, social media can deliver nutrition education, peer support and behaviour-change interventions.

The same mechanisms that promote unhealthy eating can, with appropriate design, regulation and policy support, be harnessed to promote healthier outcomes.

4. Discussion:

4.1 Principal Findings:

This umbrella review brings together systematic review evidence on social media and eating behaviour in adolescents and young adults. Habitual, unregulated use, especially when it involves exposure to food marketing and body-image content, is consistently associated with poorer diet quality, higher intake of unhealthy foods and an increased risk of disordered eating. This finding is supported by observational, experimental, neuroimaging and qualitative evidence from countries as diverse as South Korea, Spain, Poland, Turkey, Australia, Brazil and the United States, suggesting that the dietary influence of social media transcends specific cultural and economic contexts, even if its magnitude varies.

The review also highlights a counterbalancing finding: social media is not inherently harmful to diet. Well-designed, theory-based interventions can increase fruit and vegetable intake, improve diet quality scores, reduce fast-food consumption and produce modest but clinically meaningful changes in body weight. The key challenge for research and practice is to identify the design features that maximise these benefits while minimising harm.

4.2 Relevance to the Indian Context:

None of the included reviews reported primary studies from India, yet emerging Indian data are consistent with the global findings. In a cross-sectional study of 823 college students aged 18–22 years in Kerala, 29.4% were at risk of an eating disorder, and students with social media addiction had a higher adjusted prevalence of eating disorder risk (adjusted prevalence ratio 1.69, 95% CI 1.27 to 2.24); 42.8% reported eating more fast food since they began using social media [23]. In a survey of 144 Indian adolescents aged 15–19 years, more girls than boys reported that social media led them to visit cafés and restaurants more often (43.0% vs 29.7%), and 47% to 58% reported a media-influenced desire to change their body weight or shape [24]. Given India's large and rapidly growing population of young social media users and its rising burden of diet-related non-communicable disease, systematic reviews and longitudinal studies from India and other low- and middle-income countries are a priority.

4.3 Strengths and Limitations:

The evidence base draws on diverse designs, from neuroimaging studies that provide mechanistic insight to large epidemiological studies and RCTs, and its broad geographical coverage strengthens external validity. Several limitations apply. First, most observational primary studies were cross-sectional, preventing causal inference; longitudinal studies are few and generally have short follow-up [25]. Second, social media exposure was mostly self-reported as time spent, which is prone to recall and social desirability bias, and the lack of standardised, validated measures of exposure and dietary outcomes hampers comparison and meta-analysis. Third, the social media landscape changes rapidly, and studies conducted even five years ago may not capture the current dominance of short-form video, food-influencer culture or modern recommendation algorithms. Fourth, the included reviews frequently noted poor control for confounders such as socioeconomic status, parental diet, mental health and pre-existing eating disorder pathology, which may inflate the observed associations. At the level of this umbrella review, the restriction to English-language publications, the small number of eligible reviews and probable overlap of primary studies across reviews may limit completeness and give some primary studies greater weight.

4.4 Public Health and Policy Implications:

First, regulation of food advertising on social media should be strengthened. Exposure to food advertising and influencer marketing is associated with higher consumption of energy-dense, nutrient-poor foods, yet consumer protection laws in many jurisdictions do not adequately address the disclosure, targeting or volume of digital food marketing. Rules comparable to those for broadcast media are warranted, particularly for content directed at minors.

Second, digital media literacy should be incorporated into school and university health education, so that young people can recognise commercial sponsorship, evaluate health claims and understand how social comparison, parasocial relationships and algorithmic amplification shape their eating and body image. Media literacy programmes have reduced the effect of thin-ideal imagery on body dissatisfaction and may similarly buffer the dietary harms of social media use.

Third, clinicians and school health staff should screen for problematic social media use as part of routine assessment of diet and eating disorder risk, especially among secondary school students. Fourth, practitioners using social media for dietary change should prioritise theory-based content, peer interaction, personalised feedback, gamification and platforms that match the current habits of the target group. Because engagement declines over time, interventions should be co-designed with young people, user-experience researchers and social media design experts.

4.5 Directions for Future Research:

Longitudinal studies following social media exposure and dietary outcomes over several years are needed to establish the direction of causality and developmental trajectories, ideally using objective measures of use, such as device screen-time data or platform application programming interfaces, rather than self-report alone. Platform-specific research is a priority given the rapid growth of TikTok and short-form video. Most intervention evidence relates to Facebook, a platform now less popular among young people, and the dietary effects of TikTok, Instagram Reels and YouTube Shorts are under-studied. Content analyses should characterise the balance of healthy and unhealthy food content, the frequency and nature of food advertising and the characteristics of high-engagement food influencers.

Intervention research should move beyond discussion boards and blogs to evaluate short-form video, live streaming, augmented reality and personalisation driven by artificial intelligence, ideally in comparative-effectiveness trials. Finally, mediation analyses should test whether body dissatisfaction, exposure to food marketing, sleep disturbance and social norms independently mediate the association between social media and diet, and studies of moderators such as age, gender, socioeconomic status, mental health and cultural context are needed to identify the most susceptible subgroups [26].

5. Conclusions

This umbrella review of seven systematic reviews shows that habitual social media use, particularly exposure to food marketing, peer food content and idealised body imagery, is consistently associated with poorer diet quality, higher intake of energy-dense foods and a greater risk of disordered eating in adolescents and young adults. These effects appear across cultural settings, begin in early adolescence and are amplified by the still-developing reward and self-regulation systems of young people. Social media also has demonstrated potential to improve diet when interventions are grounded in behavioural theory and incorporate personalisation, peer support and features that sustain engagement.

Addressing this dual role requires coordinated action by researchers, clinicians, educators, policymakers and platform developers, including stronger regulation of digital food marketing, digital literacy within health education and investment in longitudinal and intervention research that keeps pace with a rapidly changing media environment.

References:

1. World Health Organization. World Obesity Day 2022 – accelerating action to stop obesity [Internet]. Geneva: World Health Organization; 2022 [cited 2026 Oct 27]. Available from: https://www.who.int/news/item/04-03-2022-world-obesity-day-2022-accelerating-action-to-stop-obesity
2. Moffitt L, Thomas MS. Influence of social media on dietary habits and nutritional choices in adolescents: a systematic review of the evidence. Int J Nutr Food Sci 2025; 14(4): 211-25. doi:10.11648/j.ijnfs.20251404.14
3. Sina E, Boakye D, Christianson L, Ahrens W, Hebestreit A. Social media and children's and adolescents' diets: a systematic review of the underlying social and physiological mechanisms. Adv Nutr 2022; 13(3): 913-37. doi:10.1093/advances/nmac018
4. Laranjo L, Arguel A, Neves AL, et al. The influence of social networking sites on health behavior change: a systematic review and meta-analysis. J Am Med Inform Assoc 2015; 22(1): 243-56.
5. Hutchesson MJ, Gough C, Müller AM, et al. eHealth interventions targeting nutrition, physical activity, sedentary behavior, or obesity in adults: a scoping review of systematic reviews. Obes Rev 2021; 22: e13295.
6. Klassen KM, Douglass CH, Brennan L, Truby H, Lim MSC. Social media use for nutrition outcomes in young adults: a mixed-methods systematic review. Int J Behav Nutr Phys Act 2018; 15: 70. doi:10.1186/s12966-018-0696-y
7. Chau MM, Burgermaster M, Mamykina L. The use of social media in nutrition interventions for adolescents and young adults – a systematic review. Int J Med Inform 2018; 120: 77-91. doi:10.1016/j.ijmedinf.2018.10.001
8. Goodyear VA, Wood G, Skinner B, Thompson JL. The effect of social media interventions on physical activity and dietary behaviours in young people and adults: a systematic review. Int J Behav Nutr Phys Act 2021; 18: 72. doi:10.1186/s12966-021-01138-3
9. Cal-Herrera A, Corbella-González A, Climent-Llinares S, Fernández-Rodríguez OI. The impact of social media on adolescents' eating and sleeping habits: a systematic review and meta-analysis. Healthcare (Basel) 2025; 13: 2962. doi:10.3390/healthcare13222962
10. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021; 372: n71. doi:10.1136/bmj.n71
11. Tang H, Spreckley M, van Sluijs E, Ahern AL, Smith AD. The impact of social media interventions on eating behaviours and diet in adolescents and young adults: a mixed methods systematic review protocol. BMJ Open 2024; 14: e083465. doi:10.1136/bmjopen-2023-083465
12. Shea BJ, Reeves BC, Wells G, et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. BMJ 2017; 358: j4008.
13. Whiting P, Savović J, Higgins JPT, et al. ROBIS: a new tool to assess risk of bias in systematic reviews was developed. J Clin Epidemiol 2016; 69: 225-34.
14. Ryu S, Jang H, Oh H. Smartphone usage patterns and dietary risk factors in adolescents. J Nutr 2022; 152: 2109-16.
15. Joo MJ, Kim DB, Ko J, Lim JH, Park EC, Shin J. Association between watching eating shows and unhealthy food consumption in Korean adolescents. Nutr J 2024; 23: 58.
16. Bradbury KM, Turel O, Morrison KM. Electronic device use and beverage related sugar and caffeine intake in US adolescents. PLoS One 2019; 14(10): e0223912.
17. Miedzobrodzka E, Du J, van Koningsbruggen GM. TikTok use versus TikTok self-control failure: investigating relationships with well-being, academic performance, bedtime procrastination, and sleep quality. Acta Psychol (Amst) 2024; 251: 104565.
18. Khan A, Thomas G, Karatela S, Morawska A, Werner-Seidler A. Intense and problematic social media use and sleep difficulties of adolescents in 40 countries. J Adolesc 2024; 96: 1116-25.
19. Sanzari, C. M., Gorrell, S., Anderson, L. M., Reilly, E. E., Niemiec, M. A., Orloff, N. C., ... & Hormes, J. M. (2023). The impact of social media use on body image and disordered eating behaviors: Content matters more than duration of exposure. Eating behaviors, 49, 101722.
20. Jaruga-Sękowska S, Staśkiewicz-Bartecka W, Woźniak-Holecka J. The impact of social media on eating disorder risk and self-esteem among adolescents and young adults: a psychosocial analysis in individuals aged 16–25. Nutrients 2025; 17: 219.
21. Frieiro P, González-Rodríguez R, Domínguez-Alonso J. Self-esteem and socialisation in social networks as determinants in adolescents' eating disorders. Health Soc Care Community 2022; 30: e4416-24.
22. Lonergan AR, Bussey K, Fardouly J, et al. Protect me from my selfie: examining the association between photo-based social media behaviors and self-reported eating disorders in adolescence. Int J Eat Disord 2020; 53: 485-96.
23. Krishna S, Olickal JJ, Sarma PS, Thankappan KR. Prevalence and factors associated with eating disorder risk among college students in Kerala, India: a cross-sectional study. Cureus 2025; 17(3): e80374. doi:10.7759/cureus.80374
24. Patil A, Salimath G, Angolkar M. Impact of social media influence on eating behavior in mid and late adolescent children: a cross-sectional study. Indian J Health Sci Biomed Res KLEU 2024; 17(2): 125-30. doi:10.4103/kleuhsj.kleuhsj_551_23
25. Livet A, Boers E, Laroque F, Afzali MH, McVey G, Conrod PJ. Pathways from adolescent screen time to eating related symptoms: a multilevel longitudinal mediation analysis through self-esteem. Psychol Health 2024; 39: 1167-82.
26. Erdoğdu Yıldırım AB, Gündoğdu Ü, Eroğlu M. Myths regarding gender difference in eating disorders in adolescents. Turk Psikiyatri Derg 2025; 36: 27-35.

