ISSN-0976-0245 (Print) • ISSN-0976-5506 (Electronic)

Volume 17 | Number 3 | July-September 2026

# Indian Journal of Public Health Research & Development

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**Print-ISSN**: 0976-0245-Electronic- ISSN: 0976-5506, Frequency: Quarterly

**Website : www.ijphrd.com**



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Published at

**Institute of Medico-legal Publications Pvt**
**Logix Office Tower, Unit No. 1704, Logix City Centre Mall ,Sector- 32, Noida - 201 301 (Uttar Pradesh)**

Indian Journal of Public Health Research and Development

IJPHRD Vol 17 No 3 July-September 2026

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*DOI: https://doi.org/10.37506/2r75b906*

# Integrating Clinical Trials into Clinical Care: Aligning Patient and Physician Perspectives

**Avni Tambi[1], Rhea Aggarwal[2], Adarsh Keshari[3], Khushboo Sharma[4]**

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**How to cite this article**: Avni Tambi, Rhea Aggarwal, Adarsh Keshari et. al. Integrating Clinical Trials into Clinical Care: Aligning Patient and Physician Perspectives. Indian Journal of Public Health Research and Development / Vol. 17 No. 3, July-September 2026.

## Abstract

**Background:** Clinical trials have traditionally been framed as experimental tools rather than therapeutic options, and the doctor-patient relationship has largely been paternalistic. The emergence of precision medicine and the shift toward patient-centred care challenge this dichotomy, suggesting that clinical trials could be considered part of routine treatment pathways. This perspective is particularly relevant in low- and middle-income countries, where clinical trials may represent a critical pathway to access care.

**Methods:** A narrative synthesis of published literature was conducted to examine patient and physician perspectives on clinical trials when offered as treatment choices. Evidence was analysed to identify key motivators, barriers, and areas of alignment and divergence between patients and physicians.

**Results:** Patients value access to advanced therapies, close monitoring, and a sense of hope, while physicians emphasise therapeutic innovation and ethical responsibility. Barriers include therapeutic misconception, limited clinician awareness, workload constraints, and logistical challenges. Despite these obstacles, both groups support transparent discussion of clinical trials within clinical care.

**Conclusion:** Integrating clinical trials into treatment frameworks, with informed patients and physicians, ethical safeguards, and institutional support, can make them a legitimate and patient-centred treatment option.

**Keywords:** Clinical trials; patient-centred care; therapeutic misconception; treatment options; shared decision-making, patients and clinical trials, investigator driven trials.

## Introduction

Clinical trials occupy a unique position at the intersection of scientific research and therapeutic care. Historically, they have been presented to patients as experiments, distinct from routine treatment- a divide evident even in early research endeavours-

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**Submission date:** December 31, 2025 **Revision date:** February 4, 2026 **Published date:** June 29, 2026

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such as Jenner's smallpox vaccine trial[1]. Modern medicine increasingly recognises that patients often perceive participation as a means to access advanced care, particularly in conditions with limited or ineffective standard treatments[2]. Clinical trials as a care option refers to offering eligible patients trial participation as one of several legitimate treatment pathways within routine clinical decision making, rather than treating research and care as separate entities[3]. This is especially true in context of rare diseases, oncology, and precision medicine where the line separating research and treatment becomes blurred[4]. The shift from paternalistic models of healthcare to participatory care has furthered the narrative that doctors should disclose all possible treatment options- which includes- clinical trials[5].

In low- and middle-income countries (LMICs), including India, public health systems are constrained by limited access to novel therapies, uneven specialist availability, and high out of pocket expenses, which makes the concept of clinical trials as a care option particularly relevant[6]. For many patients, prominently those with cancer, rare diseases, or refractory conditions, clinical trials may represent the only feasible pathway to advanced diagnostics, multidisciplinary expertise, and newer therapeutic agents.

In India, patient advocacy organisations and non-governmental groups have increasingly supported disease-specific registries and community-driven data collection initiatives for rare diseases. These efforts facilitate participant identification for clinical trials, natural history studies, evaluation of emerging therapies and help position well-designed clinical trials as legitimate care pathways for patients with progressive or life-limiting rare disorders (Lysosomal Storage Disorders Support Society - https://lsdssindia.org/ and CureSMA- https://www.curesmaindia.org/.)

As patient centricity takes centre stage, patients are increasingly recognised as equal stakeholders in healthcare decision-making. When patients are fully informed and empowered to choose treatment options that align with their values and preferences-including whether to participate in a clinical trial-engagement and retention in trials are naturally improved. Despite this shift, patient enrolment and retention remain major challenges in clinical research: approximately 55% of clinical trials terminate due to low accrual, and globally more than 80% of trials fail to enrol participants on time[7]. Informing eligible patients about clinical trials early in the care pathway and presenting trials as a legitimate treatment option is therefore likely to enhance enrolment and retention[8].

Although the role of clinical trials as a potential care option has long been debated there is limited synthesis of how patients and physicians respectively understand and evaluate this approach[2,9]. This narrative review presents a consolidated perspective on how patients and physicians view clinical trials when framed as treatment options.

## Materials and Methods

A **narrative literature review with a perspective framework** was conducted to identify studies examining patient and physician perceptions of clinical trials within the context of clinical care. Databases searched included PubMed and Google Scholar using combinations of the terms: *"clinical trials as care," "clinical trials as treatment options," "patient perceptions," "doctor attitudes," "therapeutic misconception," "trial access," "motivators,"* and *"barriers."* Studies were included if they reported clinician or patient views on clinical trials offered as part of clinical care or discussed factors influencing the acceptance, recommendation, or uptake of trials in this context. The literature included in this review encompasses studies published from 1987 to 2025, providing historical and contemporary perspectives, with emphasis on diverse health-system settings including LMICs.

Findings were synthesised thematically under four domains: (1) motivators, (2) barriers, (3) alignment, and (4) divergence between patient and clinician perspectives. Given the narrative nature of this review, **no formal quality assessment or meta-analysis was undertaken**.

## Results

### 1. Motivators

#### Patient motivators

Patients perceive clinical trials offered as care options as opportunities to access advanced therapies,

better care and enhanced clinical oversight that may not be available through standard care[10]. Motivators include access to close monitoring, structured follow-up, advanced diagnostics, and multidisciplinary expertise, which collectively enhance perceived quality of care[11].

For individuals with limited treatment options-such as those with orphan diseases or advanced cancers, trials provide hope and meaningful therapeutic opportunities[12]. Trust in the treating clinician strongly influences participation, particularly when trials are framed as legitimate treatment pathways. Additional motivators include altruism, the desire to contribute to scientific advancement, improved health literacy, and a sense of empowerment through active engagement in decision-making[13].

Evidence from India and other LMICs suggests that patient motivation to participate in clinical trials is frequently shaped by structural and economic considerations alongside therapeutic hope. Access to free or subsidised investigations, medications, and specialist care is a significant motivator, particularly where out-of-pocket expenditure remains high [14].

These motivations are not uniform and vary by disease severity, socioeconomic status, and prior healthcare experiences.

**Physician motivators**

Physicians view clinical trials as care options for a range of reasons grounded in both clinical practice and ethical responsibility. Therapeutic innovation remains a central motivator, as trials allow clinicians to offer cutting-edge or personalised therapies when standard treatment pathways are inadequate or exhausted[15].

Ethical considerations further support this approach; under conditions of clinical equipoise, several authors argue that offering trial participation is a moral and professional obligation, emphasising that research and clinical care need not exist in opposition[16,17].

Additional motivators include the ability to provide patients with enhanced diagnostic resources, multidisciplinary expertise, and closer monitoring, opportunities for professional development, institutional expectations that encourage research referrals and the desire to contribute to future standards of care[18–20].

In India and other LMICs, physician motivation to offer clinical trials is also shaped by health-system constraints and limited resources. Clinicians may view trials as ways to provide patients access to otherwise unaffordable diagnostics, treatments, and specialist care. In tertiary centres, academic clinicians often see trials as a means to introduce contemporary medical advances while supporting capacity building, professional development, and strengthening local research ecosystems [21].

**2. Barriers**

**Patient barriers**

Despite recognising potential benefits, patients face multiple barriers when considering clinical trials as clinical care options. Therapeutic misconception remains a key challenge, with patients conflating research with individualized medical care. They may believe trial participation guarantees experimental treatment or clinical benefit, leading to overestimation of cure or improvement and viewing trials as superior therapy rather than a research endeavour[22]. Unmet expectations were associated with disappointment, regret, and betrayal, alongside retrospective desires for clearer communication and greater opportunity to ask questions at enrolment[23].

Concerns about randomisation and loss of control over treatment decisions often deter patients, who may prefer established therapies even when options are limited[24]. Logistical and financial constraints- travel, frequent hospital visits, and out-of-pocket expenses-continue to impede participation, particularly in low- and middle-income settings[25].

Acceptance is also shaped by social stigma and fear of experimentation, reinforced by limited trial literacy, distrust of research organisations, and apprehension about unknown risks or side-effects(24). Family opposition, along with cultural or religious reservations, can strongly influence decision-making (26). Additionally, patients may perceive trial participation as disruptive to work, while uncertainties about insurance coverage, management of complications, or post-trial access

further erode confidence in accepting trials as part of routine care[27].

In LMICs, patient perceptions are also shaped by historical and societal narratives. In the early 2000s, sections of mainstream media portrayed clinical research as unethical experimentation, often labelling participants as "guinea pigs." Such narratives, widely circulated in influential outlets fuelled misinformation, fear, and mistrust, effects that have taken years of regulatory reform and patient education to partially reverse[28]. Limited trial literacy, financial insecurity, loss of daily wages, travel to tertiary centres, and concerns about post-trial access are particularly salient in India. Family-centred decision-making further highlights how patient reluctance is often rooted in broader socioeconomic vulnerability [29].

**Physician barriers**

Even when clinicians recognise the value of clinical trials, several systemic, practical, and perceptual barriers limit their integration into routine care. Limited awareness of ongoing trials, eligibility criteria, and referral pathways reduces physician confidence in offering trials, compounded by time constraints in busy clinical settings [30]. Institutional and administrative hurdles such as absence of infrastructure for trial referral, complex documentation requirements, and fragmented communication between clinical and research teams further discourage trial discussions[31].

Physicians may also fear loss of clinical control, particularly when referring patients to external trial sites, raising concerns about continuity of care and patient retention [32]. Scepticism about the relevance or safety of certain trials, especially early-phase or high-risk studies, leads some clinicians to favour standard care over experimental options [33].

Lack of incentives, institutional recognition, formal guidelines, and concerns about therapeutic misconception further reduce motivation to actively recommend trials [18].

In LMIC settings, these challenges are amplified by high patient volumes, limited consultation time, and insufficient institutional support, including shortages of dedicated research staff and fragmented trial information systems. Regulatory complexity, unclear referral mechanisms, and concerns about follow-up and post-trial continuity- particularly for trials conducted at distant tertiary centres- further deter clinician engagement [34].

**3. Areas of Alignment**

Patients and physicians demonstrate important areas of alignment when clinical trials are framed as care options. Both share an underlying optimism that trials may offer meaningful therapeutic opportunities, especially where standard treatments are limited such as rare cancers or orphan diseases[35,36]. There is also widespread agreement that trials should be presented transparently and integrated into shared decision making, rather than being reserved solely for "research purposes." [17,37].

Furthermore, both groups acknowledge the importance of personalisation, viewing clinical trials as increasingly aligned with precision medicine and individualised care pathways[4]. Altruism and contribution to scientific progress are recognised as legitimate motivations from both perspectives, reinforcing the broader societal value of trial participation[18,35].

Trust-based clinician-patient relationships are central to healthcare delivery worldwide and are particularly influential in India, where strong reliance on physician guidance supports convergence around transparent clinical trial discussions. Additionally, both groups also agree on the importance of ethical safeguards, voluntariness, and clear communication, reflecting growing awareness of research ethics and patient rights in India . [33,38].

Finally, both groups prefer that trial conversations originate from the primary treating clinician, reflecting the centrality of trust and continuity of care in decisions surrounding trial participation[39].

**4. Areas of Divergence**

Despite shared perspectives, patients and physicians diverge in several key ways when clinical trials are framed as care options. A key divergence concerns the *timing*: patients prefer early, proactive disclosure of relevant studies to support autonomy and preparedness, whereas clinicians often introduce trial later in the disease trajectory to avoid information

overload, false hope, or to reserve trials for situations of limited therapeutic alternatives. [40,41].

Unclear expectations from trials further separates perspectives, patients may assume that enrolment guarantees more comprehensive oversight, whereas clinicians recognise that this varies from trial to trial[42,43].

Emotional versus analytical framing further separates perspectives, with patients often being driven by hope, fear, or urgency, and physicians relying more on statistical reasoning and clinical evidence[44].

Additionally, perceptions of conflict of interest diverge: while some patients worry that the trial recommendations are influenced by physician or institutional incentives, physicians consider their decision to offer clinical trials to patients to be largely unbiased and rooted in patient welfare[45]. Relatedly, physicians may underestimate how their authority can feel coercive to patients[46]. Difference in understanding trial eligibility persists as well, with patients sometimes interpreting ineligibility as a denial of care, whereas physicians view it as a necessary scientific safeguard[47].

In LMIC settings, divergences between patient and physician perspectives may be further shaped by socioeconomic constraints, traditionally hierarchical healthcare relationships, and differing priorities around feasibility, cost relief, and access. These highlight enduring structural and emotional divides in integrating trials into clinical care.

## Discussion

The findings highlight an evolving landscape in which clinical trials are increasingly intertwined with clinical care with both patients and physicians acknowledging potential therapeutic value, particularly in diseases with few effective treatments[35,36]. Yet systemic limitations, ranging from logistical burdens to clinician awareness gaps, prevent clinical trials from being offered consistently as care options[25,30,48].

From an ethical standpoint, discussing trials alongside conventional treatments aligns with the principles of patient-centred care and informed decision making [17]. Achieving this responsibly requires clinicians to be adequately informed about relevant trials and supported by institutional structures that facilitate transparent communication, protect voluntariness, and minimise therapeutic misconception.

In India and other LMICs, improving patient engagement with clinical trials requires coordinated systemic interventions. Although national trial registries such as the Clinical Trials Registry of India (CTRI- https://ctri.nic.in ) are well established, limited clinician awareness and routine utilisation remain significant gaps. Strengthening clinician familiarity with existing registries through targeted training, integration of registry information into clinical workflows, and the use of decision-support tools-alongside protected time for research-related discussions-can improve trial visibility and consideration at the point of care. Simplifying referral pathways and integrating research coordinators within clinical teams may reduce administrative burden and support continuity of care. At the patient level, culturally appropriate education materials, use of local languages, and involvement of patient advocacy organisations can enhance trial literacy and trust. Policy measures that address reimbursement for trial-related travel, compensation for wage loss, and clarity on post-trial access to effective interventions are also critical to ethically sustaining participation. Collectively, these strategies emphasise that patient engagement in LMICs depends not only on communication, but on the health-system design[49].

As clinical trials increasingly overlap with care, greater emphasis is needed on structures that support timely, informed, and ethically sound trial discussions, including clinician education and improved access to trial information. Policymaking that promotes transparency, consistency in trial offering, and protection of patient autonomy may help ensure that research opportunities are integrated into care in a way that is both equitable and patient-centred.

Integrating clinical trials into routine conversations should not be seen as urging every patient toward research. Rather, it ensures that patients are given the chance to make informed decisions and that access to potential therapeutic opportunities is not left to chance or geography. As

precision medicine evolves, the line between research and treatment will continue to blur. In that context, recognising clinical trials as part of the broader care landscape becomes not only relevant but essential to patient-centric care.

Patient Advocates for Clinical Research (PACER) India (https://pacercankidsindia.org/), a coalition of over 35 patient advocacy organisations spanning cancer and rare diseases, supports the considered inclusion of clinical trials as potential care options when clinically appropriate. Framing trials transparently alongside standard treatments reinforces shared and informed decision-making between clinicians and patients, a cornerstone of patient-centred care, while promoting equitable access to emerging therapeutic opportunities without compromising ethical standards.

This review is limited by its narrative design and reliance on heterogeneous literature, which precludes formal quality assessment or quantitative synthesis. Much of the existing evidence is derived from oncology and high-income settings, with comparatively limited data from low- and middle-income countries and non-oncology disciplines. Future research should focus on prospective, context-sensitive studies that evaluate patient outcomes, ethical safeguards, and clinician workflows when trials are integrated into routine care discussions. Greater attention is also needed to develop practical frameworks, educational interventions, and institutional policies that support consistent, informed, and equitable trial offering in clinical practice

## Conclusion

Patient and physician perspectives indicate that clinical trials can reasonably be framed as treatment options when discussed transparently and supported by ethical safeguards. Despite shared support for transparent and ethical discussion, practical, informational, and structural barriers continue to limit their consistent integration into routine practice. Strengthening clinician awareness, reducing logistical barriers, and improving communication can enable trials to be integrated into routine counselling. This integration is particularly consequential in LMICs, where clinical trials may serve as a critical bridge between constrained health systems and access to emerging therapies. Looking ahead, policies that support trial visibility, equitable access, and clinician engagement, alongside future research on ethical integration of trials into care pathways, will be critical to sustaining patient-centred clinical practice.

**Acknowledgements:** The authors would like to acknowledge the team at APAR Health for their support and contributions through the SPARK Program. (https://aparhealth.co.in/)

**Funding Sources:** None

**Ethical Clearance:** Not required

**Declaration of conflicts of interest:** Authors declare no conflict of interests.

## References

1. Riedel S. Edward Jenner and the history of smallpox and vaccination. Proc (BaylUniv Med Cent). 2005 Jan;18(1):21–5.
2. Ferrell B, Williams AC, Borneman T, Chung V, Smith T. Clinical Trials: Understanding Patient Perspectives and Beliefs About Treatment. Clin J Oncol Nurs. 2019 Dec 1;23(6):592–8.
3. Van de Beek H. Clinical research as a care option: optimizing approaches. Appl Clin Trials [Internet]. 2019 Jun;32–5.
4. Li A, Bergan RC. Clinical trial design: Past, present, and future in the context of big data and precision medicine. Cancer. 2020 Nov 15;126(22):4838–46.
5. Bagai P, Sharma P, Ansari A, Singh N, Sharma S, Singh P, et al. Patient Advocates for Clinical Research (PACER): A Step Toward Ethical, Relevant, and Truly Participatory Clinical Research in India. Cureus. 2024 Apr;16(4):e58454.
6. Grover S, Xu M, Jhingran A, Mahantshetty U, Chuang L, Small W, et al. Clinical trials in low and middle-income countries - Successes and challenges. Gynecol Oncol Rep. 2017 Feb;19:5–9.
7. Desai M. Recruitment and retention of participants in clinical studies: Critical issues and challenges. Perspect Clin Res. 2020;11(2):51–3.
8. Pan M, Lee ATC, Seaward SA, Ilano A, House K, Duran E, et al. Impact of early engagement of patients with clinical trial information in a system-based multidisciplinary breast cancer clinic on clinical trial enrollment. Journal of Clinical Oncology. 2012 Dec 1;30(34_suppl):149–149.

9. Miller FG, Brody H. A Critique of Clinical Equipoise: Therapeutic Misconception in the Ethics of Clinical Trials. Hastings Cent Rep. 2003 May;33(3):19.
10. Lee GE, Kim S, Chu SH, Seok JH, Kim SY, Kim S. Improving patient satisfaction based on service quality in clinical trials: A cross-sectional study. PLoS One. 2024;19(12):e0313340.
11. Udrea G, Dumitrescu B, Purcarea M, Balan I, Rezus E, Deculescu D. Patients' perspectives and motivators to participate in clinical trials with novel therapies for rheumatoid arthritis. J Med Life. 2009;2(2):227–31.
12. Avery J, Bell JAH, Baryolay K, Rodin G, Nissim R, Balneaves LG. Decision-making and autonomy among participants in early-phase cancer immunotherapy trials: a qualitative study. BMC Cancer. 2024 Mar 25;24(1):373.
13. Estcourt S, Epton J, Epton T, Vaidya B, Daly M. Exploring the motivations of patients with type 2 diabetes to participate in clinical trials: a qualitative analysis. Res InvolvEngagem. 2016 Dec 12;2(1):34.
14. Shah JY, Phadtare A, Rajgor D, Vaghasia M, Pradhan S, Zelko H, et al. What leads Indians to participate in clinical trials? A meta-analysis of qualitative studies. PLoS One. 2010 May 20;5(5):e10730.
15. Hrna Z. The Role of Oncology Clinical Trials in Advancing Cancer Treatment. J Oncol Med &Pract. 2024 Sep;252.
16. Freedman B. Equipoise and the Ethics of Clinical Research. New England Journal of Medicine. 1987 Jul 16;317(3):141–5.
17. Vermeulen SF, Hordijk M, Visser RJ, Bunnik EM. Do Physicians Have a Duty to Discuss Expanded Access to Investigational Drugs with their Patients? A Normative Analysis. Journal of Law, Medicine & Ethics. 2023 May 25;51(1):172–80.
18. Rahman S, Majumder A, Shaban S, Rahman N, Ahmed SM, Abdulrahman K, et al. Physician participation in clinical research and trials: issues and approaches. Adv Med EducPract. 2011 Mar;85.
19. Engelbak Nielsen Z, Eriksson S, Schram Harsløf LB, Petri S, Helgesson G, Mangset M, et al. Are cancer patients better off if they participate in clinical trials? A mixed methods study. BMC Cancer. 2020 Dec 8;20(1):401.
20. Durden K, Hurley P, Butler DL, Farner A, Shriver SP, Fleury ME. Provider motivations and barriers to cancer clinical trial screening, referral, and operations: Findings from a survey. Cancer. 2024 Jan 18;130(1):68–76.
21. Kengia JT, Kalolo A, Barash D, Chwa C, Hayirli TC, Kapologwe NA, et al. Research capacity, motivators and barriers to conducting research among healthcare providers in Tanzania's public health system: a mixed methods study. Hum Resour Health. 2023 Sep 5;21(1):73.
22. Christopher PP, Stein MD, Springer SA, Rich JD, Johnson JE, Lidz CW. An exploratory study of therapeutic misconception among incarcerated clinical trial participants. AJOB EmpirBioeth. 2016 Jan 2;7(1):24–30.
23. Chichua M, Mazzoni D, Marzorati C, Pravettoni G. The journey of patients in cancer clinical trials: A qualitative meta-synthesis on experiences and perspectives. Patient Educ Couns. 2025 Jan;130:108469.
24. Mills EJ, Seely D, Rachlis B, Griffith L, Wu P, Wilson K, et al. Barriers to participation in clinical trials of cancer: a meta-analysis and systematic review of patient-reported factors. Lancet Oncol. 2006 Feb;7(2):141–8.
25. Williams CP, Deng L, Caston NE, Gallagher K, Angove R, Pisu M, et al. Understanding the financial cost of cancer clinical trial participation. Cancer Med. 2024 Apr 17;13(8).
26. Aabdien M, Abdallah I, Bougmiza MI, Siepmann T, Illigens B. Perceptions and attitudes toward participation in clinical research in the Eastern Mediterranean Region: A systematic review. Medicine. 2022 Aug 19;101(33):e29959.
27. Sofaer N, Thiessen C, Goold SD, Ballou J, Getz KA, Koski G, et al. Subjects' views of obligations to ensure post-trial access to drugs, care and information: qualitative results from the Experiences of Participants in Clinical Trials (EPIC) study. J Med Ethics. 2009 Mar;35(3):183–8.
28. In drug research, guinea pigs of choice are humans. Times of India. 2004 Aug 4;
29. Ghotankar SS, Devkar R, Deshmukh M. Bridging the Divide: Tackling Recruitment Challenges in Indian Clinical Trials: A Narrative Review. JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH. 2024;
30. Wong AR, Sun V, George K, Liu J, Padam S, Chen BA, et al. Barriers to Participation in Therapeutic Clinical Trials as Perceived by Community Oncologists. JCO Oncol Pract. 2020 Sep;16(9):e849–58.
31. Kumar G, Chaudhary P, Quinn A, Su D. Barriers for cancer clinical trial enrollment: A qualitative study of the perspectives of healthcare providers. Contemp Clin Trials Commun. 2022 Aug;28:100939.
32. Nass SJ MHMJ. A National Cancer Clinical Trials System for the 21st Century: Reinvigorating the NCI Cooperative Group Program. Institute of Medicine (US) Committee on Cancer Clinical Trials and the NCI Cooperative Group Program. 2010;
33. Perez GK, Oberoi AR, Finkelstein-Fox L, Park ER, Nipp RD, Moy B. Qualitative study of Oncology Clinicians' Perceptions of Barriers to Offering Clinical Trials to Underserved Populations. Cancer Control. 2023;30:10732748231187828.

34. Alemayehu C, Mitchell G, Nikles J. Barriers for conducting clinical trials in developing countries- a systematic review. Int J Equity Health. 2018 Dec 22;17(1):37.
35. Nielsen ZE, Berthelsen CB. Cancer patients' perceptions of factors influencing their decisions on participation in clinical drug trials: A qualitative meta-synthesis. J Clin Nurs. 2019 Jul 3;28(13–14):2443–61.
36. Fountzilas E, Tsimberidou AM, Vo HH, Kurzrock R. Clinical trial design in the era of precision medicine. Genome Med. 2022 Aug 31;14(1):101.
37. Dennstädt F, Putora PM, Iseli T, Treffers T, Panje C, Fischer GF. Patient autonomy and shared decision-making in the context of clinical trial participation. Eur J Clin Invest. 2024 Nov 31;54(11).
38. Burt T, Dhillon S, Sharma P, Khan D, MV D, Alam S, et al. PARTAKE Survey of Public Knowledge and Perceptions of Clinical Research in India. PLoS One. 2013 Jul 16;8(7):e68666.
39. Sood A, Prasad K, Chhatwani L, Shinozaki E, Cha SS, Loehrer LL, et al. Patients' Attitudes and Preferences About Participation and Recruitment Strategies in Clinical Trials. Mayo Clin Proc. 2009 Mar;84(3):243–7.
40. Castillo BS, Boehmer L, Schrag J, Howson A, Oyer R, Pierce L, et al. Oncologist-Reported Barriers and Facilitators to Offering Cancer Clinical Trials to Their Patients. Current Oncology. 2024 May 28;31(6):3017–29.
41. Datta SS, Samanta B, Chatterjee S, Mallick I, Sharma A, Gangopadhyay G, et al. Conduct of cancer clinical trials: a qualitative study reporting views of patients, caregivers, public and clinical researchers. Ecancermedicalscience. 2025;19:1950.
42. Flynn KE, Kramer JM, Dombeck CB, Weinfurt KP. Participants' perspectives on safety monitoring in clinical trials. Clinical Trials. 2013 Aug 3;10(4):552–9.
43. Barnes B, Stansbury N, Brown D, Garson L, Gerard G, Piccoli N, et al. Risk-Based Monitoring in Clinical Trials: Past, Present, and Future. Ther InnovRegul Sci. 2021 Jul 29;55(4):899–906.
44. Reyna VF, Nelson WL, Han PK, Pignone MP. Decision making and cancer. Am Psychol. 2015;70(2):105–18.
45. Klein E, Solomon AJ, Corboy J, Bernat J. Physician compensation for industry-sponsored clinical trials in multiple sclerosis influences patient trust. Mult SclerRelatDisord. 2016 Jul;8:4–8.
46. A. Gregersen T, Birkelund R, Wolderslund M, Dahl Steffensen K, Ammentorp J. Patients' experiences of the decision-making process for clinical trial participation. Nurs Health Sci. 2022 Mar 21;24(1):65–72.
47. Dwyer CP, McAneney H, Rogers FM, Joyce R, Hynes SM. Exploring the impact of ineligibility on individuals expressing interest in a trial aimed at improving daily functioning regarding perceptions of self, research and likelihood of future participation. BMC Med Res Methodol. 2021 Dec 27;21(1):264.
48. DasMahapatra P, Raja P, Gilbert J, Wicks P. Clinical trials from the patient perspective: survey in an online patient community. BMC Health Serv Res. 2017 Dec 27;17(1):166.
49. Eldridge L, Goodman NR, Chtourou A, Galassi A, Monge C, Cira MK, et al. Barriers and Opportunities for Cancer Clinical Trials in Low- and Middle-Income Countries. JAMA Netw Open. 2025 Apr 28;8(4):e257733.

**Review Article**

*DOI: https://doi.org/10.37506/jt83d473*

# Beyond Pharmacological Reductionism: Reframing Community Mental Health in India

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**How to cite this article**: Kimberley Maria D'Souza. Beyond Pharmacological Reductionism: Reframing Community Mental Health in India. Indian Journal of Public Health Research and Development / Vol. 17 No. 3, July-September 2026.

**Abstract**

Mental health care in India continues to be shaped largely by a biomedical paradigm that prioritises diagnosis and pharmacological treatment while insufficiently addressing the social and structural determinants of psychological distress. Such an approach risks pathologising normal responses to chronic adversity and inadequately serving populations facing poverty, gender-based violence, caste discrimination and other forms of structural oppression. This commentary argues for a shift towards inclusive, community-based mental health systems integrated within primary health care. Drawing on evidence from Indian programmes such as the National Mental Health Programme, District Mental Health Programme, VISHRAM and Sangath, the paper highlights the need for culturally responsive, decentralised and socially grounded approaches that move beyond pharmacological reductionism to improve population mental wellbeing.

**Keywords:** Mental health, social determinants, primary health care

## Introduction

Mental health disorders constitute a significant proportion of the global burden of disease and contribute substantially to disability-adjusted life years in India. Despite growing awareness and policy initiatives, a large treatment gap persists, with many individuals unable to access timely, affordable and contextually appropriate care. Contemporary psychiatric practice remains strongly influenced by the biomedical model, which conceptualises mental disorders primarily as neurochemical or genetic abnormalities requiring pharmacological correction. While biological mechanisms undeniably play a role, an exclusive focus on them risks overlooking the social, economic and cultural contexts that shape mental health.

In India, where structural inequities such as poverty, caste-based marginalisation, gender inequality and precarious labour conditions are widespread, psychological distress often emerges from lived adversity rather than solely from intrinsic pathology. Therefore, a comprehensive public health response must address these upstream determinants alongside clinical care.

Recent epidemiological estimates highlight the scale of psychiatric morbidity in India. Findings from

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**Submission date:** February 16, 2026 **Revision date:** March 18, 2026 **Published date:** June 29, 2026

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the Global Burden of Disease (GBD) Study indicate that mental disorders account for approximately 7.4% of total disability-adjusted life years and nearly one fifth of all years lived with disability in the country. Depressive and anxiety disorders represent the largest contributors to this burden, with prevalence estimates suggesting that nearly one in seven Indians experiences a mental disorder during their lifetime. These findings underscore the magnitude of unmet mental health needs and the importance of strengthening population-level responses beyond specialist psychiatric services.[1,2]

**Dominance of the biomedical model in mental health care**

The biomedical model has historically driven advances in diagnosis and pharmacotherapy and has improved outcomes for several severe psychiatric conditions. However, critics argue that reducing mental illness to biological dysfunction alone oversimplifies complex human experiences and ignores structural contributors to distress.[3] Overmedicalisation can inadvertently pathologisenormative emotional responses to chronic stressors such as domestic violence, financial insecurity or social exclusion.

Such reductionism also risks reinforcing passive models of care in which individuals become reliant on medical systems without addressing the socio-economic conditions perpetuating their distress. In low-resource settings, this approach may fail to produce sustained improvements in wellbeing if structural vulnerabilities remain unaddressed.

**Treatment gaps and inequities in India**

India faces a substantial mental health treatment gap driven by limited infrastructure, shortage of trained professionals and high out-of-pocket expenditure. The National Mental Health Survey reported that nearly 70% to 85% of individuals with mental illness do not receive adequate treatment.[4] Financial barriers, stigma and concentration of specialist services in urban centres further restrict access for rural and marginalised populations.

Recent analyses further estimate that the treatment gap for common mental disorders such as depression and anxiety may exceed 80%, particularly in rural and underserved regions where specialist services are scarce.[5]

The cost of mental health care can consume a considerable proportion of monthly household income, making sustained treatment unaffordable for many.[6] These inequities underscore the need for decentralised service delivery and integration of mental health into primary health care systems to ensure equitable access.

**Structural determinants and intersectional vulnerabilities**

A growing body of evidence demonstrates strong associations between structural oppression and poor mental health outcomes. Exposure to caste discrimination, gender-based violence, religious marginalisation and economic precarity contributes significantly to anxiety, depression and substance use disorders.[7] Intersectionality provides a useful framework for understanding how overlapping identities such as caste, gender, religion and sexuality compound vulnerability and restrict access to supportive resources.

Historical trauma and collective experiences of displacement and violence also exert intergenerational effects on psychological wellbeing.[8] These findings highlight that mental health is shaped not only by individual biology but also by broader socio-political environments. Therefore, effective interventions must extend beyond clinical treatment to address systemic inequities.

**Cultural limitations of standard diagnostic frameworks**

Standardised diagnostic systems such as the DSM-5 provide useful clinical structure but may insufficiently account for cultural diversity in symptom expression and lived experiences. Overemphasis on biological explanations for gender differences in mental illness, for example, may obscure the role of patriarchal social structures, unpaid labour burdens and exposure to violence in shaping women's mental health.[9]

Furthermore, rigid diagnostic categorisation risks pathologising neurodivergent traits and promoting deficit-oriented perspectives. A culturally informed diagnostic approach that incorporates social context

is essential for equitable and person-centred care in diverse populations such as India's.

**Community-based mental health as a public health priority**

To address the complex interplay of biological and structural determinants, mental health systems must adopt a holistic, community-based approach integrated within primary health care. Such models emphasise early detection, psychosocial support and community participation while reducing reliance on specialist-centric services.

**Integration within primary health care**

Strengthening mental health services at primary health care level is critical to improving accessibility and continuity of care. Routine screening using validated tools such as the Patient Health Questionnaire-9 facilitates early identification of depressive symptoms and enables timely intervention.[10]Training primary care physicians, nurses and community health workers in basic counselling and mental health assessment can bridge workforce shortages and decentralise care delivery.

**National programmes supporting integration**

India has implemented several initiatives aimed at integrating mental health into general health services. The National Mental Health Programme (NMHP) launched in 1982 and the District Mental Health Programme (DMHP) provide frameworks for decentralised service delivery, training of health personnel and community awareness activities. [11]These programmes aim to make mental health services accessible at district and sub-district levels, although implementation gaps and resource constraints persist.

Strengthening these programmes through adequate funding, workforce development and monitoring mechanisms can substantially reduce treatment gaps and improve population mental health outcomes.