Review Article: Pure and Applied Sciences

Chrono Nutrition and the Regulation of Glucose Transporter 4 in Insulin-Sensitive Tissues: A Narrative Review

Neha Choudhury[1], Arnab Chatterjee[1]
[1]Department of Food & Nutrition, Asansol Girls' College, Asansol, India
Author for Correspondence: Arnab Chatterjee, Assistant Professor, Department of Food & Nutrition, Asansol Girls' College, Asansol, India, Email: arnabchatterjeenin@gmail.com, Mobile: +918801544129

Received on:09.09.2026 **Accepted on:** 31.10.2026

ABSTRACT: Chrononutrition studies how the timing of food intake interacts with circadian rhythms to influence health. Glucose transporter 4, the insulin-responsive glucose transporter in skeletal muscle and adipose tissue, is central to whole-body glucose homeostasis, yet its role in chrononutrition has received little attention.

This narrative review summarises the biology of glucose transporter 4 and examines evidence that circadian clocks and meal timing influence its expression, translocation and function.

Insulin releases glucose transporter 4 from intracellular storage vesicles and drives its tethering, docking and fusion with the plasma membrane. In mice, loss of the muscle clock gene Bmal1 reduces muscle glucose transporter 4 content and insulin-stimulated glucose uptake, and in human muscle cells, disruption of the CLOCK gene impairs glucose uptake and genes governing transporter translocation. In humans, circadian misalignment and late eating impair glucose tolerance, whereas early time-restricted eating and front-loading energy intake improve insulin sensitivity, including in Indian adults with type 2 diabetes.

Aligning food intake with circadian rhythms may improve glucose handling partly through clock control of glucose transporter 4. Human studies measuring the transporter directly are needed.

Keywords: Circadian rhythm; Meal timing; Glucose transporter type 4; Insulin resistance; Skeletal muscle; Adipocytes; Circadian clocks

1. Introduction:

Chrononutrition is an emerging field that combines chronobiology and nutritional science to study how the timing of food intake interacts with circadian rhythms to influence health [1]. Nearly every tissue contains a molecular clock, and the timing of meals is a major signal that synchronises clocks in peripheral metabolic tissues. Disruption of these rhythms, for example through irregular meal schedules, late-night eating, shift work or insufficient sleep, has been linked to obesity, impaired glucose tolerance, type 2 diabetes and cardiovascular disease [1,2].

People who consume a greater share of their daily energy later in the day tend to have higher adiposity and cardiometabolic risk [1]. Circadian rhythms, sleep and the gut microbiota interact in regulating metabolism, and disturbance of any of these systems can reduce glucose tolerance [3,4]. Chronotype, an individual's preference for morning or evening activity, is also associated with food choices and meal timing, and because eating patterns are shaped by culture and ethnicity, chrononutrition recommendations must be flexible and culturally sensitive [1].

Within this framework, the glucose transporter (GLUT) family, and particularly glucose transporter 4 (GLUT4), deserves attention. GLUT4 is the main route of insulin-stimulated glucose uptake into skeletal muscle and adipose tissue [5], and therefore a plausible point at which meal timing and circadian clocks could influence whole-body glucose homeostasis. This narrative review summarises the biology of GLUT4 and examines the evidence that circadian clocks and meal timing regulate its expression, translocation and function.

2. Glucose Transporter 4 in Insulin-Sensitive Tissues:

2.1 Skeletal Muscle: Skeletal muscle accounts:

for approximately 40% of body mass and is the principal site of insulin-stimulated glucose disposal [5]. Its fibres are bundled and supported by collagen and reticular fibres. GLUT4 mediates glucose entry into muscle cells, where glucose is either stored as glycogen or used as a rapid energy source during activity. Beyond its role in movement, skeletal muscle is therefore a key regulator of whole-body glucose balance, and impaired muscle glucose uptake contributes to the development and progression of insulin resistance and type 2 diabetes [5].

2.2 Adipose Tissue: Adipocytes store fat and also act as endocrine cells, releasing cytokines and hormones such as leptin and adiponectin that regulate appetite, energy intake and insulin sensitivity [5]. According to their mitochondrial content and function, adipocytes are classified as white, beige or brown. Although adipose tissue takes up less glucose than muscle, GLUT4 in adipocytes has a disproportionate influence on systemic insulin sensitivity [5].

2.3 Heart, Brain and Regulation of Expression: GLUT4 is also expressed in the heart and brain [5]. Besides insulin-induced translocation, the amount of GLUT4 available is regulated at the level of expression of the Slc2a4 gene and GLUT4 protein by hormonal, nutritional and transcriptional factors. Studies have used a wide range of experimental techniques and antibodies to assess GLUT4 expression and translocation, which complicates comparison between studies [5].

3. Insulin-Stimulated Translocation of Glucose Transporter 4:

In the basal state, most GLUT4 is held inside the cell, and insulin increases glucose uptake by moving it to the plasma membrane. The cycle in adipocytes is summarised in Figure 1 [5]. GLUT4 at the cell surface is continually internalised by endocytosis and delivered to early endosomes, from which it passes to recycling compartments or follows a retrograde route through the trans-Golgi network and the endoplasmic reticulum–Golgi intermediate compartment. Specialised GLUT4 storage vesicles formed from these compartments are retained inside the cell by the tether containing a UBX domain for GLUT4 (TUG) protein.

Insulin signalling releases these vesicles from TUG-mediated retention. They are loaded onto microtubules, transported towards the cell periphery by kinesin motor proteins and tethered close to the plasma membrane. Docking requires assembly of a ternary soluble N-ethylmaleimide-sensitive factor attachment protein receptor (SNARE) complex, after which the vesicle and plasma membranes fuse and GLUT4 is inserted into the cell surface, increasing glucose uptake [5]. The cortical actin cytoskeleton helps retain vesicles in the resting state and is remodelled on insulin stimulation to allow their release, and β-catenin influences the size of the insulin-responsive GLUT4 pool in adipocytes [5].

4. Circadian Clock Control of Glucose Transporter 4:

Glucose tolerance and insulin sensitivity show clear diurnal variation in humans, being generally higher in the morning than in the evening [6]. Evidence that this rhythm is partly generated by peripheral clocks acting on GLUT4 comes from studies of skeletal muscle (Table 1). In mice, muscle-specific deletion of the core clock gene Bmal1 impaired insulin-stimulated glucose uptake and reduced muscle protein levels of GLUT4 and of TBC1D1, a Rab-GTPase-activating protein that regulates GLUT4 translocation [7]. A second muscle-specific Bmal1 knockout model showed a 47% reduction in Glut4 messenger RNA and a 76% reduction in GLUT4 protein in the gastrocnemius, impaired insulin-stimulated glucose uptake in isolated muscle, lower activity of the glycolytic enzymes hexokinase 2 and phosphofructokinase 1, and a 52% larger area under the glucose tolerance curve [8].

Comparable evidence exists in humans. Rhythmic transcription is extensive in human skeletal muscle in vivo, and depletion of the core clock gene CLOCK in primary human myotubes significantly reduced both basal and insulin-stimulated glucose uptake and negatively affected genes involved in GLUT4 expression, translocation and recycling [9]. Together, these findings indicate that the muscle clock is required to maintain GLUT4 content and insulin-responsive glucose uptake. The timing of food intake is a dominant cue for peripheral clocks such as that of muscle [6], providing a plausible mechanism through which meal timing could influence GLUT4 function.

5. Meal Timing and Glucose Homeostasis:

Human studies of meal timing support this mechanism at the whole-body level, although none has measured GLUT4 directly. Under controlled circadian misalignment, in which eating and sleeping occurred out of phase with the internal clock, healthy adults showed increased postprandial glucose and insulin concentrations, and some reached glucose levels in the prediabetic range [10]. In overweight and obese women following an isocaloric weight-loss diet for 12 weeks, consuming most energy at breakfast rather than dinner produced greater weight loss and larger reductions in fasting glucose, insulin and insulin resistance [11]. In a five-week randomised crossover trial in men with prediabetes, early time-restricted feeding, with all meals eaten within six hours and dinner before 3 p.m., improved insulin sensitivity and β-cell responsiveness and lowered blood pressure and oxidative stress, without weight loss [12]. In mice fed a high-fat diet, restricting food access to the active phase prevented obesity, hyperinsulinaemia and hepatic steatosis without reducing energy intake [13].

5.1 Evidence from India: Evidence from Indian populations is emerging. In a cross-sectional study of 227 adults with type 2 diabetes in Gujarat, late diners had significantly worse blood glucose irrespective of the glycaemic index of the meal, whereas those whose largest meal fell in the active phase had better glycaemic control; frequent midnight eating was associated with poor control, and the triglyceride-glucose index correlated with eating the largest meal in the resting phase [14]. In a crossover study in Mumbai of ten Asian Indian adults with uncontrolled type 2 diabetes, skipping breakfast raised fasting glucose, post-lunch glucose excursions and insulin resistance, assessed by the homeostatic model assessment of insulin resistance (3.05 vs 2.03), largely through a greater glucagon response [15]. Late dinners and breakfast skipping are common in urban India, making meal timing a practical target for prevention.

6. Implications for Metabolic Health and Future Research:

The circadian clock regulates feeding behaviour, nutrient absorption and metabolism, and food intake in turn resets peripheral clocks. This bidirectional relationship makes meal timing an important and modifiable lifestyle factor [1,6]. Interactions between meal timing, sleep and the gut microbiota further shape the metabolic response to diet [3,4], and circadian disruption also affects cardiovascular function [2].

Several gaps remain. Most mechanistic evidence linking the clock to GLUT4 comes from genetic knockout models and cultured cells; human studies have measured whole-body insulin sensitivity rather than tissue GLUT4 expression or translocation. Future trials of meal timing should therefore include muscle and adipose tissue biopsies at several times of day to determine whether early eating restores rhythmic GLUT4 expression and translocation. The roles of chronotype, sleep, physical activity timing and the gut microbiota as modifiers should be examined, and populations with distinct meal patterns, including those in India, should be studied.

Table 1. Selected evidence linking circadian clocks and meal timing to glucose transporter 4 and glucose handling

Study	Model or population	Exposure	Main finding
Dyar et al. (2014) [7]	Mice	Muscle-specific Bmal1 knockout	Impaired insulin-stimulated glucose uptake; lower muscle GLUT4 and TBC1D1 protein
Harfmann et al. (2016) [8]	Mice	Muscle-specific Bmal1 knockout	GLUT4 mRNA −47%, protein −76%; impaired insulin-stimulated uptake; worse glucose tolerance
Perrin et al. (2018) [9]	Human muscle biopsies and primary myotubes	siRNA depletion of CLOCK	Lower basal and insulin-stimulated glucose uptake; GLUT4 expression, translocation and recycling genes affected
Scheer et al. (2009) [10]	Healthy adults (n = 10)	Circadian misalignment (forced desynchrony)	Higher postprandial glucose and insulin; some values in prediabetic range
Jakubowicz et al. (2013) [11]	Overweight/obese women (n = 93)	Large breakfast vs large dinner, 12 weeks, isocaloric	Greater weight loss and larger falls in fasting glucose, insulin and insulin resistance with large breakfast
Sutton et al. (2018) [12]	Men with prediabetes (n = 8)	Early time-restricted feeding (6-h window), 5-week crossover	Improved insulin sensitivity and β-cell responsiveness without weight loss
Hatori et al. (2012) [13]	Mice on high-fat diet	Time-restricted feeding in active phase	Prevented obesity, hyperinsulinaemia and hepatic steatosis without reduced energy intake
Chandorkar et al. (2023) [14]	Indian adults with type 2 diabetes (n = 227)	Meal timing and chronotype (cross-sectional)	Late dining and midnight eating associated with poorer glycaemic control
Chauhan et al. (2024) [15]	Indian adults with type 2 diabetes (n = 10)	Breakfast skipping vs eating (crossover)	Higher fasting and post-lunch glucose and insulin resistance with skipping

GLUT4, glucose transporter 4; TBC1D1, TBC1 domain family member 1; mRNA, messenger RNA; siRNA, small interfering RNA; CLOCK, circadian locomotor output cycles kaput; Bmal1, brain and muscle ARNT-like 1.

Figure Legend

Figure 1. Insulin-regulated trafficking of glucose transporter 4 (GLUT4) in adipocytes. (1) GLUT4 at the plasma membrane is internalised by endocytosis and passes through early and recycling endosomes or a retrograde route via the trans-Golgi network and the endoplasmic reticulum–Golgi intermediate compartment. (2) GLUT4 storage vesicles are retained intracellularly by TUG (tether containing a UBX domain for GLUT4) proteins. (3) Insulin releases the vesicles, which move along microtubules towards the cell surface. (4) Vesicles are tethered with the help of kinesin motor proteins. (5) Docking follows assembly of a ternary SNARE (soluble N-ethylmaleimide-sensitive factor attachment protein receptor) complex. (6) Fusion inserts GLUT4 into the plasma membrane, increasing glucose uptake. Reproduced from Wang et al. [5], World Journal of Biological Chemistry, published under the Creative Commons Attribution Non-Commercial (CC BY-NC 4.0) licence.

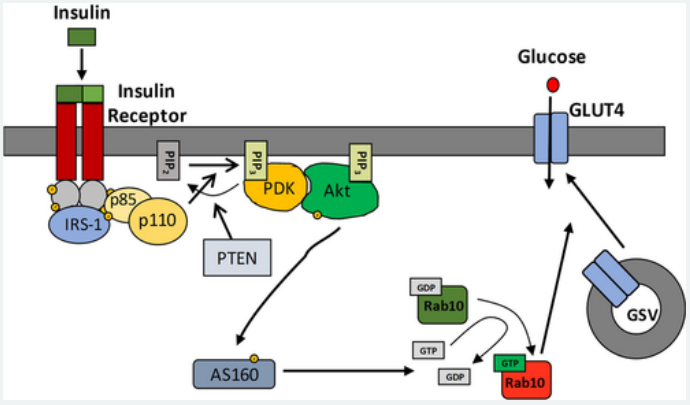


Figure - 1

Meta-analyses of meal-timing interventions are needed to support chrononutrition recommendations in national dietary guidelines. The establishment of chrononutrition societies in Japan and Brazil reflects growing international interest in translating this evidence into practice [1].

7. Conclusion:

GLUT4 is the key mediator of insulin-stimulated glucose uptake into skeletal muscle and adipose tissue. Experimental evidence shows that the muscle clock is required to maintain GLUT4 content and insulin-responsive glucose uptake, and human studies show that circadian misalignment and late eating impair glucose tolerance, whereas earlier eating improves insulin sensitivity. Aligning food intake with circadian rhythms may therefore support glucose homeostasis partly through clock regulation of GLUT4. Human studies that measure GLUT4 directly in response to meal-timing interventions are needed to confirm this mechanism and to inform chrononutrition-based strategies for preventing metabolic disease.

References:

1. Saplontai LC, Najar A, Lynch K, Geere M. Chrono-nutrition: understanding the interplay between circadian rhythms and personalized nutrition. Int J Transl Sci 2024; 2024(3): 221-56.
2. Rana S, Prabhu SD, Young ME. Chronobiological influence over cardiovascular function: the good, the bad, and the ugly. Circ Res 2020; 126(2): 258-79.
3. Frazier K, Chang EB. Intersection of the gut microbiome and circadian rhythms in metabolism. Trends Endocrinol Metab 2020; 31(1): 25-36.
4. Gutierrez Lopez DE, Lashinger LM, Weinstock GM, Bray MS. Circadian rhythms and the gut microbiome synchronize the host's metabolic response to diet. Cell Metab 2021; 33(5): 873-
Wang T, Wang J, Hu X, Huang XJ, Chen GX. Current understanding of glucose transporter 4 expression and functional mechanisms. World J Biol Chem 2020; 11(3): 76-98. doi:10.4331/wjbc.v11.i3.76
5. Poggiogalle E, Jamshed H, Peterson CM. Circadian regulation of glucose, lipid, and energy metabolism in humans. Metabolism 2018; 84: 11-27.
6. Dyar KA, Ciciliot S, Wright LE, et al. Muscle insulin sensitivity and glucose metabolism are controlled by the intrinsic muscle clock. Mol Metab 2014; 3(1): 29-41.
7. Harfmann BD, Schroder EA, Kachman MT, Hodge BA, Zhang X, Esser KA. Muscle-specific loss of Bmal1 leads to disrupted tissue glucose metabolism and systemic glucose homeostasis. Skelet Muscle 2016; 6: 12. doi:10.1186/s13395-016-0082-x
8. Perrin L, Loizides-Mangold U, Chanon S, et al. Transcriptomic analyses reveal rhythmic and CLOCK-driven pathways in human skeletal muscle. eLife 2018; 7: e34114. doi:10.7554/eLife.34114
9. Scheer FA, Hilton MF, Mantzoros CS, Shea SA. Adverse metabolic and cardiovascular consequences of circadian misalignment. Proc Natl Acad Sci U S A 2009; 106(11): 4453-8.
10. Jakubowicz D, Barnea M, Wainstein J, Froy O. High caloric intake at breakfast vs. dinner differentially influences weight loss of overweight and obese women. Obesity (Silver Spring) 2013; 21(12): 2504-12.
11. Sutton EF, Beyl R, Early KS, Cefalu WT, Ravussin E, Peterson CM. Early time-restricted feeding improves insulin sensitivity, blood pressure, and oxidative stress even without weight loss in men with prediabetes. Cell Metab 2018; 27(6): 1212-21.
12. Hatori M, Vollmers C, Zarrinpar A, et al. Time-restricted feeding without reducing caloric intake prevents metabolic diseases in mice fed a high-fat diet. Cell Metab 2012; 15(6): 848-60.
13. Chandorkar SS, Mehta NS, Rathod NM. Chrono-nutrition and its association with chronotype and blood glucose control among people with type 2 diabetes. EMJ Diabet 2023. doi:10.33590/emjdiabet/10300576
14. Chauhan YV, Hakke MD, Sanamandra P, et al. Glucagon, rather than glucagon-like peptide 1, mediates higher post-lunch glucose excursions during breakfast skipping in Asian Indian patients with uncontrolled type 2 diabetes mellitus. Indian J Endocrinol Metab 2024; 28: 645-52. doi:10.4103/ijem.ijem_295_24

Review Article: Business and Economics Sciences

Breaking the Metabolic Cycle: From Awareness to Action Against Obesity

Sukanta Bhunia[1], Sonali Giri[2], Dr.Suprakash Pradhan[3]

[1]Community Nutritionist, Nurture Nutrition Solution, NAWT., [2]M. Sc. in Food and Nutrition, Department of Home science, University of Calcutta, [3]SACT-1, Department of Nutrition, Prabhat Kumar College (Affiliated to Vidyasagar University, Contai, Purba Medinipur, West Bengal-721401.

Author for Correspondence: Sukanta Bhunia, Email: bhunia.s2003@gmail.com, **Mobile:** +918345841254

Received on: 22.08.2026 **Accepted on:** 31.10.2026

ABSTRACT: Obesity is a complex, chronic and relapsing disease arising from interactions among biological, behavioural, environmental and social determinants. The continuing rise in obesity requires a shift from weight-focused awareness campaigns toward sustained, evidence-informed prevention and integrated management.

This review synthesizes contemporary evidence on the global burden of obesity, the metabolic and environmental factors that sustain the "metabolic cycle," and practical strategies for prevention, early identification and long-term management. A narrative literature review was undertaken using current guidance and evidence from the World Health Organization (WHO) and major peer-reviewed literature on obesity, physical activity, dietary patterns, obesity prevention and chronic disease management. Priority was given to recent international guidance and authoritative sources.

Current evidence indicates that obesity is driven by multiple interacting pathways rather than by personal choice alone. Increased exposure to energy-dense foods, sedentary behaviour, inadequate sleep, stress, obesogenic environments and biological adaptations to weight loss can reinforce weight gain and weight regain. Effective action therefore requires a life-course approach combining health literacy, healthier food environments, regular physical activity, behavioural support, primary-care screening, management of cardiometabolic risk factors and, when clinically appropriate, pharmacological or surgical treatment. WHO reports that more than 1 billion people were living with obesity in 2022, including approximately 160 million children and adolescents. The evidence also supports multidisciplinary and health-system approaches rather than isolated individual interventions.

Breaking the metabolic cycle requires coordinated action at individual, clinical, community and policy levels. Sustainable obesity control should move beyond stigma and short-term dieting toward prevention, early intervention, continuity of care and supportive environments. Translating awareness into measurable action is essential for reducing obesity-related morbidity and improving population health.

Keywords: obesity; metabolic health; overweight; lifestyle intervention; physical activity; nutrition; prevention; public health; chronic disease; weight management.

1. Introduction:

Obesity has emerged as one of the most important public-health challenges of the 21st century. It is defined by abnormal or excessive adiposity that may impair health and is now recognized as a complex chronic disease rather than simply a consequence of individual behaviour. WHO reports that more than 1 billion people worldwide were living with obesity in 2022, including approximately 160 million children and adolescents aged 5–19 years. Between 1990 and 2022, the prevalence of obesity among adults more than doubled globally, while obesity among children and adolescents increased approximately four-fold.

The public-health importance of obesity extends beyond body weight. Excess adiposity is associated with increased risk of type 2 diabetes, cardiovascular disease, hypertension, dyslipidaemia, musculoskeletal disorders, sleep

related disorders and several cancers. The risk is influenced by the amount and distribution of adipose tissue, metabolic health, duration of exposure and the presence of other risk factors.

The term "metabolic cycle" in this paper describes the reinforcing interaction between energy imbalance, adipose-tissue dysfunction, insulin resistance, appetite regulation, physical inactivity, environmental exposures and behavioural responses that can promote weight gain and make long-term weight reduction difficult. Weight gain can itself alter appetite and energy expenditure, while repeated restrictive dieting without adequate behavioural and clinical support may contribute to weight cycling. Thus, obesity prevention and management should not be reduced to "eat less and exercise more."

Modern obesity care emphasizes a life-course and systems approach. WHO recommends supportive food and physical-activity environments, early prevention, primary-health-care integration and appropriate management of people already living with obesity. The central question is therefore not simply how to make people aware of obesity, but how to convert awareness into sustainable action.