**Role of community-based interventions**

Evidence from Indian community mental health initiatives demonstrates the effectiveness of task-sharing and culturally embedded care. The VISHRAM programme in rural Maharashtra utilised community health workers, counsellors and physicians to deliver psychosocial interventions for depression and alcohol use disorders, showing significant improvements in symptom reduction and functioning.[12] Similarly, Sangath, a non-governmental organisation based in Goa, has developed scalable community-based mental health interventions that integrate lay counsellors and evidence-based psychological therapies.[13]

Additional examples from India further illustrate the potential of community-centred mental health care. The Dawa-Dua model implemented in Gujarat integrates biomedical treatment with spiritual and community-based support, demonstrating how culturally embedded approaches can improve treatment adherence and reduce stigma among individuals with severe mental illness. Similarly, community outreach initiatives led by NIMHANS have incorporated lay counsellors, family engagement and community rehabilitation strategies to extend mental health care beyond institutional settings. These initiatives highlight the importance of culturally sensitive and community-partnered approaches in improving mental health outcomes. [14,15]

These models highlight the feasibility of delivering effective mental health care through community participation and intersectoral collaboration rather than relying solely on specialist-led hospital services.

**Socio-economic empowerment and supportive networks**

Mental health interventions must address upstream socio-economic determinants that contribute to chronic distress. Vocational training, microfinance linkages and livelihood support programmes can enhance financial independence and resilience, particularly among women and marginalised communities. Women's self-help groups and community collectives can provide social support, facilitate access to legal resources and create safe spaces for survivors of domestic violence and substance use disorders.

Such integrated approaches align with the principles of social medicine and recognise that sustained mental wellbeing requires both clinical and socio-economic interventions.

**Policy implications and future directions**

Reframing mental health care in India requires coordinated policy action across health, social welfare and labour sectors. First, mental health services must be fully integrated into primary health care under the framework of comprehensive primary health care and Health and Wellness Centres. Second, training curricula for medical and public health professionals should incorporate cultural competence, social determinants of health and community engagement. Third, monitoring and evaluation systems for programmes such as NMHP and DMHP should be strengthened to ensure accountability and equitable implementation.

Evidence from other Global South settings also demonstrates the impact of social protection and community support programmes on mental health outcomes. Conditional and unconditional cash transfer programmes in several low- and middle-income countries have been associated with reductions in depressive symptoms and suicide rates by alleviating financial stress and improving household stability. For example, Brazil's Bolsa Família programme and similar initiatives in Latin America have been linked with improvements in population mental wellbeing and reductions in suicide mortality. These findings highlight the importance of addressing socio-economic determinants alongside clinical interventions when designing comprehensive mental health strategies. [16,17]

Additionally, increased investment in community mental health research is necessary to generate context-specific evidence and guide scalable interventions. Public awareness campaigns addressing stigma and promoting mental health literacy can further enhance service utilisation and community participation.

## Conclusion

Mental health care in India must move beyond an exclusive reliance on pharmacological and biomedical paradigms towards a comprehensive public health framework that acknowledges the central role of social determinants and structural inequities. Community-based, culturally responsive and decentralised models integrated within primary health care offer a promising pathway to reduce treatment gaps and promote equitable mental wellbeing. Community-based approaches combined with social protection policies and culturally responsive care models offer a promising pathway for reducing psychiatric morbidity and treatment inequities in India.By strengthening national programmes, supporting community participation and addressing socio-economic vulnerabilities, India can develop a more inclusive mental health system that responds meaningfully to the lived realities of its diverse population.

**Funding Sources if applicable***:* Nil

**Ethical Clearance:** NA

**Declaration of conflicts of interest statement if applicable:** NA

## References

1. GBD 2019 Mental Disorders Collaborators. Global, regional and national burden of mental disorders in 204 countries and territories, 1990–2019. *Lancet Psychiatry*. 2022.
2. Sagar R, Dandona R, Gururaj G, et al. The burden of mental disorders across the states of India: the Global Burden of Disease Study 1990–2017. *Lancet Psychiatry*. 2020.
3. Ramos M. Against biological reductionism in psychiatry. Boston Review.
4. Gururaj G, Varghese M, Benegal V, et al. National Mental Health Survey of India, 2015–16: Summary. Bengaluru: NIMHANS; 2016.
5. Patel V, Saxena S, Lund C, et al. The Lancet Commission on global mental health and sustainable development. *Lancet*. 2018.
6. Patel V, Chisholm D, Parikh R, et al. Addressing the burden of mental, neurological and substance use disorders in India. Lancet Psychiatry. 2016;3(2):125–132.
7. Meyer IH. Prejudice, social stress and mental health in minority populations. Psychol Bull. 2003;129(5):674–697.
8. Bhugra D, Becker MA. Migration, cultural bereavement and cultural identity. World Psychiatry. 2005;4(1):18–24.
9. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 5th ed. Washington DC: APA; 2013.

10. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: Validity of a brief depression severity measure. J Gen Intern Med. 2001;16(9):606–613.
11. Ministry of Health and Family Welfare. National Mental Health Programme and District Mental Health Programme: Operational Guidelines. New Delhi: Government of India.
12. Patel V, Weobong B, Weiss HA, et al. The Healthy Activity Program and VISHRAM: Community-based psychological interventions for depression in rural India. Lancet. 2017;389(10065):176–185.
13. Patel V, Chowdhary N, Rahman A, Verdeli H. Improving access to psychological treatments: Lessons from developing countries. Behav Res Ther. 2011;49(9):523–528.
14. Trivedi JK, Dhyani M. The Dawa-Dua model: integrating faith and psychiatric care in India. *Indian Journal of Psychiatry*. 2014.
15. Murthy RS. Community mental health care in India: reflections from NIMHANS initiatives. *Indian Journal of Psychiatry*. 2011.
16. Ridley M, Rao G, Schilbach F, Patel V. Poverty, depression and anxiety: causal evidence and mechanisms. *Science*. 2020.
17. Machado DB, Rasella D, Dos Santos DN. Impact of income inequality and conditional cash transfer programmes on suicide rates in Brazil. *Lancet Psychiatry*. 2018.

**Review Article**

*DOI: https://doi.org/10.37506/cyt1m019*

# Green space Access to the Disadvantaged using Park Service Area Analysis: A Study of Bhubaneswar

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**How to cite this article**: Monalipa Dash. Green space Access to the Disadvantaged using Park Service Area Analysis: A Study of Bhubaneswar. Indian Journal of Public Health Research and Development / Vol. 17 No. 3, July-September 2026.

**Abstract**

Urban green spaces (UGS) are widely recognized for their significant health and well-being benefits. However, recent research highlights increasing disparities in access to these spaces, particularly among disadvantaged groups. This study investigates the accessibility of UGS for disadvantaged community groups in Bhubaneswar, Odisha, India.

**Methods:** Disadvantaged communities, particularly slum settlements, were identified using high-resolution satellite imagery. Data on urban green spaces were sourced from previous studies. A network analysis was conducted in QGIS to delineate Park Service Areas (PSAs) using a 500-meter walking distance threshold from park entry points, assessing the accessibility of urban green spaces.

**Results:** Among Bhubaneswar's 67 wards, approximately 42 wards demonstrated that only 0–25% of slum areas fall within a 500-meter PSA. In 8 wards, 25–50% of slum areas were covered. Notably, only 9 wards showed 75–100% coverage of slum areas by PSA. These findings reveal a significant deficit in UGS access for slum dwellers and residents of informal settlements.

**Conclusion:** This study underscores the urgent need for spatially equitable planning of urban green spaces. The findings can inform urban planners and landscape designers in optimizing the distribution of green spaces and strategically placing park entry points to enhance accessibility for marginalized communities.

**Keywords:** Urban green spaces, Disadvantaged community, Environmental justice, Bhubaneswar

## Introduction

Researchers have highlighted the significant impact of green spaces on obesity and physical activity (PA).[1-3] PA involves physical and experiential interaction with green space that includes multiple open-air activities of different physical intensities, from walking a dog, strolling, hiking, running, or cycling in a green environment.[4] In fact, studies have shown that having parks near home has lower odds of being obese and obesity is prevalent in areas where land use prevents people from walking.[5-6] Urban green spaces (UGS), such as public parks and sports

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**Submission date:** January 23, 2026 **Revision date:** March 12, 2026 **Published date:** June 29, 2026

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grounds, play a crucial role in promoting physical activity within communities.[3] Studies have shown that the 'greenness' of a neighborhood is more strongly associated with mental health outcomes than physical health, with residents perceiving their environment as highly green reporting better mental well-being.[7-8] Numerous research have also emphasized the link between open spaces and quality of life, asserting that health, recreation, and the quality of the urban environment are key components in achieving an enhanced quality of life, with studies exploring the benefits of outdoor access and its positive effects on mental well-being.[9-10]

Given the numerous health benefits of UGS, recent studies have increasingly focused on the physical distribution of these spaces. A growing body of literature examines how the socio-economic status (SES) of neighborhoods influences the distribution of UGS. However, the findings across studies remain inconsistent.[11]Many studies suggest that UGS are not equally distributed, with low SES neighborhoods having significantly fewer parks and recreational facilities compared to higher SES areas.[11-16] On the other hand, some studies highlight that park distribution is either equal or more favorable in low SES areas[17-20], while others note a greater number of parks in neighborhoods with ethnically mixed populations and middle-income groups.[21]

UGS constitute a vital environmental resource that significantly contributes to community health and overall well-being. Their impact, however, is strongly influenced by factors such as availability, spatial distribution, size, and quality. Existing research consistently highlights disparities in the distribution of UGS, particularly across different socio-economic, racial, and cultural groups, revealing patterns of environmental inequality.[12,13,21]UGS provide valuable opportunities for physical activity, social interaction, and psychological restoration, and have the potential to benefit a broad segment of the urban population. Importantly, they can play a critical role in supporting disadvantaged groups who may have limited access to alternative recreational or health-promoting resources. In this context, *disadvantaged groups* refer to populations that face social, economic, physical, and environmental barriers that restrict their access to opportunities, resources, and essential services compared to the general population. Ensuring equitable access to UGS is therefore fundamental to promoting inclusive and sustainable urban development.[22-23] In the Indian context, this study defines disadvantaged groups as migrant workers and low-income households residing in informal settlements or "slums." These populations experience multiple layers of vulnerability, including economic hardship, social marginalization, and environmental deprivation, and often live in substandard housing conditions with limited access to basic services and urban amenities.[24-26]

Despite policies advocating for inclusive participation, the uniform distribution of UGS remains largely overlooked in urban planning processes.[27] While extensive literature has explored the widening wage gap in India—especially within service sectors[28-29], and highlighted the challenges faced by slum dwellers, comparatively little attention has been given to spatial inequalities in access to basic recreational infrastructure, such as urban green spaces (UGS). A few existing research has highlighted the lack of accessible green spaces in megacities like Mumbai, with the only notable study linking green space distribution to SES.[30] Building on this, the objective of the present study is to analyze the accessibility of UGS in Bhubaneswar, India, with a focus on access to slum settlements. This accessibility study will examine UGS as key indicator to determine whether there is inequality in accessing UGS in Bhubaneswar, a city where 36% of the population lives in slums. Bhubaneswar, with a population of around 800,000, is considered a mid-sized city compared to mega cities like Mumbai, Delhi, Bangalore, Kolkata, or Chennai, each of which has populations exceeding one million. The novelty of this study lies in its focus on a mid-sized city and its exploration of the relationship between SES and UGS distribution. It is assumed that the wealth gap between the rich and poor may not be as pronounced in cities like Bhubaneswar, making it particularly interesting to investigate whether the distribution of green spaces in such cities mirrors the biases observed in larger urban centers globally.

**Objective:**

- To identify and map slum settlements, in Bhubaneswar using high-resolution satellite imagery.

- To evaluate the accessibility of urban green spacesfor slum settlements
- To quantify disparities in UGS accessibility for the slum settlements
- To identify spatial inequities in green space access and provide planning insights to support equitable urban landscape design and policy interventions.

## Method

Study Area

Bhubaneswar has been selected as the study area due to its scale and significance. As the capital of Odisha, located in eastern India (Figure 1), Bhubaneswar falls under the jurisdiction of the Bhubaneswar Municipal Corporation (BMC), the primary urban local body responsible for governance and service delivery. Covering an area of 146.86 square kilometers, BMC had a population of approximately 856,555 according to the 2011 Census. The city is divided into 67 census tracts, or wards, which represent the smallest administrative units for which census data is available.

Originally planned by Otto Koenigsberger in 1948, Bhubaneswar was envisioned as a city for around 40,000 residents, with administration as its central function. The planning aimed to promote social equity and bridge the gap between rich and poor.[31]Over time, however, the city has experienced significant demographic and economic transformation, attracting a large number of migrant workers due to growing employment opportunities. Today, slums house approximately 36% of the city's population, occupying just 3.9% of the municipal area.[32]




**Figure 1. Location of Bhubaneswar in respect to India (Source: Internet, Not to Scale).**

UGS identification and Area Calculation

The study utilized the mapping tool of QGIS to understand the UGS distribution. First, the UGS are identified from the google maps having certain characteristics. The methodology is explained elsewhere.[33] UGS are later designated into gardens, community parks and neighbourhood parks based on URDPFI guidelines. The typology is mentioned elsewhere.[33] The area of the UGS was calculated from the map using attribute table.

Park entry point designation

Previous studies have deduced that proximity to parks remains an important determinant for park visitation. It is understood that the proximity to parks most popularly calculated using network analysis from a) park centroid b) park entrance.[34] Spangler's study have concluded that park centroid is a reasonable method for representing small and compact parks for the purpose of identifying access (below 5 acres).This particular study decided to use park centroid for the neighbourhood parks because they are mostly regular and compact in terms of shape. However, it utilized park entrance method for both community parks and gardens because of their irregular shapes and larger sizes. Generally, parks and gardens are enclosed in Indian cities with controlled entrance and thus the entrance seem to be a better method for accessibility. Entrance for community parks and gardens are identified by physically visiting the site. All the entrances are photographed by utilizing the GPSMapCamera app that captures the co-ordinates of the entrance. Later the locations were transferred to the Map in QGIS.Open-source roads data were extracted from OpenStreetMap.

Slum Indicators

The study developed three data points for understanding the slum settlements and their relationship with UGS.

Slum household

The term *slum households* in this study refers to the number of identified slum settlements within each ward. Data on the number and distribution of slums were obtained from the Jaga Mission, an initiative under the Housing and Urban Development Department of Odisha. Jaga Mission is a state-led program that surveys slum settlements, provides legal land tenure rights to residents, and facilitates the in-situ upgrading of slums by improving access to basic services, as well as social and economic infrastructure. The location of the slum settlements was cross verified by the author by visiting the site.

Slum Area

In recent years, there has been a growing interest in analyzing slum morphology using high-resolution satellite imagery. From a remote sensing standpoint, much of the current research has centered on developing automated methods for identifying and classifying slum areas. These techniques typically rely on physical characteristics of the slum built environment—such as irregular building alignments[35], unstructured street patterns[36], small building sizes[37], and high building densities[26], to distinguish informal settlements from formal urban areas.

The research identified the slums through cognitive perception and identifying settlements which are termed as " Sahi" ," Basti" or "Slum" in google earth imagery. A standardized digitization protocol used to get the extent of the slum area (Google earth) by digitizing the street block represented by a single polygon. In places where complexity of dense building patterns and respective roof structures are overlapped, a generalized polygon representing a mixture of houses are substituted instead of an individual polygon per block. If a dense settlement area turns abruptly into an open space without a street as separating line, a street or boundary is introduced to differentiate the high and low density areas.

PSA Overlapped

Network analysis in QGIS was employed to delineate the Park Service Area (PSA), using a 500-meter threshold from park entry points to evaluate accessibility. This distance, equivalent to approximately half a mile has been widely adopted in previous research as a reasonable benchmark for park access.[38-39] Given the high levels of motorization in Indian cities[40], the study considers 500 meters to be an appropriate initial measure for defining service coverage. PSA determines areas around the park that fall within 500m from the entrance of the park along the road network. Overlapping the PSA with the slum area can provide the proportion of slums accessed from the parks. To spatially define the PSA boundary, the Convex Hull tool was utilized, generating a polygon that connects the outermost points of the network service area. The overlap between the PSA and slum areas was quantified using the Intersection tool in QGIS, which calculates spatial intersections between multiple vector layers. This enabled the study to determine the proportion of slum areas falling within the designated PSA and termed as PSA overlapped.

## Result & Discussion

The study aims to measure the access to UGS for slum dwellers. The measurement is done in two stages. First it aims to analyse the UGS distribution and UGS PSA for all the wards of BMC. Second, it tries to identify the slum extent that are within the PSA of the UGS.

Potential UGS distribution and UGS PSA

**Figure 2a** illustrates the distribution of Recreational Green Spaces within the BMC limits. Gardens are predominantly concentrated on the western side, particularly in Wards 15 and 23. Community parks, on the other hand, are more dispersed, appearing in the northern, southern, and central regions. However, the eastern part of BMC features a noticeably lower presence of community parks. Although community parks are generally accessible from major streets, many are situated at corners with limited entry points, which could restrict easy public access.

Neighborhood parks, in contrast, display a more uniform spatial distribution across the city. The average park size is approximately 6,693.6 square meters (1.63 acres), with a median size of 4,720 square meters (1.16 acres). Notably, the smallest park measures just 450 square meters, highlighting a considerable variation in park sizes across different wards.

**Figure 2b** depicts a non-uniform distribution of PSAs. The eastern region of Bhubaneswar has limited PSA coverage, whereas the central part shows a significantly higher density of PSAs. Overlaps in PSAs are observed in Wards 14, 24, 25, and 30, which reduce the effective coverage area of individual UGS. In contrast, certain wards such as 4, 5, 18, and 67 show no PSA coverage at all, indicating a lack of accessible green space in these areas.

Park Access

Slums are widely distributed throughout the BMC region and are present in nearly all wards. As described in the methodology, the study overlaid slum areas with PSAs to examine spatial relationships. Figure 2c presents the overlap between PSAs and slum regions. Understanding the fact that, gardens and community parks are limited in numbers for BMC region, we then assessed the correlation between slum areas and park areas with the PSA overlapped zones. The results indicate a positive and significant correlation between UGSareas and PSA overlapped ($r = 0.553$), suggesting that larger park areas are associated with broader PSA coverage leading to bigger PSA overlapped zones. In contrast, slum areas showed a weak correlation with PSA overlapped ($r = 0.250$), implying that increase in slum area do not necessarily lead to proportional changes in PSA overlapped zone. These findings highlight the differing spatial dynamics between park distribution and slum settlements in relation to service area coverage.

**Table 1. Correlational analysis between UGS and Slum indicators**

| | Slum Household | Slum Area | PSA overlapped | UGS Area |
|---|---|---|---|---|
| UGS Area | -.102 | -.197 | 0.553** | |
| PSA overlapped | 0.157 | 0.250* | | 0.553** |

*Correlation is significant at 0.05 level (2-tailed)

** Correlation is significant at 0.01 level (2-tailed)

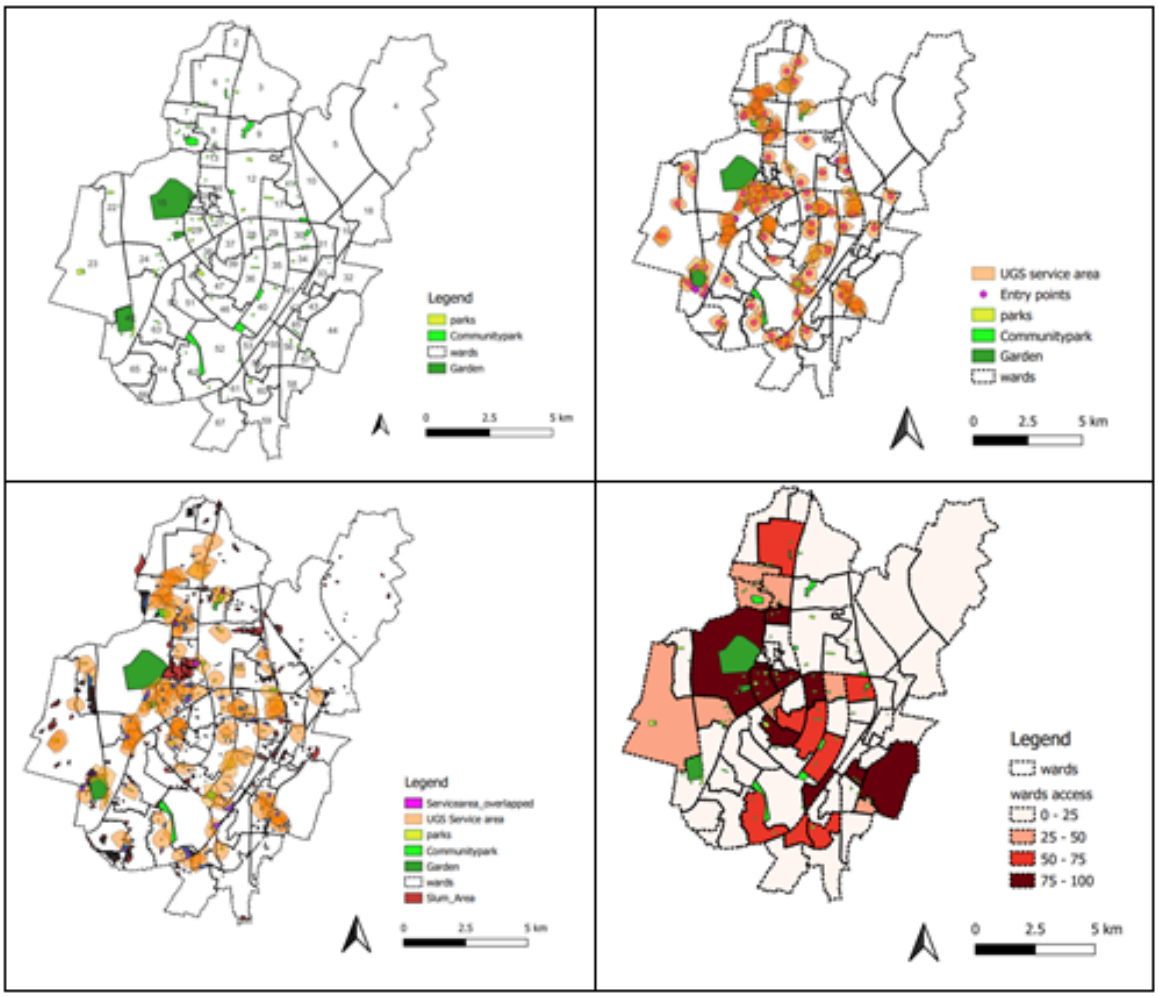



**Figure 2. a) Shows the distribution of UGS within BMC limit b) Park service area considering entry points c) Park service area overlapped d) Park access**

The study calculated the percentage of PSA overlapped relative to slum areas and mapped this data to assess access to UGS for the slum population. Figure 2d illustrates this access in percentage terms. Of the 67 wards, approximately 42 wards show that only 0–25% of slum areas within the wards have parks within 500m walking distance. In 8 wards, 25–50% of slum areas are covered by PSAs of 500 meters. Notably, only 9 wards—shaded in the darkest color—indicate that 75–100% of slum areas have parks within 500m walking distance. This highlights a significant overall deficit in park access for slum dwellers and residents of informal settlements. The outcome is in congruent with previous studies on access to UGS for disadvantaged population in USA and other countries.[11-15,39,41-42].

Wards 16, 20, 21, 22, 26, and 65—each with a high number of slum households and substantial slum area coverage—exhibit some of the lowest percentages of PSA overlap. Additionally, restricted entry policies in many gardens and community parks further limit access to UGS for slum residents. Field audits revealed that slum settlements are often situated in areas with minimal or poorly distributed entry points to nearby green spaces, compounding the challenge of equitable access.

## Conclusion

By analyzingUGS in terms of their distribution, PSAs, and the overlap of PSAs with demarcated slum areas, this study offers a comprehensive understanding of green space accessibility for slum populations. While UGS distribution provides insight into how green spaces are spread across the wards of the BMC, PSAs highlight the spatial extent within which these green spaces are accessible. In

contrast, the PSA overlap with slum areas specifically measures the proportion of slum settlements that can access a park within a 500-meter radius.

The methodology presents a replicable framework for assessing UGS distribution in Indian cities—one that can be adopted by city planners and urban designers to promote equitable access. Findings from our study reveal that the majority of slum settlements in Bhubaneswar lack access to UGS within a 500-meter reach. Although the poor living conditions of slum dwellers are frequently discussed, there is a notable absence of studies that directly address their access to green spaces.

Given the well-documented benefits of UGS for physical and mental well-being, it is imperative for city authorities to ensure the equitable distribution of green spaces. Urban planning must adopt an inclusive approach that prioritizes the needs of marginalized communities, ensuring that all residents—especially those in informal settlements—can benefit from the advantages of accessible green infrastructure. Slum settlements in Indian cities have traditionally comprised temporary structures. However, in recent years, government initiatives have increasingly granted land ownership rights to slum dwellers, enabling them to construct permanent housing. As this transformation continues, it is essential to conduct similar studies at regular intervals to monitor changes in access to UGS and ensure equitable distribution across evolving urban landscapes.

## Recommendations

- *Prioritize UGS Provision in Slum-Dense Wards*

Municipal authorities should identify wards with low PSA coverage of slum settlements and prioritize them for the development of new recreational green spaces. Spatial planning tools should be used to ensure that future parks are located within a 500-meter walking radius of underserved communities.

- *Integrate Green Space Planning with Slum Upgrading Programs*

Urban green space development should be embedded within slum redevelopment and upgrading initiatives. Jaga Mission can incorporate neighborhood parks, community gardens, and open recreational spaces as essential components of in-situ improvement projects rather than treating them as secondary amenities.

- *Optimize Park Entry Points and Connectivity*

Improving accessibility does not always require new parks. Strategic placement of additional park entry points, removal of physical barriers, and enhancement of pedestrian pathways can significantly expand effective PSAs and improve access for slum residents.

- *Promote Small-Scale and Flexible Green Interventions*

In high-density settlements where large parks are not feasible, planners should introduce:

- Pocket parks
- Community gardens
- Green corridors
- School-ground sharing models
- Vacant land greening initiatives

These micro-level interventions can collectively improve neighborhood-level accessibility.

- *Establish Accessibility Standards in Urban Planning Policies*

Urban local bodies should incorporate measurable accessibility benchmarks (e.g., 500-meter walking distance to a recreational green space) into master plans and development control regulations to ensure equitable distribution.

- *Encourage Community Participation*

Slum communities should be involved in the planning, design, and maintenance of green spaces to ensure cultural relevance, safety, and long-term sustainability.

- *Conduct Further Research on Quality,Usability and implication on Health*

Future studies should move beyond spatial access to evaluate:

- Quality and maintenance of UGS
- Safety perceptions
- Usage patterns among slum populations
- Usage and the impact on Health

This will provide a more holistic understanding of green space equity.

**Limitations**

1. The study could not deduce the number of slum households with UGS access due to unavailability of satellite data on a finer scale. Future studies should explore other methods to derive the number of households to provide a better understanding on UGS access.
2. Other important characteristics of parks such as park pressure and park quality are not considered in this study. Future studies should include those.

**Funding Sources if applicable:** Nil

**Ethical Clearance:** Not applicable

**Declaration of conflicts of interest statement:** Nil

## References

1. Brown RE, Sharma AM, Ardern CI, Mirdamadi P, Kuk JL. Secular differences in the association between caloric intake, macronutrient intake, and physical activity with obesity. Obesity Research & Clinical Practice. 2016;10(3):243–255.
2. Lee JE, Pope Z, Gao Z. The role of youth sports in promoting children's physical activity and preventing pediatric obesity: a systematic review. Behavioral Medicine. 2018;44(1):62–76.
3. Sallis JF, Floyd MF, Rodríguez DA, Saelens BE. Role of built environments in physical activity, obesity, and cardiovascular disease. Circulation. 2012;125(5):729–737.
4. Cortinovis C, Zulian G, Geneletti D. Assessing nature-based recreation to support urban green infrastructure planning in Trento (Italy). Land. 2018;7(4):112.
5. Frank LD, Andresen MA, Schmid TL. Obesity relationships with community design, physical activity, and time spent in cars. American Journal of Preventive Medicine. 2004;27(2):87–96.
6. Veitch J, Christian H, Carver A, Salmon J. Physical activity benefits from taking your dog to the park. Landscape and Urban Planning. 2019;185:173–179.
7. Mukherjee A, Mazumder K, Kaushal V, Ghoshal S. Effect of supportive psychotherapy on mental health status and quality of life of female cancer patients receiving chemotherapy for recurrent disease. Indian Journal of Palliative Care. 2017;23(4):399.
8. Sugiyama T, Leslie E, Giles-Corti B, Owen N. Associations of neighbourhood greenness with physical and mental health: do walking, social coherence and local social interaction explain the relationships? J of Epidemiology & Community Health. 2008;62(5):e9.
9. Bratman GN, Hamilton JP, Daily GC. The impacts of nature experience on human cognitive function and mental health. Annals of the New York Academy of Sciences. 2012;1249(1):118–136.
10. Douglas JW, Evans KL. An experimental test of the impact of avian diversity on attentional benefits and enjoyment of people experiencing urban green-space. People and Nature. 2022;4(1):243–259.
11. Tan PY, Samsudin R. Effects of spatial scale on assessment of spatial equity of urban park provision. Landscape and Urban Planning. 2017;158:139–154.
12. Crawford D, Timperio A, Giles-Corti B, Ball K, Hume C, Roberts R, et al. Do features of public open spaces vary according to neighbourhood socio-economic status? Health & Place. 2008;14(4):889–893.
13. Estabrooks PA, Lee RE, Gyurcsik NC. Resources for physical activity participation: Does availability and accessibility differ by neighborhood socioeconomic status? Annals of Behavioral Medicine. 2003;25(2):100–104.
14. Moore LV, Diez Roux AV, Evenson KR, McGinn AP, Brines SJ. Availability of recreational resources in minority and low socioeconomic status areas. American Journal of Preventive Medicine. 2008;34(1):16–22.
15. Vaughan KB, Kaczynski AT, Wilhelm Stanis SA, Besenyi GM, Bergstrom R, Heinrich KM. Exploring the distribution of park availability, features, and quality across Kansas City, Missouri by income and race/ethnicity: An environmental justice investigation. Annals of Behavioral Medicine. 2013;45(S1):28–38.
16. Wolch JR, Byrne J, Newell JP. Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'. Landscape and Urban Planning. 2014;125:234–244.
17. Gilliland J, Holmes M, Irwin JD, Tucker P. Environmental equity is child's play: Mapping public provision of recreation opportunities in urban neighbourhoods. Vulnerable Children and Youth Studies. 2006;1(3):256–268.
18. Lee RE, Cubbin C, Winkleby M. Contribution of neighbourhood socioeconomic status and physical activity resources to physical activity among women. Journal of Epidemiology & Community Health. 2007;61(10):882–890.

19. Nicholls S. Measuring the accessibility and equity of public parks: A case study using GIS. Managing Leisure. 2001;6(4):201–219.
20. Xiao Y, Wang Z, Li Z, Tang Z. An assessment of urban park access in Shanghai – Implications for the social equity in urban China. Landscape and Urban Planning. 2017;157:383–393.
21. Abercrombie LC, Sallis JF, Conway TL, Frank LD, Saelens BE, Chapman JE. Income and racial disparities in access to public parks and private recreation facilities. American Journal of Preventive Medicine. 2008;34(1):9–15.
22. Dolan SA, Jarman B, Bajekal M, Davies PM, Hart D. Measuring disadvantage: changes in the underprivileged area, Townsend, and Carstairs scores 1981–91. Journal of Epidemiology & Community Health. 1995;49(Suppl 2):S30–S33.
23. Townsend P. Poverty in the United Kingdom: A survey of household resources and standards of living. Berkeley: University of California Press; 1979.
24. Chimankar DA. Urbanization and condition of urban slums in India. Indonesian Journal of Geography. 2016;48(1):28–36.
25. Islam J, Ali MJ, Mithun S. Slums in India: Making sense of place in urban planning. GeoJournal. 2022;87:1913–1928.
26. Taubenböck H, Kraff NJ. The physical face of slums: A structural comparison of slums in Mumbai, India, based on remotely sensed data. Journal of Housing and the Built Environment. 2014;29(1):15–38.
27. Sister C, Wolch J, Wilson J. Got green? Addressing environmental justice in park provision. GeoJournal. 2010;75(3):229–248.
28. Nissanke M, Thorbecke E. Comparative analysis of the globalization-poverty nexus in Asia, Latin America, and Africa. World Development. 2010;38(6):797–802.
29. Pieters J. Growth and inequality in India: Analysis of an extended social accounting matrix. World Development. 2010;38(3):270–281.
30. Sathyakumar V, Ramsankaran R, Bardhan R. Linking remotely sensed urban green space distribution patterns and socio-economic status – A multi-scale probabilistic analysis based in Mumbai, India. GIScience& Remote Sensing. 2019;56(5):645–669.
31. Kalia R. Bhubaneswar: contrasting visions in traditional Indian and modern European architecture. Journal of Urban History. 1997;23(2):164–191.
32. Anand G, Deb A. Planning, 'Violations,' and Urban Inclusion: A Study of Bhubaneswar. New Delhi: YUVA; 2017.
33. Dash M, Chakraborty M. Distribution of green spaces across socio-economic groups: a study of Bhubaneswar, India. Journal of Architecture and Urbanism. 2023;47(1):57–67.
34. Spangler KR, Brochu P, Nori-Sarma A, Milechin D, Rickles M, Davis B, et al. Calculating access to parks and other polygonal resources: a description of open-source methodologies. Spatial and Spatio-temporal Epidemiology. 2023;47:100606.
35. Owen KK, Wong DW. An approach to differentiate informal settlements using spectral, texture, geomorphology and road accessibility metrics. Applied Geography. 2013;38:107–118.
36. Niebergall S, Loew A, Mauser W. Integrative assessment of informal settlements using VHR remote sensing data—The Delhi case study. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. 2008;1(3):193–205.
37. Baud I, Kuffer M, Pfeffer K, Sliuzas R, Karuppannan S. Understanding heterogeneity in metropolitan India: The added value of remote sensing data for analyzing sub-standard residential areas. International Journal of Applied Earth Observation and Geoinformation. 2010;12(5):359–374.
38. Boone CG, Buckley GL, Grove JM, Sister C. Parks and people: An environmental justice inquiry in Baltimore, Maryland. Annals of the Association of American Geographers. 2009;99(4):767–787.
39. Wolch J, Wilson JP, Fehrenbach J. Parks and park funding in Los Angeles: An equity-mapping analysis. Urban Geography. 2005;26(1):4–35.
40. Datey A, Darji V, Patel T, Mahadevia D. Walking and cycling in Indian cities: A struggle for reclaiming road edges. Center for Urban Equality; 2012.
41. Germann-Chiari C, Seeland K. Are urban green spaces optimally distributed to act as places for social integration? Results of a GIS approach for urban forestry research. Forest Policy and Economics. 2004;6(1):3–13.
42. Kabisch N, Haase D. Green justice or just green? Provision of urban green spaces in Berlin, Germany. Landscape and Urban Planning. 2014;122:129–139.