2. Objectives:

To describe the current global burden and public-health significance of overweight and obesity.

To examine major biological, behavioural, dietary, environmental and social factors contributing to the metabolic cycle of obesity.

To review evidence-informed strategies for prevention, early identification and long-term management of obesity.

To highlight the role of nutrition, physical activity, behavioural support, primary health care and supportive environments.

To propose a practical framework for translating obesity awareness into measurable action at individual, community and health-system levels.

3. Methods:

This paper was prepared as a narrative review rather than as an original clinical or community-based research study. Literature and guidance were identified through targeted searches of authoritative sources, with emphasis on WHO publications and major peer-reviewed evidence concerning obesity epidemiology, determinants, prevention, physical activity, nutrition and management. Recent international guidance published up to September 2026 was prioritized, while foundational guidance was retained where it remains relevant.

The synthesis focused on five domains: (1) burden and trends; (2) metabolic and behavioural drivers; (3) dietary and physical-activity determinants; (4) clinical and public-health interventions; and (5) implementation strategies. Evidence was narratively compared for consistency, relevance and applicability. Because this is a narrative review, no pooled effect estimate or formal meta-analysis was performed. The "results" section therefore reports findings from the literature synthesis and does not represent newly collected participant data.

4. Results:

Global burden

The reviewed evidence demonstrates a sustained global increase in obesity across age groups. WHO estimates that more than 1 billion people were living with obesity in 2022. The increase has occurred in both adults and younger populations, demonstrating that obesity prevention cannot be restricted to adult weight management. Obesity is also increasingly relevant in low- and middle-income countries, where rapid urbanization, changing food systems and reduced physical activity can coexist with other forms of malnutrition.

Determinants of the metabolic cycle:

The evidence indicates that obesity is multifactorial dietary patterns characterized by

frequent intake of energy-dense foods and sugar-sweetened products can increase energy intake, while sedentary behaviour reduces energy expenditure. Environmental factors—including food availability, marketing, transport systems, urban design and access to safe spaces for activity—can shape these behaviours. Psychological stress, sleep disruption and social disadvantage may further influence appetite, food choice and physical activity.

Biological adaptation is another important component. After weight loss, changes in appetite regulation and energy expenditure can make weight maintenance difficult. This helps explain why obesity is appropriately managed as a chronic condition requiring continued support rather than as a short-term dieting problem.

Health Consequences:

The reviewed literature consistently links excess adiposity with cardiometabolic and other chronic conditions. Higher-than-optimal BMI is a major risk factor for cardiovascular disease and diabetes, while obesity is also associated with musculoskeletal disorders and multiple cancers. Childhood and adolescent obesity are particularly concerning because excess weight can persist into adulthood and increase the lifetime burden of disease.

Evidence-informed prevention and management strategies:

Effective obesity prevention and management is multidimensional. WHO recommends healthier dietary patterns, regular physical activity, reduction of sedentary behaviour, healthy sleep and supportive environments. For adults, WHO guidance supports at least 150–300 minutes of moderate-intensity aerobic physical activity per week, or an equivalent combination of moderate and vigorous activity; children and adolescents are generally advised to undertake an average of at least 60 minutes of moderate-to-vigorous physical activity daily.

Health-system interventions are also essential. WHO's health-service delivery framework recommends integrating obesity prevention and management into primary health care and providing accessible, affordable and sustainable services across the life course.For people with established obesity, management may include structured lifestyle intervention and, where clinically indicated, pharmacological or surgical approaches alongside ongoing professional support. WHO's 2025 guideline on GLP-1 therapies emphasizes that medication should be part of comprehensive care rather than a substitute for behavioural and health-system interventions.

Discussion:

The findings support a fundamental change in how obesity is communicated and managed. Awareness is necessary but insufficient. Public messages that focus exclusively on willpower can reinforce stigma and fail to address the environmental and biological mechanisms that maintain obesity. WHO increasingly frames obesity as a chronic disease requiring integrated prevention and management across communities and health systems.

A useful way to understand the metabolic cycle is as a feedback system. An obesogenic environment can increase exposure to energy-dense foods and sedentary lifestyles; repeated positive energy balance can increase adiposity; adipose-tissue dysfunction and metabolic changes can worsen insulin resistance and cardiometabolic risk; biological adaptations can increase hunger or reduce energy expenditure after weight loss; and social stigma or repeated unsuccessful dieting can undermine long-term engagement. Breaking this cycle therefore requires intervention at several points rather than reliance on a single strategy.

Nutrition remains central. A sustainable dietary approach should prioritize vegetables, fruits, legumes, whole grains, nuts and other nutrient-dense foods while reducing excessive intake of foods high in free sugars, unhealthy fats and excess energy. Importantly, culturally appropriate and affordable dietary strategies are more likely to be maintained than highly

restrictive diets. WHO also emphasizes the importance of supportive food environments, indicating that responsibility should not rest entirely with individuals.

Physical activity should be promoted for both weight-related and non-weight-related health benefits. Regular activity improves cardiovascular fitness, insulin sensitivity, functional capacity and psychological well-being even when changes in body weight are modest. Consequently, success should be assessed through a broader set of outcomes, including waist circumference, blood pressure, glucose, lipids, fitness, sleep, quality of life and functional health.

Primary health care provides a practical platform for breaking the cycle early. Routine assessment of weight, height/BMI and cardiometabolic risk, followed by appropriate counselling and referral, can help identify risk before complications become established. Multidisciplinary teams involving physicians, dietitians, nurses, psychologists and exercise professionals can provide more comprehensive support.

At the policy level, obesity prevention requires changes beyond the clinic. WHO's 2026 Acceleration Plan emphasizes setting measurable goals, developing implementation plans, executing evidence-informed interventions, and scaling, enforcing and monitoring progress. This is particularly important because food systems, marketing, urban design, transport and socioeconomic conditions influence the choices available to individuals.

The evidence also supports moving away from weight stigma. Stigma may discourage people from seeking care and can contribute to psychological distress and unhealthy behaviours. A respectful, person-centred approach recognizes obesity as a chronic condition while still emphasizing prevention, healthy behaviours and individual agency.

Overall, the transition from awareness to action should follow a continuum: awareness → risk identification → individualized counselling → sustained behaviour change → clinical management when needed → long-term monitoring. This approach is more consistent with current public-health and chronic-care principles than isolated weight-loss campaigns.

Conclusion:

Obesity is a complex chronic disease shaped by biological, behavioural, environmental and social determinants. The evidence reviewed in this paper indicates that awareness alone cannot break the metabolic cycle. Effective action requires a coordinated life-course strategy that combines healthy and culturally appropriate nutrition, regular physical activity, behavioural support, early identification of cardiometabolic risk, accessible primary-care services and appropriate clinical treatment.

The most sustainable approach is to shift from short-term dieting and stigma toward prevention, continuity of care and supportive environments. Individuals, families, health professionals, communities and policy-makers each have a role. The practical goal should be measurable improvement in health and quality of life—not simply a temporary reduction in body weight. Breaking the metabolic cycle is therefore both a clinical responsibility and a public-health priority.

References:

1. World Health Organization. Obesity and overweight. WHO; 2025. Available from: https://www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight
2. World Health Organization. The WHO acceleration plan to stop obesity: a joint WHO/UNICEF operational model for designing and implementing the response. Geneva: WHO; 2026. ISBN 978-92-4-011605-4.
3. World Health Organization. Obesity. WHO Health Topics. Updated 2026. Available from: https://www.who.int/health-topics/obesity/
4. World Health Organization. Health service delivery framework for prevention and management of obesity. Geneva: WHO; 2023. ISBN 978-92-4-007323-4.
5. World Health Organization. Recommendations for the prevention and management of obesity over the life course. In: Seventy-fifth World Health Assembly, resolutions and decisions. Geneva: WHO; 2022.
6. World Health Organization. Physical activity. WHO Fact

sheet. Geneva: WHO; current guidance.
7. World Health Organization. WHO issues global guideline on the use of GLP-1 medicines in treating obesity. Geneva: WHO; 1 December 2025.
8. World Health Organization. A primary health care approach to obesity prevention and management in children and adolescents: policy brief. Geneva: WHO; 2023. ISBN 978-92-4-007267-

Practical Action Framework

Level	Priority action	Examples	Suggested indicator
Individual	Build sustainable habits	Balanced diet, regular activity, adequate sleep, self-monitoring	Adherence; waist/BMI trend; activity minutes
Family/community	Create supportive environments	Healthy food availability, walking groups, school/community programs	Participation; environmental availability
Primary care	Detect and manage risk early	BMI/waist assessment, BP/glucose/lipids, counselling and referral	Screening and follow-up rates
Health system	Provide integrated chronic care	Multidisciplinary services; behavioural, pharmacological and surgical options when indicated	Access, retention and clinical outcomes
Policy	Change obesogenic environments	Food-system measures, physical-activity infrastructure, health education	Population prevalence and policy implementation

Review Article: Student Innovation

Gut Microbiome-Informed Precision Nutrition for Cardiometabolic Risk Reduction: A Narrative Review

Paushali Ghosh[1], Arnab Chatterjee[2]

[1]Student, Department of Food & Nutrition, Asansol Girls' College, Asansol, India; [2]Assistant Professor, Department of Food & Nutrition, Asansol Girls' College, Asansol, India,

Author for Correspondence: Arnab Chatterjee, Email: arnabchatterjeenin@gmail.com, Mobile: +918801544129

Received on: 29.07.2026 **Accepted on:** 31.10.2026

ABSTRACT: Cardiometabolic diseases are the leading cause of death worldwide, and responses to the same diet vary widely between individuals. The gut microbiota, which transforms dietary components into metabolically active compounds, may explain part of this variation and offers a target for personalised dietary strategies.

This narrative review examines the mechanisms linking diet, gut microbiota and cardiometabolic health, and evaluates evidence from human trials of microbiome-informed and microbiome-targeted nutrition.

Microbial production of short-chain fatty acids, bile acid transformation, endotoxin translocation and trimethylamine metabolism plausibly link the microbiota to glucose and lipid regulation. Algorithms combining clinical and microbiome data predict individual glycaemic responses better than carbohydrate content alone. Personalised diets have improved postprandial glucose, glycated haemoglobin and triglycerides in randomised trials, although effects were modest and low-density lipoprotein cholesterol was largely unchanged. Fibre, fermented foods, a Mediterranean diet and its green variant altered microbial composition alongside metabolic improvements.

Microbiome-informed nutrition is promising but not yet proven superior to well-delivered standard advice. Larger, longer trials with standardised microbiome reporting, including in Indian populations, are needed.

Keywords: Dietary fiber; Probiotics; Prebiotics; Fatty acids, volatile; Diet, Mediterranean; Insulin resistance; Dyslipidemia; Postprandial period

1.Introduction:

Cardiometabolic diseases, including atherosclerotic cardiovascular disease, type 2 diabetes, obesity, dyslipidaemia, hypertension and metabolic dysfunction-associated steatotic liver disease, are together the largest contributor to premature death worldwide. The number of people living with cardiovascular disease and the number of cardiovascular deaths have risen steadily since 1990, with ischaemic heart disease and stroke accounting for most of the burden [1]. India faces a particularly heavy burden: a national survey of more than 113,000 adults estimated the prevalence of diabetes at 11.4%, prediabetes at 15.3%, generalised obesity at 28.6% and dyslipidaemia at 81.2% [2].

Current prevention guidance places dietary quality at the centre of risk reduction [3]. Yet population-level dietary advice produces modest and inconsistent average effects. In a 12-month trial comparing healthy low-fat and healthy low-carbohydrate diets, weight change varied widely between participants assigned to the same diet, and neither genotype pattern nor insulin secretion predicted who would benefit [4]. This variability has prompted interest in precision nutrition, which tailors dietary advice to individual characteristics such as genetics, metabolic responses, anthropometry, lifestyle and the gut microbiome [5].

The gut microbiota is a promising basis for such tailoring because it differs markedly between individuals, responds quickly to diet and shapes the metabolic effects of food [6,7]. This narrative review summarises the mechanisms

linking diet, gut microbiota and cardiometabolic health; describes the evidence for inter-individual variation in dietary responses; evaluates human trials of microbiome-informed and microbiome-targeted dietary interventions; and identifies gaps for future research, including in the Indian context.

2. Diet, Gut Microbiota and Cardiometabolic Mechanisms:

2.1 Dietary Modulation of the Microbiota: The gut microbiota is a metabolically active community that ferments dietary substrates, particularly fibre and polyphenols, into compounds that act on host physiology [6,7]. Diet alters microbial composition within days: switching between animal-based and plant-based diets produced measurable shifts in community structure and metabolic output in less than a week [8]. Early work showing an obesity-associated microbiome with greater capacity for energy harvest [9], and transfer of metabolic phenotypes through microbiota from twins discordant for obesity into germ-free mice [10], established biological plausibility. In humans, transfer of intestinal microbiota from lean donors increased insulin sensitivity in men with metabolic syndrome [11], although causal effects in humans remain incompletely established.

2.2 Short-Chain Fatty Acids: Short-chain fatty acids (SCFAs), mainly acetate, propionate and butyrate, are produced by bacterial fermentation of dietary fibre [12]. They act through free fatty acid receptors to stimulate secretion of glucagon-like peptide-1 [13] and influence adipose tissue lipid handling, gut barrier integrity and energy balance [12]. Specific fibre structures direct SCFA production in different ways, suggesting that substrates could be matched to an individual's microbial capacity [14].

2.3 Bile Acids, Endotoxaemia and Amino Acid Metabolism: Gut bacteria deconjugate and transform bile acids, altering signalling through the farnesoid X receptor and the G-protein-coupled bile acid receptor TGR5, which regulate hepatic lipid and glucose metabolism [15]. Lipopolysaccharide from Gram-negative bacteria can cross a compromised gut barrier, producing low-grade metabolic endotoxaemia that initiates obesity and insulin resistance in animal models [16]. Microbial biosynthesis of branched-chain amino acids has also been linked to the serum metabolome and insulin resistance in humans [17].

2.4 Trimethylamine N-Oxide: Gut microbes convert dietary choline and phosphatidylcholine into trimethylamine, which the liver oxidises to trimethylamine N-oxide (TMAO). TMAO promoted atherosclerosis in mice [18], and higher plasma concentrations predicted major adverse cardiovascular events in humans [19]. Diets that change precursor intake or microbial capacity could therefore act partly through this pathway.

3. Inter-Individual Variation in Dietary Responses:

Several large studies show that people respond very differently to the same foods. In 800 adults monitored with continuous glucose monitors, postprandial glycaemic responses to identical meals varied widely between individuals, and a machine-learning algorithm combining clinical characteristics with gut microbiome features predicted these responses more accurately than carbohydrate or energy content alone [20]. In a randomised crossover trial comparing white bread with sourdough wholegrain bread, there was no difference between breads on average, but individual glycaemic responses were person-specific and could be predicted from the baseline microbiome [21].

The PREDICT 1 study extended these findings to more than 1,000 deeply phenotyped adults in the United Kingdom and the United States, showing large variation in postprandial glucose, insulin and triglyceride responses to standardised meals, of which only a modest proportion was explained by genetics [22]. In a related analysis of 1,098 participants, specific microbial species were associated with healthy dietary patterns

and with favourable cardiometabolic markers [23]. Variation also extends to supplements: colonisation by empirical probiotics differed markedly between individuals according to host and microbiome features, with many people resisting colonisation altogether [24].

4. Microbiome-Informed Personalised Nutrition:

The first strategy uses microbiome and other biomarker data to generate individual dietary recommendations (Table 1). In the original glycaemic-response study, a blinded randomised trial in 26 participants showed that diets personalised by the algorithm lowered postprandial glucose responses and consistently altered gut microbiota composition [20]. In 225 adults with prediabetes, a six-month personalised postprandial-targeting diet, based on an algorithm that used clinical and microbiome features, reduced daily time with glucose above 140 mg/dL by 1.3 hours compared with 0.3 hours on a Mediterranean diet, and reduced glycated haemoglobin (HbA1c) by 0.16 versus 0.08 percentage points; the between-group differences persisted at 12 months [25]. A pilot trial extended this approach to adults with newly diagnosed type 2 diabetes [26].

The largest trial to date randomised 347 adults aged 41 to 70 years in the United States to an 18-week app-based personalised dietary programme, which scored foods using individual postprandial glucose and triglyceride responses, microbiome data and health history, or to standard advice based on national dietary guidelines [27]. The programme significantly reduced triglycerides (mean difference −0.13 mmol/L) but not low-density lipoprotein (LDL) cholesterol, the other primary outcome. Body weight, waist circumference, HbA1c, diet quality and microbiome composition improved, particularly among highly adherent participants, whereas blood pressure, fasting glucose and insulin did not differ between groups.

These trials show that personalisation can improve glycaemic and some lipid outcomes, but the effects are modest, and it is difficult to separate the contribution of microbiome data from that of glucose monitoring, intensive coaching and better general diet quality. A meta-analysis of dietary interventions in type 2 diabetes concluded that tailored regimens appeared more effective than standard diets for glucose metabolism, but cautioned that samples were small and heterogeneous [28].

5. Microbiome-Targeted Dietary Interventions

The second strategy does not personalise advice but targets the microbiota directly. Prebiotics are substrates selectively used by host microorganisms that confer a health benefit [29], and probiotics are live microorganisms that confer a benefit when administered in adequate amounts [30]. In adults with type 2 diabetes, a diet high in diverse fibres selectively promoted a group of SCFA-producing bacteria and produced a greater improvement in HbA1c than standard dietary care [31]. Supplementation with pasteurised Akkermansia muciniphila for three months in overweight and obese insulin-resistant adults improved insulin sensitivity and reduced insulinaemia and total cholesterol [32].

Fermented foods offer another route. In a ten-week randomised trial in healthy adults, a diet high in fermented foods increased microbiota diversity and decreased multiple inflammatory markers, whereas a high-fibre diet did not increase diversity over the same period [33]. Whole dietary patterns also act through the microbiota. An eight-week isocaloric Mediterranean diet in overweight and obese adults lowered plasma cholesterol and changed the gut microbiome and metabolome independently of energy intake [34]. In the 18-month DIRECT-PLUS trial, a green-Mediterranean diet enriched with polyphenol-rich green tea and a plant-based protein shake produced greater reductions in intrahepatic fat than a standard Mediterranean or healthy diet [35], and more pronounced microbiome changes that were associated with weight loss and cardiometabolic improvements [36].

Responses to microbiome-targeted interventions are also heterogeneous. Single-strain probiotics in particular may fail to colonise many individuals [24], which may explain the inconsistent effects reported for some probiotic products. Interventions that supply diverse fermentable substrates or whole dietary patterns may be more robust than single agents, although direct comparisons are few.

6. Relevance to the Indian Context:

Evidence from Western populations may not translate directly to India. A multi-omics study of 110 healthy adults from Bhopal and Kerala found that the Indian gut microbiome forms a distinct cluster from those of American, Danish and Chinese populations, with Prevotella dominant in people eating plant-based, carbohydrate-rich diets and Bacteroides, Ruminococcus and Faecalibacterium more abundant in people eating omnivorous diets [37]. Given the high prevalence of dysglycaemia and dyslipidaemia in India [2], and the diversity of regional diets, the Prevotella-dominant microbiota and high-carbohydrate dietary patterns common in India may modify responses to fibre, probiotics and personalised advice. No randomised trial of microbiome-informed personalised nutrition in Indian adults has yet been reported , and such trials, using foods and dietary patterns familiar to Indian populations, are a priority.

7. Limitations of Current Evidence:

Several limitations constrain interpretation. Interventions vary widely in type, dose and duration, from algorithm-driven programmes to single-strain probiotics and whole dietary patterns, and comparators range from usual diet to structured standard advice. Most trials are small and short, and few are powered for lipid or glycaemic outcomes. Dietary intake is usually self-reported, with recognised measurement error [38]. Microbiome methods differ in sample handling, sequencing approach and analysis, host factors such as stool consistency confound community measures [39], and reporting is inconsistent [40]. Finally, personalised programmes depend on glucose monitoring, laboratory testing, sequencing and software, raising concerns about cost, scalability, equity of access and data governance.

8. Future Directions:

Future trials should be adequately powered for cardiometabolic outcomes, preregistered and at least 12 to 24 weeks long, with extended follow-up to test durability. Comparators should be active, such as guideline-based standard advice, so that the added value of personalisation can be isolated, and the personalisation algorithm, its inputs and adherence should be described in enough detail to be replicated. Microbiome methods should be reported according to the Strengthening The Organization and Reporting of Microbiome Studies (STORMS) checklist [40]. Baseline microbial predictors of response should be prespecified and validated in independent cohorts, and mediation designs should test whether microbial change precedes and explains clinical change. Trials in South Asian populations, using culturally appropriate foods and low-cost personalisation tools, are particularly needed.

9. Conclusion:

The gut microbiota helps explain why individuals respond differently to the same diet, and plausible mechanisms link microbial metabolism to glucose and lipid regulation. Personalised diets informed by microbiome and metabolic data have improved postprandial glucose, HbA1c and triglycerides in randomised trials, and fibre, fermented foods and Mediterranean-style diets alter the microbiota alongside metabolic benefits. However, effects are modest, LDL cholesterol has been largely unaffected, and it is not yet established that microbiome-informed approaches outperform well-delivered standard dietary advice. Larger, longer and more standardised trials, including in Indian populations, are needed before microbiome-informed nutrition can be recommended in routine cardiometabolic prevention.