**Review Article**

*DOI: https://doi.org/10.37506/p3z0xq64*

# Digital Inequity in Health Access: A Literature Review of Ayushman Bharat and ABDM in India

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**How to cite this article**: Renia Ganguly, Patil Nagaraj. Digital Inequity in Health Access: A Literature Review of Ayushman Bharat and ABDM in India. Indian Journal of Public Health Research and Development/Vol. 17 No. 3, July-September 2026.

## Abstract

**Background:** Ayushman Bharat, launched in 2018, is India's flagship initiative toward Universal Health Coverage through the Pradhan Mantri Jan Arogya Yojana (PM-JAY) and strengthened primary healthcare services. The Ayushman Bharat Digital Mission (ABDM), introduced in 2021, further aims to improve healthcare access, efficiency, and transparency through digital health innovations. However, emerging evidence suggests that digital inequities may limit equitable access to these initiatives, particularly among rural, low-income, and digitally marginalised populations.

**Objective:** This review examines the role of digital barriers in shaping access to and utilisation of Ayushman Bharat and ABDM, with a focus on digital literacy, infrastructure, awareness, trust, and ethical concerns within the Indian healthcare context.

**Methods:** A narrative literature review was conducted using PubMed, Google Scholar, government reports, and policy documents published between 2018 and 2025. Relevant studies were identified using key search terms related to Ayushman Bharat, ABDM, digital health, and healthcare access in India, and were thematically synthesised.

**Results:** The review identified persistent gaps in awareness and utilisation of PM-JAY and ABDM, especially in rural and underserved areas. Major barriers included low digital literacy, inadequate internet connectivity, limited access to digital devices, and concerns regarding data privacy and system trust. While digital tools such as ABHA IDs, electronic health records, and telemedicine platforms offer significant potential, their benefits remain unevenly distributed. Community-based intermediaries, including ASHAs and Ayushman Mitras, play a crucial role in bridging digital gaps, though systemic challenges persist.

**Conclusion:** Despite notable progress, digital inequities continue to constrain the equity goals of Ayushman Bharat and ABDM. Strengthening digital literacy, ensuring data protection, expanding infrastructure, and maintaining offline access mechanisms are essential for achieving inclusive and equitable Universal Health Coverage in India.

**Keywords:** Behavioural Intervention, Patient Education & Diabetes Management, Nudge Theory, Local Ambassador, Sikkim

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**Submission date:** January 1, 2026 **Revision date:** March 31, 2026 **Published date:** June 29, 2026

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## Introduction

India's healthcare system faces persistent challenges, including inadequate infrastructure, urban-rural disparities, and high out-of-pocket health expenditures. In response, the Government of India launched the **Ayushman Bharat** in 2018 to provide financial protection through the **Pradhan Mantri Jan Arogya Yojana (PM-JAY)** and strengthen primary care via

Health and Wellness Centres (HWCs). To further modernise healthcare delivery, the **Ayushman Bharat Digital Mission (ABDM)** was introduced in 2021, promoting digital technologies to improve access, affordability, and transparency.

While these schemes represent important steps toward Universal Health Coverage (UHC), evidence suggests that digital barriers may limit equitable access, particularly among rural, low-income, and less digitally literate populations. Studies report limited awareness and underutilisation of PM-JAY in underserved areas [1], and even among educated groups such as postgraduate health students, awareness of ABDM tools remains low, with ongoing concerns around usability and data privacy [2].

This narrative literature review examines digital barriers shaping access to healthcare under Ayushman Bharat and ABDM. The literature was identified through structured searches in PubMed and Google Scholar, covering 2018–2025, and included peer-reviewed studies, government reports, and grey literature. Key terms included "Ayushman Bharat", "PM-JAY ", "Ayushman Bharat Digital Mission", "digital health", "digital literacy", "digital barriers", and "healthcare access in India". Selected studies were thematically analyzed to assess how digital literacy, infrastructure, awareness, and trust influence uptake. While peer-reviewed and grey literature were synthesized, limitations of unpublished sources, including potential bias and lack of peer review, are acknowledged. By integrating these findings, this review highlights challenges related to digital exclusion and identifies policy-relevant strategies for inclusive healthcare delivery in India.

## Review methodology

This study adopts a narrative literature review approach with structured search procedures to enhance transparency and reproducibility.

### Search Strategy

A systematic search was conducted in PubMed and Google Scholar for publications between January 2018 and October 2025. Additional grey literature was obtained from government reports, National Health Authority documents, WHO publications, and reputable news sources.

Search terms included:

- "Ayushman Bharat"
- "PM-JAY"
- "Ayushman Bharat Digital Mission"
- "ABDM"
- "digital health India"
- "digital literacy"
- "digital divide"
- "healthcare access India"
- "health data privacy India"

### Inclusion Criteria

- Published between 2018–2025
- English-language publications
- Empirical research, peer-reviewed articles, policy analyses, and official reports
- Focus on implementation, access, utilisation, digital tools, equity, governance, or ethics related to Ayushman Bharat or ABDM

### Exclusion Criteria

- Commentaries without analytical content
- Studies unrelated to India
- Articles focused exclusively on clinical outcomes without relevance to access or digital health systems

### Study Selection

The initial search yielded 112 records. After removal of duplicates and screening for relevance, 46 articles were assessed for eligibility. Of these, 23 sources were included in the final synthesis:

- 15 peer-reviewed journal articles
- 5 government or institutional reports
- 3 grey literature sources (including unpublished reports and media investigations)

**Analytical Approach**

The selected literature was thematically analysed across five domains:

1. Systemic health system gaps
2. Digital architecture and implementation
3. Equity and utilisation
4. Governance and accountability
5. Data privacy and ethics

Where applicable, findings from peer-reviewed literature were distinguished from grey sources to maintain analytical clarity. Evidence gaps and inconsistencies were explicitly noted where available.

**Indian Healthcare System: Gaps and Opportunities**

India's healthcare system comprises a complex mix of public and private providers, yet persistent challenges limit equitable access. Public health infrastructure in rural and remote areas remains inadequate, with shortages of primary health centers, sub-centers, and district hospitals essential for basic care[3]. These structural gaps are compounded by a critical deficit of trained healthcare professionals: India has approximately 0.9 doctors per 1,000 population, below the World Health Organization's recommended minimum of 1 per 1,000 [4]. Workforce shortages are particularly severe in rural regions, where the majority of the population resides, resulting in unequal access to quality services.

The system is further fragmented, with private providers delivering over 70% of outpatient care and 60% of inpatient care, often at high cost [5]. This fragmentation complicates patient navigation and contributes to high out-of-pocket expenditure, which constitutes nearly 60% of total health spending, disproportionately affecting low-income households and exacerbating cycles of poverty[1]

Government initiatives such as the National Health Mission and Ayushman Bharat aim to expand financial protection and strengthen public infrastructure; however, public healthcare spending remains low at roughly 1.5% of GDP, limiting the capacity to close systemic gaps [5].

Digitisation has emerged as a strategic response to these challenges. The **Ayushman Bharat Digital Mission (ABDM)** seeks to create a unified digital health ecosystem through initiatives such as digital health IDs, electronic health records, and telemedicine platforms, potentially improving continuity of care, reducing service duplication, and enhancing transparency. Yet, evidence indicates that digital solutions alone cannot overcome structural inequities. Barriers such as uneven internet connectivity, limited access to digital devices in rural areas, and low digital literacy constrain adoption. Trust issues surrounding data privacy and security further limit uptake[1] . Thus, while digital health initiatives present important opportunities, addressing foundational infrastructure, workforce, and equity gaps remains essential to ensure inclusive healthcare access across India.

**Ayushman Bharat and ABDM: Vision and Design**

The **Pradhan Mantri Jan Arogya Yojana (PM-JAY)**, launched in 2018 under **Ayushman Bharat**, is among the world's largest publicly funded health insurance programs. It provides financial protection of up to ₹5 lakh per family annually for over 100 million vulnerable families, covering secondary and tertiary hospitalization costs[5]. PM-JAY operates through trust or insurance models across states, enabling cashless treatment at empaneled public and private hospitals. Portability across regions allows beneficiaries to access care beyond their home state, reducing catastrophic out-of-pocket expenses and addressing both affordability and fragmented service delivery challenges in India.

Complementing PM-JAY's coverage, the Ayushman Bharat Digital Mission (ABDM), launched in 2021, aims to build an integrated digital health ecosystem that facilitates seamless data exchange while ensuring privacy and security 6,7 Central to ABDM is the Ayushman Bharat Health Account (ABHA) ID, a unique digital identifier that allows individuals to access and share electronic health records (EHRs). The mission also maintains key registries such as the Health Facility Registry (HFR) and the Healthcare Professionals Registry (HPR), which catalogue providers and institutions to enhance transparency, regulation, and coordination. These tools enable teleconsultations, appointment scheduling, and continuity of care, potentially improving healthcare reach and system efficiency.

ABDM's open and interoperable architecture supports a unified digital marketplace through platforms such as the Unified Health Interface (UHI),

facilitating telemedicine, digital pharmacies, and diagnostics across public and private sectors. Patients retain control over their Personal Health Records (PHR), which are portable and interoperable, while anonymized system data can inform policy planning, cost regulation, and disease surveillance.

While the design promises improved quality, access, and efficiency, evidence suggests that real-world adoption is uneven. Implementation varies across states due to differences in infrastructure, administrative capacity, and digital literacy [6,7].

Rural and low-income populations face significant barriers in creating ABHA IDs or accessing digital services, and concerns around data privacy and system usability persist.

Thus, while ABDM exemplifies India's vision for a digitally integrated health system, its impact on equitable healthcare access depends critically on addressing underlying infrastructure, literacy, and governance gaps.

**Digital Tools in Implementation**

The implementation of Ayushman Bharat and the Ayushman Bharat Digital Mission relies on a suite of digital tools designed to streamline service delivery and enhance accessibility.

Under PM-JAY, the Beneficiary Identification System (BIS) portal and e-cards facilitate enrolment and cashless claim processing, while hospital empanelment is managed digitally to ensure quality standards and regulatory compliance (NHA, 2024).

Within ABDM, the Ayushman Bharat Health Account (ABHA) provides individuals with a unique digital health ID that links electronic health records across providers. Complementary platforms include DigiDoctor, which registers healthcare professionals, and the Health Facility Registry (HFR), which maintains an updated database of health institutions, enabling better coordination, oversight, and regulatory transparency [6].

Despite these technological advances, significant integration challenges remain. Variations in digital infrastructure, interoperability standards, and state-level administrative capacities hinder seamless data exchange and limit the potential for unified service delivery [7].

Moreover, disparities in digital literacy among both patients and providers constrain the effective use of these tools, particularly in rural and underserved regions. These gaps may perpetuate inequities, undermining the mission's goal of inclusive access.

Addressing these challenges requires coordinated strategies, including standardized protocols for digital integration, targeted capacity-building for healthcare workers and beneficiaries, and cross-sector collaboration to ensure infrastructure readiness. Only through these complementary measures can digital health innovations achieve their intended impact across India's diverse healthcare landscape.

**Digital Barriers in Access and Utilisation**

**1. Digital Literacy and Awareness**

Priya and Maiya (2021) report limited PM-JAY utilisation in rural Tamil Nadu. Awareness gaps persist even among educated groups8. This suggests that digital health adoption is not solely a function of education but also trust and system usability.[1]

**2. Infrastructure Constraints**

Connectivity gaps, low smartphone penetration among low-income households, and unstable electricity in remote areas constrain digital participation. Evidence comparing state-level digital infrastructure remains limited, representing another research gap.

**3. Fraud and Governance Challenges**

A 2025 investigation reported rejection of 3.56 lakh fraudulent claims worth ₹643 crore under PM-JAY 9. While audits demonstrate monitoring mechanisms, such reports highlight systemic vulnerabilities and the need for robust algorithmic and human oversight.

**4. Data Privacy, Consent, and Ethical Concerns**

Digital health expansion raises significant privacy concerns. India currently lacks a comprehensive digital health-specific data protection framework tailored to ABDM architecture. Although broader data protection legislation exists, its operationalisation in digital health contexts remains evolving.

Under ABDM:

- Consent is designed to be granular and revocable.
- Patients theoretically retain control over Personal Health Records.

- Data exchange occurs through consent managers.

However, empirical research assessing how consent functions in practice is sparse.

Questions remain regarding:

- Digital comprehension of consent forms
- Secondary use of anonymised data
- Data ownership and custodianship
- Grievance redressal mechanisms

Gopichandran (2021) emphasises that ethical legitimacy depends not only on technological safeguards but also on distributive justice and public accountability[10]. Evidence remains weak regarding how marginalised populations understand and exercise digital consent rights.

**Policy and Program Responses**

Recognising the digital divide in healthcare access, the Government of India has initiated several policy responses to improve the reach and equity of the Ayushman Bharat and the Ayushman Bharat Digital Mission initiatives. However, the persistence of disparities in digital literacy, infrastructure, and institutional trust indicates that platform-based solutions alone are insufficient. Bridging digital inequity requires coordinated efforts that combine community-level engagement, offline access mechanisms, infrastructure investment, and strengthened governance frameworks. In this context, existing programmatic measures and future reforms must prioritise inclusion, accountability, and capacity-building to ensure that digital health transformation advances, rather than undermines, equitable healthcare access.

**Current Programmatic Measures**

• **Community health workers (ASHAs):** Accredited Social Health Activists (ASHAs) play a pivotal role in raising awareness, identifying beneficiaries, and assisting with enrolment, particularly in rural and tribal areas where digital literacy and infrastructure are limited.

• **Offline enrolment and verification**: Common Service Centres (CSCs) and health facility kiosks enable beneficiaries without smartphones or internet access to register for PM-JAY.

• **Digital intermediaries (Ayushman Mitras):** Stationed at hospitals, they guide patients through the Beneficiary Identification System (BIS), support e-card generation, and assist in claim processing.

• **Capacity-building programs**: Initiatives such as ASHA Kirana empower ASHAs with digital tools for maternal risk assessment, while SAMBHAV supports frontline workers' mental health through digital stress-reduction interventions.[11,12]

**Recommended Policy Enhancements**

1. **Targeted Digital Literacy Interventions**
   - Focus on women, elderly populations, and rural households.
   - Leverage community health workers and self-help groups for training.
   - Use vernacular-language audiovisual tools and mobile-based learning modules.
2. **Infrastructure Investments**
   - Expand broadband and mobile connectivity under rural digital inclusion initiatives.
   - Subsidize smartphones and digital devices for low-income households.
   - Ensure stable electricity supply at Health and Wellness Centres (HWCs).
3. **Governance and Accountability Reforms**
   - Establish independent digital health audit authorities
   - Maintain public dashboards tracking grievance redressal and claim processing.
   - Implement algorithmic audits and fraud detection mechanisms to prevent misuse of PM-JAY funds.
4. **Data Protection and Ethical Oversight**
   - Develop a digital health–specific regulatory framework.
   - Standardize consent procedures in clear, accessible language.
   - Introduce state-level digital health ombudsman offices to monitor compliance and protect patient rights.
5. **Evidence Generation and Research**
   - Conduct independent, state-wise evaluations of digital health implementation.

- Study user comprehension and uptake of digital consent mechanisms.
- Fund research on bridging rural–urban digital inequities and improving inclusive service delivery.

## Conclusion

Ayushman Bharat and ABDM represent transformative policy efforts to expand financial protection and modernize healthcare delivery in India. While PM-JAY has significantly expanded coverage, and ABDM has introduced a sophisticated digital architecture, digital inequities threaten to reproduce existing social disparities. The literature reveals a tension between technological optimism and structural realities. Digital health cannot substitute for foundational infrastructure, workforce investment, and institutional trust. Without targeted digital literacy initiatives, infrastructure expansion, governance reform, and strengthened data protection, digital systems risk excluding the very populations they aim to serve. Achieving equitable Universal Health Coverage in India will require integrating technological innovation with social justice principles, ensuring that digital transformation enhances rather than undermines health equity

**Funding**: NIL

**Conflict of Interest**: Authors declare no conflict of interest

## References

1. Priya SVGV, Maiya GR. Coverage, utilization, and impact of Ayushman Bharat scheme among the rural field practice area of Saveetha Medical College and Hospital,Chennai. J Family Med Prim Care. 2021;10(3):1171–1176
2. Karnataka Study. *Digital Health Awareness Among Postgraduate Health Students in Karnataka*. Unpublished report; 2024.
3. World Health Organization (WHO). *India Health Profile 2021*. Geneva: WHO; 2021. Available from: https://cdn.who.int/media/ docs/ default-source/country-profiles/ health-profiles-ind-2021.pdf [Accessed 4 October 2025]
4. WHO Global Health Observatory. Density of physicians (per 1,000 population). *Global Health Observatory*. Available from:https://data.worldbank.org/indicator/SH.MED.PHYS.ZS?locations=IN [Accessed 4 October 2025]
5. National Health Authority (NHA). Annual Report on PM-JAY Implementation. New Delhi: Ministry of Health and Family Welfare; 2024. Available from: https://nha.gov.in/PM-JAY [Accessed 4 October 2025]
6. Athaley P. Ayushman Bharat Digital Mission: Challenges and Opportunities. Indian J Public Health. 2023;67(2):123–129.
7. Mishra S, Athaley P, Singh R. Ayushman Bharat Digital Mission: Building a unified health ecosystem in India. Health Policy Technol. 2024;13(1):45–52.
8. Karnataka Study. Digital Health Awareness Among Postgraduate Health Students in Karnataka. Unpublished report; 2024
9. The Economic Times. 3.56 lakh claims worth Rs 643 crore rejected for frauds under Ayushman Bharat scheme. 2025. Available from: https://economictimes.indiatimes.com/news/ india/3-56-lakh-claims-worth-rs-643.
10. Gopichandran V. Ayushman Bharat National Health Protection Scheme: an ethical analysis. *Asian Bioethics Rev*. 2021;13(4):371–383. doi: ttps://doi.org/10.1007/s41649-019-00083-5
11. Shrivastava R, et al. Stress Alleviation Methods for Community-Based Health Activists (SAMBHAV): Development of a digital program for stress reduction for community health workers in rural India. *Soc Sci Ment Health*. 2023;5(2):100230. doi: https://doi.org/10.1016/ j.ssmmh.2023.100230
12. Srinidhi V, et al. ASHA Kirana: when digital technology empowered front-line health workers. BMJ Glob Health. 2021;6(10):e005039. doi: https://doi.org/10.1136/bmjgh.

**Review Article**

*DOI: https://doi.org/10.37506/5afn8468*

# Antimicrobial Resistance: New Mechanisms, Surveillance Strategies and Novel Approaches

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**How to cite this article**: Shweta Dattatreya Sawant, Inayat Isak Kabir. Antimicrobial Resistance: New Mechanisms, Surveillance Strategies and Novel Approaches. Indian Journal of Public Health Research and Development/Vol. 17 No. 3, July-September 2026.

**Abstract**

Antimicrobial resistance (AMR) represents a critical and escalating global public health threat, driven primarily by the overuse and misuse of antibiotics in human medicine, agriculture, and animal production. The emergence and dissemination of multidrug-resistant (MDR) organisms are further accelerated by horizontal gene transfer, environmental reservoirs, and inadequate infection prevention and control practices. Recent global estimates indicate that bacterial AMR was directly responsible for 1.27 million global deaths in 2019 and contributed to 4.95 million deaths, with projections suggesting substantial increases in mortality and economic burden if effective interventions are not implemented.

This review summarizes the major molecular mechanisms underlying antimicrobial resistance, including enzymatic drug inactivation, target modification, porin modifications, efflux pump overexpression, and biofilm formation. Innovative approaches, including phage therapy, CRISPR-based antimicrobials, monoclonal antibodies, nanomaterials, vaccination and artificial intelligence (AI) are highlighted as promising next-generation alternatives.

Despite scientific advances, the antibiotic development pipeline remains constrained by economic and regulatory challenges. Sustained research and development, strengthened antimicrobial stewardship, global surveillance, and collaborative industry-academic partnerships are essential to preserve existing therapies and ensure future treatment options against MDR pathogens.

**Keywords:** Antimicrobial resistance, Antibiotic stewardship, Novel approaches, Phage therapy, Antimicrobial peptides

## Introduction

The discovery and widespread clinical implementation of antibiotics represent one of the most transformative achievements in modern medicine. Antibacterial agents have dramatically reduced morbidity and mortality associated with

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**Submission date:** March 17, 2026 **Revision date:** April 30, 2026 **Published date:** June 29, 2026

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infectious diseases and enabled complex medical interventions such as organ transplantation, cancer chemotherapy, neonatal intensive care, and major surgical procedures. However, these advances are increasingly threatened by the rapid emergence and global dissemination of antimicrobial resistance (AMR).[1,2]

Antimicrobial resistance arises when bacteria, viruses, fungi, and parasites develop the ability to survive despite the use of antimicrobial medicines designed to kill or inhibit them. When this happens, antibiotics and other treatments become less effective or even ineffective. As a result, infections become harder or sometimes impossible to treat, which increases the risk of disease spreading, severe illness, disability, and death.[1,2]

Drug-resistant bacterial infections are currently estimated to cause over 1.2 million deaths annually worldwide, with substantially higher mortality when associated deaths are included. The extensive and often inappropriate use of antibiotics in human medicine, veterinary care, and agriculture has accelerated the selection of resistant strains. Environmental contamination with residual antibacterial compounds further contributes to the persistence and spread of resistance determinants. Recent global analyses estimate that in 2019 alone, drug-resistant infections were associated with nearly 4.95 million deaths, of which approximately 1.27 million were directly attributable to bacterial AMR. These findings underscore the scale and urgency of the crisis.[2,3]

The frequent use of broad-spectrum antibiotics, invasive medical procedures, and the presence of immuno-compromised patients create conditions that favor resistant organisms. Medical devices such as catheters, ventilators, and prosthetic implants provide surfaces for bacterial colonization and biofilm formation, leading to persistent hospital-associated infections. Biofilms confer additional protection against antimicrobial agents and host immune responses, complicating eradication and promoting recurrent infections.[1,2,4,5,6]

In parallel with traditional antibiotic discovery, attention has shifted toward alternative and next-generation therapeutic strategies. Drug repurpose strategies have gained traction by leveraging existing non-antibacterial agents with newly identified antimicrobial properties.[1,2,4,5]

Combination therapies represent another promising approach, pairing conventional antibiotics with adjuvant compounds such as efflux pump inhibitors or quorum-sensing antagonists to enhance efficacy and suppress resistance development. Emerging strategies including antimicrobial peptides, bacteriophage therapy, CRISPR-based antimicrobials, monoclonal antibodies, nanotechnology-driven drug delivery systems, and microbiome-modulating strategies are being actively investigated as alternative or adjunctive therapies. These approaches aim to improve specificity, reduce collateral damage to beneficial microbiota, and minimize selective pressure that drives resistance. The integration of artificial intelligence (AI) and machine learning into drug discovery pipelines further accelerates the identification and optimization of promising antibacterial candidates.[1,2,4,5]

Despite these advances, critical gaps remain. There is limited integration of emerging therapies such as phage therapy, CRISPR-based antimicrobials, and microbiome modulation with conventional antibiotics in clinical practice. Comparative data on efficacy, safety, and scalability of these next-generation interventions are scarce, and knowledge is fragmented regarding AI-driven drug discovery and drug repurposing in antimicrobial development. These gaps hinder the translation of promising research into practical solutions for AMR.

Therapeutic innovation alone cannot resolve the AMR crisis. Effective stewardship programs, rational prescribing practices, enhanced infection prevention and control measures, and robust global surveillance systems are essential to preserve the efficacy of both existing and emerging therapies. International initiatives such as the Global Antimicrobial Resistance and Use Surveillance System (GLASS) underscore the importance of coordinated data collection and monitoring of resistance trends worldwide. Addressing AMR requires sustained interdisciplinary collaboration among researchers, clinicians, policymakers, industry stakeholders, and global health organizations.[1,2,4,5]

Even with significant progress in understanding how antimicrobial resistance works and the emergence of various new treatments, substantial gaps in knowledge and practical application still exist. Current research often examines resistance mechanisms, surveillance frameworks, and emerging therapies separately; it rarely compares their potential, scalability, or readiness for clinical use. What's more, few reviews systematically assess why some treatment strategies have failed, which approaches truly show promise for real-world application, or how new tools like artificial intelligence might fit into existing stewardship and surveillance systems. This review aims to fill these gaps by synthesizing and critically evaluating resistance mechanisms, surveillance strategies, and novel therapies. It then compares their advantages, limitations, and barriers to implementation.

**Mechanisms of Antimicrobial Resistance: Clinical Relevance and Therapeutic Implications**

Antimicrobial resistance (AMR) mechanisms are more than just molecular adaptations. They're critical in determining clinical failure, how long treatments last, and patient outcomes. While we categorize resistance mechanisms as intrinsic or acquired, their true impact in the real world depends on how they co-exist, whether they can be induced, and how they interact with host and environmental factors. Multidrug resistance often arises from several mechanisms accumulating and acting in concert, rather than just one pathway taking over.[4,5]

These mechanisms collectively reduce antibiotic efficacy, enabling bacterial survival under therapeutic pressure and facilitating the spread of resistance across and within species.

The major mechanisms of antimicrobial resistance are summarized in Figure 1. The schematic highlights how bacteria employ multiple complementary strategies to evade antimicrobial activity, including enzymatic inactivation of drugs, modification of antibiotic target sites, activation of efflux pumps that expel antibiotics from the cell, and reduced membrane permeability due to porin alterations. In addition, structural changes in penicillin-binding proteins (PBPs) further decrease antibiotic binding. Importantly, these mechanisms often coexist within a single bacterial cell, resulting in multidrug resistance and significantly limiting therapeutic options.

**Enzymatic Inactivation of Antibiotics**

Enzymatic inactivation is one of the most prevalent resistance mechanisms, whereby bacteria produce enzymes that degrade or chemically modify antimicrobial agents. The most well-known example is the hydrolysis of β-lactam antibiotics by β-lactamases, which disrupt the β-lactam ring and render penicillins, cephalosporins and related drugs ineffective. In addition, enzymes may inactivate antibiotics through acetylation, phosphorylation, or nucleotidylation, affecting aminoglycosides, chloramphenicol, rifamycins, lincosamides, tetracyclines, and streptogramins. [2,5] Among these, β-lactamases including penicillinases, AmpC enzymes, extended-spectrum β-lactamases (ESBLs), and carbapenemases (e.g., KPC, VIM, IMP, and OXA-type)are of clinical concern due to their broad substrate spectrum and rapid dissemination, especially in Gram-negative bacteria.[2,5,7,8,9]

**Biofilm-Associated Resistance**

Biofilm formation represents an important adaptive mechanism in which bacteria grow as structured communities embedded in a self-produced extracellular matrix composed of polysaccharides, proteins, and extracellular DNA. Biofilm-associated bacteria can exhibit up to 10,000-fold increase resistance compared with planktonic cells. This enhanced resistance results from limited antibiotic penetration, altered metabolic states, and increased expression of resistance determinants.[5,10,11] Clinically significant pathogens such as *Pseudomonas aeruginosa* and *Acinetobacter baumannii* frequently combine biofilm formation with additional resistance mechanisms, contributing to persistent and difficult-to-treat infections.[2]

**Efflux Pump-Mediated Resistance**

Efflux pumps (EPs) enable bacteria to eliminate a wide range of toxic substances, including antibiotics, heavy metals, disinfectants, and antiseptics. These systems actively expel antibiotics and other toxic compounds from bacterial cells, maintaining intracellular drug concentrations below bactericidal levels. Efflux pumps may be constitutively expressed or induced in response to environmental stimuli, including antibiotic exposure.[2,8,12]

There are five major families of efflux pumps: (i) the major facilitator superfamily (MFs), (ii) the small multidrug resistance family (SMR), (iii) the resistance-nodulation cell-division family (RND), (iv) the ATP-binding cassette family, and (v) the multidrug and toxic compound extrusion family. These efflux pump families vary in their structural organization, energy sources, substrate specificity, and distribution across different bacterial species.[5,7,12]

**Target Site Modification**

Modification of antibiotic target sites reduces drug binding and represents a major resistance strategy. This may occur through mutations or enzymatic alterations affecting ribosomes, DNA replication enzymes, or cell wall synthesis proteins.

For example, mutations in DNA gyrase and topoisomerase confer resistance to quinolones, while methylation of ribosomal RNA mediated by *erm* genes leads to resistance to macrolides and related agents. Similarly, alterations in penicillin-binding proteins (PBPs), which are essential for peptidoglycan synthesis, reduce β-lactam binding. The acquisition of PBP2a, encoded by the *mecA* gene and its homologs, is a well-known mechanism conferring resistance to β-lactam antibiotics. Enzymatic drug inactivation and efflux pump overexpression are major clinical challenges in resistance, stemming from their broad substrate profile and rapid horizontal dissemination.[5,7,8,12]

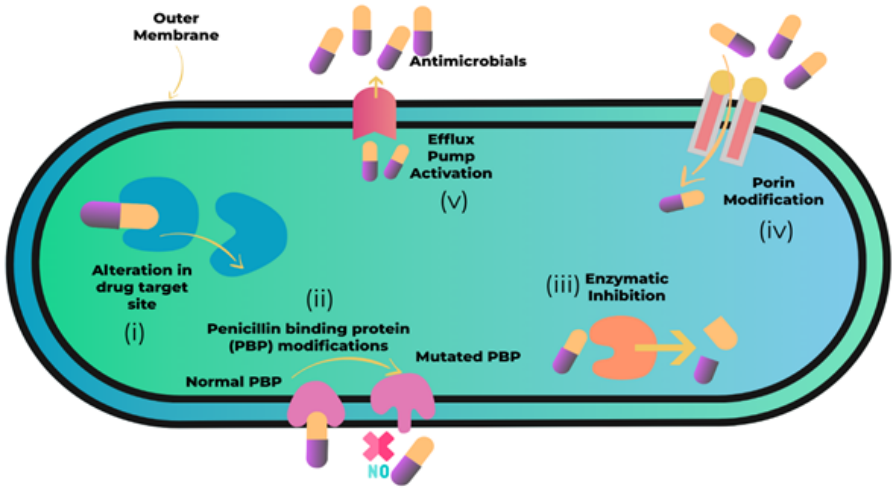



**Figure 1**: **Overview of major mechanisms of antimicrobial resistance in bacteria**

This schematic representation illustrates the principal mechanisms by which bacteria resist antimicrobial agents. These include: (i) alteration of drug target sites that reduces antibiotic binding, (ii) modification of penicillin-binding proteins (PBPs), (iii) enzymatic inactivation of antibiotics (e.g., β-lactamase-mediated degradation), (iv) porin modifications that limit antibiotic entry and (v) activation of efflux pumps that actively remove antibiotics from the bacterial cell. The figure also emphasizes the combined effect of these mechanisms in reducing intracellular drug concentrations and promoting the development of multidrug-resistant bacterial strains.

**Reduced Membrane Permeability (Porin Modification)**

Porins act as channels that facilitate the passive diffusion of hydrophilic molecules, including certain antibiotics, into bacterial cells. Reduced permeability of the bacterial cell envelope limits antibiotic entry, particularly in Gram-negative bacteria. Porins may undergo structural alterations or decreased expression, restricting drug uptake.

Examples include OmpF, OmpC, and PhoE in *Escherichia coli*, and OprD in *Pseudomonas aeruginosa*. Loss or modification of OprD is associated with resistance to carbapenems such as imipenem and meropenem. These permeability changes often act

synergistically with other mechanisms, including efflux pump overexpression.[5,7,12]

**Summary of antimicrobial resistance mechanisms are given in Table 1.**

**Table 1: Summary of antimicrobial resistance mechanisms**

| Resistance Mechanism | Primary Advantage to Bacteria | Why It Matters Clinically | Key Limitation |
|---|---|---|---|
| Enzymatic inactivation | Rapid antibiotic neutralization | Leads to broad ß-lactam failure | Can be targeted by inhibitors |
| Efflux pumps | Multidrug resistance | Limits intracellular drug levels | Energetically costly |
| Target modification | High specificity | Causes class-specific failure | Often requires mutations |
| Reduced permeability | Prevents drug entry | Critical in Gram-negative MDR | Synergistic, not standalone |
| Biofilm formation | Community protection | Causes chronic, recurrent infections | Vulnerable to physical disruption |

**Global Strategies for Tracking Antimicrobial Resistance**

**Antimicrobial Stewardship**

Antimicrobial stewardship (AMS) is central to global efforts to mitigate AMR by promoting the rational use of antibiotics. Antimicrobial Stewardship Programs (ASPs) involve systematic monitoring and coordinated interventions among clinicians, infection control personnel, pharmacists, and information technology teams. These programs aim to ensure the optimal use of antibiotics, including appropriate selection, dosing, route of administration, and treatment duration.[13]

To support the appropriate use of antibiotics, the WHO developed the AWaRe (Access, Watch, Reserve) classification. The AWaRe antibiotic book provides clear, evidence-based guidance on antibiotic selection, dosing, route of administration, and treatment duration for over 30 common infections in children and adults in both primary care and hospital settings. In parallel, WHO Priority Pathogen Lists (PPLs) identify high-risk drug–pathogen combinations requiring urgent research and policy attention. Together, these frameworks connect surveillance data with clinical practice, ensuring that prescribing behavior aligns with evolving resistance patterns.[14,15]

However, stewardship alone cannot address the AMR crisis without parallel advances in drug development. Global initiatives such as the Global Antibiotic Research & Development Partnership (GARDP), CARB-X, and the AMR Action Fund aim to address persistent gaps in antimicrobial innovation. These efforts highlight the need for coordinated strategies that align stewardship with research investment and equitable access to new therapeutics.[14,16]

**WHO BPPL: Guiding Antimicrobial Research and Investment**

Since 2017, the WHO Bacterial Priority Pathogens List (BPPL) has guided R&D investment and AMR surveillance. Despite these efforts, antibiotic innovation and access remain limited. The 2024 BPPL updates the list, categorizing 15 antibiotic-resistant pathogen families into critical, high, and medium priorities. Critical pathogens include *Acinetobacter baumannii*, Enterobacterales, and rifampicin-resistant *Mycobacterium tuberculosis* due to their severity, transmissibility, and global burden, particularly in LMICs. High-priority pathogens include *Pseudomonas aeruginosa*, *Staphylococcus aureus*, multidrug-resistant *Neisseria gonorrhoeae*, and *Enterococcus faecium*. Medium-priority pathogens, such as Group A and B Streptococci, *Streptococcus pneumoniae*, and *Haemophilus influenzae*, pose significant risks to vulnerable populations.[17,18,19]

While the BPPL provides a valuable global benchmark, its impact depends on regional adaptation. Differences in pathogen distribution, healthcare infrastructure, and antibiotic use patterns require context-specific prioritization to ensure relevance and effectiveness, particularly in high-burden settings.[17]

**Strengthening AMR Surveillance: WHO's GLASS Initiative**

Surveillance systems play a vital role in controlling antimicrobial resistance. Yet, their real strength lies not just in gathering data, but in how effectively that information shapes clinical choices, enhances stewardship efforts, and guides research priorities.