Table 1. Selected human randomised trials of microbiome-informed and microbiome-targeted dietary interventions

Trial	Population	Intervention vs comparator; duration	Main cardiometabolic and microbiome findings
Zeevi et al. (2015) [20]	Healthy adults (n = 26, blinded trial)	Algorithm-personalised "good" vs "bad" diets; 1 week each	Personalised diets lowered postprandial glucose and consistently altered microbiota
Korem et al. (2017) [21]	Healthy adults	White bread vs sourdough wholegrain bread; crossover, 1 week each	No average difference; individual glycaemic responses predicted by baseline microbiome
Ben-Yacov et al. (2021) [25]	Adults with prediabetes (n = 225)	Personalised postprandial-targeting diet vs Mediterranean diet; 6 months	Time with glucose >140 mg/dL −1.3 vs −0.3 h/day; HbA1c −0.16 vs −0.08 percentage points; maintained at 12 months
Bermingham et al. (2024) [27]	US adults aged 41–70 years (n = 347)	App-based personalised programme (glucose, triglyceride, microbiome and health data) vs guideline-based advice; 18 weeks	Triglycerides −0.13 mmol/L; LDL cholesterol unchanged; weight, waist, HbA1c and microbiome improved
Zhao et al. (2018) [31]	Adults with type 2 diabetes	High, diverse-fibre diet vs standard care	Promoted SCFA-producing bacteria; greater HbA1c improvement
Depommier et al. (2019) [32]	Overweight/obese, insulin-resistant adults	Pasteurised Akkermansia muciniphila vs placebo; 3 months	Improved insulin sensitivity; lower insulinaemia and total cholesterol
Wastyk et al. (2021) [33]	Healthy adults	High-fermented-food vs high-fibre diet; 10 weeks	Fermented foods increased microbiota diversity and decreased inflammatory markers
Meslier et al. (2020) [34]	Overweight/obese adults	Isocaloric Mediterranean diet vs habitual diet; 8 weeks	Lower plasma cholesterol; microbiome and metabolome changes independent of energy intake
DIRECT-PLUS (2021–2022) [35,36]	Adults with abdominal obesity or dyslipidaemia	Green-Mediterranean vs Mediterranean vs healthy dietary guidelines; 18 months	Greatest reduction in intrahepatic fat; microbiome changes linked to weight and cardiometabolic improvement

HbA1c, glycated haemoglobin; LDL, low-density lipoprotein; SCFA, short-chain fatty acid. Sample sizes are given where stated in the text of the source; see original reports for full details.

References:

1. Roth GA, Mensah GA, Johnson CO, et al. Global burden of cardiovascular diseases and risk factors, 1990–2019: update from the GBD 2019 study. J Am Coll Cardiol 2020; 76(25): 2982-3021. doi:10.1016/j.jacc.2020.11.010
2. Anjana RM, Unnikrishnan R, Deepa M, et al. Metabolic non-communicable disease health report of India: the ICMR-INDIAB national cross-sectional study (ICMR-INDIAB-17). Lancet Diabetes Endocrinol 2023; 11(7): 474-89.
3. Lichtenstein AH, Appel LJ, Vadiveloo M, et al. 2021 dietary guidance to improve cardiovascular health: a scientific statement from the American Heart Association. Circulation 2021; 144(23): e472-87. doi:10.1161/CIR.0000000000001031
4. Gardner CD, Trepanowski JF, Del Gobbo LC, et al. Effect of low-fat vs low-carbohydrate diet on 12-month weight loss in overweight adults and the association with genotype pattern or insulin secretion: the DIETFITS randomized clinical trial. JAMA 2018; 319(7): 667-79. doi:10.1001/jama.2018.0245
5. Ordovas JM, Ferguson LR, Tai ES, Mathers JC. Personalised nutrition and health. BMJ 2018; 361: k2173. doi:10.1136/bmj.k2173
6. Sonnenburg JL, Bäckhed F. Diet–microbiota interactions as moderators of human metabolism. Nature 2016; 535(7610): 56-64. doi:10.1038/nature18846
7. Valdes AM, Walter J, Segal E, Spector TD. Role of the gut microbiota in nutrition and health. BMJ 2018; 361: k2179. doi:10.1136/bmj.k2179
8. David LA, Maurice CF, Carmody RN, et al. Diet rapidly and reproducibly alters the human gut microbiome. Nature 2014; 505(7484): 559-63. doi:10.1038/nature12820
9. Turnbaugh PJ, Ley RE, Mahowald MA, Magrini V, Mardis ER, Gordon JI. An obesity-associated gut microbiome with increased capacity for energy harvest. Nature 2006; 444(7122): 1027-31. doi:10.1038/nature05414
10. Ridaura VK, Faith JJ, Rey FE, et al. Gut microbiota from twins discordant for obesity modulate metabolism in mice. Science 2013; 341(6150): 1241214. doi:10.1126/science.1241214
11. Vrieze A, Van Nood E, Holleman F, et al. Transfer of intestinal microbiota from lean donors increases insulin sensitivity in individuals with metabolic syndrome. Gastroenterology 2012; 143(4): 913-6. doi:10.1053/j.gastro.2012.06.031
12. Koh A, De Vadder F, Kovatcheva-Datchary P, Bäckhed F. From dietary fiber to host physiology: short-chain fatty acids as key bacterial metabolites. Cell 2016; 165(6): 1332-45. doi:10.1016/j.cell.2016.05.041
13. Tolhurst G, Heffron H, Lam YS, et al. Short-chain fatty acids stimulate glucagon-like peptide-1 secretion via the G-protein-coupled receptor FFAR2. Diabetes 2012; 61(2): 364-71. doi:10.2337/db11-1019
14. Deehan EC, Yang C, Perez-Muñoz ME, et al. Precision microbiome modulation with discrete dietary fiber structures directs short-chain fatty acid production. Cell Host Microbe 2020; 27(3): 389-404. doi:10.1016/j.chom.2020.01.006
15. Wahlström A, Sayin SI, Marschall HU, Bäckhed F. Intestinal crosstalk between bile acids and microbiota and its impact on host metabolism. Cell Metab 2016; 24(1): 41-50. doi:10.1016/j.cmet.2016.05.005
16. Cani PD, Amar J, Iglesias MA, et al. Metabolic endotoxemia initiates obesity and insulin resistance. Diabetes 2007; 56(7): 1761-72. doi:10.2337/db06-1491
17. Pedersen HK, Gudmundsdottir V, Nielsen HB, et al. Human gut microbes impact host serum metabolome and insulin sensitivity. Nature 2016; 535(7612): 376-81. doi:10.1038/nature18646
18. Wang Z, Klipfell E, Bennett BJ, et al. Gut flora metabolism of phosphatidylcholine promotes cardiovascular disease. Nature 2011; 472(7341): 57-63. doi:10.1038/nature09922
19. Tang WHW, Wang Z, Levison BS, et al. Intestinal microbial metabolism of phosphatidylcholine and cardiovascular risk. N Engl J Med 2013; 368(17): 1575-84. doi:10.1056/NEJMoa1109400
20. Zeevi D, Korem T, Zmora N, et al. Personalized nutrition by prediction of glycemic responses. Cell 2015; 163(5): 1079-94. doi:10.1016/j.cell.2015.11.001
21. Korem T, Zeevi D, Zmora N, et al. Bread affects clinical parameters and induces gut microbiome-associated personal glycemic responses. Cell Metab 2017; 25(6): 1243-53. doi:10.1016/j.cmet.2017.05.002
22. Berry SE, Valdes AM, Drew DA, et al. Human postprandial responses to food and potential for precision nutrition. Nat Med 2020; 26(6): 964-73. doi:10.1038/s41591-020-0934-0
23. Asnicar F, Berry SE, Valdes AM, et al. Microbiome connections with host metabolism and habitual diet from 1,098 deeply phenotyped individuals. Nat Med 2021; 27(2): 321-32. doi:10.1038/s41591-020-01183-8
24. Zmora N, Zilberman-Schapira G, Suez J, et al. Personalized gut mucosal colonization resistance to empiric probiotics is associated with unique host and microbiome features. Cell 2018; 174(6): 1388-405. doi:10.1016/j.cell.2018.08.041
25. Ben-Yacov O, Godneva A, Rein M, et al. Personalized postprandial glucose response-targeting diet versus Mediterranean diet for glycemic control in prediabetes. Diabetes Care 2021; 44(9): 1980-91. doi:10.2337/dc21-0162
26. Rein M, Ben-Yacov O, Godneva A, et al. Effects of personalized diets by prediction of glycemic responses on glycemic control and metabolic health in newly diagnosed T2DM: a randomized dietary intervention pilot trial. BMC Med 2022; 20: 56. doi:10.1186/s12916-022-02254-y
27. Bermingham KM, Linenberg I, Polidori L, et al. Effects of a personalized nutrition program on cardiometabolic health: a randomized controlled trial. Nat Med 2024; 30(7): 1888-97. doi:10.1038/s41591-024-02951-6
28. Xu X, Zhang F, Ren J, et al. Dietary intervention improves metabolic levels in patients with type 2 diabetes through the gut microbiota: a systematic review and meta-analysis. Front Nutr 2024; 10: 1243095. doi:10.3389/fnut.2023.1243095
29. Gibson GR, Hutkins R, Sanders ME, et al. Expert consensus document: the International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of prebiotics. Nat Rev Gastroenterol Hepatol 2017; 14(8): 491-502. doi:10.1038/nrgastro.2017.75
30. Hill C, Guarner F, Reid G, et al. Expert consensus document: the International Scientific Association for Probiotics and Prebiotics consensus statement on the scope and appropriate use of the term probiotic. Nat Rev Gastroenterol Hepatol 2014; 11(8): 506-14. doi:10.1038/nrgastro.2014.66
31. Zhao L, Zhang F, Ding X, et al. Gut bacteria selectively promoted by dietary fibers alleviate type 2 diabetes. Science 2018; 359(6380): 1151-6. doi:10.1126/science.aao5774
32. Depommier C, Everard A, Druart C, et al. Supplementation with Akkermansia muciniphila in overweight and obese human volunteers: a proof-of-concept exploratory study. Nat Med 2019; 25(7): 1096-103. doi:10.1038/s41591-019-0495-2

33. Wastyk HC, Fragiadakis GK, Perelman D, et al. Gut-microbiota-targeted diets modulate human immune status. Cell 2021; 184(16): 4137-53. doi:10.1016/j.cell.2021.06.019
34. Meslier V, Laiola M, Roager HM, et al. Mediterranean diet intervention in overweight and obese subjects lowers plasma cholesterol and causes changes in the gut microbiome and metabolome independently of energy intake. Gut 2020; 69(7): 1258-68. doi:10.1136/gutjnl-2019-320438
35. Yaskolka Meir A, Rinott E, Tsaban G, et al. Effect of green-Mediterranean diet on intrahepatic fat: the DIRECT PLUS randomised controlled trial. Gut 2021; 70(11): 2085-95. doi:10.1136/gutjnl-2020-323106
36. Rinott E, Meir AY, Tsaban G, et al. The effects of the Green-Mediterranean diet on cardiometabolic health are linked to gut microbiome modifications: a randomized controlled trial. Genome Med 2022; 14: 29. doi:10.1186/s13073-022-01015-z
37. Dhakan DB, Maji A, Sharma AK, et al. The unique composition of Indian gut microbiome, gene catalogue, and associated fecal metabolome deciphered using multi-omics approaches. GigaScience 2019; 8(3): giz004. doi:10.1093/gigascience/giz004
38. Subar AF, Freedman LS, Tooze JA, et al. Addressing current criticism regarding the value of self-report dietary data. J Nutr 2015; 145(12): 2639-45. doi:10.3945/jn.115.219634
39. Vandeputte D, Falony G, Vieira-Silva S, Tito RY, Joossens M, Raes J. Stool consistency is strongly associated with gut microbiota richness and composition, enterotypes and bacterial growth rates. Gut 2016; 65(1): 57-62. doi:10.1136/gutjnl-2015-309618
40. Mirzayi C, Renson A, Genomic Standards Consortium, et al. Reporting guidelines for human microbiome research: the STORMS checklist. Nat Med 2021; 27(11): 1885-92. doi:10.1038/s41591-021-01552-x

Review Article: Student Innovation

Air Pollution, Iron Status and Anaemia: A Narrative Review

Aishee Ghatak[1], Arnab Chatterjee[2]

[1]Student, Department of Food & Nutrition, Asansol Girls' College, Asansol, India; [2]Assistant Professor, Department of Food & Nutrition, Asansol Girls' College, Asansol, India,

Author for Correspondence: Arnab Chatterjee, Email: arnabchatterjeenin@gmail.com, Mobile: +918801544129

Received on: 29.09.2026 **Accepted on:** 03.11.2026

ABSTRACT: Background: Almost the entire world population breathes air that exceeds World Health Organization guideline limits, and nearly a quarter of people are anaemic. Anaemia has traditionally been attributed to inadequate diet, infection and blood loss, but environmental exposures are increasingly recognised as contributors.