WHO's Global Antimicrobial Resistance and Use Surveillance System (GLASS) represented a significant advance. It harmonized AMR and AMU data across countries under a "One Health" approach. This standardized method allows for international comparisons, helps spot resistance trends early, and aligns prescribing practices with epidemiological data.

For instance, limited lab capacity, underrepresentation from low- and middle-income countries, and slow reporting all hinder real-time responses. Furthermore, surveillance data rarely incorporate genomic sequencing, environmental monitoring, or analyses of prescribing behavior. This makes the data less useful for prediction.

Future surveillance needs to go beyond passive reporting and truly embrace predictive modeling. This means incorporating AI-driven analytics, real-time genomic surveillance, and clinical outcome data. Otherwise, surveillance risks staying merely descriptive, rather than becoming genuinely transformative.

Effective AMR control relies on robust and standardized surveillance systems. Historically, global surveillance has been limited by fragmented data and inconsistent methodologies. The WHO's Global Antimicrobial Resistance and Use Surveillance System (GLASS), established in 2015, addresses these challenges by harmonizing AMR and antimicrobial use (AMU) data across countries within a One Health framework. [15,20]

Since its inception, GLASS has accumulated data from over 23 million laboratory confirmed infections reported by 104 countries. By focusing on priority pathogens and key infection syndromes, it ensures that surveillance remains targeted and policy-relevant. Importantly, GLASS employs statistical modeling to adjust for variations in laboratory capacity and reporting completeness, enabling more reliable cross-country comparisons and trend analysis.

Despite these advances, important limitations persist. Participation and data quality remain uneven, with low-and middle-income countries often facing constraints in laboratory infrastructure and data systems. This can lead to underrepresentation of high-burden regions and limit the precision of global estimates.

Nevertheless, GLASS represents a critical shift from passive data collection to actionable surveillance. By enabling benchmarking, informing stewardship interventions, and guiding research priorities, it serves as a cornerstone of global AMR governance. Strengthening national surveillance capacity, improving data completeness, and integrating real-time and genomic tools will be essential to maximize its impact.[14,15,20]

**EMERGING AND INNOVATIVE SOLUTIONS**

Recent advancements in the discovery and development of novel therapeutics such as phage therapy, antimicrobial peptides (AMPs), CRISPR-Cas9, monoclonal antibodies, drug repurposing strategies and use of artificial intelligence (AI) and computational strategies have shown significant promise in addressing antimicrobial resistance.

Collectively, these emerging therapeutic strategies differ in their mechanisms, specificity, stage of clinical development, and translational challenges. While approaches such as phage therapy and CRISPR-based antimicrobials offer high specificity and precision, others including antimicrobial peptides and nanoparticles provide broad-spectrum activity. In contrast, vaccines and probiotics function as preventive strategies, reducing infection burden and antibiotic use. Despite their promise, limitations such as cost, delivery challenges, regulatory hurdles, and scalability issues continue to influence their clinical applicability, highlighting the need for integrated and combination approaches to effectively combat antimicrobial resistance. Comparison of these novel therapeutic approaches for antimicrobial resistance is presented in Table 2.

**Table 2: Comparison of novel therapeutic approaches for antimicrobial resistance**

| Approach | Mechanism of Action | Advantages | Limitations |
|---|---|---|---|
| Phage therapy | Lytic bacteriophages infect and lyse bacterial hosts through lytic cycle. | High specificity, preserves beneficial microbiota, low toxicity and good tolerance, cost-effective, effectively kill gram positive and gram-negative bacteria, effective against biofilms. | Narrow host range, Maintenance, regulatory and logistic challenges, phage selection & production complexity. |
| Antimicrobial peptides (AMPs) | Membrane disruption (pore formation, leakage) and non-membrane mechanisms (inhibition of DNA, RNA, protein synthesis) | Broad-spectrum activity, low risk of resistance development, effective against MDR pathogens. | Short half-life, hostcytotoxicity, high production cost. |
| Monoclonal antibodies | Neutralization of bacterial toxins, targeting virulence factors and immune system enhancement, direct bactericidal production for killing the bacteria. | High specificity, favorable safety profile, low toxicity, preserves microbiota, reduced resistance development | High production cost, intravenous administration. |
| CRISPR-based antimicrobials | Sequence-specific targeting and cleavage of resistance genes or plasmids using CRISPR-Cas systems | Highly specific and programmable, targets AMR genes directly, effective in MDR pathogens. | Narrow host range and delivery challenges. |
| Drug repurposing | New use of existing drugs | reduces costs and time, accelerates the development of new treatments, faster approval. | Limited efficacy, unknown mechanisms, Patent related issues. |
| Nanoparticles, Nanomaterials | Bactericidal activity, ROS generation, membrane damage or act as nanocarriers for antibiotics and AMPs. | Broad spectrum of activity, Multifunctional, synergistic effects, reduces resistance development. | Toxicity concerns, scalability |
| Probiotics | Production of antimicrobial bacteriocins, microbiome modulation, enhancement of mucosal barrier to prevent bacterial attachment. | Safe, preventive approach, active against biofilms and virulence factors. | Strain-specific effects, variability in host response, stability and storage issues. |
| Algae-based treatment | Removal of antibiotic-resistant bacteria (ARB) and genes (ARGs) | Eco-friendly, sustainable, reduces antibiotic residues | Limited clinical relevance, variability in efficiency, scalability challenges |
| Vaccines | Prevent infections | Reduces antibiotic use and resistance, long-term impact | Variable efficacy, pathogen-specific, development gaps |
| AI & computational tools | Drug discovery, prediction, surveillance | Rapid, data-driven, enables drug repurposing | Data dependency, validation needed, algorithm bias |

**Phage Therapy**

Bacteriophages (phages) are viruses that infect and multiply within bacteria. The global rise of AMR has renewed attention to phages as promising alternatives to antibiotics, particularly in Eastern European countries where phage therapy has long been integrated into clinical practice.[2,21]

Phage therapy involves the administration of lytic phages to selectively eliminate pathogenic bacteria, including multidrug-resistant (MDR) and extensively drug-resistant (XDR) strains. Clinical and preclinical studies have demonstrated efficacy against pathogens such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Klebsiellapneumoniae*. Phages also show potential in preventing and disrupting biofilms, which are major contributors to chronic and resistant infections. Additionally, innovative approaches such as phage–nanoparticle conjugates (e.g., T7 phages with silver nanoparticles) have demonstrated synergistic antibiofilm activity without significant toxicity.[2,11,21,22,23,24]

Overall, phage therapy represents a highly specific, adaptable, and promising strategy for combating AMR, particularly in the context of personalized medicine.

**Antimicrobial Peptides (AMPs)**

AMPs primarily exert antimicrobial effect through membrane disruption by interacting with negatively charged components of bacterial cell membranes, leading to pore formation, leakage of intracellular contents, and cell death. Some AMPs also act via non–membrane-disruptive mechanisms, including inhibition of DNA, RNA, or protein synthesis and interference with enzymatic and metabolic pathways. Their multi-targeted mechanisms reduce the likelihood of resistance development compared to traditional antibiotics.

Several AMPs, including polymyxins, gramicidin, daptomycin, and lipoglycopeptides such as dalbavancin and telavancin, have received regulatory approval. Combination strategies, such as peptide–antibiotic conjugates, have demonstrated enhanced efficacy against MDR pathogens.[4,11,21,22,24]

**Monoclonal Antibody-Based Therapies (mAbs)**

Monoclonal antibodies (mAbs) are laboratory-engineered proteins that selectively target specific antigens, offering high specificity and a favorable safety profile.mAbs exert antimicrobial effects by neutralizing bacterial toxins, targeting virulence factors, promoting complement-mediated killing, and enhancing immune clearance.

Currently, only a limited number of mAbs have received regulatory approval for bacterial infections, including bezlotoxumab (for recurrent *Clostridioides difficile* infection) and raxibacumab and obiltoxaximab (for inhalational anthrax).

Despite their therapeutic potential, widespread clinical use is limited by high production costs and intravenous administration requirements. Nevertheless, mAbs represent a targeted and adjunctive strategy for combating multidrug-resistant bacterial infections.[11,21,22,25]

**CRISPR-Based Antimicrobials**

CRISPR–Cas technologies particularly CRISPR–Cas9 have been repurposed as novel antimicrobial tools to combat AMR. CRISPR-based antimicrobials function by selectively targeting and cleaving antibiotic resistance genes or virulence determinants within bacterial genomes or plasmids. Delivery systems such as bacteriophages, phagemids, and conjugative plasmids have been used to introduce CRISPR constructs into MDR pathogens, including *Escherichia coli* and *Staphylococcus aureus*.Despite its promise, several challenges limit clinical translation.

Overall, CRISPR-based antimicrobials represent a highly specific and programmable strategy with significant potential to complement existing therapies and restore antibiotic susceptibility in resistant bacterial populations.[4,23,24,26]

**Drug Repurposing Strategies**

Drug repurposing involves identifying new antimicrobial applications for existing drugs that have already undergone safety and clinical evaluation.

In response to the growing AMR crisis, drug repurposing has gained increasing attention. Collaborative initiatives and compound libraries from organizations such as Medicines for Malaria

Venture (MMV) and the Drugs for Neglected Diseases Initiative (DNDi) facilitate large-scale screening of approved and investigational molecules. Several non-antibiotic drugs, including certain anticancer agents and statins, have demonstrated antibacterial or antibiotic-sensitizing effects against multidrug-resistant pathogens.[4,17,24,27]

**Nanoparticles and Nanotechnology-Based Approaches**

Nanoparticles offer a promising strategy to combat AMR due to their high surface-to-volume ratio, tunable surface chemistry, and ability to interact efficiently with microbial cells. They exhibit dual functionality: intrinsic antimicrobial activity and use as nanocarriers for antibiotics or antimicrobial peptides (AMPs).

Metal nanoparticles particularly silver nanoparticles (AgNPs) and gold nanoparticles (AuNPs), exert antimicrobial effect by disrupting bacterial membranes, generating reactive oxygen species (ROS), interfering with biofilms, and damaging cellular proteins and DNA. These multimodal mechanisms reduce the likelihood of resistance development and demonstrate activity against MDR Gram-positive and Gram-negative bacteria. Conjugation of antibiotics such as vancomycin, ampicillin, and gentamicin with nanoparticles have shown synergistic antibacterial effects.[21,22,25]

**Probiotics**

Probiotics are live microorganisms, commonly from *Bifidobacterium, Lactobacillus, Saccharomyces,* and *Bacillus* species, that confer health benefits when administered in adequate amounts. They combat pathogenic bacteria by producing antimicrobial compounds (bacteriocins), enhancing gut barrier function, restoring microbiome balance, and modulating immunity. This reduces infections and the need for antibiotics, lowering selective pressure for AMR.Advantages include targeted activity, no risk of AMR, and improved host health, while limitations involve strain-specific efficacy, host variability, and production or storage challenges. Despite these, probiotics offer a natural and effective strategy to reduce infections, antibiotic use, and AMR.[11,21]

**Algae mediated treatments**

Domestic and agricultural wastewaters are significant sources of antibiotic-resistant bacteria (ARB) and antibiotic resistance genes (ARGs) due to widespread antibiotic use. Algae-mediated treatments, particularly using green algae, have emerged as an eco-friendly alternative. Microalgae efficiently remove nutrients, heavy metals, pathogens, and antibiotic residues while reducing ARB and ARGs.[22]

A study comparing conventional wastewater treatment with an algae-based system found that the algal system achieved significantly greater reductions in sulfamethoxazole- and erythromycin-resistant bacteria than the conventional treatment.[28]

**Vaccines for Reducing Antibiotic Use**

Vaccination plays critical role in combating AMR by preventing infections and reducing the need for antibiotics, thereby lowering selective pressure for emergence of resistant strains. Long-term vaccination against diseases like pertussis, diphtheria, *Haemophilus influenzae* type b (Hib), and *Streptococcus pneumoniae* has led to substantial reductions in infections and multidrug-resistant cases.[24] For example, the PCV7 pneumococcal vaccine reduced multidrug-resistant invasive pneumococcal disease by 84%.[22]

While vaccines exist for some WHO priority pathogens (e.g., *S. pneumoniae*, *H. influenzae*, *Salmonella Typhi*), effective vaccines are still under development for other major AMR contributors, including *S. aureus*, *E. coli*, *K. pneumoniae*, and *A. baumannii*.[15]

Overall, vaccines provide direct and indirect protection against AMR, representing a sustainable and preventative strategy that complements other antimicrobial interventions.

**Artificial Intelligence and Computational Strategies**

Artificial intelligence (AI) and machine learning (ML) are increasingly recognized as transformative tools in combating AMR, particularly in resistance prediction, surveillance, and antimicrobial discovery. AI-driven models can integrate genomic data, phenotypic susceptibility profiles, and clinical metadata to accurately predict resistance phenotypes and identify novel resistance determinants.

In addition, AI enhances AMR surveillance by detecting emerging resistance patterns, forecasting outbreak risks, and informing antimicrobial stewardship strategies. Beyond diagnostics and surveillance, computational platforms leveraging deep learning and advanced bioinformatics are accelerating antimicrobial discovery by enabling virtual screening of large compound libraries and facilitating the rational design of novel agents capable of overcoming existing resistance mechanisms.[29,30]

No single emerging therapy is sufficient to replace antibiotics. Phage therapy and antimicrobial peptides appear most promising for multidrug-resistant and biofilm-associated infections, yet face significant challenges in delivery, regulation, and scalability. Notably, many approaches have stalled not due to lack of efficacy, but economic, regulatory, and logistical barriers.

## Conclusion

Antimicrobial resistance represents a multifaceted global crisis driven by microbial evolution, antibiotic misuse, and systemic gaps in surveillance and innovation. This review demonstrates that while remarkable progress has been made in understanding resistance mechanisms and developing alternative therapies, fragmentation between science, clinical practice, and policy continues to limit impact.

We won't find one "replacement" for antibiotics. Instead, the most promising path forward combines next-generation therapies, strong surveillance, antimicrobial stewardship, and preventive measures like vaccination. Precision tools, such as CRISPR-based antimicrobials and AI-enabled drug discovery, hold great promise. But they'll only truly transform things if we back them with scalable delivery systems and fair global access.

To truly combat AMR, we'll need to shift away from just reacting with drugs. Instead, we must adopt proactive, system-based strategies guided by One Health principles. Ongoing collaboration across disciplines, practical research, and aligned policies are essential. These are what we'll need to preserve how well antimicrobials work and to protect global health.

**Funding Sources**: NA

**Conflicts of interest statement:** The authors declare no conflicts of interest.

## Reference

1. Tängdén T, Carrara E, Hellou MM, Dafna Yahav, Paul M. Introducing new antibiotics for multidrug-resistant bacteria: obstacles and the way forward. Clinical Microbiology and Infection. 2024 Oct 1.
2. Niño-Vega GA, Ortiz-Ramírez JA, Everardo López-Romero. Novel Antibacterial Approaches and Therapeutic Strategies. Antibiotics. 2025 Apr 15;14(4):404–4.
3. Antimicrobial Resistance Collaborators. Global Burden of Bacterial Antimicrobial Resistance in 2019: a Systematic Analysis. The Lancet [Internet]. 2022 Feb 12;399(10325):629–55.
4. Rajesh AM, Pawar SS, Kruthi Doriya, Rambabu Dandela. Combating antibiotic resistance: mechanisms, challenges, and innovative approaches in antibacterial drug development. 2025 Jan 26.
5. Kateryna Volodymyrivna Kon, Mahendra Rai. Antibiotic resistance: mechanisms and new antimicrobial approaches. Amsterdam: Elsevier, Academic Press; 2016.
6. Temur BZ, Cetinkaya IC, Acikel Elmas M, Unubol N, Arbak S, Kocagoz T, et al. New Generation Antibiotics Derived from DABCO-Based Cationic Polymers. Antibiotics [Internet]. 2025 Aug 25.
7. Munita JM, Arias CA. Mechanisms of antibiotic resistance. Virulence Mechanisms of Bacterial Pathogens, Fifth Edition. 2016 Oct 1;4(2):481–511.
8. Halawa EM, Fadel M, Al-Rabia MW, Behairy A, Nouh NA, Abdo M, et al. Antibiotic action and resistance: updated review of mechanisms, spread, influencing factors, and alternative approaches for combating resistance. Frontiers in Pharmacology. 2023;14(1):1305294.
9. Terreni M, Taccani M, Pregnolato M. New Antibiotics for Multidrug-Resistant Bacterial Strains: Latest Research Developments and Future Perspectives. Molecules [Internet]. 2021 May 2;26(9):2671.
10. Gadar K, McCarthy RR. Using next generation antimicrobials to target the mechanisms of infection. *npj Antimicrob Resist* [Internet]. 2023;1(1):11.
11. Berger I, Loewy ZG. Antimicrobial Resistance and Novel Alternative Approaches to Conventional Antibiotics. Bacteria [Internet]. 2024 Jul 22;3(3):171–

82. Available from: https://www.mdpi.com/2674-1334/3/3/12.

12. Elkady H, Salman IN, Khalifa MM. Small-molecule strategies to combat antibiotic resistance: mechanisms, modifications, and contemporary approaches. RSC Advances. 2025;15(30):24450–74.
13. Habboush Y, Guzman N. Antibiotic Resistance [Internet]. National Library of Medicine. StatPearls Publishing; 2023. Available from: https://www.ncbi.nlm.nih.gov/ books/NBK513277/
14. World Health Organization. Antimicrobial resistance [Internet]. World Health Organization. 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance https://www.who.int/news-room/ fact-sheets/ detail/antimicrobial-resistance
15. Reza N, Dubey V, Sharland M, Hope W. Antimicrobial use and resistance. BMJ. 2025 Dec 12;391:e082681.
16. Farha MA, Tu MM, Brown ED. Important challenges to finding new leads for new antibiotics. Current Opinion in Microbiology [Internet]. 2024 Nov 26;83:102562.
17. World Health Organization. WHO bacterial priority pathogens list, 2024: Bacterial pathogens of public health importance to guide research, development and strategies to prevent and control antimicrobial resistance [Internet]. www.who.int. 2024. https://www.who.int/ publications/i/item/9789240093461.
18. Machado E, Sousa JC. New Antibiotics for Treating Infections Caused by Multidrug-Resistant Bacteria. Antibiotics. 2025 Oct 5;14(10):997.
19. Hatim Sati, Carrara E, Savoldi A, Hansen P, Jacopo Garlasco, Enrica Campagnaro, et al. The WHO Bacterial Priority Pathogens List 2024: a prioritisation study to guide research, development, and public health strategies against antimicrobial resistance. The Lancet Infectious Diseases [Internet]. 2025 Apr 1.
20. Antimicrobial Resistance Division (AMR. Global antibiotic resistance surveillance report 2025: summary [Internet]. Who.int. World Health Organization; 2025. https://www.who.int/ publications/i/item/B09585.
21. Gideon Sadikiel Mmbando, Ally O, Misinzo G. Current approaches and tools for combating antibiotic resistance. Deleted Journal. 2025 Aug 20;7(9).
22. Ahmed S, Ahmed MZ, Rafique S, Almasoudi SE, Shah M, Jalil NAC, et al. Recent Approaches for Downplaying Antibiotic Resistance: Molecular Mechanisms. Kandeel M, editor. BioMed Research International. 2023 Jan 23;2023:1–27.
23. Shim H. Three Innovations of Next-Generation Antibiotics: Evolvability, Specificity, and Non-Immunogenicity. Three Innovations of Next-Generation Antibiotics: Evolvability, Specificity, and Non-Immunogenicity [Internet]. 2023 Jan 18;12(2):204–4.
24. Bhandari V, Suresh A. Next-Generation Approaches Needed to Tackle Antimicrobial Resistance for the Development of Novel Therapies Against the Deadly Pathogens. Frontiers in Pharmacology. 2022 Jun 2;13.
25. Arun Karnwal, Amar Yasser Jassim, Mohammed AA, Said M, Selvaraj M, Malik T. Addressing the global challenge of bacterial drug resistance: insights, strategies, and future directions. Frontiers in Microbiology. 2025 Feb 24;16.
26. Sun S. Emerging antibiotic resistance by various novel proteins/enzymes. European Journal of Clinical Microbiology & Infectious Diseases. 2025 Apr 15.
27. Lorente-Torres B, Llano-Verdeja J, Castañera P, Ferrero HÁ, Fernández-Martínez S, Javadimarand F, et al. Innovative Strategies in Drug Repurposing to Tackle Intracellular Bacterial Pathogens. Antibiotics (Basel, Switzerland) [Internet]. 2024 Feb;13(9):834.
28. Cheng X, Delanka-Pedige HMK, Munasinghe-Arachchige SP, Abeysiriwardana-Arachchige ISA, Smith GB, Nirmalakhandan N, et al. Removal of antibiotic resistance genes in an algal-based wastewater treatment system employing Galdieria sulphuraria: A comparative study. Science of The Total Environment. 2020 Apr;711:134435.
29. Li Y, Cui X, Yang X, Liu G, Zhang J. Artificial intelligence in predicting pathogenic microorganisms' antimicrobial resistance: challenges, progress, and prospects. Frontiers in cellular and infection microbiology [Internet]. 2024 Jan;14:1482186
30. de P, Samuel, Pal T, Cesar, Pletzer D. From Data to Decisions: Leveraging Artificial Intelligence and Machine Learning in Combating Antimicrobial Resistance – a Comprehensive Review. Journal of Medical Systems. 2024 Aug 1;48(1).

**Short Communication**

*DOI: https://doi.org/10.37506/a4x0ak53*

# Lessons From My 30 Years of Snakebite Management

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**How to cite this article**: Patel DC, Sovani VB. Lessons From My 30 Years of Snakebite Management. Indian Journal of Public Health Research and Development/Vol. 17 No. 3, July-September 2026.

**Abstract**

Inspite of various guidelines for snakebite management, in real life, every case of snakebite poses a unique challenge and one may not always be able to abide strictly by the guidelines. There are a just a handful of physicians who are experts in managing snakebite. This article has been written by Dr D C Patel in Dharampur, Gujarat who has been treating snakebite victims for more than 30 years. This short communication draws on over three decades of clinical data and practice-based insights, offering guidance for public health professionals and community medicine practitioners in remote, resource-constrained settings.

Data from April 1993 to March 2024 has been presented along with tips on snakebite management. His analysis presents a few insights- Russell's viper bites have increased steeply over the years in Dharampur area and Valsad district of Gujarat. The mean number of vials used to manage bites by various species have fallen over time. Regular public awareness programshave borne fruit. Fewer patients visit faith healers and they reach the hospital quickly. Management of cases using the syndromic approach, early and adequate administration of clinically estimated amount of AVS along with organ support is the essential triad of management.

**Keywords:** Russell's viper, Saw scaled viper, Cobra, Krait, envenomation, haemotoxic, neurotoxic, anti-snake venom serum.

## Introduction

There are guidelines provided by the government and WHO to simplify the management of snakebite,[1,2] but they are just that; guidelines. On ground, every case of snake bite is unique and a learning experience due to the extensive effects of the venom. In each state we have a handful of physicians who treat snakebites regularly.

Dr Dhirubhai Patel is the director of Shree Sainath Hospital, Dharampur, Gujarat, and the vice-chairman of the Snake Research Institute, under the Department of Forests, Government of Gujarat.

He grew up in a rural tribal area where agriculture and forest produce were the means of subsistence, and snakebite was a major concern that never got enough attention. After becoming a surgeon, he set up his own hospital in Dharampur in 1990.

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**Submission date:** February 22, 2026 **Revision date:** April 30, 2026 **Published date:** June 29, 2026

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According to census 2011,[3] Dharampur Tehsil in Valsad district has a population of two hundred and sixteen thousand. Dharampur municipality is surrounded by about 107 villages, all agricultural land. Most of the patients are tribals owning small land plots or farm labourers. Snakes appear during the rainy season and are around through the harvesting season. Agricultural labourers' risk being bitten from June to November/December. This is the primarycatchment area of Sainath hospital. But other than Valsad district, patients from Dang and Navsari district are also brought here.

From early 1993 to March 2024, he has managed about twenty thousand cases of snakebite. Every case is uploaded on Integrated Health Information Platform (Ministry of Health and Family Welfare, Gov. of India), from October2023 onwards. Previously, local district officials used to be informed about ASV usage in detail.

The local authorities recognized his service by providing free Anti Snake Venom (ASV). These records are a treasure trove of information. This article summarises the change in types and number of snakes over the years and Dr Patel's management tips.

## Methods

For 30 years Dr Patel has maintained detailed records of snakebite patients including demographic information, dates of bite, admission, discharge, type of snake, site of bite, number of Antivenom vials used, surgical procedures, dialysis, ventilation requirements, and outcome of the case. This data was compiled and analysed to look for changes in snake varieties over the years, mean number of antivenomvials needed to manage cases of different envenomation syndromes, mortality per year and per snake type. Dr Patel also discussed his favoured method of management for each snake type.

## Results

8104 of 19698 cases of snakebite between 1993 and March 2024, were due to venomous snakes requiring admission and administration of ASV.

The number of bites due to Russell's viper have risen dramatically over the years. Bites due to the other three of the big four have also shown a small increase. (Fig 1)

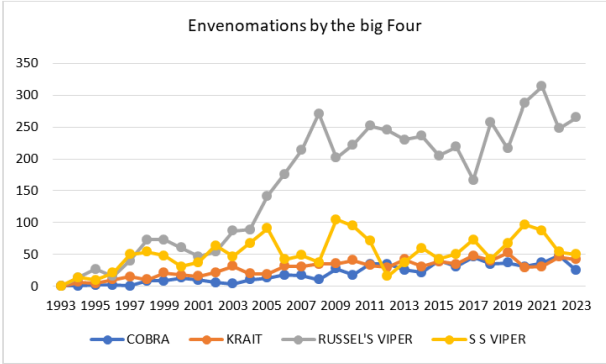



**Fig 1: Envenomation by the big four over time absolute numbers per year**

Sawscaled viper and krait bites are reducing and cobra bites are showing a slight increase as a percentage of overall annual bites. (Fig 2)

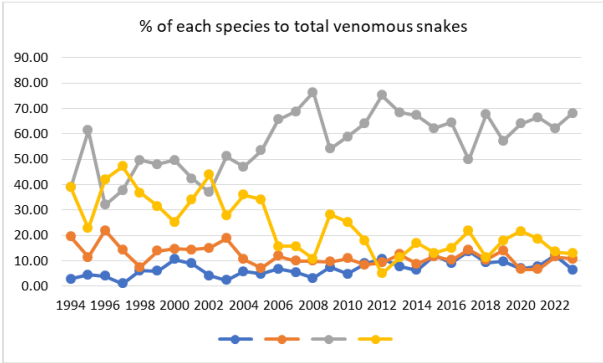



**Fig 2: Envenomation by the big Four, a proportional representation**

Mean number of vials of ASV used to manage different type of envenomation have reduced over the years (Fig 3)

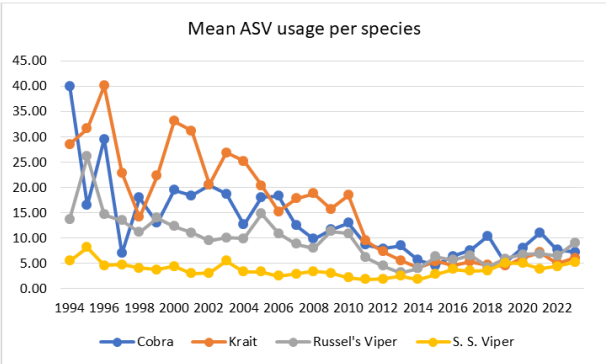



**Fig 3: ASV usage per snake type over time (mean number of vials)**

If one breaks this into groups of 10 years, the information is revealing. (Table 1) There is a drop in number of vials used for 3 of the big four.

**Table 1: Mean ASV usage per snake type over tranches of 10 years**

| | Mean ASV usage per species | | | | |
|---|---|---|---|---|---|
| **Period (April to March)** | **Cobra** | **Krait** | **Russell's Viper** | **Saw scaled viper** | **Bamboo pit viper** |
| April1993 – March 2003 | 18.47 | 26.41 | 12.62 | 4.25 | 2.00 |
| April 2003-March 2013 | 11.25 | 14.68 | 8.34 | 2.78 | 6.28 |
| April 2013 -March 2024 | 7.44 | 4.76 | 6.24 | 4.02 | 0.87 |
| Overall for 30 years | 9.76 | 12.54 | 7.74 | 3.61 | 2.35 |

Mortality figures are given in table 2. Overall mortality is only 1.79 % across 30 years

**Table 2: Overall Mortality and mortality across species**

| **Species** | **Cobra** | **Krait** | **Russell's Viper** | **Saw Scaled Viper** | **Bamboo pit viper** | **Hump Nosed Viper** | **Slender Coral** | **Pts with envenomation** | **Overall mortality** |
|---|---|---|---|---|---|---|---|---|---|
| Number | 621 | 872 | 4951 | 1617 | 39 | 1 | 3 | 8104 | 1.79 |
| Deaths | 8 | 42 | 90 | 4 | 0 | 1 | 0 | 145 | |
| Mort/sp | 1.29 | 4.82 | 1.82 | 0.25 | 0 | 100 | 0 | | |

## Discussion

Dr Patel and his team have carried out numerous awareness programmes in the locality over the years. Along with information of common types of snakes in the region, their habits and how to avoid snakebites, they also impart knowledge of first aid when handling a snakebite patient like immobilisation, pressure bandage, dangers of tourniquets. But the most important message is the futility of visiting local healers and use of traditional methods like cutting, suction, herbal poultices, or chemical cauterisation, and the need to transport the case to the nearest health centre immediately. An outline of such programmes is provided in the WHO guidelines [1]. Hence patients are brought to the hospital quickly. Almost all patients are from nearby talukas. So, we can safely say that the figures represent the change in snake varieties over the years for this district.

Russell's Viper cases have steadily increased, while cases of Saw-Scaled Vipers have decreased over these 3 decades. Cobra and Krait bite cases have more or less remained constant. We have had occasional cases of Bamboo Pit Viper bites,39, and Slender coral, 3, in 30 years.

This finding is not unusual, but expected. Over the years, irrigation has improved in Gujarat due to the Narmada dam project. If dry arid areas are transformed into green ones, the dominant species in the area changes, with more Russell's vipers and fewer saw scaled vipers [4]. More important is the factor of climate change. A recent study by Indian and Korean scientists using available past data and AI modelling projects that over the next 50 years population of certain varieties of snakes will reduce in south India and increase in the north and east. A similar change could have happened over the past 30 leading to our observations [5]

**Usage of ASV**

Inspite of increasing number of venomous snakebites, the number of vials used per species has reduced over time.

On breaking up the data in groups of 10 years, one notices that there is a learning curve for the team with a stabilized low figure having been reached in the last 10 years. In case of bamboo pit viper there is a jump in use followed by a fall. Saw scaled vipers present a slightly different picture where there was a period of low usage with an increase

in the last 10 years.. This could indicate a period of experimentation. There were 4 deaths among saw scaled viper patients and all these were in the last 10 years. These cases were administered at least 30 vials each. We have also noticed that the number of these snakes in the total mix is reducing. Within these fewer snakes, there could have been a change in the venom characteristics, a change in the balance between different type of toxic proteins, which are still neutralized by the available ASV but at a higher dose.

The overall doses used for management of various types of envenomation however, are markedly lower than those required in past published studies summarized in Table 3.

**Table 3: Summary of past articles showing mean vial usage**

| Author, year | Envenomation | N | Mean # of vials used, range/SD |
|---|---|---|---|
| Amin MR et al (2008)[6] | Neurotoxic | 35 | 10 |
| Suchitra N et al (2008)[7] | Hemo and neurotoxic | 200 | 22 ( 3 to 62) |
| Bhattacharya P et al (2007)[8] | Neurotoxic | 13 | 20 ( 10 to 30) |
| Sudeep Kumar et al (2019)[9] | Haemotoxic | 24 | 22.04 +/- 13.11 |
| | Neurotoxic | 11 | 16.36 +/- 11.80 |
| | Local | 5 | 13 +/- 12.55 |
| Ramesh J et al (2020)[10] | Haemotoxic | 59 | 26.44 +/- 13.36 |
| | Neurotoxic | 12 | 26.67 +/- 13.03 |
| | Local | 16 | 19.88 +/- 8.34 |
| | Hemo& neurotoxic | 9 | 32.22 +/- 13.97 |
| Menon J C et al(2016)[11] | Neurotoxic | 435 | 12.26 (2 to 32) |
| | Haemotoxic | 456 | 16.79 (2 to 52) |

One possible explanation for the use of fewer vials of antivenom serum (ASV) in our setting is the shorter bite-to-needle time, likely due to rapid referral to the hospital. N Suchitra et al. [7] reported that patients with a bite-to-needle time exceeding 6 hours had a significantly higher incidence of complications. In contrast, Sudeep Kumar et al. [9] conducted a similar analysis but did not observe statistically significant results, possibly due to a smaller sample size. However, their findings indicated a trend whereby patients with neurotoxic and local envenomation required a higher number of ASV vials and had longer hospital stays when the bite-to-needle time exceeded 6 hours.

Further supporting this, Dr Patel et al. [12], in their evaluation of outliers with prolonged hospital stays (>11 days), found that all but one patient had a bite-to-needle time ranging from 4 to 14 hours. These patients required intensive interventions, including haemodialysis for renal failure or mechanical ventilation for respiratory failure. Additionally, the pharmacokinetic study by Sahanjaria S et al. [13] demonstrated that antivenom efficacy decreases once venom has redistributed from the bite site into the tissue compartment, reinforcing the importance of early administration.

A second contributing factor may be the cumulative clinical experience and confidence developed over three decades in our setting, coupled with the flexibility afforded by operating outside a highly regulated institutional framework. In contrast, many other studies have been conducted in structured institutional environments with multiple stakeholders, where standardized protocols are necessary. In such settings, senior clinicians may not always be immediately available, leading to reliance on Standard Operating Procedures (SOPs) that recommend fixed initial and repeat dosing. Additionally, adherence to national guidelines further constrains individualized decision-making. Consequently, patients presenting during off-hours may receive two initial cycles of 10 ASV vials before senior review, potentially contributing to higher overall ASV usage.

**Management of bites by different snakes**

**Cobras**

Cobra bites need early and adequate amount of ASV administration as well as cardio-pulmonary support. After extubation, victim should be kept under strict observation for 3-4 days as recurrence of neurotoxicity may occur. This could be due to continued absorption of venom from the site of bite which serves as a depot. The absorption is facilitated by correction of shock and hypovolaemia thus improving blood supply to the area, and at the same time, the antivenom administered earlier has been eliminated from the system. Redistribution of the venom from the tissue compartment to the blood compartment after the antivenom has acted on available venom is also a possibility.[1,2]

Tissue damage can be prevented and chances of disability significantly reduced, with early intervention like cleaning and dressing the wound, debridement where necessary and followed later with skin grafting. [1,2, 14] In few cases amputation was needed due to development of gangrene

Major causes of death have been hypoxic brain damage due to late arrival of the patient, comorbidities and possibly extremely quick action of the venom

**Krait**

Key to Krait bites is also early administration of ASV and cardiopulmonary support.Early intubation increases the chance of survival and prevents complications.

Recovery phase can be prolonged due to β-bungarotoxininduced depletion of synaptic vesicles, with degeneration of motor nerve terminals, that may recover in about 7 days. Prasarnpun et al, further mention that there is also an alpha bungarotoxin that acts on post synaptic vesicles. The ASV used initially will take care of toxin released from the local site. Once that is taken care of, the patient will not respond to any further ASV. Neostigmine will also not help as the presynaptic vesicles are damaged[15]. Blessman J et al [16] propose use of ASV in all patients with krait bite in the initial six hours regardless of neurotoxic signs. KularatneSAM [17] observed that the time lag between bite and the need for ventilation ranged between 30 min and 50 h (mode 6 h) and the duration of ventilation ranged between 12 h and 29 days (mode 2 days).

The above studies support the practice of not administering any more ASV after the initial 5-10 vials even if the patient is on ventilatory support**.** Even after the patient can breathe spontaneously, he should be extubated only after 24 hours.

In our series, krait bite shows maximum mortality, about 4.8%. These bites occur at nights and the sleeping patient is often unaware of it. The symptoms he presents the next morning are misdiagnosed, mistreated and this delays referral to the hospital. Major cause of death has been hypoxic brain damage due to late arrival, and aspiration pneumonia.

**Russell's Viper**

Russell's viper bites are characterized by pain, swelling, coagulopathy, kidney damage and neurotoxicity[18]

The goal of management is to achieve a speedy recovery, prevent organ damage, minimize disability. Although we do monitor bleeding tendency by performing simple tests like 20 minute WBCT, we do not wait for 6 hours to administer the next dose. Based on the clinical signs and our experience we adjudge the amount of ASV that may be required and administer it over the first 3-4 hours. The idea is to neutralize as much venom as possible before it reaches the tissue compartment. Additional vials can be administered later based on clinical findings.

Renal support in the form of dialysis is also needed in some cases. In our experience neurotoxicity was rare, yet occurred in about 212 of 4951 cases (4.3%), some of them requiring ventilator support

There have been a few cases of sudden unexplained cardiac arrest and of severe cardiotoxicity, not responsive to inotropics. Veno arterial extracorporeal membrane oxygenation(VA ECMO) works in some cases.

Massive intracerebral bleeding soon after bite possibly due to DIC [Disseminated Intravascular Coagulation], can be the major cause of death. Most of the death cases came to the hospital after some delay. But even in patients that came in early, there have been cases which did not respond to ASV or supportive therapy indicating that more research on the pathophysiology and regional variation of Daboia russelii venom is needed.

**Saw scaled viper**

The first 2-4 hoursare crucial. They estimate the number of vials required based on clinical status,

and administer the first dose of ASV strictly within 2 hours of admission. They start with 5 -10 vials, depending on the severity of clinical presentation, evaluate the improvement, and give additional vials soon after.

In fact, this unique style of ASV administration, different from that suggested by WHO or Indian guidelines has been used for all varieties of snakes. [1,2,12]

20 WBCT may show anot clotted status up to 7 days but if vitals are stable, urine output adequate and of normal colour, and external bleeding stops, patient can be kept under observation without further use of ASVs.

There have been 4 deaths in cases of Saw scaled viper bites. All these were due to massive intracerebral haemorrage even before ASV administration.

## Conclusion

The public awareness programs carried out over the years are finally bearing fruit. Fewer patients visit faith healers and they reach the hospital quickly. Management of cases using the syndromic approach, early and adequate administration of clinically estimated amount of AVS along with organ support is the essential triad of management. One mustsee the symptoms due to snake venom evolving after admission, and the same resolving gradually after the use of ASV. Over the years, with experience, individual doctors will gain enough confidence to couple clinical management with just enough vials of ASV.

## References


1. Guidelines for management of Snakebites, New Delhi, WHO Regional Office for South East Asia,2016
2. Standard Treatment Guidelines, Management of Snakebites. Ministry of Health and Family Welfare. January 2016
3. https://www.censusindia2011.com/gujarat/valsad/dharampur-population.html Downloaded in April 2026
4. https://india.mongabay.com/2025/10/indias-snakes-changing-range-thanks-to-climate-change/ Downloaded in April 2026
5. Abedin I, Kang H-E, Saikia H, Jung W-K, Kim H-W, Kundu S (2025) Future of snakebite risk in India: Consequence of climate change and the shifting habitats of the big four species in next five decades. PLoS Negl Trop Dis 19(9): e0013464. https://doi.org/10.1371/ journal.pntd.0013464
6. Amin MR, Mamun SMH, Rashid R et al. Antisnake Venom: Use and adverse reactions in a snake bite study clinic in Bangladesh. J. Venom. Anim. Toxins incl. Trop. Dis. 2008; 14:660-672
7. N Suchithra, J M Pappachan, P Sujathan.Snakebite envenoming in Kerala, South India: clinical profile and factors involved in adverse outcomesEmerg Med J 2008;25:200–204
8. Bhattacharya P, Chakroborty A. Neurotoxicsnakebite with respiratory failure. Indian J Crit CareMed 2007; 11:161
9. Sudeep Kumar , Sovani VB ,BhogeDP ,Postmarketingsafety and usage study of anti-snake venom in atertiary hospital in Talegaon, Maharashtra, Global J ofMed. And Pub. Health (GJMPH), 2019; 8:4,1
10. Ramesh J, Sovani VB, Baskeran R, Sivasankari N, ArunR, Efficacy and Safety of Anti Snake Venom, used asper National Guidelines, at a Tertiary Care Centre inPuducherry, Indian J of Pub. Health Res. and Dev.2020; 11:220
11. JC Menon, JK Joseph, MP Jose, BL Dhananjaya, OVOommen, Clinical Profile and Laboratory Parametersin1051 Victims of Snakebite from a Single Centre inKerala, South India; Journal of Association ofPhysicians of India,2016;64:22
12. Patel DC, Sovani VB, Patel NJ. Post Marketing evaluation of Anti Snake Venom (ASV) administered as a standard treatment for snakebite. Experience from western India. Indian Journal of Public Health Research and Development .2024;15:278-285
13. Suchaya Sanhajariya , Stephen B. Duffull , Geoffrey K. Isbister, Pharmacokinetics of Snake Venom, Toxins 2018, 10: 73; doi:10.3390/toxins10020073
14. WHO Guidelines for the prevention and Clinical management of snakebite in Africa. Regional office for Africa, Brazzaville, 2010
15. PrasarnpunS, Walsh J, Awad SS , Harris JB. Envenoming bites by kraits: the biological basis of treatment-resistant neuromuscular paralysis. Brain (2005), 128: 2987–2996
16. Blessmann J, Kreuels B Urgent administration of antivenom following proven krait bites in Southeast Asia irrespective of neurotoxic symptoms. PLoS Negl Trop Dis (2024) 18(4): e0012079. https://doi.org/10.1371/journal.pntd.0012079
17. Kularatne SAM Common krait (Bungarus caeruleus) bite in Anuradhapura, Sri Lanka: a prospective clinical study,1996–98, Postgrad Med J (2002);78:276–280
18. Indunil Karunarathna, Kapila De Alvis1, S Rajapaksha1, K Gunawardana1, P Aluthge1, T Hapuarachchi1, Pathophysiology of Russell's Viper Venom and Its Clinical Implications, UVA CLINICAL INTENSIVE CARE AND TROPICAL MEDICINE 2024; 1-7 DOI: 10.13140/RG.2.2.19907.62246.

**Commentory**

*DOI: https://doi.org/10.37506/p0x1tv27*

# Elimination of Urinary Schistosomiasis in Iraq: A Historical Review and Path to WHO Certification

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**How to cite this article**: Talah Khudhair Abbas, Sinan Ghazi Mahdi. Elimination of Urinary Schistosomiasis in Iraq: A Historical Review and Path to WHO Certification. Indian Journal of Public Health Research and Development/ Vol. 17 No. 3, July-September 2026.

**Abstract**

**Context:** Urinary schistosomiasis, caused by Schistosoma haematobium, was once a major neglected tropical disease (NTD) endemic across sub-Saharan Africa, the Nile Valley, and parts of the Middle East, including Iraq. The disease relies on freshwater snails of the genus Bulinus as an obligate intermediate host. This review aimed to characterise the full epidemiological trajectory of S. haematobium in Iraq from earliest records to the present day.

**Methods:** Epidemiological databases (Communicable Diseases Control Center/Iraq, PubMed, ISI, Scopus) were searched for records spanning 1919 to July 2025.

**Results:** Iraq's National Schistosomiasis Control Programme achieved a dramatic decline in infection prevalence — from 27% in 1954 to 0.02% in 2002 — through integrated strategies encompassing mass treatment with praziquantel, molluscicide-based snail control, engineering interventions, and sustained health education. No locally acquired cases have been recorded since 2011, and comprehensive vector surveillance has confirmed the absence of Bulinus truncatus from all 19 governorates. Iraq is currently in the WHO-guided elimination certification process.

**Conclusions:** Urinary schistosomiasis has been effectively eliminated as a public health problem in Iraq through decades of coordinated national and international effort. Pending WHO/EMRO formal verification, Iraq stands as a regional model for NTD elimination in the Middle East.

**Keywords:** Urinary schistosomiasis; Schistosoma haematobium; neglected tropical diseases; Iraq; elimination; epidemiology; Bulinus truncatus; vector control

## Introduction

**Schistosomiasis**—clinically known as bilharzia or 'snail fever'—is a major neglected tropical disease (NTD) caused by parasitic trematodes of the genus *Schistosoma* [1, 14]. The disease is transmitted to humans through contact with freshwater bodies harboring infected intermediate host snails, specifically those of the genus *Bulinus* for the urogenital form [3, 11]. *Schistosoma haematobium*, the primary agent of urogenital schistosomiasis, remains endemic across sub-Saharan Africa, the Nile Valley,

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**Submission date:** Jan 10, 2026 **Revision date:** April 10, 2026 **Published date:** June 29, 2026

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and specific foci in the Middle East, including the river basins of Iraq [9, 12].

Infection typically occurs during routine agricultural, domestic, occupational, or recreational activities that bring individuals into contact with cercariae-infested water [11, 13]. On a global scale, the disease exerts a substantial public health burden that is frequently underestimated in morbidity statistics [2]. Chronic infection can lead to severe, long-term clinical sequelae, including:

- **Obstructive uropathy** and hydronephrosis.
- **Squamous cell bladder carcinoma**.
- **Chronic anaemia** and significant productivity loss in endemic communities [3, 15].

To combat this, the **World Health Organization (WHO)** has established a strategic roadmap aimed at eliminating schistosomiasis as a public health problem, with critical milestones set for 2025 and 2030 [4].

Iraq represents a particularly significant case study in the global effort to eradicate NTDs. Historically, the disease was highly endemic across the country's central and southern irrigation networks and marshlands [6]. However, through seven decades of rigorous national control programming, Iraq has reached the threshold of WHO-verified elimination [10]. As of **July 2025**, official surveillance and joint reports indicate that Iraq has successfully maintained the interruption of local transmission [5, 8].

This review synthesizes the epidemiological trajectory of *S. haematobium* in Iraq, spanning from the earliest documented records of the 20th century to the current 2025 data. It further evaluates the multi-sectoral methods, public health milestones, and the remaining formal requirements for the official certification of Iraq as a schistosomiasis-free nation [6, 8, 10].

## Methods

This historical review searched epidemiological databases including the Communicable Diseases Control Center/Iraq (CDCC Iraq), PubMed, ISI Web of Science, and Scopus. The search covered publications, surveillance reports, and programme records from 1919 to July 2025. Iraqi Ministry of Health annual reports, WHO/EMRO technical documents, and field survey datasets from the Institute of Endemic Diseases (Baghdad) were additionally reviewed. Official permission was obtained to access surveillance data from CDCC Iraq.

### Historical Background

#### Ancient and Early Modern Records

References to urinary schistosomiasis in the Mesopotamian region date to the Assyrian era, with further accounts during the medieval period. The first systematic scientific documentation emerged after World War II, when cases were identified among British forces stationed in Basra, Al-Hindiya, and Kufa. A landmark survey by Boulanger in 1919 across the Euphrates basin recorded infection rates ranging from 20% in Samarra to 85% in Al-Qurna. Hall (1925) subsequently documented rates of 80% in rural Diwaniyah and 47% among school students in Basra. Studies conducted between 1921 and 1928 confirmed cases in most governorates except Mosul and Sulaymaniyah, with the highest burden concentrated in Basra, Nasiriyah, and southeastern Baghdad.

#### Establishment of the National Control Programme (Post-1950)

Formal institutional engagement began in 1950 with the establishment of the Schistosomiasis Section within Iraq's Institute of Endemic Diseases. Under the leadership of Dr. Watson and subsequently Dr. Stefan Yousefani (from 1951), the section launched the first systematic control campaigns and trained national staff. From 1954, collaboration with WHO led to structured snail surveys using Baghdad province as a model zone. In the 1960s, a formal training programme was implemented in the Hor Rajab area (1962–1966) in partnership with WHO, establishing institutional capacity that would sustain control activities for decades.

#### Geographical Distribution and Transmission Ecology

The disease was endemic in the central and southern governorates, particularly along the Tigris, Euphrates, Diyala, and Greater Zab rivers. Focal transmission was also documented in northern areas including Nineveh and Erbil. The extensive and

complex irrigation infrastructure — including the Dujail, Latifiya, and Mussayib projects — created ideal ecological conditions for the snail intermediate host, Bulinus truncatus, by sustaining slow-moving, heavily vegetated freshwater bodies throughout the agricultural calendar.

Infection rates in the 1950s ranged from 2.7% in Kirkuk to 85% in some southern communities. A nationwide school survey in 1955 found 29.4% prevalence across 10 governorates. By 1970, the national average had declined to approximately 20%, though localised hotspots such as Tel Muhammad in Baghdad still exceeded 80%.

**Vector Biology and Control Approaches**

The intermediate host, Bulinus truncatus, thrives in marshes, swamps, and irrigation canals across central and southern Iraq. Vector control strategies included the application of molluscicides (principally Baylluside) at a frequency of three to four treatments per year in endemic areas, alongside engineering recommendations to the Ministry of Irrigation to design waterway infrastructure less conducive to snail colonisation, including canal lining and removal of aquatic vegetation.

**Evolution of Pharmacological Treatment**

Early-generation treatments — antimony compounds (including Stibophen), Niridazole, and Hycanthone — carried significant adverse effect profiles and practical limitations for field deployment. In 1966, Ambilhar tablets were introduced, followed in 1972 by Etrenol (single intramuscular injection) with a reported cure rate of approximately 70%. The pivotal therapeutic advance came in 1982 with the adoption of praziquantel, which offered high efficacy across all Schistosoma species, a favourable safety profile, and suitability for mass drug administration (MDA). Praziquantel remains the cornerstone of treatment to the present day.

## Results

**Human Surveillance: Epidemiological Trends**

**Historical Reduction in Prevalence (1954–2002)**

National surveillance data spanning nearly five decades demonstrate a sustained and substantial decline in urinary schistosomiasis prevalence in Iraq. As shown in Table 1, the infection rate fell from a peak of 27% in 1954–1955 to 0.02% by 2002 — a reduction exceeding 99%. This trajectory reflects the cumulative impact of the integrated National Schistosomiasis Control Programme, encompassing mass drug administration, vector control, health education, and water resource management.

Notably, the volume of samples examined increased dramatically between 1989 and 1994 — reaching over 2.2 million in 1990 — coinciding with a sharp decline in reported infection percentage, consistent with intensified passive surveillance reaching previously unscreened populations alongside genuine epidemiological decline.

**Table 1. Prevalence of Urinary Schistosomiasis in Iraq by Year (1954–2002).**

| Year | Samples Examined | Positive Samples | Infection Rate (%) |
|---|---|---|---|
| 1954 | 16,569 | 4,468 | 27.0 |
| 1955 | 20,400 | 5,478 | 27.0 |
| 1957 | 65,731 | 10,043 | 15.0 |
| 1958 | 39,493 | 8,165 | 20.7 |
| 1959 | 34,643 | 4,914 | 14.0 |
| 1960 | 106,371 | 12,253 | 11.5 |
| 1961 | 142,574 | 14,669 | 10.0 |
| 1964 | 132,021 | 9,972 | 7.5 |
| 1965 | 89,123 | 7,943 | 8.9 |
| 1966 | 45,875 | 3,280 | 7.0 |
| 1967 | 81,023 | 5,721 | 7.0 |

Continue.....

| Year | Samples Examined | Positive Samples | Infection Rate (%) |
|---|---|---|---|
| 1968 | 73,414 | 2,995 | 4.0 |
| 1970 | 73,733 | 3,613 | 4.9 |
| 1972 | 124,278 | 5,470 | 4.0 |
| 1975 | 137,016 | 7,247 | 5.3 |
| 1978 | 232,795 | 8,968 | 3.9 |
| 1980 | 218,231 | 3,338 | 1.5 |
| 1982 | 116,528 | 1,721 | 1.48 |
| 1985 | 95,935 | 1,250 | 1.3 |
| 1989 | 803,899 | 1,955 | 0.24 |
| 1990 | 2,232,438 | 1,449 | 0.06 |
| 1991 | 1,016,474 | 395 | 0.04 |
| 1994 | 1,027,125 | 814 | 0.08 |
| 2002 | — | 278 | 0.02 |

**Transition to Elimination (2003–2010)**

The post-2003 period posed significant challenges to the control programme, including damage to health infrastructure, marshland reflooding creating new potential snail habitats, and population displacement from endemic areas. Despite these disruptions, the number of confirmed cases continued to decline, falling from 142 in 2003 to just 4 in 2010 (Table 2).

Al-Anbar governorate accounted for the majority of cases in the early part of this period (129 of 142 cases in 2003), likely reflecting geographic and demographic factors including proximity to the Euphrates river system and irrigation infrastructure. Diyala remained the final governorate to record confirmed cases. A national school survey conducted in 2004–2005, covering approximately 2,405 primary school students across four geographic zones, confirmed significantly reduced prevalence consistent with near-elimination status.

**Table 2. Confirmed Urinary Schistosomiasis Cases by Governorate, Iraq (2003–2010). Active transmission areas only.**

| Governorate | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|
| Nineveh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kirkuk | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Salah Al-Din | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diyala | 13 | 26 | 38 | 19 | 9 | 4 | 2 | 4 |
| Baghdad | 0 | 3 | 6 | 4 | 0 | 0 | 0 | 0 |
| Al-Anbar | 129 | 72 | 64 | 16 | 48 | 14 | 1 | 0 |
| Babylon | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Wasit | 0 | 0 | 1 | 5 | 0 | 1 | 0 | 0 |
| Karbala | 0 | 4 | 0 | 0 | 0 | 1 | 0 | 0 |
| Najaf | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| Al-Diwaniyah | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 0 |
| Dhi Qar | 0 | 21 | 17 | 2 | 0 | 2 | 0 | 0 |
| Maysan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Basra | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| TOTAL | 142 | 126 | 128 | 48 | 58 | 25 | 6 | 4 |

**Current Status: Verification Phase (2022–2025)**

No locally acquired cases of urinary schistosomiasis have been recorded in Iraq since 2011. Surveillance activities conducted since 2022 across all 19 governorates have returned uniformly negative results for all investigated urine samples (Table 3). In 2017–2018, a comprehensive two-phase epidemiological survey was conducted covering primary school students in previously endemic areas and internally displaced persons (IDP) camps. Samples were tested by visual inspection, haemastix for haematuria, and urine filtration for egg detection, with samples stored at −20°C for planned ELISA confirmation. However, procurement of ELISA kits was disrupted by the COVID-19 pandemic, and after prolonged storage (approximately five years), the samples were deemed unsuitable for molecular testing and were safely disposed of in 2023. Discussions with WHO/EMRO regarding an updated pathway to elimination certification have since resumed.

**Table 3. Urine Surveillance Samples Examined by Governorate, Iraq (2022–2025). All results negative.**

| Governorate | 2022 | 2023 | 2024 | 2025 (Jan–Jul) |
|---|---|---|---|---|
| Duhok | — | — | 1,149 | 500 |
| Erbil | — | — | 16,597 | 7,193 |
| Sulaymaniyah | — | — | 1,525 | 500 |
| Nineveh | — | 1,734 | 3,160 | 2,639 |
| Kirkuk | 715 | 600 | 750 | 750 |
| Salah Al-Din | 3,037 | 2,895 | 3,484 | 2,140 |
| Diyala | 649 | 1,241 | 735 | 587 |
| Al-Anbar | 5,074 | 9,191 | 4,038 | 5,925 |
| Baghdad (Rusafa) | 600 | 601 | 600 | 450 |
| Baghdad (Karkh) | 2,341 | 1,929 | 2,365 | 2,639 |
| Wasit | 728 | 1,198 | 691 | 544 |
| Karbala | 14,759 | 5,644 | 16,735 | 12,634 |
| Najaf | 1,200 | 900 | 1,300 | 800 |
| Babylon | 450 | 525 | 631 | 575 |
| Al-Diwaniyah | 750 | 660 | 840 | 540 |
| Al-Muthanna | — | — | 1,200 | 500 |
| Dhi Qar | — | 253 | 836 | 320 |
| Maysan | 1,889 | 1,968 | 1,854 | 1,934 |
| Basra | 481 | 885 | 1,064 | 914 |

**Vector Surveillance**

**Historical Distribution of Bulinus truncatus (1954–1994)**

Historical snail surveys documented widespread presence of Bulinus truncatus across central and southern Iraqi governorates from the 1950s through the 1970s. Baghdad and Diyala showed the most consistent snail presence during this period. Northern governorates such as Salah Al-Din and Najaf began recording snail presence from the late 1970s and 1980s, coinciding with expansion of irrigation networks. By the late 1980s and early 1990s, snail distribution had become increasingly sporadic, reflecting the impact of sustained molluscicide application and habitat modification.

**Verification of Vector Elimination (2011)**

A comprehensive national vector survey conducted in 2011 investigated 959 waterways across all 19 governorates of Iraq (Table 4). Despite collection and laboratory examination of 27,612 snail specimens, no Bulinus truncatus was identified in any infested stream. This landmark survey constituted

strong field evidence for interruption of transmission and formed a critical component of Iraq's elimination dossier for WHO review.

**Table 4. National Vector Survey: Streams Investigated and Snails Collected by Governorate, Iraq (2011). No infested streams identified.**

| No. | Governorate | Streams Investigated | Infested Streams | Snails Collected |
|---|---|---|---|---|
| 1 | Erbil | 18 | 0 | 280 |
| 2 | Al-Anbar | 55 | 0 | 1,025 |
| 3 | Basra | 26 | 0 | 1,075 |
| 4 | Al-Diwaniyah | 110 | 0 | 2,072 |
| 5 | Sulaymaniyah | 13 | 0 | 240 |
| 6 | Al-Muthanna | 29 | 0 | 890 |
| 7 | Najaf | 74 | 0 | 1,552 |
| 8 | Babylon | 79 | 0 | 6,320 |
| 9 | Baghdad/Rusafa | 59 | 0 | 1,195 |
| 10 | Baghdad/Karkh | 40 | 0 | 870 |
| 11 | Duhok | 6 | 0 | 172 |
| 12 | Diyala | 42 | 0 | 510 |
| 13 | Dhi Qar | 81 | 0 | 2,175 |
| 14 | Salah Al-Din | 65 | 0 | 2,225 |
| 15 | Karbala | 31 | 0 | 1,890 |
| 16 | Kirkuk | 75 | 0 | 525 |
| 17 | Maysan | 53 | 0 | 2,921 |
| 18 | Nineveh | 44 | 0 | 730 |
| 19 | Wasit | 59 | 0 | 945 |
| TOTAL | — | 959 | 0 | 27,612 |

Vector control measures applied until 2011 included molluscicide spraying (Baylluside), canal lining to prevent snail adherence, and periodic removal of aquatic vegetation to reduce breeding sites. These engineering and chemical interventions were progressively phased down as transmission evidence declined, with monitoring continuing in their absence.

**Recent Vector Surveillance (2024–2025)**

Active vector surveillance has continued on an annual basis to ensure against re-emergence of B. truncatus. In 2024, high numbers of snails were collected and examined from key sentinel sites including Baghdad Karkh (1,030 snails), Wasit (970 snails), and Nineveh (900 snails); all investigations confirmed zero Bulinus specimens. Data through July 2025 demonstrates continued monitoring in Baghdad and Wasit, with the status of zero Bulinus maintained consistently across all sites.

**POST-PANDEMIC PERIOD AND PATH TO WHO CERTIFICATION (2021–2025)**

Based on WHO standards, Iraq has fulfilled the epidemiological criteria for declaring the elimination of urinary schistosomiasis: no locally acquired cases have been documented since 2011, and no infected Bulinus snails have been identified in national waterway surveys. In 2001 — the last year with substantial reported incidence — there were 345 recorded cases at an incidence rate of 1.64 per 100,000 population. The trajectory since then has been consistent with sustained elimination of transmission.

Field surveys conducted among primary school students in previously endemic areas and IDP camps since 2011 have returned no positive diagnoses using conventional diagnostic methods. Formal certification by the WHO Regional Office for the Eastern Mediterranean (EMRO) is pending. Training

workshops on ELISA diagnostics were conducted in China to strengthen laboratory capacity for serology-based confirmation, and a renewed survey protocol is under discussion with WHO to replace the COVID-impacted 2017–2018 sample collection.

Iraq's current National Plan for schistosomiasis elimination encompasses the following implementation mechanisms:

1. Continued active surveillance for human schistosomiasis infections in schools and residential areas in previously endemic regions.
2. Monthly collection and Epi-Info entry of statistical surveillance forms, with ongoing epidemiological analysis.
3. Coordination with governorate Health Directorates to ensure availability of praziquantel for management of any potential imported cases.
4. Periodic field surveys targeting primary school students aged 6–15 years in historically endemic areas.
5. Capacity building through training workshops for medical and health staff on diagnostic methods and epidemiological updates.
6. Supervisory field visits to governorate Health Directorates to monitor plan implementation (at minimum one visit per directorate per year).
7. Active vector surveillance for B. truncatus coordinated with the Vector Control Division, with prompt response protocols in the event of snail detection.
8. Engagement of health promotion staff in preparation of public health bulletins and community education materials on schistosomiasis.

**Summary of results**

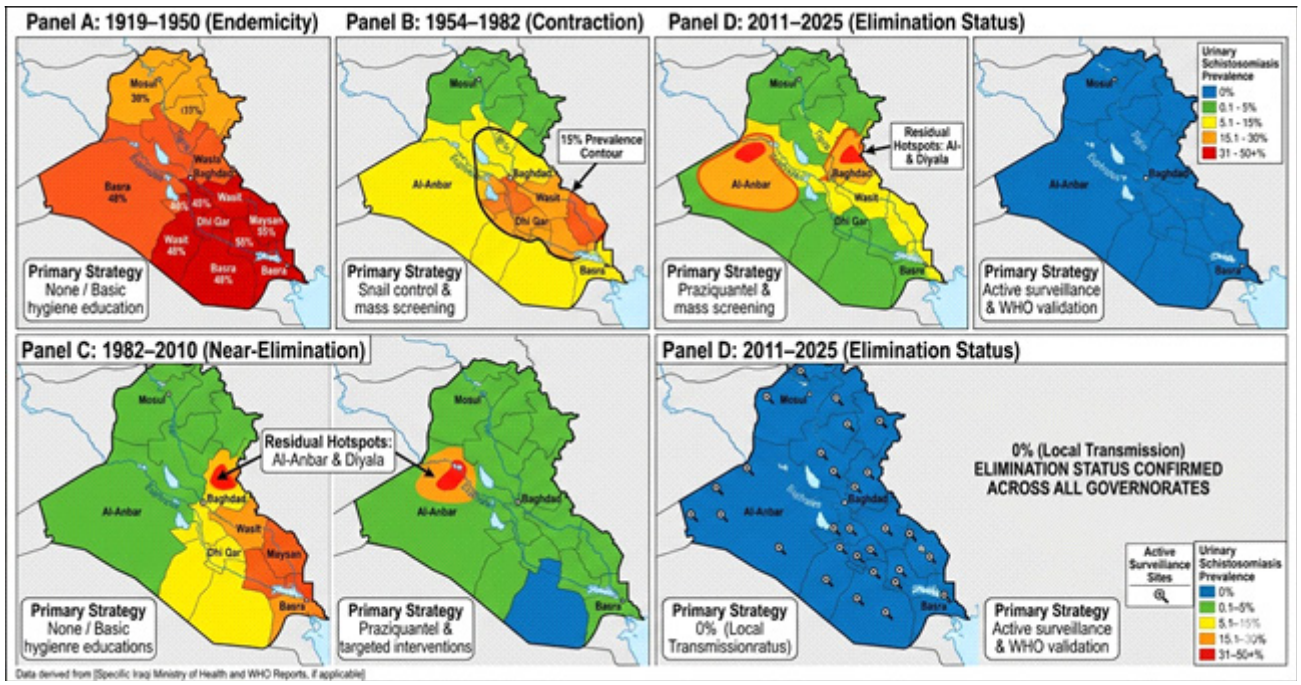



**Figure 1: Evolution of Urinary Schistosomiasis in Iraq (1919-2025)**

Figure 1. Serial maps of urinary schistosomiasis distribution in Iraq across four time periods. Panel A (1919–1950): distribution of endemic governorates at peak historical burden; community infection rates annotated. Panel B (1954–1982): contraction of endemic foci following establishment of the National Control Programme and snail control campaigns. Panel C (1982–2010): near-elimination of transmission; residual foci in Al-Anbar and Diyala governorates. Panel D (2011–2025): elimination status; active surveillance sites (human and vector) indicated. Governorate boundaries and major river systems (Tigris, Euphrates, Diyala) labelled throughout for reader orientation.

**Table 1: Chronological milestones in the epidemiology and control of urinary schistosomiasis in Iraq (1919–2025). Prevalence data derived from national surveillance reports of the Institute of Endemic Diseases, Iraqi Ministry of Health.**

| Period | Key Intervention / Finding | Prevalence / Cases |
|---|---|---|
| 1919–1949 | First systematic surveys; infection rates of 20–85% along Euphrates and Tigris basins | 20–85% (community surveys) |
| 1950 | Establishment of Schistosomiasis Section, Institute of Endemic Diseases; first control campaigns | 27% (1954 national survey) |
| 1954 | WHO collaboration; Baghdad model zone snail surveys initiated | 27% |
| 1966–1972 | Introduction of Ambilhar (1966) and Etrenol (1972); snail control scaled up | ~4–7% |
| 1982 | Praziquantel adopted nationally — decisive therapeutic advance | 1.5% (1980) → 0.24% (1989) |
| 1990–2002 | Intensified passive surveillance; mass drug administration maintained | 0.06% → 0.02% |
| 2003–2010 | Post-conflict surveillance; cases declined from 142 to 4 nationally | 142 cases (2003) → 4 (2010) |
| 2011 | National vector survey: 959 waterways surveyed; zero Bulinus truncatus identified | 0 locally acquired cases |
| 2011–present | Elimination phase: active human and vector surveillance sustained | 0 local cases; 0 Bulinus |
| 2025 | Ongoing WHO/EMRO certification process; all surveillance negative | Pending formal verification |

## Discussion

Iraq's elimination of urinary schistosomiasis represents one of the most significant public health achievements in the Middle East in recent decades. The country's experience illustrates the effectiveness of a sustained, integrated, multi-component control strategy implemented over several generations — from the early molluscicide campaigns of the 1950s through to the mass praziquantel administration era that began in 1982 and the comprehensive surveillance systems of the 2010s and 2020s.

Several factors are particularly instructive for other countries at earlier stages of NTD elimination. First, the introduction of praziquantel in 1982 marked a decisive turning point: infection rates, which had been declining slowly under earlier treatment regimens, fell sharply in the decade following its adoption, reflecting both its superior efficacy and suitability for large-scale deployment. Second, vector control was not simply additive but synergistic — simultaneous reduction in both human reservoir and snail host accelerated transmission interruption beyond what either measure could have achieved alone.

The post-2003 period merits specific attention. Despite the collapse of much of Iraq's health infrastructure following the 2003 conflict, the maintenance of minimal surveillance and treatment capacity, combined with ongoing WHO technical assistance, was sufficient to sustain the elimination trajectory. This resilience underscores the importance of embedding NTD programmes within primary health care systems rather than relying on vertical, specialist-dependent structures vulnerable to disruption.

The primary outstanding challenge for Iraq is completion of the WHO certification process. The disruption to the 2017–2018 serological survey by the COVID-19 pandemic introduced a significant delay; however, resumed dialogue with WHO/EMRO and the development of a replacement survey protocol represent constructive progress. Vigilance against

importation of cases from endemic neighbouring countries — particularly Syria, which continues to report transmission — remains an ongoing surveillance priority.

## Conclusions

Urinary schistosomiasis, once a major communicable disease burden in Iraq with infection rates exceeding 80% in some communities, has been effectively eliminated as a public health problem through seven decades of sustained national programming and WHO collaboration. No locally acquired cases have been recorded since 2011, and comprehensive vector surveillance has confirmed the absence of Bulinus truncatus from all 19 governorates of Iraq.