Aim: This narrative review summarises epidemiological evidence linking ambient and household air pollution with anaemia and iron status, and the biological mechanisms that may explain the association.

Main findings: A 2026 meta-analysis of 36 studies found that each 10 μg/m^3 increase in fine particulate matter was associated with a 20% higher risk of anaemia, with similar associations for nitrogen dioxide and household solid fuel use, although heterogeneity was very high. Indian studies link fine particulate matter to anaemia in young children and women of reproductive age. Proposed mechanisms include systemic inflammation that raises hepcidin and restricts iron availability, oxidative damage to red cells, and lead-related inhibition of haem synthesis.

Conclusion: Air pollution is a plausible, modifiable contributor to anaemia, particularly in India. Longitudinal studies with detailed iron biomarkers are needed, alongside integrated clean-air and nutrition policies.

Keywords: Particulate matter; Anemia, iron-deficiency; Hepcidins; Inflammation; Oxidative stress; Household air pollution; Hemoglobins; India

1. Introduction

Air pollution ranks as one of the primary environmental determinants affecting global health. Approximately 99% of the world's population breathes air that exceeds WHO recommended limits [1], with ambient fine particulate matter (PM2.5), measuring 2.5 μm or smaller in diameter, recognized as a significant cause of cardiovascular and respiratory ailments [2][3]. In India alone, air pollution accounted for around 1.67 million deaths in 2019—17.8% of total fatalities within the country [4]. Concurrently, anaemia is prevalent worldwide; in 2021 an estimated 1.92 billion people—24.3% of the global populace—were reported as anaemic due primarily to iron deficiency [5]. The most severely affected groups include women of reproductive age and young children residing in low- to middle-income countries [6]. According to the National Family Health Survey conducted from 2019–21 in India, an alarming prevalence rate shows that 67.1% of children aged between six months to five years are anaemic along with 57% of women aged between fifteen to forty-nine years [7]. Although traditionally attributed to inadequate dietary iron intake along with factors such as poor bioavailability or infections leading to blood loss [6][8], these explanations do not fully account for its ongoing prevalence despite decades-long supplementation efforts. Recent epidemiological research has begun investigating the potential role of air pollution as a contributor to anaemia [9–11]. Given India's high levels both for air pollution and rates of anaemia prevalence warrant urgent public health attention regarding this relationship.

This narrative review aims to collate existing epidemiological evidence linking both ambient outdoor and indoor household air pollution

with haemoglobin levels alongside implications for nutrition practice policy-making.

2 . Epidemiological Evidence

2 .1 Evidence from Systematic and Scoping Reviews: The existing body of evidence has been consolidated through various reviews (see Table 1). A systematic review published in 2021 on PM2.5's effects on haematological disorders identified only ten relevant studies but concluded that exposures lasting two to five years were linked with increased instances of anaemia among children as well as older adults [12]. A global scoping review published in early 2024 identified twenty-one studies wherein all but one found positive associations between indoor or outdoor air pollution exposure correlating with increased rates of anaemia [10]. Furthermore, a comprehensive examination conducted in late-2025 revealed that out of twenty-six observational inquiries into environmental contaminants related directly tied indoor/outdoor air quality assessments explicitly linked twenty-four cases positively towards either iron deficiency itself or associated forms thereof indicating a firm connection establishing these pollutants directly influencing health outcomes related specifically toward anemia conditions overall observed across varying demographics studied [11].

In terms quantitatively analyzing data thus far collected up until now concerning PM2·5 impacts upon human health—most notably focusing correlations surrounding risks posed—an extensive meta-analysis appearing later during year two thousand twenty-six assessed thirty-six individual investigations ultimately resulting revealing every additional increment measured at ten micrograms per cubic meter equated correspondingly yielding roughly about twenty percent upward shift chance likelihood developing anemia while likewise increases nitrogen dioxide concentrations also yielded distinct correlational correlations presenting thirteen percent greater probabilities risk ratios respectively showing similar patterns emerging amongst other studied variables initially mentioned above—household utilization solid fuel sources further adding complexity dimensions seen throughout findings examined herein amongst various socioeconomic strata explored further detailed analyses thereafter being suggested considered necessary moving forward thoroughly required collect more varied datasets thereby enhancing understanding mechanisms underlying interactions perceived impacting overall populations examined closely throughout this literature examined henceforth conclusively derived insights previously articulated herein prior sections presented above quite thoroughly succinctly articulating core components integral underpinning discussions held perpetually revolving around these fundamental issues presently occurring globally today.

2.2 Evidence from India: Several large Indian studies support these findings. Using National Family Health Survey 2015–16 data with satellite-derived exposure estimates, each 10 μg/m^3 increase in average PM2.5 exposure from birth was associated with 9% higher odds of anaemia (odds ratio 1.09, 95% CI 1.06 to 1.11) and a 0.14 g/dL lower haemoglobin concentration in children under five years [13]. In women of reproductive age, each 10 μg/m^3 increase in PM2.5 was associated with a 7.23% increase in average anaemia prevalence; sulfate and black carbon components showed stronger associations than organic matter and dust, and meeting national clean-air targets was projected to reduce anaemia prevalence in this group from 53% to 39.5% [14].

Household air pollution from cooking with solid fuels is also relevant in India. In an analysis of 29,768 children aged 0–35 months from the 1998–99 National Family Health Survey, use of biofuels such as wood, dung and crop residues was associated with a higher risk of moderate-to-severe anaemia (relative risk ratio 1.58, 95% CI 1.28 to 1.94), and about 31% of moderate-to-severe anaemia in children aged 6–35 months was

estimated to be attributable to biofuel smoke [15].

2.3 Evidence from Other Populations: Associations have been reported in diverse settings. Among 139,368 children aged 6–59 months in Lima, Peru, higher outdoor PM2.5 concentrations were associated with moderate-to-severe anaemia [16]. Among 10,611 older adults in China, an interquartile-range increase in three-year average PM2.5 was associated with an 11% higher prevalence of anaemia and lower haemoglobin [17]. In a prospective UK Biobank analysis, each 10 μg/m^3 increase in PM2.5 was associated with a higher risk of incident iron-deficiency anaemia (hazard ratio 2.00, 95% CI 1.71 to 2.33), with smaller associations for NO2 and PM10 [18]. The consistency of findings across countries with very different pollution sources and dietary patterns strengthens the case for a real association, although residual confounding cannot be excluded.

2.4 Evidence by Pollutant: PM2.5 has the strongest and most consistent evidence [9,11]. Evidence for NO2 is growing, whereas evidence for sulfur dioxide and ozone is limited and inconsistent. Carbon monoxide acts differently: it binds haemoglobin to form carboxyhaemoglobin and impairs oxygen delivery [19], producing functional hypoxia without necessarily altering iron status. Airborne lead, historically from leaded petrol and still emitted by some industries, inhibits haem synthesis and is associated with anaemia, although evidence on its relationship with iron deficiency is mixed [11,20].

3. Biological Mechanisms:

3.1 Systemic Inflammation and Hepcidin: Inhaled PM2.5 provokes pulmonary and systemic inflammation, with release of cytokines such as interleukin-6 (IL-6) [3]. IL-6 induces hepatic synthesis of hepcidin, the master regulator of iron homeostasis [21]. Hepcidin degrades the iron exporter ferroportin, reducing intestinal iron absorption and trapping iron in macrophages and hepatocytes [22]. The result is functional iron deficiency: iron stores may be adequate, but iron is unavailable for red cell production, as in anaemia of inflammation [23]. This pathway may explain why some studies report low haemoglobin with normal or raised ferritin, which acts as an acute-phase protein as well as an iron-store marker. However, few epidemiological studies have measured hepcidin directly in relation to air pollution, and this mechanism remains largely inferred [11].

3.2 Oxidative Stress and Disrupted Iron Handling: Particulate matter generates reactive oxygen species, both directly through transition metals and organic compounds on particle surfaces and indirectly through inflammatory cells [24]. Experimental evidence shows that particles can complex iron from host cells, prompting cellular iron import and redistribution that produces a functional iron deficiency in exposed tissues [25]. Oxidative stress may also damage red cell membranes and shorten red cell survival; PM2.5 suspensions induced haemolysis in vitro, although this has not been confirmed in humans [11].

3.3 Heavy Metals: Lead inhibits δ-aminolevulinic acid dehydratase and ferrochelatase, enzymes of the haem synthesis pathway, and shortens red cell lifespan [20]. Iron deficiency increases intestinal absorption of lead and cadmium, so the two problems may reinforce each other, and cadmium reduces intestinal iron uptake in animal studies [11].

3.4 Interaction with Nutritional Status: In populations with low dietary iron and poor bioavailability, such as many Indian communities, any further restriction of iron absorption by inflammation may tip marginal iron status into anaemia [6]. Deficiencies of vitamin A, vitamin C and zinc, which are common in the same populations, may further impair iron utilisation. Women of reproductive age and young children, who already have high iron requirements, are therefore likely to be most vulnerable [13,14]. This combined burden

suggests that iron supplementation alone may be less effective in highly polluted settings.

4. Limitations of Current Evidence:

Most studies are cross-sectional or ecological, so the direction and causality of associations cannot be established. Exposure is usually estimated at area level from satellite or monitoring data, which does not capture individual exposure, indoor sources or time spent in different places. Few studies distinguish iron-deficiency anaemia from other forms of anaemia, and few measure ferritin, transferrin saturation, soluble transferrin receptor or hepcidin; ferritin itself is difficult to interpret in the presence of inflammation. Confounding by socioeconomic status, diet, infection and access to health care is a major concern, because poorer households often face both higher pollution exposure and poorer nutrition. Finally, heterogeneity between studies is very high [9], and publication bias cannot be ruled out.

5.Implications for Practice, Policy and Research:

For nutrition practice, the evidence suggests that anaemia assessment in polluted settings should consider environmental exposures, including household cooking fuel, alongside dietary intake. Ferritin should be interpreted together with an inflammatory marker such as C-reactive protein. Dietary counselling should continue to emphasise iron-rich foods and enhancers of absorption such as vitamin C, while recognising that diet alone may not correct anaemia where inflammation restricts iron availability.

For policy, the projection that meeting India's clean-air targets could substantially reduce anaemia in women of reproductive age [14] suggests that air-quality measures should be considered part of anaemia control. Programmes such as Anaemia Mukt Bharat could be linked with clean-cooking initiatives and air-quality programmes For research, longitudinal cohorts with individual-level exposure assessment and comprehensive iron biomarkers, including hepcidin, are needed to establish causality and mechanisms. Intervention studies, such as trials of clean cooking fuels or household air purifiers with haemoglobin and iron-status outcomes, would provide stronger evidence. Studies should also examine whether pollution modifies the response to iron supplementation and fortification, and identify which particle components and sources matter most.