Iraq is currently on the cusp of formal WHO verification of elimination — a milestone that would position it as a model for NTD control in the Middle East and the Eastern Mediterranean region. Continued active surveillance, sustained laboratory capacity, and readiness for rapid response to any detected re-introduction remain essential to maintaining and formally certifying this achievement.

## Declarations

**Conflict of Interest:** None declared.

**Funding:** Self-funded; no external financial support.

**Ethical Clearance:** Official permission was obtained to access surveillance data from the Communicable Diseases Control Center, Iraqi Ministry of Health (24 August 2024).

## References

1. World Health Organization. Schistosomiasis. Fact Sheet. Geneva: WHO; 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/schistosomiasis
2. King CH, Galvani AP. Underestimation of the global burden of schistosomiasis. Lancet. 2018;391(10118): 307–8.
3. Nelwan ML. Schistosomiasis: life cycle, diagnosis, and control. Curr Ther Res. 2019;91:5–9.
4. Deol AK, Fleming FM, Calvo-Urbano B, et al. Schistosomiasis — assessing progress toward the 2020 and 2025 global goals. N Engl J Med. 2019;381(26):2519–28.
5. Institute of Endemic Diseases, Iraqi Ministry of Health. Annual Surveillance Reports 1954–2025. Baghdad: Ministry of Health [unpublished].
6. Al-Saqur IM, Al-Obaidi HS. Schistosomiasis in Iraq: a mini-review of literature. Baghdad J Sci. 2022;19(4):1012–18.
7. McManus DP, Li Y, Gray DJ, Ross AG. Conquering 'snail fever': schistosomiasis and its control in China. Expert Rev Anti Infect Ther. 2009;7(4):473–85.
8. Ministry of Health Iraq & WHO. Joint statement on World Health Day 2025: Iraq maintains elimination of local schistosomiasis transmission. Baghdad: WHO Iraq; 2025.
9. WHO Regional Office for the Eastern Mediterranean. Schistosomiasis — Health topics. Cairo: WHO/EMRO; 2024. https://www.emro.who.int/health-topics/schistosomiasis/
10. World Health Organization. WHO Results Report 2020–2021: Iraq country profile. Geneva: WHO; 2022.
11. Lu XT, Gu QY, Limpanont Y, et al. Snail-borne parasitic diseases: an update on global epidemiological distribution, transmission interruption and control methods. Infect Dis Poverty. 2018;7:28.
12. Mahmoud AAF. Schistosomiasis. London: Imperial College Press; 2001.
13. WHO. Prevention and control of schistosomiasis and soil-transmitted helminthiasis. WHO Technical Report Series 912. Geneva: WHO; 2002.
14. Karunamoorthi K, Almalki MJ, Ghailan KY. Schistosomiasis: a neglected tropical disease of poverty. J Health Res Rev. 2018;5(1):1–2.
15. Tandon V, Shylla JA, Ghatani S, et al. Neglected tropical diseases: trematodiases — the Indian scenario. Proc Natl Acad Sci India Sect B Biol Sci. 2015;85:901–7.

**Original Article**

*DOI: https://doi.org/10.37506/v444cq87*

# Dietary Patterns among Urban and Rural School Teachers in Guntur District of Andhra Pradesh

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**How to cite this article**: G. Mohan Chandrasekhar, Samson Sanjeeva Rao Nallapu. Dietary Patterns among Urban and Rural School Teachers in Guntur District of Andhra Pradesh. Indian Journal of Public Health Research and Development/Vol. 17 No. 3, July-September 2026.

## Abstract

**Introduction:** Urban and rural diets in India are subject to influences like income, food availability, and life styles. As school teachers are also health promoters and role models for their students and communities, this study was set to identify the dietary patterns of urban and rural school teachers in Guntur district of Andhra Pradesh, India along with comparison of anthropometrics and Diet Related Non-Communicable Disease (DRNCDs).

**Methods:** This descriptive study involved all teachers of five schools each from rural and urban mandals of Guntur district selected by simple random sampling. A predetermined questionnaire covering various aspects of diet, socio – demographic variables and anthropometric measurements like height, weight, BMI and waist hip-ratio were administered to each teacher after taking an informed consent. Data was entered in MS excel and presented in tables and graphs. Important findings were subjected to tests of significance like Chi square test at 5 % Level of Significance.

**Results:** Chronic non communicable illnesses were present in 27.6% of the rural teachers and 66.0% of urban teachers (Chi square 16.5%, p value < .0001, OR 5.1, 95% CI 2.1 to 12.5). DRNCDs were present in 27 (46.6%) rural teachers and 24 (45.3%) urban teachers.86.8% of the male teachers and 43.1% of the female teachers were obese according to their BMI (Chi Square 22.93, p value <0.0001). Normal BMI was not seen in any of them. Urban teachers and families were indulging more in junk foods probably due to more access (Chi Sq 5.9, p 0.01). 66.7% of all the teachers were unsure if their diets were complete or healthy.

**Discussion:** Significant gender differences were found in the anthropometric measurements which were more adverse in the males. Important dietary patterns based on intake of breakfast daily, beverages, spicy foods, junk foods, fresh fruits and vegetables, nutritional, ayurvedic and homeopathic supplements.

**Conclusion:** Knowledge of dietary patterns enables identification of unhealthy practices prevalent in the community. There is a need for educating the communities about balanced and healthy diets.

**Keywords:** Dietary patterns**,** Diet Related **–** Non communicable diseases (DR-NCDs), teachers, urban, rural

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**Submission date:** November 4, 2025 **Revision date:** February 24, 2026 **Published date:** June 29, 2026

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## Introduction

Diet Related Non-Communicable Diseases (DR-NCDs) are increasing significantly in India both in urban and rural areas. Dietary changes include intake of refined cereals, decreased pulses, fruits and vegetables and increased intake of meat products. An increased purchasing power and availability of high fat, energy-dense foods have led to a rapid increase in the prevalence of obesity in India along with an increased prevalence of metabolic syndrome and type 2 diabetes mellitus (T2DM)[1,2].

With an average consumption of 11 grams per day, Indians have a high salt intake as against the WHO recommended limit of less than 6 grams per day[3]. Podder V et al looking at physical activity patterns in India found that 77% of the respondents were physically inactive or mildly active. Individuals living in urban localities were proportionately more inactive[4].

Traditional Indian food practices have evolved over the centuries and provide wholesome, balanced, nourishing meals. The traditional "Thali" (meaning plate) concept emphasizes that all of the necessary food groups are provided in the right proportions on par with current dietary recommendations[5]. Green R et al identified Indian traditional dietary patterns made up of cereals (rice), pulses, meat, vegetables, fruit and also dietary patterns high in sweets and snacks[6].

Indian diets have become unwholesome of late as households are consuming more calories from processed foods. There is also an excess consumption of cereals and not enough proteins, fruits, and vegetables. Compared to the reference diet where 29% calories are to be obtained from proteins, the share from protein sources is only 6–8% in most Indian diets.[7] Micro nutrient deficiencies in terms of minerals and vitamins are present in two-thirds of the people in India [8]. An understanding of the diverse dietary patterns in local populations will provide a better knowledge of what people are eating and the relationship with DR-NCDs [6].

School teachers are also health promoters, gate keepers, educators, and role models for their students and the community they live in. The implication is that they themselves must follow diets that enable the achievement of optimal nutrition-related health and wellbeing[9]. Parker EA et al in their study, found an overall poor diet quality in the teachers they interviewed and also found a high prevalence of overnutrition among them. They suggest that teachers with unhealthy dietary habits can set a poor example to their students in terms of dietary patterns.[10]. Wiradnyani A et al in their study with school teachers in Bandung, West Java, found that nearly half of them expressed their lack of self-confidence in delivering nutrition education showing their lack of knowledge in nutrition[11].

This study is set to identify various dietary patterns among urban and rural school teachers in Guntur district of Andhra Pradesh, India and to compare dietary patterns with anthropometric measurements like height, weight, BMI and waist hip-ratio and also to compare dietary patterns with DR-NCDs.

## Methods

This is a descriptive study done between July and August 2025 involving 5 schools from rural mandals and 5 schools from urban mandals of Guntur district selected by simple random sampling. All the teachers included from the above schools (58 from rural schools and 53 from urban schools) were administered a predetermined and tested questionnaire covering various aspects of diet, socio – demographic variables and anthropometric measurements like height, weight, BMI and waist hip-ratio after obtaining IEC clearance and informed consent.

Predefined dietary items included in the proforma were as per standard classification of food groups by ICMR / NIN like fruits, vegetables, dairy, whole grains etc. Face validity of questionnaire was ensured by sharing it with other departmental professors. Pilot testing was done on a few teachers locally. The questionnaire was modified appropriately and administered after taking an informed consent. Anthropometric measurements taken were height, weight, waist and hip circumference. After taking consent and observing gender sensitivity, accurate, reliable data was obtained following standardised measurement techniques and equipment. (stadiometer, digital scale and flexiblenon-stretchable tape)

The collected data was entered in Microsoft Excel 2019 and presented in tables and graphs. Cronbach's alpha of 0.70 and 0.78 were found for scores assigned to good dietary habits and poor dietary habits respectively indicating acceptable internal consistency of data. Important findings were subjected to tests of significance like Chi square test and Z test at 5 %Level of Significance.

## Results

A total of 111 teachers (53 men & 58 women) were interviewed of whom 58 were from rural schools and 53 from urban schools. All the teachers, both in urban and rural schools were between 30 to 55 years age. 52.5% of rural and 63.0% of the urban teachers were > 40 years age. 55 were working in Govt Schools while 56 were working in private schools. 43 were in primary schools while 68 were in secondary schools. 93 teachers (83.8%) had an income of between Rs.15000 to Rs. 25000 per month. 63 teachers were educated upto degree and 48 upto to post graduation.

Chronic illness was present in 27.6% of the rural teachers and 66.0% of urban teachers (Chi square 16.5%, p value < .0001, OR 5.1, 95% CI 2.1 to 12.5) The common NCDs seen among the teachers were diabetes, hypertension, diabetes with hypertension, osteoarthritis, gastritis / peptic ulcer and hypothyroidism. Diet Related Non-Communicable diseases (DR NCDs) were present in 27 (46.6%) rural teachers and 24 (45.3%) urban teachers. 86.8% of the male teachers and 43.1% of the female teachers were obese according to their BMI (Chi Square 22.93, p value 0.00002). 33 women and 7 men were overweight. Normal BMI was not seen in any of them. 52.8% of the male teachers and 10.3 % of the female teachers had an increased waist hip ratio (Chi Square 23.53, p value 0.00008). Excess waist hip ratio (WHR) was seen in 28 males and 6 females. 78.8% of them said that they changed their diet after being diagnosed with an NCD. 66.7% of all the teachers were unsure if their diets were complete or healthy.

Regarding intake of proteins of animal origin among the non-vegetarians, there is no significant difference between urban and rural school teachers and their families (7 families, 6 rural and 1 urban, were vegetarians). However, it is seen that only 12.6 % of all families eat mutton regularly, 69.9 % eat fish and 99.0 % eat poultry. Intake of eggs was surprisingly low at 38.8% only. Table 1 gives information about healthy nutritional practices in urban and rural school teachers. Table 2 looks at the dietary patterns identified in school teachers and their families. Table 3 recognizes the distribution of teachers, both urban and rural, according to certain unhealthy dietary practices.

**Table 1: Healthy nutritional practices in urban and rural school teachers**

| S. No. | Healthy nutritional practices (Daily intake) | Urban (n= 53) No. (%) | Rural (n= 58) No. (%) | Total (n= 111) No. (%) | Chi Sq | p |
|---|---|---|---|---|---|---|
| 1 | Green leafy vegetables | 5 (9.4) | 11 (19.0) | 16 (14.4) | 2.04 | 0.2 |
| 2 | Green tea | 5 (9.4) | 5 (8.6) | 10 (9.0) | 0.02 | 0.9 |
| 3 | Nutritional Supplements | 16 (30.2) | 13 (22.4) | 29 (26.1) | 0.87 | 0.4 |
| 4 | Brown rice | 16 (30.2) | 23 (39.7) | 39 (35.1) | 1.10 | 0.3 |
| 5 | Millets | 11 (20.8) | 16 (27.6) | 27 (24.3) | 0.70 | 0.4 |
| 6 | Nuts & Seeds | 6 (11.3) | 5 (8.6) | 11 (9.9) | 0.23 | 0.6 |
| 7 | Dry fruits | 5 (9.4) | 5 (8.6) | 10 (9.0) | 0.02 | 0.9 |
| 8 | Spouted grams | 8 (15.1) | 14 (24.1) | 22 (19.8) | 1.43 | 0.2 |
| 9 | Fresh fruits | 10 (18.1) | 15 (25.9) | 25 (22.5) | 0.78 | 0.4 |
| 10 | Fresh vegetables | 53 (100) | 58 (100) | 111 (100) | | |

**Table 2: Nutritional patterns identified in school teachers and their families**

| S.No | Nutritional patterns | Rural n=58 (%) | Urban (%) n=53 | Chi Square | p value | Total (%) n=111 |
|---|---|---|---|---|---|---|
| 1 | Daily breakfast consumers | 42 (72.4) | 40 (75.5) | 0.13 | 0.70 | 82 (73.9) |
| 2 | Regular coffee and tea consumers | 17 (29.3) | 13 (24.5) | 0.32 | 0.57 | 30 (27.0) |
| 3 | Mutton, Fish, Poultry and Eggs consumers | 51 (87.9) | 52 (98.1) | 2.9 (Yates) | 0.09 | 103 (92.8) |
| 4 | Spicy food eaters | 15 (25.9) | 15 (28.3) | 0.08 | 0.78 | 30 (27.0) |
| 5 | Unhealthy practices - Junk foods, fried foods, salty snacks, eating out etc. | 31 (53.4) | 29 (54.7) | 0.02 | 0.89 | 60 (54.1) |
| 6 | Fresh vegetables, fruits, dairy products etc. | 31 (53.4) | 20 (37.7) | 2.75 | 0.09 | 51 (45.9) |
| 7 | Regular users of nutritional supplements | 13 (22.4) | 16 (30.2) | 0.87 | 0.35 | 29 (26.1) |
| 8 | Ayurveda and Homeopathy supplements | 13 (22.4) | 6 (11.3) | 0.87 | 0.35 | 19 (17.1) |
| 9 | Brown rice (unpolished / home pounded) | 23 (39.7) | 16 (30.2) | 1.09 | 0.30 | 39 (35.1) |
| 10 | Daily intake of sprouted grams | 14 (24.1) | 8 (15.1) | 1.40 | 0.23 | 22 (19.8) |

**Table 3: Distribution of teachers according to unhealthy dietary practices**

| S.No | Unhealthy dietary practices | Urban (%) n=53 | Rural (%) n=58 | Total (%) n=111 | Chi Square | p value |
|---|---|---|---|---|---|---|
| 1 | Regular use of microwave oven to heat / cook food | 17 (32.1) | 14 (24.1) | 31 (27.9) | 0.87 | 0.35 |
| 2 | No Breakfast | 13 (24.5) | 16 (27.6) | 29 (26.1) | 0.13 | 0.70 |
| 3 | Excess sugar intake | 20 (37.7) | 25 (43.1) | 45 (40.5) | 0.33 | 0.57 |
| 4 | Excess salt intake | 30 (56.6) | 34 (58.6) | 64 (57.7) | 0.05 | 0.83 |
| 5 | Excess chilly intake | 15 (28.3) | 15 (25.9) | 30 (27.0) | 0.08 | 0.78 |
| 6 | Regular junk foods intake | 20 (37.7) | 10 (17.2) | 30 (27.0) | 5.90 | 0.01* |
| 7 | Regular fried foods intake | 12 (22.6) | 6 (10.3) | 18 (16.2) | 3.10 | 0.08 |
| 8 | Regular eating out | 14 (26.4) | 13 (22.4) | 27 (24.3) | 0.24 | 0.62 |
| 9 | Regular intake of prepacked salty snacks | 1 (1.9) | 5 (8.6) | 6 (5.4) | 2.46 | 0.12 |
| 10 | Daily twice or more snacks intake | 12 (22.6) | 12 (20.7) | 24 (21.6) | 0.06 | 0.80 |
| 11 | Regular sweets intake | 26 (49.1) | 35 (60.3) | 61 (55.0) | 1.43 | 0.23 |
| 12 | Regular soft drinks intake | 29 (54.7) | 27 (46.6) | 56 (50.5) | 0.74 | 0.39 |
| 13 | Regular intake of excess Ghee and Butter | 2 (3.8) | 10 (17.2) | 12 (10.8) | 5.20 | 0.02* |
| 14 | Regular intake of pickles | 16 (30.2) | 28 (48.3) | 44 (39.6) | 3.80 | 0.05* |

* Statistically significant

## Discussion

**Urban / Rural differences:** All the interviewed teachers in this study, working both in urban and rural schools, were found to have similar income levels. Very few differences were found between the two groups in relation to dietary patterns. Urban teachers and families were indulging more in junk foods compared to their urban counterparts probably due to higher availability. Urbanization does influence food consumption in some ways mainly due to infrastructure, market access, percentage working women in urban areas, norms and institutions etc.[12]

**Salt intake:** In the current study, 57.7% of the teachers said that their salt intake was higher. Johnson C et al summarized existing data between 1986 and 2014 in India and found that mean salt consumption level per capita was 10.98 g/day with no evidence of a change in intake over time. They concluded that population salt consumption far exceeds the WHO-recommended maximum of 5 g per person per day[13].

The 66th World Health Assembly adopted the goal of a 30% relative reduction in mean population intake of salt for the prevention and control of noncommunicable diseases[14]. Strict monitoring of the nutritional composition of processed foods is necessary to ensure that the food industry is voluntarily compliant with salt reduction [15]. The National Multi-Sectoral Action Plan to reduce premature NCDs in India, if adopted adequately, can enhance, implement and monitor salt reduction efforts [16].

**Dietary patterns:** In the current study, 10 dietary patterns have been identified (Table 2). Sharma M et al found in their study, twenty-nine dietary patterns based on fruit, vegetables, pulses and rice with additional dairy products, meat and eggs[17]. Green R et al in their systematic review, found eleven separate models of dietary patterns the majority being vegetarian with a predominance of fruit, vegetables, cereals and pulses [6].Satija A et al identified three dietary patterns: 'cereals–savory foods' (cooked grains, rice/rice-based dishes, snacks, condiments, soups, nuts), 'fruit–veg–sweets–snacks' (Western cereals, vegetables, fruit, fruit juices, cooked milk products, snacks, sugars, sweets) and 'animal-food' (red meat, poultry, fish/seafood, eggs). Positive associations were found between the 'animal-food' pattern and anthropometric risk factors while moderate intake of the 'cereals–savory foods' pattern was associated with reduced odds of obesity and central obesity[18].

The Nutritional Intake Survey Series, conducted by the National Sample Survey Organisation (NSSO), found a gradual reduction in the consumption of calories and proteins with a concomitant increase in fat consumption both in rural and urban India[19].Tak M et al found that a majority of Indian households are consuming cereal-focused, dairy-focused heavy diets with a high content of processed food. Consumption of micronutrient-rich food groups such as fruits, vegetables, meat, and eggs is still low. Five predominant dietary types were identified; Cereal based, Processed Foods Heavy, Dairy based, Balanced diet with dairy and Balanced diet with meat[20].

**Role of breakfast:** Breakfast is often referred to as the most important meal of the day and in recent years has been implicated in weight control, cardio-metabolic risk factors and cognitive performance[21].A noticeable dietary change in recent times has been one of meal skipping, notably the skipping of the breakfast meal[22].

Educating people about the benefits of a healthy breakfast is an important and necessary public healthmessage[23]. Skipping breakfast was associated with a larger waist circumference, cardiometabolic risk factors, poorer diet quality, and unhealthy lifestyle behaviors[24].

Most institutes of nutrition and dietetics recommend eating a healthy breakfast as an integral component of a nutritionally optimal diet. While dietary patterns in school teachers both from urban and rural areas were mostly similar, notable difference is seen in those with NCDs. Public health efforts to control NCDs will be successful when mechanisms to control salt, sugar, and fat consumption are endorsed. Processed and packaged foods are increasingly being consumed by every household across social strata, both rural and urban[25].

**Dietary supplements:** A nutritional supplement is an external food product supplied to a person as per physician or dietician's recommendation. In this study 26.1% of the teachers (more among urban

based teachers) were taking nutritional supplements. Nutraceuticals are a growing market in India and are made available in all super markets and online shopping apps. However, consumers must be concerned about the proper quality and safety of these foods[26]. As these items can be freely purchased in stores without a prescription, people do not seek professional advice regarding their safety and use.

**Millets:** Millets or Nutri-cereals are considered as super foods as they are a rich source of nutrients like carbohydrate, protein, dietary fibre, minerals like calcium, potassium, magnesium, iron, manganese, zinc and vitamin B complex and antioxidants. As millets have a low glycemic index, they are good for diabetic patients [27]. In the current study, 20.8% of urban and 27.6% rural teachers said that they ate millets on a regular basis.

**Beverage consumption:** The commonly consumed sources of caffeine all over the world are **c**offee and tea. Caffeine has both positive and negative effects on one's psychological health. Individual differences in caffeine metabolism, genetic factors, and other lifestyle factors may influence the effects of tea, coffee, and green tea on cognitive function and mental health[28].A systematic review by Mancini et al, informs that green tea influences psychopathological symptoms (*e.g.* reduction of anxiety), cognition (*e.g.*benefits in memory and attention) and brain function (*e.g.* activation of working memory)[29].

**Spicy foods:** No statistically significant relation was found between frequency of spicy food intake and health effects except for loss of appetite. When combined with other poor dietary habits, smoking and excessive consumption of beverages and alcohol, spicy foods can cause adverse health effects[30]. Increased consumption of spicy foods and frequency of spicyfood intake were independently associated with general obesity. It was seen that spicy flavor and spicy food frequency were positively associated with general obesity in Chinese rural populations[31].

**Dietary supplements from indigenous health systems:** India has various indigenous health systems like Ayurveda, Yoga, Naturopathy, Siddha, Unani, and Homeopathywhich are widely accepted and practiced parallel to allopathy. The Ayurvedic system of medicine has its own advantages and also fulfills social health demands. Ayurveda emphasizes two points, i.e., how to promote and maintain good health and how to prevent illness[32]. However, it is likely that an ayurvedic preparation may cause adverse events due to adulteration or the presence of inherent constituents like alkaloids, and hence may not always be completely safe[33].

## Conclusion

Identifying dietary patterns gives a better idea of the shift towards healthy eating habits of people. Improving dietary knowledge, a highly feasible policy measure, has the potential to prevent obesity and overweight if effectively implemented[34]. Development of 'nutrient-dense' breakfast foods that can be prepared easily, school breakfast programmes and education on the importance of breakfast are the needs of the hour[22].

**Limitations of the study:** As we limited the number of schools to 5 each in urban and rural areas, the resulting sample of teachers was small. The study relies on self-reported information on dietary practices.

No Funding sources were availed for this research. Ethical clearance was obtained from the institution (NRI Medical college & General Hospital), with reference number IEC 2025 F013, dated (11 th February 2025). We solemnly state that there is no conflict of interest with regard to this article.

## References

1. Misra A, Singhal N, Sivakumar B, Bhagat N, Jaiswal A, Khurana L. Nutrition transition in India: secular trends in dietary intake and their relationship to diet-related non-communicable diseases. J Diabetes. 2011 Dec;3(4):278-92. Doi: 10.1111/j.1753-0407.2011.00139.x. PMID: 21649865.
2. Gulati S, Misra A, Sugar Intake, Obesity, and Diabetes in India, Nutrients 2014, 6, 5955-5974; doi:10.3390/nu6125955
3. George AS, George ASH, High Salt Intake in India: Health and Economic Impacts, Partners Universal International Innovation Journal, 2023; 1 (6). DOI:10.5281/zenodo.10297864
4. Podder V, Nagarathna R, Anand A, Patil SS, Singh AK, Nagendra HR. Physical Activity Patterns in

India Stratified by Zones, Age, Region, BMI and Implications for COVID-19: A Nationwide Study. Annals of Neurosciences. 2021;27(3-4):193-203. doi:10.1177/09727531211998507

5. Salis S, Virmani A, Priyambada L, Mohan M, Hansda K, Beaufort C. 'Old Is Gold': How Traditional Indian Dietary Practices Can Support Pediatric Diabetes Management. Nutrients. 2021 Dec 10;13(12):4427. Doi: 10.3390/nu13124427. PMID: 34959978; PMCID: PMC8707693.
6. Green R, Milner J, Joy EJ, Agrawal S, Dangour AD. Dietary patterns in India: a systematic review. Br J Nutr. 2016 Jul;116(1):142-8. doi: 10.1017/S0007114516001598. Epub 2016 May 5. PMID: 27146890; PMCID: PMC4890343.
7. Sharma, M., Kishore, A., Roy, D.et al.A comparison of the Indian diet with the EAT-Lancet reference diet. BMC Public Health**20**, 812 (2020). https://doi.org/10.1186/s12889-020-08951-8
8. Rao ND, Min J, DeFries R, Ghosh-Jerath S, Valin H, Fanzo J, Healthy, affordable and climate-friendly diets in India, Global Environmental Change, 2018; 49: 154-165, doi.org/10.1016/ j. gloenvcha.2018.02.013.
9. Jakstas T, Follong B, Bucher T, Miller A, Shrewsbury VA, Collins CE. Addressing schoolteacher food and nutrition-related health and wellbeing: a scoping review of the food and nutrition constructs used across current research. Int J Behav Nutr Phys Act. 2023 Sep 12;20(1):108. doi: 10.1186/s12966-023-01502-5. PMID: 37700281; PMCID: PMC10498614.
10. Parker EA, Feinberg TM, Lane HG,Deitch R, Zemanick A, Saksvig BI,Turner L,Hager ER, Diet quality of elementary and middle school teachers is associated with healthier nutrition-related classroom practices, Preventive Medicine Reports, 2020; 18, https://doi.org/10.1016/j.pmedr.2020.101087
11. Wiradnyani A, Kekalih A, Anggraini R, Februhartanty J, Teachers' Experiences with Nutrition Education Activities and their Perceived Key Factors to an Effective Nutrition Education. The Southeast Asian journal of tropical medicine and public health, 2021; 52(Supplement 1).
12. Pandey B, Reba M, Joshi PK, Seto KC. Urbanization and food consumption in India. Sci Rep. 2020 Oct 14;10(1):17241. doi: 10.1038/s41598-020-73313-8. PMID: 33057014; PMCID: PMC7560883.
13. Johnson C, Praveen D, Pope A, Raj TS, Pillai RN, Land MA, Neal B. Mean population salt consumption in India: a systematic review. J Hypertens. 2017 Jan;35(1):3-9. doi: 10.1097/HJH.0000000000001141. PMID: 27755388.
14. WHO, Noncommunicable Diseases Global Monitoring Framework: Indicator Definitions and Specifications. https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/who-gmf-targets-and-indicators-list.pdf?sfvrsn=4dcf2a55_3&download=true
15. Webster J, Trieu K, Dunford E, Hawkes C. Target salt 2025: a global overview of national programs to encourage the food industry to reduce salt in foods. Nutrients. 2014 Aug 21;6(8):3274-87. doi: 10.3390/nu6083274. PMID: 25195640; PMCID: PMC4145308.
16. Gupta P, Mohan S, Johnson C, Garg V, Thout SR, Shivashankar R, Krishnan A, Neal B, Prabhakaran D. Stakeholders' perceptions regarding a salt reduction strategy for India: Findings from qualitative research. PLoS One. 2018 Aug 6;13(8): e0201707. doi: 10.1371/journal.pone.0201707. PMID: 30080888; PMCID: PMC6078292.
17. Sharma, M., Kishore, A., Roy, D.*et al.*A comparison of the Indian diet with the EAT-Lancet reference diet.*BMC Public Health***20**, 812 (2020). https://doi.org/10.1186/s12889-020-08951-8
18. Satija A, Hu FB, Bowen L, Bharathi AV, Vaz M, Prabhakaran D, Reddy KS, Ben-Shlomo Y, Davey Smith G, Kinra S, Ebrahim S. Dietary patterns in India and their association with obesity and central obesity. Public Health Nutr. 2015 Nov;18(16):3031-41. doi: 10.1017/S1368980015000312. Epub 2015 Feb 20. PMID: 25697609; PMCID: PMC4831640.
19. Jignesh Shah J, Ayush Kumar A, Datta TN, Trends and Patterns in Nutritional Intake in India, Journal of Rural Development, 2017; 36 (3): 311 - 332
20. Tak M, Shankar B, Kadiyala S. Dietary Transition in India: Temporal and Regional Trends, 1993 to 2012. *Food and Nutrition Bulletin*. 2019; 40 (2): 254-270. doi:10.1177/0379572119833856
21. Gibney MJ, Barr SI, Bellisle F, Drewnowski A, Fagt S, Livingstone B et al. Breakfast in Human Nutrition: The International Breakfast Research Initiative. Nutrients. 2018 May 1;10(5):559. Doi: 10.3390/nu10050559. PMID: 29723985; PMCID: PMC5986439.
22. Sivaramakrishnan M, Kamath V. A typical working-day breakfast among children, adolescents and adults belonging to the middle and upper socio-economic classes in Mumbai, India - challenges and implications for dietary change. Public Health Nutr. 2012 Nov;15(11):2040-6. Doi: 10.1017/S1368980012002777.
23. Smith KJ, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ, Skipping breakfast: longitudinal associations with cardiometabolic risk factors in the

Childhood Determinants of Adult Health Study123, The American Journal of Clinical Nutrition, 2010; 92 (6): 1316-1325. https://doi.org/10.3945/ajcn.2010.30101.

24. Smith KJ, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ, Skipping breakfast: longitudinal associations with cardiometabolic risk factors in the Childhood Determinants of Adult Health Study123, The American Journal of Clinical Nutrition, 2010; 92 (6): 1316-1325. https://doi.org/10.3945/ajcn.2010.30101.
25. Dasgupta R, Pillai R, Kumar R, Arora NK. Sugar, salt, fat, and chronic disease epidemic in India: is there need for policy interventions? Indian J Community Med. 2015 Apr-Jun;40(2):71-4. doi: 10.4103/0970-0218.153858. PMID: 25861165; PMCID: PMC4389505.
26. Swapan Banerjee, Dietary supplements market in India is rapidly growing– An overview, MS Management Journal, 2018; 10 (1): ISSN No.0975-0800
27. Rajib Kumar Sen; Hemant Kumar Meena and Vedeika Shekhar, Promoting Millets in Diets: Best Practices Across States/UTs of India, Report-on-Promoting-Best-practices-on-Millet-26_4_23 Publishing Agency: NITI Aayog, 2023
28. Ikar M, Sable S, Tea, coffee and green tea consumption and mental health outcomes: A systematic review and meta-analysis of observational and intervention studies on stress and related conditions Journal of Pharmacognosy and Phytochemistry 2023; 12(2): 209-221 DOI: https://doi.org/10.22271/phyto.2023.v12.i2c.14660
29. Mancini E, Beglinger C, Drewe J, Zanchi D, Lang UE, Borgwardt S, Green tea effects on cognition, mood and human brain function: A systematic review, Phytomedicine,2017; 34: 26-37, https://doi.org/10.1016/j.phymed.2017.07.008.
30. Rajkotiya NH, Sawant SU, Deepak S. Effect of Spicy Diet on Health: A Comprehensive Study. Indian J Nutri. 2023;10(1): 272. https://www.opensciencepublications.com/ fulltextarticles/IJN-2395-2326-10-269.html
31. K. Yang, Y. Li, Z. Mao, X. Liu, H. Zhang, R. Liu, Y. Xue, R. Tu, X. Liu, X. Zhang, W. Li, C. Wang, Relationship between spicy flavor, spicy food intake frequency, and general obesity in a rural adult Chinese population: The RuralDiab study, Nutrition, Metabolism and Cardiovascular Diseases, 2018; 28 (3): 252-261. https://doi.org/ 10.1016/j.numecd.2017.10.021.
32. Jha M, Sah MK, Singh PK, Kumar A. Role of Ayurveda in Public Health: A Critical Review. IJRAPS [Internet], 2022; 5(12):595-9. https://ijraps.in/index.php/ijraps/article/view/123
33. Paudyal B, Thapa A, Sigdel KR, Adhikari S, Basnyat B. Adverse events with ayurvedic medicines-possible adulteration and some inherent toxicities. Wellcome Open Res. 2019; 4:23. doi: 10.12688/wellcomeopenres.15096.3.
34. Shimokawa S, When Does Dietary Knowledge Matter to Obesity and Overweight Prevention? Food Policy, 2013; 38 (1): 35–46. DOI: 10.1016/j.foodpol.2012.09.001.

**Original Article**

*DOI: https://doi.org/10.37506/tppzc886*

# Assessment of Anthropometric Profile and Nutrient Adequacy among Middle-Aged Adults with Long Duration Type 2 Diabetes in Mumbai: A Cross-Sectional Study

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**How to cite this article**: Hema Goenka, Reema Mathur. Assessment of Anthropometric Profile and Nutrient Adequacy among Middle-Aged Adults with Long Duration Type 2 Diabetes in Mumbai: A Cross-Sectional Study. Indian Journal of Public Health Research and Development/Vol. 17 No. 3, July-September 2026.

## Abstract

**Background:** Type 2 Diabetes Mellitus is a major public health concern in India, with increasing prevalence among middle-aged adults. Nutritional status plays a crucial role in glycemic control and prevention of complications, particularly in individuals with long-duration disease. However, limited hospital-based data are available regarding anthropometric profile and nutrient adequacy among such patients.

**Methods:** An observational cross-sectional study was conducted with a total of 75 people aged 55-65 years (with long duration type 2 diabetes) in Mumbai city. A personal survey (Face-to-face Interview) was taken and information about their anthropometry and dietary habits were recorded. A food frequency questionnaire, 24-hour recall and dietary diversity were used to assess their nutrient intakes.

**Result:** According to their BMI, a greater number of people were obese (84%). According to waist circumference all females and 90% males had abdominal obesity. In the nutrient analysis, consumption of energy was low compared to EAR (1321.05 ± 241.91kcal & 1061.09 ± 249.40 kcal) and consumption of fat (54.9g ± 9.314 & 41.7g ± 10.094) and carbohydrate (144.16g ± 23.852 & 134.79g ± 32.610) was moderate in both males and females respectively. Protein consumption was slightly higher than EAR (45.5g ± 8.396 & 37.8g ±12.670) in both males and females respectively.

**Conclusion:** The study highlights a high prevalence of obesity and nutrient imbalance among middle-aged adults with long-duration Type 2 Diabetes Mellitus. Regular nutritional assessment and individualized dietary counselling should be integrated into routine diabetes care to improve long-term outcomes.