6. Conclusion:

Accumulating epidemiological evidence, including a meta-analysis of 36 studies and large Indian surveys, links exposure to PM2.5, NO2 and household solid-fuel smoke with lower haemoglobin and a higher risk of anaemia. Inflammation-driven increases in hepcidin, oxidative stress and lead toxicity provide plausible mechanisms, although direct evidence on iron biomarkers is limited and most studies are observational. In countries such as India, where high air pollution and high anaemia prevalence coincide, air pollution should be considered a potentially modifiable contributor to anaemia, and integrating clean-air and nutrition policies may help reduce the anaemia burden.

References:

1. 1World Health Organization. Billions of people still breathe unhealthy air: new WHO data [news release]. Geneva: World Health Organization; 4 April 2022. Available from: https://www.who.int/news/item/04-04-2022-billions-of-people-still-breathe-unhealthy-air-new-who-data
2. Pope CA 3rd, Dockery DW. Health effects of fine particulate air pollution: lines that connect. J Air Waste Manag Assoc 2006; 56(6): 709-42.
3. Brook RD, Rajagopalan S, Pope CA 3rd, et al. Particulate matter air pollution and cardiovascular disease: an update to the scientific statement from the American Heart Association. Circulation 2010; 121(21): 2331-78.
4. India State-Level Disease Burden Initiative Air Pollution Collaborators. Health and economic impact of air pollution in the states of India: the Global Burden of Disease Study 2019. Lancet Planet Health 2021; 5(1): e25-38.
5. GBD 2021 Anaemia Collaborators. Prevalence, years lived with disability, and trends in anaemia burden by severity and cause, 1990–2021: findings from the Global Burden of Disease Study 2021. Lancet Haematol 2023; 10(9): e713-34.
6. Balarajan Y, Ramakrishnan U, Ozaltin E, Shankar AH, Subramanian SV. Anaemia in low-income and middle-income countries. Lancet 2011; 378(9809): 2123-35

7. International Institute for Population Sciences (IIPS), ICF. National Family Health Survey (NFHS-5), 2019–21: India. Mumbai: IIPS; 2021.
8. Camaschella C. Iron-deficiency anemia. N Engl J Med 2015; 372(19): 1832-43.
9. Dinh CT, Lee YL, Chang LT, et al. Assessing the impact of air pollution on anemia: a comprehensive review and meta-analysis. Expert Rev Hematol 2026; 19(5): 529-38. doi:10.1080/17474086.2026.2643325
10. Exposure to air pollution as a risk factor for anaemia: a global scoping review. Int J Environ Health Res 2024: 1-13. doi:10.1080/09603123.2024.2327532
11. Lichtler R, Cowley M. Environmental contaminants, iron deficiency, and iron-deficiency anemia: a review of the literature. Scientifica (Cairo) 2025; 2025: 5007983. doi:10.1155/sci5/5007983
12. Fongsodsri K, Chamnanchanunt S, Desakorn V, et al. Particulate matter 2.5 and hematological disorders from dust to diseases: a systematic review of available evidence. Front Med (Lausanne) 2021; 8: 692008. doi:10.3389/fmed.2021.692008
13. Mehta U, Dey S, Chowdhury S, Ghosh S, Hart JE, Kurpad A. The association between ambient PM2.5 exposure and anemia outcomes among children under five years of age in India. Environ Epidemiol 2021; 5(1): e125. doi:10.1097/EE9.0000000000000125
14. Chaudhary E, Dey S, Ghosh S, et al. Reducing the burden of anaemia in Indian women of reproductive age with clean-air targets. Nat Sustain 2022; 5(11): 939-46. doi:10.1038/s41893-022-00944-2
15. Mishra V, Retherford RD. Does biofuel smoke contribute to anaemia and stunting in early childhood? Int J Epidemiol 2007; 36(1): 117-29.
16. Morales-Ancajima VC, Tapia V, Vu BN, Liu Y, Alarcón-Yaquetto DE, Gonzales GF. Increased outdoor PM2.5 concentration is associated with moderate/severe anemia in children aged 6–59 months in Lima, Peru. J Environ Public Health 2019; 2019: 6127845.
17. Elbarbary M, Honda T, Morgan G, et al. Ambient air pollution exposure association with anaemia prevalence and haemoglobin levels in Chinese older adults. Int J Environ Res Public Health 2020; 17(9): 3209.
18. Li L, Ran Y, Zhuang Y, et al. Risk analysis of air pollutants and types of anemia: a UK Biobank prospective cohort study. Int J Biometeorol 2024. PMID: 38607561.
19. Weaver LK. Carbon monoxide poisoning. N Engl J Med 2009; 360(12): 1217-25.
20. Flora G, Gupta D, Tiwari A. Toxicity of lead: a review with recent updates. InterdiscipToxicol 2012; 5(2): 47-58.
21. Nemeth E, Rivera S, Gabayan V, et al. IL-6 mediates hypoferremia of inflammation by inducing the synthesis of the iron regulatory hormone hepcidin. J Clin Invest 2004; 113(9): 1271-6.
22. Ganz T, Nemeth E. Hepcidin and iron homeostasis. BiochimBiophys Acta 2012; 1823(9): 1434-43.
23. 23. Weiss G, Ganz T, Goodnough LT. Anemia of inflammation. Blood 2019; 133(1): 40-50.
24. 24. Kelly FJ. Oxidative stress: its role in air pollution and adverse health effects. Occup Environ Med 2003; 60(8): 612-6.
25. 25. Ghio AJ, Soukup JM, Dailey LA, Madden MC. Air pollutants disrupt iron homeostasis to impact oxidant generation, biological effects, and tissue injury. Free Radic Biol Med 2020; 151: 38-55.
26.

Table 1. Selected reviews and large studies on air pollution and anaemia

Study	Design and population	Exposure	Main finding
Dinh et al. (2026) [9]	Meta-analysis of 36 studies	PM2.5, NO2, PM10, solid and biomass fuel	Anaemia RR 1.20 per 10 μg/m³ PM2.5; RR 1.13 per 10 μg/m³ NO2; $I^2 > 80\%$
Lichtler and Cowley (2025) [11]	Literature review of environmental contaminants	Air pollution, lead, cadmium	24 of 26 air pollution studies linked to iron deficiency or iron-deficiency anaemia
Scoping review (2024) [10]	Global scoping review, 21 studies	Indoor and outdoor air pollution	All but one study reported a positive association with anaemia
Fongsodsri et al. (2021) [12]	Systematic review, 10 studies	PM2.5	Anaemia in children and older adults after 2–5 years of exposure
Mehta et al. (2021) [13]	Indian children under 5 years (NFHS-4)	Ambient PM2.5 (satellite)	OR 1.09 for anaemia and −0.14 g/dL haemoglobin per 10 μg/m³
Chaudhary et al. (2022) [14]	Indian women aged 15–49 years	Ambient PM2.5 and components	+7.23% anaemia prevalence per 10 μg/m³; clean-air targets projected to cut prevalence from 53% to 39.5%
Mishra and Retherford (2007) [15]	29,768 Indian children aged 0–35 months (NFHS-2)	Household biofuel smoke	RRR 1.58 for moderate-to-severe anaemia
Elbarbary et al. (2020) [17]	10,611 older adults, China	Ambient PM2.5	11% higher anaemia prevalence per IQR increase
Li et al. (2024) [18]	UK Biobank prospective cohort	PM2.5, NO2, PM10	HR 2.00 for iron-deficiency anaemia per 10 μg/m³ PM2.5

PM2.5 and PM10, particulate matter with aerodynamic diameter ≤2.5 μm and ≤10 μm; NO2, nitrogen dioxide; RR, risk ratio; OR, odds ratio; RRR, relative risk ratio; HR, hazard ratio; IQR, interquartile range; NFHS, National Family Health Survey.

About DAY:

'Diabetes Awareness and You (DAY)' is a not-for-profit social welfare Organization. Since its inception in 2006, we have been instrumental in conducting a slew of initiatives in building up public awareness about prevention and management of Diabetes, conducting school awareness programs, adopting and conducting diabetes camps in villages, live workshops among communities, providing free insulin /medicines/tests to those who cannot afford treatment. We have also initiated the idea to establish the role of Diabetes Educators in our society and dedicate "5th September" as International Diabetes Educator's Day (IDED) since 2016 (launched by the then IDF President) and organizing DAYDEIC (DAY Diabetes Educator's International Conference) annually. The THEME of IDED (2022-26) is: 'Access to Diabetes Education for ALL'. To establish the role of Diabetes Educators in our society and to recognize their importance, we have also instituted the award of 'Best Indian Diabetes Educator of the year' since 2019-20.This year we have completed our **19** years of glorious journey. Please visit us at www.day.org.in and at FB www.facebook.com/day.org.in.

About NAWT:

Nurture Academy Welfare Trust (NAWT), a nonprofit organization established in 2020 in West Bengal, is dedicated to empowering marginalized communities through sustainable initiatives in education, health, hygiene, and environmental development. Guided by the vision of fostering long-term positive change through value-based education and social awareness, NAWT strives to democratize access to education and employability, nurturing sustainable community growth for a peaceful and inclusive world where every child can realize their full potential. NAWT believes that education is the lighting of a fire—an ignited lamp that can kindle countless others—guided by the spirit of innovation to "Learn to Teach, Learn to Earn," and "Connect Dream with Emotion." Please visit for more details: www.nurtureacademywelfaretrust.co.in

গর্ভবতী হবেন যিনি; দেখতেই হবে তাঁর চিনি

POSITIVELY TEST BLOOD SUGAR; BEFORE PREGNANT YOU ARE

इससे पहले गर्वोबती हो; मधुमेह का जंच जोरूर करो

WORLD DIABETES DAY

Early Action on Diabetes

DIABETES AWARENESS & YOU
Combat the silent killer

বয়েস হলে ২৫ বছর; ব্লাড সুগার টেস্ট প্রতিবছর

ANNUALLY TEST BLOOD SUGAR; ONCE 25+ YOU ARE

उमरे हे पोचिस साल; मधुमेह का जंच हर साल

UpDAYtes

ISSN : 2839-6642

International Journal for Multidisciplinary Research and Innovation

Published by 'Diabetes Awareness & You (DAY)' in collaboration with 'Nurture Academy Welfare Trust (NAWT)'

Web: www.updaytes.org Email: updaytesjournal@gmail.com

Editor-in-Chief: Prof. (Dr.) Satinath Mukhopadhyay

This bi-annual journal aims to publish:

· Quality research that advances understanding of the complex biological, environmental, behavioral, and social determinants of metabolic health including obesity and diabetes.

· The journal adopts a multidisciplinary approach, integrating perspectives from nutrition science, metabolism, physiology, public health, behavioral sciences, clinical medicine, genetics, and policy research to address the growing global challenges related to metabolic disorders and nutrition-related diseases.

Join Us Today

Authors

Submit your latest research or review article and contribute to impactful knowledge

Editorial Board

Collaborate with experts and be part of the journey of this innovative journal

Reviewers

Lend your valued expertise and help us to maintain highest standard

Next Issue: 14th May, 2027

Last Date of Submission : 15th March, 2027

Submit Your Article Now

updaytesjournal@gmail.com