**Keywords:** Type 2 Diabetes Mellitus, Nutritional Status, Anthropometry, Nutrient Adequacy, Middle-Aged Adults, Hospital-Based Study.

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**Submission date:** April 6, 2026 **Revision date:** May 8, 2026 **Published date:** June 29, 2026

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## Introduction

Diabetes is being acknowledged as a major global health epidemic. According to the report of International Diabetes Federation (IDF) 2019, around 537 million adults aged 20-79 years in the world are living with diabetes. The global ubiquity of diabetes is expected to rise from 643 million (11.3%) to 783 million (12.2%) by 2045 [1].

The Framingham Heart Study data revealed that, men and women with diabetes who are 50 years and older live an average 7.5 and 8.2 years less than individuals without diabetes [2]. National non-communicable disease (NCD) monitoring survey done in rural and urban areas all over India in 2017-18, reported the prevalence of diabetes mellitus as 9.3% and impaired fasting blood glucose as 24.5%, highest among the urban middle age group (50-69 yrs). Of those with diabetes nearly half were aware 45.8%, one third on treatment 36.1%, and only 15.7% had their blood glucose level under control [3].

Since recent decades, the Type 2 Diabetes Mellitus epidemic has wreaked devastation. A chronic metabolic disorder, Diabetes Mellitus derived from Greek word 'Diabetes' means to pass through and the Latin word 'Mellitus' means sweet, which indicates high sugar level in the urine (glycosuria) of patients with diabetes [4]. Commonly diabetes is classified as type I and type II. T1DM occurs through the destruction of pancreatic beta-cells which presents in youngsters who remain entirely insulin deficient and as a consequence, require exogenous insulin. Patients with T1DM are exposed to diabetic ketoacidosis (DKA), diabetic coma and/or even death. T2DM happens due to gradual loss of insulin secretion and insulin resistance [5].

The progression of Diabetes Mellitus (T2DM) is rooted by combination of two factors: defective insulin secretion by pancreatic beta cells and the inability of insulin-sensitive tissues to respond to insulin. Therefore, defects in any of the mechanisms involved can lead to a metabolic imbalance that leads to the pathogenesis of diabetes [6].Several studies have found various risk factors associated with type 2 diabetes like, obesity, age, gender, marital status and education. Among these, obesity was the major risk factor [5].

The impact of different diets on glycemic control and weight loss is emerging nowadays. All types of diets like low-carbohydrate, low-fat, and Mediterranean diets and those replacing saturated and trans- fats with unsaturated fats significantly affect weight loss [7].

Indian diets, across states and income groups, have been found to be unhealthy. The consumption of cereals is more as compared to other food groups. Except for the richest 5% of the population, every group compared had an average daily calorie intake that is lower than the advised 2503kcal/capita/day. In India, only 6-8% of calories come from protein sources contrary to 29% in the EAT-Lancet reference diet [8]. Education and income both affect one's ability to make healthy diabetic decisions [9].

### Need for the study

Despite the growing burden of Type 2 Diabetes Mellitus in India, hospital-based data on anthropometric status and nutrient adequacy among middle-aged adults with long-duration disease remain scarce. Most existing studies focus on newly diagnosed patients or community populations, leaving a critical gap in understanding dietary practices and nutritional inadequacies in individuals with established, long-standing disease. Studies have shown that long-term dietary adherence in patients with T2DM is poor, with high levels of dietary fatigue reported even among those who are aware of recommended dietary guidelines [23,24].

The present study was therefore undertaken with the objective to address this gap by assessing the anthropometric profile, dietary intake, morbidity profile and nutrient adequacy among middle-aged adults aged 55–65 years with Type 2 Diabetes Mellitus of more than five years' duration, attending a tertiary care hospital in Mumbai.

## Materials & Methods

### Study Design

A hospital-based cross-sectional study was conducted among patients with Type 2 Diabetes Mellitus attending the outpatient department of a tertiary care hospital in Mumbai.

**Study Population**

The study included 75 middle-aged adults diagnosed with Type 2 Diabetes Mellitus with a disease duration of more than five years.

**Inclusion & Exclusion Criteria**

Participants were included in the study if they were diagnosed cases of Type 2 Diabetes Mellitus, belonged to the age group of 55–65 years, and had a duration of diabetes of more than five years. Additionally, participants were required to be willing to provide informed consent and able to communicate in either English or Hindi. Participants were excluded from the study if they had Type 1 Diabetes Mellitus or gestational diabetes, were critically ill, or had severe complications that could significantly affect their dietary intake. Patients with severe complications affecting dietary intake, such as advanced diabetic nephropathy, gastroparesis, severe neuropathy, advanced retinopathy, diabetic foot ulcers requiring hospitalization, or severe cardiovascular disease, were excluded from the study.

**Sample Size**

For this study, 75 cases of Type 2 Diabetes Mellitus were recruited. They had received a confirmed medical diagnosis more than 5 years before.

**Sampling Technique**

Participants were selected using a non-probability convenience sampling method from patients attending the outpatient diabetes clinic. While this approach facilitates data collection in a hospital setting, it may limit the generalizability of findings to the broader population of individuals with Type 2 Diabetes Mellitus. To minimize selection bias, all eligible patients attending the clinic during the data collection period who met the inclusion criteria were approached consecutively.

**Data Collection**

Data were collected using an interview schedule. Participants were first provided with a Participant Information Sheet to explain the purpose of the study, ensure confidentiality, and obtain informed consent. Anthropometric measurements including height, weight, and waist circumference were recorded, and Body Mass Index (BMI) was calculated. Dietary data were collected using the 24-hour dietary recall method and a Food Frequency Questionnaire (FFQ) as described in the FAO dietary assessment guidelines (2018). The FFQ was used to assess the pattern of commonly consumed foods, while the 24-hour recall recorded the participant's daily food intake using standard household measures. Nutrient intake was calculated using the Indian Food Composition Tables (IFCT, 2017) and compared with percentage Estimated Average Requirement (%EAR 2020). Dietary diversity was assessed using the Individual Dietary Diversity Score (IDDS) based on FAO guidelines (2013), which measures the number of food groups consumed within 24 hours. The collected data were entered into MS Excel and analyzed using SPSS version 25. Descriptive statistics such as frequencies, percentages, means, and standard deviations were calculated, and a t-test was used to evaluate differences in nutrient intake between males and females. Ethical approval for the study was obtained from the ISBEC (Inter System Biomedica Ethics Committee), Mumbai, and written informed consent was obtained from all participants before data collection.

## Result

This was an observational cross-sectional study to assess nutritional status of type 2 diabetic patients (with long-duration Diabetes) aged 55-65 years in Mumbai city. The study population consisted of 75 people with Type 2 diabetes of which 30 were males and 45 females.

Mean age of all the participants (n=75) was 59 ± 3.58 years. All the males were married while 20% of the females were widows. Most of the females were homemakers (84.4%) whereas 83.4% males were working. Two-thirds lived in joint families and three-fourths had an annual family income less than Rs.10 lakhs. All participants showed higher levels of blood glucose. Male participants (n=30) had a mean fasting blood sugar of 205.47 ± 34.67 mg/dL, postprandial blood sugar of 284.62 ± 43.39 mg/dL and HbA1c of 7.46 ± 0.44%. Female participants (n=45) showed a mean fasting blood sugar of 202.04 ± 42.22 mg/dL, postprandial blood sugar of 293.02 ± 52.48 mg/dL and HbA1c of 8.00 ± 1.86. No participant fell into the normal category of Fasting, Post-prandial and HbA1c.

**Anthropometric data**

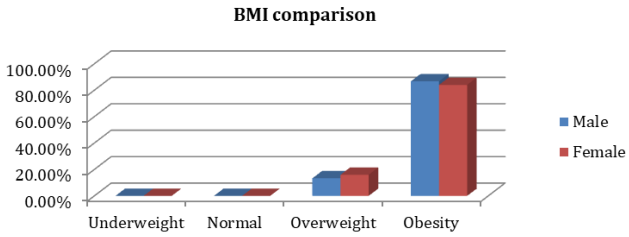



**Fig. no. 1.1 BMI comparison between male and female**

It was seen that greater number of participants fell into obesity category of BMI (84.0%). Similar proportion of male and female was seen in obesity category (86.7% & 82.2% respectively).

The mean BMI of all the participants was 27.9 ± 4.1.

In the current study waist circumference was 100.75cm ± 11.4 for males & 96.7 cm ± 11.0 for females which is higher compared to Asian cut-offs [17]. When compared to cut-off values i.e. ≥80cm in females and ≥90cm in males, all the females (100%) and 90% males were above the cut-off value indicating abdominal obesity.

So, the finding show that the participants had both general and abdominal obesity. This may further put them at risk of complications.

**Distribution of subjects according to Self-reported symptoms**

The distribution of subjects according to self-reported symptoms showed that the majority of participants experienced weakness and fatigue, with a higher prevalence among females (53.3%) compared to males (33.3%). This was followed by joint pain, which was reported by 46.7% of females and 20% of males. Additionally, frequent urination was a commonly reported symptom among both males (70%) and females (82.2%). Increased hunger and thirst were also reported, with 51.1% of males and 23.3% of females experiencing these symptoms.

**Nutrient analysis**

Nutrient intake was assessed using a 24-hour dietary recall and analyzed with IFCT (2017). Mean intake of energy was 1321 ± 241.9 kcal and 1061 ± 249.4 kcal, protein was 45.5 ± 8.3 g and 37.8 ± 12.6 g, fat was 54.9 ± 9.3 g and 41.7 ± 10.0 g and carbohydrate was 144.16 ± 23.8 and 134.79 ± 32.6 for males and females respectively. When expressed as percentage of Estimated Average Requirements (EAR) based on ICMR-NIN guidelines (2020), energy intakes were below the EAR (males 62.59 ± 11.46 % and females 63.89 ± 15.04 %) while protein intake met the EAR (106.02 ± 19.51 % males and 104.25 ± 34.9 % females). This was a moderate carbohydrate and protein diet with high fat intake.

**Dietary Diversity Score**

In the present study, IDDS (Individual dietary diversity score) were calculated from the 24- hour recall obtained for each participant.

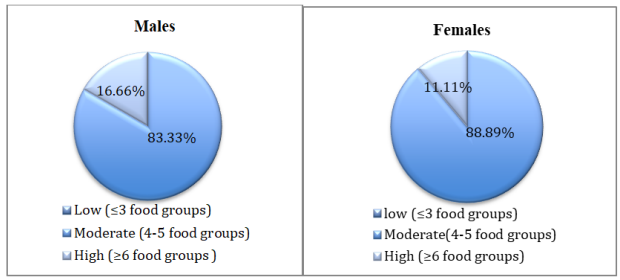



**Fig. 4.1 Individual Food group consumption:**

Starchy staples and milk & milk products were most consumed food groups, followed by legumes, nuts & seeds and other fruits & vegetables. Around 24% of participants had meat & fish. No one had organ meat. Eggs food group were consumed by 44% of participants. The consumption of dark green leafy vegetables was too low (2.67%).

The study included a total of 75 participants, comprising 30 males and 45 females. Overall, the combined mean score for all participants was 4.76 ± 0.67.

**Dietary pattern**

Data from food frequency questionnaire which reflects the pattern over last 12 months showed that cereal consumption was universal among participants, with 100% of both males and females consuming wheat flour as the staple cereal. Lentil dal was the most commonly consumed legume, other favourite being Bengal gram and green gram. Commonly consumed vegetables included bathua, spinach, cauliflower, tomato, and onion, with the

latter two consumed daily by all participants. Fruit intake was relatively low, with apple being the favourite while dates, papaya, banana, and lemon were eaten occasionally. Roots and tubers such as carrot, radish, potato, and beetroot were also commonly consumed. Almonds were consumed by 80% of participants, and packaged cow milk by all. Curd intake was slightly higher among females than males, while paneer consumption was occasional. About 57.3% of participants consumed eggs twice a week, and among non-vegetarians, mutton was the most eaten by females, while chicken and fish were consumed less frequently. Tea consumption was universal, whereas coffee was only occasional. Processed foods consumption revealed that around three-fourths of the participants consumed Namkeen as a snack option, while bakery products like biscuits were the next favourite (38.7%). Sweets and aerated drink were consumed occasionally not regularly. The higher consumption of processed foods like farsans was seen which is in line with result of SUN cohort study by Lavero-valero et al. [26].

## Discussion

The present study assessed the anthropometric profile, dietary intake, and nutrient adequacy among middle-aged adults with long-duration Type 2 Diabetes Mellitus attending a tertiary care hospital in Mumbai. All the participants who were visiting the hospital had been on medication since the 5 years of diagnosis but still had high blood glucose levels. The findings indicate a high prevalence of overweight and obesity both general and abdominal, consistent with previous Indian studies, highlighting that long-standing diabetes is often accompanied by suboptimal weight management despite ongoing disease awareness. Moreover, intervention-based studies demonstrate that meaningful weight reduction is typically achieved only through structured and intensive lifestyle modifications, while routine care alone yields limited impact [14].

The mean BMI of all the participants was 27.9 ± 4.1. This study is in line with a study where overweight/obese people were more prone to being diagnosed with type 2 diabetes [15].

The diet though low in calories was high in fat. Several confounding factors may have influenced the dietary patterns observed in this study. The long duration of diabetes (>5 years) in participants may have contributed to dietary fatigue, whereby individuals with longstanding disease gradually relapse to pre-diagnosis eating habits [23]. Less of vegetables and fruits were being consumed. Socioeconomic factors, including a household income below Rs. 10 lakhs in three-fourths of participants, may have constrained access to diverse, nutrient-dense foods. Additionally, the predominantly urban Mumbai setting, with its high availability of processed and convenience foods such as namkeen and bakery products, likely shaped food choices. Though diet diversity was moderate showing the consumption of 4-5 food groups, but the amounts were less as seen in the low-calorie intake.

Medications such as metformin and insulin, which can affect appetite and gastrointestinal tolerance, may have further influenced dietary intake, though medication data were not systematically captured in this study, which represents a limitation [24].

This is a classic example of people with diabetes who are obese but consuming a low-calorie diet. Such a diet further lowers their body's metabolic rate. This could be accompanied by poor sleep, low physical activity and stress which causes the body to store more fat. These lifestyle measures could be the confounding factors which were not part of the present study.

These findings are consistent with previous studies showing that dietary practices in individuals with long-standing type 2 diabetes may remain suboptimal despite awareness of dietary recommendations. The other lifestyle factors may also play a major role [27]. A cross-sectional study among Indian patients with Type 2 Diabetes found that high dietary adherence was observed in only 4.2% of participants, despite good medication adherence of over 90%, underscoring the gap between disease knowledge and dietary behaviour[24]. Additionally, long-term adherence to dietary guidelines tends to decline, highlighting the need for continuous, individualized, and culturally appropriate nutritional interventions [20,21].

Overall, the findings suggest that dietary habits among this population are influenced by personal food preferences and the availability of foods, and

that despite awareness of diabetes management, dietary intake may not meet the recommended nutrient requirements. These results highlight the importance of regular nutritional assessment, individualized dietary counselling, and targeted dietary interventions to improve nutrition and support better diabetes management.

## Conclusion

The study demonstrates a high prevalence of overweight and nutrient inadequacy among middle-aged adults with long-duration Type 2 Diabetes Mellitus. While staple foods and only the common vegetables are regularly consumed, intake of green vegetables, fruits and nutrient-dense foods is limited. Integration of regular anthropometric and dietary assessments, tailored nutrition education, and focused counselling into routine diabetes management is essential to improve long-term outcomes. These findings call for the integration of structured nutritional assessments and individualized dietary counselling into routine outpatient diabetes care protocols. Clinicians and registered dietitians working in tertiary care settings should prioritize culturally sensitive dietary interventions, especially for patients with long-standing disease who are at heightened risk of dietary fatigue and nutritional inadequacy.

### STRENGTHS

Hospital-based data provided real-world insights from patients with long-duration diabetes. The use of both the Food Frequency Questionnaire (FFQ) and the 24-hour dietary recall enabled assessment of habitual dietary intake as well as nutrient adequacy.

### LIMITATIONS

The study had a moderate sample size (n = 75) and purposive sampling, which may limit the generalizability of the findings. As the study was hospital-based, the results may not fully represent community-dwelling individuals with Type 2 Diabetes. Additionally, nutrient intake estimation may have been influenced by recall bias associated with the use of FFQ and 24-hour dietary recall methods.

### Recommendations for Future Research

Future research should include a larger sample size across multiple hospitals and regions of India to better capture the diversity in dietary patterns. Conducting community-based studies would also provide a broader understanding of dietary habits and nutritional status among middle-aged adults with long-duration Type 2 Diabetes beyond hospital settings. Additionally, future studies could explore different dietary patterns, such as traditional and Westernized diets, and examine their association with glycemic control and anthropometric measures. The use of mobile applications or digital food tracking tools may also help improve the accuracy of dietary data and support continuous monitoring of nutrient intake in long-term diabetes management programs. Future studies should also consider incorporating alternative anthropometric indices such as the Body Roundness Index (BRI), which has demonstrated a significant association with Type 2 Diabetes risk and may offer stronger predictive value for visceral adiposity and glycemic risk compared to BMI alone [25]. The inclusion of such indices alongside waist circumference and waist-to-height ratio would provide a more comprehensive assessment of body composition in individuals with Type 2 Diabetes Mellitus.

**Acknowledgements:** We sincerely thank all study participants for their cooperation.

### Declarations

**Conflict of Interest:** None declared

**Source of Funding:** Self-funded

**Ethical Clearance:** The study was approved by Inter-System Biomedical Ethics Committee (ISBEC ) dated 18 Nov 2022 . Approval No. ISBEC/NR-34/ KM-KM/2022..

**Informed Consent:** Written informed consent was obtained from all participants

## References

1. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: International Diabetes Federation; 2021. https://www.diabetesatlas.org
2. Rizvi AA. Nutritional challenges in the elderly with diabetes. *Int J Diabetes Mellit*. 2009;1(1):26–31. https://www.sciencedirect.com/ science/article/pii/ S1877593409000162

3. Mathur P, Leburu S, Kulothungan V. Prevalence, awareness, treatment and control of diabetes in India from the countrywide National NCD Monitoring Survey (NNMS). *Front Public Health*. 2022;205. https://www.frontiersin.org/articles/10.3389/fpubh.2022.748157/pdf
4. Demir S, Nawroth PP, Herzig S, Üstünel BE. Emerging targets in type 2 diabetes and diabetic complications. *Adv Sci*. 2021;8(18):2100275. https://onlinelibrary.wiley.com/doi/ abs/10.1002/advs.202100275
5. Pinchevsky Y, Butkow N, Raal FJ, Chirwa T, Rothberg A. Demographic and clinical factors associated with development of type 2 diabetes: a review of the literature. *Int J Gen Med*. 2020;13:121. https://www.ncbi.nlm.nih.gov/ pmc/articles/PMC7127847/
6. Galicia-Garcia U, Benito-Vicente A, Jebari S, Larrea-Sebal A, Siddiqi H, Uribe KB, Ostolaza H, Martín C. Pathophysiology of type 2 diabetes mellitus. *Int J Mol Sci*. 2020;21(17):6275. https://www.mdpi.com/812208
7. Chester B, Babu JR, Greene MW, Geetha T. The effects of popular diets on type 2 diabetes management. *Diabetes Metab Res Rev*. 2019;35(8):e3188. https://onlinelibrary.wiley.com/ doi/abs/10.1002/dmrr.3188
8. Sharma M, Kishore A, Roy D, Joshi K. A comparison of the Indian diet with the EAT-Lancet reference diet. *BMC Public Health*. 2020;20(1):1–13. https://link.springer.com/ article/10.1186/s12889-020-08951-8
9. Vasconcelos C, Almeida A, Cabral M, Ramos E, Mendes R. The impact of a community-based food education program on nutrition-related knowledge in middle-aged and older patients with type 2 diabetes: results of a pilot randomized controlled trial. *Int J Environ Res Public Health*. 2019;16(13):2403. https://www.mdpi.com/492332
10. National Health and Nutrition Examination Survey. Anthropometry procedure manual. Centers for Disease Control and Prevention; 2007. https://stacks.cdc.gov/view/cdc/50334
11. Sultana S, Lina NN, Hasan MT, Ferdaus MJ, Dash BK, Ahmad T. Dietary diversity and associated health status of newly diagnosed type 2 diabetic patients in Jashore region of Bangladesh. *Curr Res Nutr Food Sci J*. 2020;8(2):438–453. https://www.foodandnutritionjournal.org/volume8number2/dietary-diversity-and-associated-health-status-of-newly- diagnosed-type-2-diabetic-patients-in-jashore-region-of-bangladesh/
12. World Health Organization. Classification of diabetes mellitus. 2019. https://apps.who.int/iris/bitstream/handle/ 10665/325182/9789241515702-eng.pdf
13. Food and Agriculture Organization. Dietary assessment: a resource guide to method selection and application in low resource settings. 2018. https://openknowledge.fao.org/server/api/core/bitstreams/ 3dc75cfc-9128-4f29-9d76-8d1f792078f0/content
14. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: International Diabetes Federation; 2021. https://www.diabetesatlas.org
15. Mohan V, Spiegelman D, Sudha V, Gayathri R, Hong B, Praseena K, et al. Effect of a low glycaemic index diet on weight and glycaemic control in Asian Indians with type 2 diabetes: a randomized controlled trial. *Br J Nutr*. 2014;111(6):1004–12. https://journals.lww.com/ijmr/Abstract/2007/25030/ Epidemiology_of_type_2_diabetes__Indian_scenario.4.aspx
16. Barik A, Mazumdar S, Chowdhury A, Rai RK. Physiological and behavioral risk factors of type 2 diabetes mellitus in rural India. *BMJ Open Diabetes Res Care*. 2016;4(1):e000255. https://drc.bmj.com/content/4/1/e000255.short
17. Alberti KGMM, Zimmet P, Shaw J. The metabolic syndrome—a new worldwide definition. *Lancet*. 2005;366(9491):1059–62. https://pubmed.ncbi.nlm.nih.gov/16182882/
18. International Diabetes Federation. The IDF consensus worldwide definition of the metabolic syndrome. Brussels: International Diabetes Federation; 2005. https://pubmed.ncbi.nlm.nih.gov/16681555/
19. Indian Council of Medical Research, National Institute of Nutrition. *Recommended Dietary Allowances (RDA) and Estimated Average Requirements (EAR) for Indians*. Hyderabad: ICMR-NIN; 2020. https://www.nin.res.in/RDA_Full_Report_2024.html
20. National Academies of Sciences, Engineering, and Medicine. *Dietary reference intakes: the essential guide to nutrient requirements*. Washington (DC): National Academies Press; 2006. https://www.nationalacademies.org/ projects/HMD-FNB-18-P-120/publication/11537
21. Dietary patterns and their association with glycemic control among individuals with type 2 diabetes in India. *J Assoc Physicians India*. 2014;62(8):697–702. https://pmc.ncbi.nlm.nih.gov/articles/PMC10344585/
22. Implications of dietary adherence in patients with type 2 diabetes mellitus. *Diabetes Care*. 2002;25(8):1450–1456.
23. Jayasekara H, et al. Diet adherence and factors associated with nonadherence among patients with type 2 diabetes in Tamil Nadu, India. *Int J Acad Med*.

2023;9(1):25–30. doi:10.4103/ijam.ijam_10_22 https://www.researchgate.net/publication/369339821_Diet_ adherence_and_factors_associated_with_nonadherence_among_ Type_2_diabetics_at_an_urban_health_center_in_Tamil_Nadu_India

24. Pourhabibi N, Mohebbi B, Sadeghi R, Shakibazadeh E, Sanjari M, Tol A, Yaseri M. Determinants of poor treatment adherence among patients with type 2 diabetes and limited health literacy: a scoping review. *J Diabetes Res*. 2022;2022:2980250. doi:10.1155/2022/2980250 https://pubmed.ncbi.nlm.nih.gov/35832786/

25. Zhou Z, Liu J. Association between body roundness index and incidence of type 2 diabetes in a population-based cohort study. *Sci Rep*. 2025;15:13186. doi:10.1038/s41598-025-92652-y https://www.nature.com/articles/s41598-025-92652-y

26. Lavero-Valero M, Escalada-San Martín J, Martínez-González MA, Basterra-Gortari FJ, de la Fuente-Arrillaga C, Bes-Rastrollo M. Ultra-processed foods and type-2 diabetes risk in the SUN project: A prospective cohort study. Clin Nutr. 2021;40(5):2817-2824. https://www.sciencedirect.com/science/article/pii/S0261561421001862

27. Dixit JV, Kulkarni RS, Badgujar SY. Diabetes care in India: a descriptive study. Indian J Endocrinol Metab. 2021;25(4):342. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8793955/

**Original Article**

*DOI: https://doi.org/10.37506/xshm8s52*

# Morbidity Profile and Health Service Utilisation at a 24-hour Transit Point Mini Hospital and Two First Aid Camps during Gangasagar Mela, Kolkata (9-17 January 2026): A Retrospective Public Health Analysis

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**How to cite this article**: Kausik Kumar Sarangi, Shilpi Sen, Rama Bhunia. Morbidity Profile and Health Service Utilisation at a 24-hour Transit Point Mini Hospital and Two First-Aid Camps during Gangasagar Mela, Kolkata (9-17 January 2026): A Retrospective Public Health Analysis. Indian Journal of Public Health Research and Development/ Vol. 17 No. 3, July-September 2026.

## Abstract

**Background:** Mass gatherings generate sudden, time-limited surges in demand for primary care, triage, emergency referral, and public health surveillance.[1,2] Transit point facilities are strategically important but remain underreported in the Indian mass-gathering literature.[7,10] This study assessed morbidity profile, service Utilisation, and operational outcomes at a 24-hour transit point mini hospital and two first-aid camps during Gangasagar Mela 2026.

**Methods:** A retrospective descriptive observational study was conducted using routinely maintained OPD, emergency, observation, and referral registers from Outram Ghat, Kolkata, for 9-17 January 2026. All eligible patient encounters were included by complete enumeration. Duplicate and incomplete records were excluded. Data were summarized using frequencies and percentages. Chi-square testing, one-way ANOVA, and quadratic trend modelling were used for selected comparisons.

**Results:** A total of 6,480 patients were managed, including 6,472 OPD visits and 8 observation cases. Peak OPD attendance occurred on 12 January 2026 (n=1,037). The leading categories were bodyache (n=1,498, 23.1%), acidity/ dyspepsia (n=955, 14.8%), fever (n=895, 13.8%), common cold (n=654, 10.1%), cough (n=577, 8.9%), and loose motion (n=542, 8.4%). Male patients constituted 62.6% of all patients managed. Referral rate was low (8/6480, 0.12%). Morbidity distribution varied significantly across days (chi-square=798.4, df=96, $p<0.001$).

**Conclusion:** The transit point mini hospital and first-aid camps absorbed a high outpatient burden dominated by self-limiting musculoskeletal, gastrointestinal, febrile, and respiratory complaints, while maintaining safe referral for high-acuity events. The findings support the role of decentralised transit point medical systems, syndromic surveillance, and preventive preparedness in mass-gathering health management.[1,2,11]

**Keywords:** Mass gatherings; Gangasagar Mela; Public health surveillance; Morbidity; Emergency medical services; Disaster preparedness; Primary health care.

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**Submission date:** Apr 12, 2026 **Revision date:** May 30, 2026 **Published date:** June 29, 2026

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## Introduction

Mass gatherings bring together large numbers of people in a limited geographic area for a defined period and may exceed the routine planning and response capacity of local services.[1,2] Religious mass gatherings are particularly important from a public health perspective because they combine crowding, travel fatigue, variable food and water exposure, environmental stress, and increased demand for acute primary care.[3-5] These conditions may increase the risk of respiratory illness, gastrointestinal complaints, injuries, exacerbation of chronic diseases, and rare but high-acuity emergencies.[4,5,12]

Gangasagar Mela is among the major annual religious congregations in India and involves substantial pilgrim movement through Kolkata transit points before onward travel to Sagar Island.[10] Health systems deployed at such transit points serve two functions: immediate treatment of minor illnesses and early recognition of serious conditions requiring referral.[1,2,11] Published literature on mass gatherings in India, including Kumbh Mela and Gangasagar Mela, has highlighted the need for organized medical preparedness and surveillance.[7,10] However, evidence on day-wise morbidity trends and service Utilisation from transit point mini hospitals remains limited.[6,9]

The research gap is therefore operational as well as epidemiological. While tertiary-level preparedness and event-site arrangements are commonly discussed, transit point healthcare utilization is less frequently quantified.[6,9,10] Understanding the pattern of common complaints, daily patient-load variation, referral needs, and sex distribution can help public health planners optimize staffing, medicine logistics, triage points, and preventive messaging for future events.[1,2,11] This study was conducted to assess morbidity profile, daily service Utilisation, statistical trends, and public health implications of a 24-hour transit point mini hospital and two first-aid camps at Outram Ghat, Kolkata, during Gangasagar Mela 2026.

## Materials and Methods

### Study design

This was a retrospective descriptive observational study based on routinely maintained service records.

### Study setting and duration

The study was conducted at a 24-hour transit-point mini hospital and two first-aid camps established at Outram Ghat, Kolkata, during Gangasagar Mela 2026. The study period was 9 January 2026 to 17 January 2026.

### Study population

The study population included all pilgrims, staff, volunteers, and visitors who attended any of the three health service points during the study period for consultation, treatment, observation, emergency care, or referral.

### Inclusion and exclusion criteria

Inclusion criteria were all patient encounters recorded in OPD, emergency, observation, and referral registers during 9-17 January 2026. Exclusion criteria were duplicate entries, illegible entries, and records with insufficient information for classification.

### Sampling technique

Complete enumeration sampling was used. All eligible records during the study period were included; no sample selection was performed.

### Data source and data collection procedure

Data were obtained from official OPD registers, first aid camps registers, emergency intervention records, observation records, and referral logs maintained during the deployment. The extracted variables included date of attendance, total OPD count, sex distribution, presenting morbidity/service category, observation, oxygen use, Trop T/ECG use, and referral status. The dataset was compiled in spreadsheet format and checked for internal consistency using daily totals.

### Administrative permission and ethical consideration

The analysis used anonymized and aggregated operational health-service data collected during a public health deployment. No names, addresses, registration numbers, or personal identifiers were used. Administrative permission was obtained from the concerned authority for use of service statistics. As the study involved retrospective analysis of anonymized programmatic data without patient contact or intervention, formal institutional

ethics committee approval was not required. The manuscript maintains confidentiality and presents only aggregated results.

**Statistical analysis**

Data were analyzed using spreadsheet-based tabulation and SPSS-equivalent statistical procedures. Frequencies, percentages, ratios, and trend graphs were prepared. The denominator for OPD morbidity percentages was 6,472; the denominator for sex distribution was the total managed population of 6,480. Chi-square testing was used to assess variation in distribution of major syndromic categories across study days. One-way ANOVA assessed variation in daily OPD load across operational phases (early: 9-11 January; peak: 12-15 January; late: 16-17 January). A p-value below 0.05 was considered statistically significant.

## Results

During the nine-day study period, 6,480 patients were managed, comprising 6,472 OPD visits and 8 observation cases. Daily OPD attendance ranged from 353 to 1,037, with the highest load on 12 January 2026. The overall referral rate was 0.12% (8 referrals), indicating that most conditions were managed on-site.

**Table 1. Day-wise OPD attendance and selected service outcomes during Gangasagar Mela transit point health operations, 9-17 January 2026**

| Date | OPD | Refer out | Oxygen | ECG | Trop T | Observation notes |
|---|---|---|---|---|---|---|
| 09-Jan-2026 | 377 | 0 | 0 | 0 | 0 | Included in total where applicable |
| 10-Jan-2026 | 591 | 1 | 0 | 0 | 1 | Included in total where applicable |
| 11-Jan-2026 | 968 | 3 | 2 | 0 | 0 | Included in total where applicable |
| 12-Jan-2026 | 1037 | 1 | 0 | 0 | 2 | Included in total where applicable |
| 13-Jan-2026 | 763 | 0 | 0 | 0 | 0 | Included in total where applicable |
| 14-Jan-2026 | 936 | 0 | 0 | 0 | 0 | Included in total where applicable |
| 15-Jan-2026 | 831 | 1 | 0 | 1 | 1 | Included in total where applicable |
| 16-Jan-2026 | 616 | 1 | 0 | 0 | 0 | Included in total where applicable |
| 17-Jan-2026 | 353 | 1 | 1 | 0 | 0 | Included in total where applicable |

**Table 2. Aggregate morbidity and service category distribution (denominator: OPD=6,472)**

| Category | Total | Percent of OPD | Rank |
|---|---|---|---|
| Bodyache | 1498 | 23.15 | 1 |
| Acidity | 955 | 14.76 | 2 |
| Fever | 895 | 13.83 | 3 |
| Common cold | 654 | 10.11 | 4 |
| Cough | 577 | 8.92 | 5 |
| Loose motion | 542 | 8.38 | 6 |
| Weakness | 198 | 3.06 | 7 |
| Wound dressing | 145 | 2.24 | 8 |
| Headache | 126 | 1.95 | 9 |
| Vomiting | 110 | 1.70 | 10 |
| RBS check | 75 | 1.16 | 11 |
| RTI | 51 | 0.79 | 12 |
| Fungal infection | 39 | 0.60 | 13 |
| Hypertension/BP check | 38 | 0.59 | 14 |
| Redness of eye | 29 | 0.45 | 15 |
| Abdominal pain | 13 | 0.20 | 16 |

Continue.....

| | | | |
|---|---|---|---|
| Diarrhoea | 8 | 0.12 | 17 |
| Refer out | 8 | 0.12 | 18 |
| Chest pain | 6 | 0.09 | 19 |
| FBS test | 6 | 0.09 | 20 |
| Scabies | 6 | 0.09 | 21 |
| Minor burn | 4 | 0.06 | 22 |
| Oxygen | 3 | 0.05 | 23 |
| Dog bite | 2 | 0.03 | 24 |
| ECG | 1 | 0.02 | 25 |
| Cardiac arrest/CPR | 1 | 0.02 | 26 |

**Table 3. Day-wise distribution of major morbidity categories**

| Date | Fever | Bodyache | Acidity | Cough | Common cold | Loose motion | RTI |
|---|---|---|---|---|---|---|---|
| 09-Jan-2026 | 61 | 126 | 61 | 39 | 48 | 20 | 0 |
| 10-Jan-2026 | 67 | 184 | 107 | 63 | 25 | 45 | 8 |
| 11-Jan-2026 | 183 | 215 | 64 | 20 | 111 | 85 | 4 |
| 12-Jan-2026 | 128 | 286 | 195 | 20 | 106 | 83 | 16 |
| 13-Jan-2026 | 79 | 167 | 135 | 46 | 67 | 74 | 36 |
| 14-Jan-2026 | 130 | 166 | 173 | 108 | 108 | 82 | 5 |
| 15-Jan-2026 | 163 | 167 | 117 | 126 | 82 | 72 | 0 |
| 16-Jan-2026 | 84 | 129 | 90 | 79 | 58 | 65 | 0 |
| 17-Jan-2026 | 33 | 58 | 53 | 47 | 49 | 21 | 11 |

**Table 4. Sex distribution of total patients managed (N=6,480)**

| Sex | Number | Percent | Basic inference |
|---|---|---|---|
| Male | 4058 | 62.62 | Male:female ratio 1.67:1 |
| Female | 2422 | 37.38 | |

**Table 5. Statistical analysis summary**

| Analysis | Variable compared | Test statistic | df | Interpretation |
|---|---|---|---|---|
| Day-wise syndrome distribution | Day x major morbidity category | Chi-square=798.4 | 96 | p<0.001; significant heterogeneity across days |
| Sex distribution | Male vs female compared with equal distribution | Chi-square=413.04 | 1 | p<0.001; significant male predominance |
| Operational phase comparison | Daily OPD load across early, peak and late phases | F=2.87 | 2,6 | p=0.134; phase-wise variation not statistically significant |
| Trend modelling | Quadratic model for daily OPD attendance | R-squared=0.850 | - | Modelled peak near day 4 |

The chi-square test showed statistically significant variation in the distribution of major morbidity categories across days (chi-square=798.4, df=96, p<0.001; Cramer's V=0.130). Sex distribution was significantly different from an equal distribution (chi-square=413.04, df=1, p<0.001), with male patients comprising 62.62% of the total managed population. Quadratic trend modelling showed a curvilinear

attendance pattern with a peak around the middle of the deployment period (R-squared=0.850).

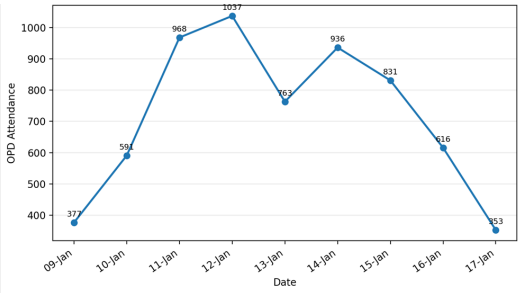



**Figure 1. Daily OPD trend showing surge and decline pattern.**

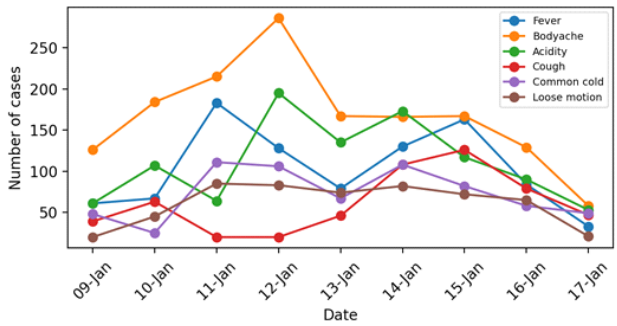



**Figure 2. Daily trends of six leading morbidity categories.**

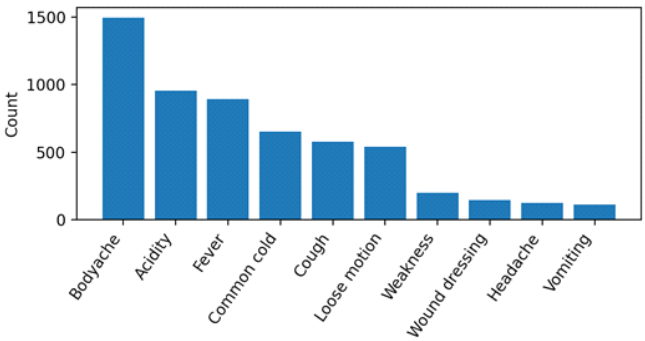



**Figure 3. Aggregate distribution of leading morbidities.**

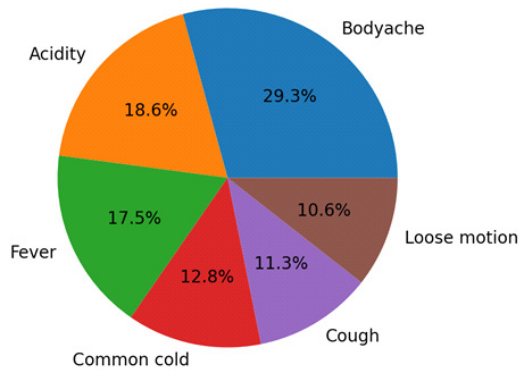



**Figure 4. Proportional share of the six leading morbidity categories.**

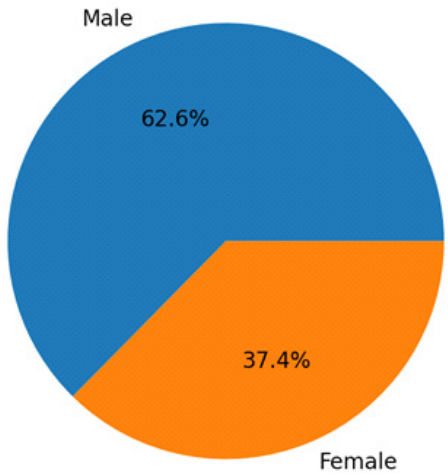



**Figure 5. Sex distribution of total patients managed.**

## Discussion

This study describes the morbidity profile and service Utilisation pattern at a 24-hour transit-point mini hospital and two first-aid camps during Gangasagar Mela 2026. The analysis demonstrates that the majority of consultations were for minor, self-limiting conditions that could be managed effectively at the transit point. The pattern was dominated by musculoskeletal complaints, gastrointestinal symptoms, febrile illness, and respiratory complaints. This profile is consistent with the expected morbidity pattern of religious mass gatherings, where prolonged travel, crowd density, altered diet, cold exposure, and physical exertion influence healthcare demand.[1,3,7,10]

Musculoskeletal symptoms, particularly bodyache, constituted the largest category. Similar observations have been described in reports from Kumbh Mela and other large gatherings, where walking long distances, carrying luggage, prolonged standing, sleep deprivation, and travel-related fatigue generate a high burden of body pain and generalized aches.[7,8] This finding is operationally important because analgesics, topical preparations, rest areas, and counselling on hydration and pacing of travel should be included in essential logistics for future deployments.[1,11]

Gastrointestinal complaints such as acidity, loose motion, and vomiting formed a substantial proportion of presentations. This is comparable to mass-gathering literature emphasizing the role of irregular meals, spicy or unfamiliar food, dehydration, and

sanitation challenges in generating gastrointestinal morbidity.[4,5,10] The finding supports the need for safe drinking water points, food-safety inspection, hand hygiene promotion, ORS availability, and syndromic surveillance for clustering of diarrhoeal illness.[1,2,11]

Respiratory complaints, including common cold, cough, and RTI, were also prominent. International experience from Hajj and other mass gatherings has repeatedly shown that crowding, close contact, variable temperature, and travel from different geographic areas facilitate respiratory symptom clusters.[3-5] Although most respiratory presentations in the present study were mild, their frequency supports health education on cough etiquette, mask use for symptomatic pilgrims, early reporting of fever with respiratory symptoms, and designated triage spaces when feasible.[1,2]

The peak attendance on 12 January reflects the surge nature of healthcare demand during mass gatherings. Similar temporal variation has been reported in large events, where patient load rises with peak movement days and declines thereafter.[6,7,9] Such information is useful for dynamic deployment of medical officers, nurses, volunteers, medicines, oxygen, transport linkage, and waste management services. Static staffing throughout the event may either underprepare peak days or overdeploy during low-demand periods.[1,11]

The referral rate in this study was low (0.12%), suggesting that the transit point model effectively absorbed the primary-care burden and prevented unnecessary crowding of higher centres. At the same time, emergency readiness remained essential, as the facility recorded chest pain cases, oxygen use, Trop T/ECG testing, and one cardiac arrest/CPR event. This demonstrates that mass-gathering clinics must combine primary-care capacity with basic emergency preparedness and rapid referral pathways.[1,2,11,12]

The male predominance observed in this study may reflect sex differences in travel patterns, mobility, pilgrim composition, and healthcare-seeking behaviour at transit points. Similar sex differences have been noted in field-based service Utilisation studies in crowded travel settings.[7,10] For future planning, however, gender-sensitive arrangements remain important, including privacy for women, adequate toilets, menstrual hygiene support, and safe access to medical services.[2,11]

Overall, the findings are aligned with global and Indian evidence that mass-gathering healthcare demand is largely driven by ambulatory primary-care conditions, with a smaller but critical requirement for emergency triage and referral.[1,3,7-10] The study contributes a transit point perspective, which is less frequently documented than event-site or hospital-based perspectives. It highlights the need to integrate public health surveillance, primary care, emergency response, sanitation, and logistics planning into one operational framework.[1,2,11]

**Preventive and Public Health Recommendations**

- Strengthen daily syndromic surveillance for fever, respiratory symptoms, diarrhoeal illness, injuries, and heat/cold exposure.[1,2,11]
- Ensure safe drinking water, ORS distribution, handwashing points, food hygiene monitoring, and toilet sanitation.[1,2,5,11]
- Pre-position analgesics, antacids, ORS, respiratory medicines, wound-care materials, oxygen, resuscitation equipment, and referral forms.[1,11]
- Use surge staffing on predicted peak days based on pilgrim movement and prior attendance trends.[6,7,9,11]
- Maintain rapid ambulance linkage and written referral criteria for chest pain, severe breathlessness, altered sensorium, collapse, suspected stroke, severe dehydration, and trauma.[1,11,12]
- Provide pilgrim-facing messages on hydration, safe food, cough etiquette, layered clothing, rest, and early reporting of warning symptoms.[1,2,5]
- Ensure gender-sensitive arrangements including privacy, female-friendly sanitation, and safe access for women and elderly pilgrims.[2,11]

**Limitations**

This study has limitations. It was retrospective and depended on routine service records, which may contain minor recording inconsistencies. The data were aggregated, and detailed age-wise distribution, residence, comorbidity profile, and laboratory

confirmation were not available for all cases. Some syndromic categories may overlap because a single patient can present with more than one symptom. Despite these limitations, the study provides useful operational evidence from a large religious mass-gathering transit point and can inform future planning.

## Conclusion

The 24-hour transit point mini hospital and two first-aid camps at Outram Ghat managed 6,480 patients during Gangasagar Mela 2026, with morbidity dominated by minor musculoskeletal, gastrointestinal, febrile, and respiratory conditions. The low referral rate indicates effective on-site management, while documented emergency events underline the need for continuous emergency readiness. Future mass-gathering preparedness should prioritise decentralised primary care, syndromic surveillance, sanitation, surge staffing, and rapid referral systems.[1,2,11] The findings should be interpreted in view of the retrospective record-based design and limited demographic detail.

**Acknowledgements**

The authors would like to acknowledge the services and dedicated contribution of all 43 Volunteers of Casualty Service, Civil Defence, Kolkata, along with the support of the office staff and drivers involved in the field activities.

The authors express their sincere gratitude to Shri Sanjay Singh, IPS, Director General of Police and Director of Civil Defence, West Bengal, and Shri U. K. Naskar, IPS, Inspector General of Police and Controller of Civil Defence, West Bengal, for their valuable guidance and encouragement.

The authors are also grateful to Dr. Swapan Soren, Director of Health Services, Government of West Bengal, and Dr. Dipankar Maji, Director of Hospital Administration and Planning, Government of West Bengal, for their valuable support and guidance.

**Source of Funding:** No external funding was received for this study.

**Conflict of Interest:** The authors declare that there is no conflict of interest.

**Author Contributions:** All authors contributed to field operations, data compilation, analysis, interpretation, manuscript drafting, critical review, and approval of the final manuscript.

## References

1. World Health Organization. Managing health risks during mass gatherings. Geneva: World Health Organization; 2024.
2. World Health Organization. Public health for mass gatherings: key considerations. Geneva: World Health Organization; 2015.
3. Memish ZA, Stephens GM, Steffen R, Ahmed QA. Emergence of medicine for mass gatherings: lessons from the Hajj. Lancet Infect Dis. 2012;12(1):56-65.
4. Ahmed QA, Arabi YM, Memish ZA. Health risks at the Hajj. Lancet. 2006;367(9515):1008-1015.
5. Abubakar I, Gautret P, Brunette GW, Blumberg L, Johnson D, Poumerol G, et al. Global perspectives for prevention of infectious diseases associated with mass gatherings. Lancet Infect Dis. 2012;12(1):66-74.
6. Tam JS, Barbeschi M, Shapovalova N, Briand S, Memish ZA, Kieny MP. Research agenda for mass gatherings: a call to action. Lancet Infect Dis. 2012;12(3):231-239.
7. Cariappa MP, Singh BP, Mahen A. Kumbh Mela 2013: Healthcare for the millions. Med J Armed Forces India. 2015;71(3):278-281.
8. Arbon P. The development of conceptual models for mass-gathering health. Prehosp Disaster Med. 2004;19(3):208-212.
9. Arbon P. Mass-gathering medicine: a review of the evidence and future directions for research. Prehosp Disaster Med. 2007;22(2):131-135.
10. Chakraborty S, et al. Gangasagar Mela 2019: Evaluation of health care in the mass gathering. Med J DY Patil Vidyapeeth. 2020;13(3):250-254.
11. National Disaster Management Authority. Managing crowd at events and venues of mass gathering: a guide for state government, local authorities, administrators and organizers. New Delhi: Government of India; 2014.
12. Steffen R, Bouchama A, Johansson A, Dvorak J, Isla N, Smallwood C, et al. Non-communicable health risks during mass gatherings. Lancet Infect Dis. 2012;12(2):142-149.

**Original Article**

*DOI: https://doi.org/10.37506/4ebjb178*

# Public Perceptions of Robotic versus Laparoscopic Surgery in India: A Knowledge, Attitudes, and Perceptions (KAP) Survey

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**How to cite this article**: Sanika Bihani, Adarsh Keshari. Public Perceptions of Robotic versus Laparoscopic Surgery in India: A Knowledge, Attitudes, and Perceptions (KAP) Survey. Indian Journal of Public Health Research and Development/Vol. 17 No. 3, July-September 2026.

## Abstract

**Background:** Minimally invasive surgery (MIS) has transformed surgical care by reducing postoperative pain, complications, and recovery time. Laparoscopic surgery and robotic-assisted surgery (RAS) are the two principal MIS approaches; however, public understanding of their differences remains limited. This study assessed the knowledge, attitudes, and perceptions (KAP) of the Indian public toward laparoscopic and robotic surgery.

**Methods:** A cross-sectional, questionnaire-based survey was conducted among Indian adults (≥18 years) who were patients or caregivers involved in surgical decision-making. The survey instrument was adapted from a previously published questionnaire developed by Brar et al. (2024). The 20-item online survey assessed demographics, knowledge, perceptions of safety and cost, and surgical preferences. Healthcare professionals were excluded from participation. Data were analyzed using descriptive statistics.

**Results:** Forty-six respondents completed the survey (52.2% males; 47.8% females). Doctors were the primary source of information for laparoscopic (61.0%) and robotic surgery (43.5%). Most participants (60.9%) perceived both approaches as equally safe, while 28.3% believed robotic surgery offered better outcomes. Robotic surgery was perceived as more expensive by 80.4% of respondents. Mean trust scores were high for both techniques on a five-point Likert scale (laparoscopic: 4.26 ± 0.85; robotic: 4.08 ± 0.94). Surgical decisions were mainly influenced by physicians (60.9%), followed by self-education (32.6%).

**Conclusion:** Respondents demonstrated high awareness and trust in minimally invasive surgery. Both laparoscopic and robotic approaches were perceived as safe and effective; however, robotic surgery was viewed as more expensive. Surgical decision-making remained predominantly doctor-led, with an emerging trend toward patient self-education and shared decision-making.

**Keywords:** Robotic surgery; Laparoscopic surgery; Public perception; Minimally invasive surgery; Surgical decision-making;

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**Submission date:** January 27, 2026 **Revision date:** Feb 24, 2026 **Published date:** June 29, 2026

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## Introduction

Minimally invasive surgery (MIS) has revolutionized surgical care by offering clear advantages over open surgery, including reduced postoperative pain, fewer wound complications, shorter hospital stays, and faster recovery times [1].

Laparoscopic surgery is a minimally invasive surgical technique performed through small abdominal or body wall incisions using long, camera-guided instruments and specialized ports. A high-definition camera provides real-time visualization of internal structures, allowing surgeons to perform procedures with precision while minimizing tissue trauma compared with open surgery. Among MIS techniques, laparoscopic surgery and robotic-assisted surgery (RAS) are the two most widely practiced approaches. While both share similar advantages, key distinctions exist. Foundational work demonstrated the technical feasibility and potential advantages of robotic surgery [1]. Subsequent evidence and meta-analyses have shown that robotic-assisted surgery is generally comparable to laparoscopy for many procedures and may offer advantages in selected complex operations, particularly in terms of reduced blood loss, lower conversion rates, and improved surgeon ergonomics, although it is often associated with longer operative times and higher costs [2]. Robotic techniques have been particularly advantageous in complex procedures that require precise manipulation within confined anatomical spaces.

Despite these technological advances, studies in both Western and Asian populations indicate that public understanding of the differences between laparoscopic and robotic surgery remains limited, with misconceptions remaining common. Early literature reported confusion regarding the role of robotic systems in surgery [1], while more recent studies have shown that many individuals believe robotic systems operate autonomously or perceive robotic and laparoscopic procedures as equivalent, highlighting persistent gaps in surgical health literacy [3,4].

In the Indian context, adoption of robotic-assisted surgery has increased steadily over the past decade. Literature describes a growing presence of robotic systems across tertiary care centers, alongside challenges related to cost, access, specialized training requirements, and infrastructural constraints [5]. Despite this growth, robotic surgery continues to constitute a smaller proportion of procedures compared with laparoscopy [6]. Reports estimate that more than 300 robotic systems are installed nationwide, with over 60,000 robotic-assisted procedures performed annually [7–9].

Public acceptance of robotic-assisted surgery is influenced by multiple factors, including trust in technology, perceived safety, quality of clinician–patient communication, and patient e-health literacy [3,10]. However, data examining public-level understanding, attitudes, and decision-making related to laparoscopic and robotic surgery in the Indian population remain limited.

This study aims to assess public awareness and perceptions of laparoscopic and robotic surgery in India. It seeks to evaluate the prevalence of misconceptions, compare perceived safety and clinical outcomes, examine economic considerations, and identify key factors influencing surgical decision-making.

## Methodology

This cross-sectional study assessed public knowledge, attitudes, and perceptions (KAP) regarding laparoscopic and robotic surgery in India.

The survey instrument was adapted from a previously published questionnaire by Brar et al. (2024) titled *"Robotic Surgery: Public Perceptions and Current Misconceptions."*The adapted questionnaire underwent internal content validation by independent subject experts to ensure contextual relevance and clarity. A pilot test was conducted among five individuals representative of the target population to assess readability, comprehension, and completion time. Participants were informed that they could withdraw at any time by closing the survey. Data were analyzed using descriptive statistical methods. Participants were informed that they could withdraw at any time by closing the survey. Minor wording refinements were made based on feedback, and no structural changes were required.

The survey was administered online using Google Forms. Eligible participants were adults aged ≥18 years residing in India who had decision-making authority regarding surgical care for themselves or family members. Healthcare professionals were excluded to minimize professional bias.

Participation was voluntary, and no personally identifiable information was collected, ensuring anonymity and confidentiality. Participants were informed that they could withdraw at any time by closing the survey. Upon completion of the survey, participants were provided with an educational video explaining the key differences between laparoscopic and robotic surgery to promote informed understanding of both surgical approaches.

The questionnaire consisted of 20 items organized into four domains:

1. Demographic characteristics
2. Knowledge of laparoscopic and robotic surgery
3. Perceptions of safety, cost, and outcomes
4. Attitudes and preferences regarding surgical decision-making

Response formats included multiple-choice questions, binary (Yes/No) options, and five-point Likert scales (1 = very low to 5 = very high). Demographic variables collected included age, gender, education level, and role in surgical decision-making. Awareness was assessed based on prior exposure to laparoscopic or robotic surgery and sources of information such as physicians, media, and family members.

Attitude and perception domains explored participants' trust in each surgical approach, perceived safety, and preferences. An optional open-ended question allowed participants to describe their reasoning and information needs when choosing between laparoscopic and robotic surgery.

As this study involved an anonymous, voluntary, non-interventional online survey with no collection of personally identifiable information, formal institutional ethics committee approval was deemed not mandatory in accordance with commonly accepted guidelines for minimal-risk survey-based research. The study adhered to the ethical principles outlined in the Declaration of Helsinki and applicable national ethical guidance for anonymous questionnaire-based research. Electronic informed consent was obtained from all participants prior to survey initiation.

Participants were recruited using convenience sampling through WhatsApp and other social media platforms. Convenience sampling was selected due to the exploratory nature of the study. To prevent duplicate responses, each participant was permitted a single submission.

## Results

A total of 46 respondents completed the survey, and all responses were included in the final analysis.

### Participant Demographics

Table 1 presents the demographic characteristics of the study population. Of the 46 participants, 52.2% were males and 47.8% were females. Approximately half of the respondents were aged 46–60 years, followed by participants aged >60 years, those aged 31–45 years, and those aged 18–30 years, in descending order of frequency.

The sample comprised predominantly postgraduate-educated participants, followed by graduates, and a smaller proportion of participants who had completed school-level education only.

### Sources of Information

Table 2 summarizes respondents' sources of information regarding laparoscopic and robotic surgery.

For laparoscopic surgery, doctors were the predominant source of information (61.0%), followed by friends and family (19.5%), television/news media (12.2%), social media (4.9%), and workplace exposure (2.4%).

For robotic surgery, doctors remained the most common source (43.5%), though media platforms played a greater role, with 21.7% citing television/news media and 21.7% citing social media.

### Perceptions of Safety, Outcomes, and Cost

Participants' perceptions regarding the safety, outcomes, and cost differences between laparoscopic and robotic surgery are shown in Table 3.

A majority of respondents (60.9%) perceived both techniques as equally safe. When asked which technique produced better outcomes, 28.3% favored robotic surgery, 34.8% considered both approaches comparable, 34.8% were uncertain, and 2.2% favored laparoscopic surgery. Regarding cost, 80.4% identified robotic surgery as the more expensive option.

**Trust Ratings (Table 4)**

Participants rated their trust in laparoscopic and robotic surgery on a five-point Likert scale (1 = very low trust; 5 = very high trust).

Laparoscopic surgery achieved a mean trust score of 4.26 ± 0.85, while robotic surgery had a mean score of 4.08 ± 0.94, indicating a slightly higher level of trust in laparoscopy.

**Decision-Making Influences and Information Priorities (Table 5)**

Physician advice was the predominant influence on participants' surgical decision-making (60.9%), followed by self-education and personal judgment (32.6%). When asked about the major factor influencing surgical choice, 46.5% reported trust in the doctor's expertise, followed by shared or informed decision-making (23.3%) and surgeon reputation (9.3%).

Information priorities before choosing between laparoscopic and robotic surgery were primarily related to safety, risks, and complications (23.9%), followed by cost and financial considerations (21.7%) and procedure-related details (21.7%).

**Table 1. Background information**

| Frequency (n=46) | | % |
|---|---|---|
| **Gender** | | |
| Male | 24 | 52.2 |
| Female | 22 | 47.8 |
| $X^2$: 0.0212, p value: 0.88 | | |
| **Age** | | |
| 18–30 | 2 | 4.3 |
| 31–45 | 10 | 21.7 |
| 46–60 | 23 | 50.0 |
| >60 | 11 | 23.9 |
| $X^2$: 17.6, p value: < 0.001 | | |
| **Education level** | | |

**Table 2. Sources of information about laparoscopic and robotic surgery**

| Source | Laparoscopic Surgery | | Robotic surgery | |
|---|---|---|---|---|
| | n | % | n | % |
| Doctor | 25 | 61.0 | 20 | 43.5 |
| Friends/Family | 8 | 19.5 | 6 | 13.0 |
| News/TV | 5 | 12.2 | 10 | 21.7 |
| Social media | 2 | 4.9 | 10 | 21.7 |
| work | 1 | 2.4 | 0 | 0.0 |

**Table 3. Participants' perceptions of safety, outcomes, and cost**

| | Laparoscopic surgery | Robotic surgery | Both are almost same | Not sure | p value |
|---|---|---|---|---|---|
| Which of the two types of surgery do you think is safer for patients? | 6 (13.0%) | 2 (4.3%) | 28 (60.9%) | 10 (21.7%) | <0.0001 |
| Which of the two types of surgery do you think gives better results? | 1 (2.2%) | 13 (28.3%) | 16 (34.8%) | 16 (34.8%) | 0.004 |
| Which of the two types of surgery do you think costs more? | 1 (2.2%) | 37 (80.4%) | 3 (6.5%) | 5 (10.9%) | <0.0001 |
| If both options were available, which would you prefer for yourself or your family? | 14 (30.4%) | 10 (21.7%) | 15 (32.6%) | 8 (17.4%) | 0.43 |

**Table 4. Trust ratings for laparoscopic and robotic surgery**

| Trust rating | Laparoscopic surgery | Robotic surgery |
|---|---|---|
| 1 | 1 | 0 |
| 2 | 0 | 3 |
| 3 | 6 | 9 |
| 4 | 18 | 14 |
| 5 | 21 | 19 |
| Mean ± SD | 4.26 ± 0.85 | 4.08 ± 0.94 |
| t = 0.96, p value: 0.34 | | |

**Table 5. Determinants of surgical decision-making and information priorities**

| | n | % |
|---|---|---|
| **If you recently heard about Robotic technologies, what would you rely on most when deciding?** | | |
| Cost of surgery | 1 | 2.2 |
| Doctor's advice | 28 | 60.9 |
| Family's opinion | 1 | 2.2 |
| My own judgment after reading/learning | 15 | 32.6 |
| Along with doctor advice will also read myself | 1 | 2.2 |
| **Reason for Choice of the surgery** | | |
| Trust in doctor's expertise and advice | 20 | 46.5 |
| Shared or informed decision-making (doctor + self-study + multiple opinions) | 10 | 23.3 |
| Dependence on illness or case-specific factors | 3 | 7.0 |
| Awareness, technology, and self-education | 3 | 7.0 |
| Trust and confidence in the surgeon | 4 | 9.3 |
| Cost | 1 | 2.3 |
| Professional / healthcare background | 2 | 4.7 |
| **What kind of information would you like to know before choosing between robotic and laparoscopic surgery? *** | | |
| Cost & Financial Aspects | 10 | 21.7 |
| Safety, Risks & Complications | 11 | 23.9 |
| Recovery & Healing | 7 | 15.2 |
| Success Rate & Outcomes | 9 | 19.6 |
| Procedure Details & Differences | 10 | 21.7 |
| Surgeon Expertise & Experience | 5 | 10.9 |
| Case-specific Information / Appropriateness | 5 | 10.9 |
| Availability & Access | 2 | 4.3 |
| General / Other / Everything | 7 | 15.2 |

*Multiple responses

## Discussion

As surgical technology continues to advance more rapidly than public understanding, bridging the gap between innovation and perception remains important. This cross-sectional KAP study provides an exploratory overview of how members of the Indian public perceive and differentiate between laparoscopic and robotic surgery, two key modalities of minimally invasive surgery (MIS). Overall, participants expressed high levels of trust in both techniques, identified doctors as their primary source of surgical information, and demonstrated openness toward technological innovation. However, the relatively high educational background of respondents in this sample may have influenced awareness levels and perceptions, and these findings should therefore be interpreted cautiously when considering the broader and more diverse Indian population.Persistent uncertainty regarding safety, cost, and the role of robotic systems suggests that public understanding has not fully kept pace with clinical adoption.

In this study, doctors were the most frequently cited source of information for both laparoscopic (61.0%) and robotic surgery (43.5%). This finding underscores the central role of clinicians in shaping patient understanding when newer surgical technologies are introduced. For robotic surgery in particular, a substantial proportion of respondents reported obtaining information from television, news media, or social media platforms. While these channels can increase awareness, they also carry a recognized risk of misinformation. Systematic reviews have reported that a significant proportion of health-related content disseminated through digital platforms contains inaccuracies or misleading claims [11,12]. Consequently, information acquired through such sources may not reliably translate into accurate understanding and may contribute to unrealistic expectations regarding surgical outcomes.

A majority of respondents (60.9%) perceived laparoscopic and robotic surgery to be equally safe, suggesting that both approaches are broadly recognized as minimally invasive techniques with comparable risk profiles. However, the findings indicate that gaps in understanding persist, particularly with respect to robotic surgery. This tendency to associate newer technology with improved outcomes reflects a broader pattern of "technology optimism," which has been described in technology adoption frameworks such as the Technology Acceptance Model (TAM) [13]. Evidence indicates that robotic surgery does not consistently outperform laparoscopy across all procedures, with benefits often limited to selected complex operations [2].

Cost emerged as a prominent differentiating factor, with 80.4% of participants perceiving robotic surgery as more expensive. This perception is consistent with literature documenting the higher capital, maintenance, and operational costs associated with robotic platforms [14]. In the Indian context, where affordability strongly influences treatment decisions, cost-related concerns may act as a practical barrier to wider public acceptance of robotic surgery, despite perceived technological advantages.

Trust ratings for both surgical approaches were high, with slightly higher mean trust scores for laparoscopy compared with robotic surgery. This difference may reflect the longer history, greater familiarity, and wider availability of laparoscopic surgery within Indian healthcare settings. Laparoscopy has been routinely practiced for decades, allowing patients to draw on personal or community experiences, which may reinforce confidence. In contrast, robotic surgery remains less accessible, limiting firsthand exposure and familiarity among patients.

The present findings are broadly consistent with prior work by Brar et al. (2024), who reported moderate-to-high comfort levels with robotic surgery and identified cost and limited understanding as key concerns [15]. Participants in the current study demonstrated trust in minimally invasive techniques while simultaneously expressing uncertainty regarding robotic technology. The reliance on digital media for initial exposure to robotic surgery further highlights the growing influence of non-clinical information sources on patient perceptions.

Decision-making remained predominantly doctor-led, with 60.9% of respondents indicating that they would rely primarily on their physician's advice when considering robotic surgery. This finding aligns with data showing that doctors remain the most trusted source of health information in India [4]. At the same time, some participants reported engaging in self-education or shared decision-making, suggesting a gradual shift towards participatory models of care. This evolving dynamic highlights the importance of ensuring that patients have access to accurate, balanced, and comprehensible information when evaluating surgical options.

When asked about information priorities, respondents most frequently cited safety, risks, and complications, followed by cost considerations and procedural details. This emphasis indicates that patients prioritize outcome-oriented information over purely technological attributes. The importance placed on surgeon expertise is consistent with existing evidence demonstrating that patient trust is often more closely linked to confidence in the surgeon than to the technology itself [3].

These findings suggest that while Indian patients appear receptive to surgical innovation, their preferences are shaped by perceived safety, affordability, and trust in medical professionals. Efforts to address knowledge gaps should therefore focus on strengthening clinician patient communication, promoting responsible digital health literacy, and ensuring transparent discussions around the benefits, limitations, and costs of emerging surgical technologies.

Looking ahead, emerging technologies such as artificial intelligence (AI)–assisted surgical planning, intraoperative decision support systems, and augmented reality–guided procedures are expected to further transform minimally invasive surgery. As these technologies become increasingly integrated into clinical workflows, public perceptions of surgical innovation will likely evolve alongside them. Understanding patient trust, technology acceptance, and expectations will therefore remain essential to ensuring informed consent and patient-centered adoption of future surgical platforms [16].

**Limitations & Future Recommendations**

This study has several limitations. The small sample size and use of convenience sampling limit generalizability and introduce potential selection and digital access bias, particularly given the relatively high educational level of respondents. As participation required internet access, the findings may not fully represent the broader and socioeconomically diverse Indian population.

Responses were based on self-reported perceptions rather than actual surgical experiences and may be subject to recall or social desirability bias. Additionally, socioeconomic and geographic factors influencing access to robotic surgery were not directly assessed.

Larger, multicentre studies involving more diverse populations are needed to better understand public perceptions of minimally invasive surgical technologies in India.Future large-scale studies exploring regional, socioeconomic, and digital literacy variations will be important to guide patient education strategies and policy development.

## Conclusion

This study demonstrates that while public awareness of laparoscopic and robotic surgery in India is considerable, notable knowledge gaps persist. Doctors remain the most trusted source of surgical information; however, the growing influence of digital and mass media highlights the need for accurate and reliable public communication. Although both approaches are widely perceived as safe and effective, robotic surgery is frequently associated with higher costs and limited accessibility, which may contribute to its comparatively lower acceptance.

Surgical decision-making remains predominantly doctor-led, but an emerging trend toward patient self-education suggests a shift toward shared decision-making. Targeted patient education and transparent clinician communication are essential to align expectations with clinical realities.

**Acknowledgements:** The authors sincerely thank all participants for their valuable time and contribution to this study. The authors also gratefully acknowledge the support of the APAR Health SPARK (Student Program for Advancement in Research and Knowledge) program.

**Funding Sources:** None

**Ethical Clearance:** All procedures followed were in accordance with the ethical standards of the institutional and/or national research committees and with the Helsinki Declaration and the ICMR National Ethical Guidelines for Biomedical and Health Research.

**Ethics Approval:** Ethical approval was not required for this study, as it was a questionnaire-based survey conducted anonymously, without the collection of identifiable personal data and with voluntary participation.

**Declaration of conflicts of interest statement:** Authors declare no conflict of interests.

## References

1. Lanfranco AR, Castellanos AE, Desai JP, Meyers WC. Robotic surgery: a current perspective. Ann Surg. 2004 Jan;239(1):14-21. doi: 10.1097/01.sla.0000103020.19595.7d. PMID: 14685095; PMCID: PMC1356187.
2. Lai TJ, Roxburgh C, Boyd KA, Bouttell J. Clinical effectiveness of robotic versus laparoscopic and open surgery: an overview of systematic reviews. BMJ Open. 2024 Sep 16;14(9):e076750. doi: 10.1136/bmjopen-2023-076750. PMID: 39284694; PMCID: PMC11409398.
3. Chan KS, Kwan JR, Shelat VG. Awareness, perception, knowledge, and attitude toward robotic surgery in a general surgical outpatient clinic in Singapore, Asia. J Clin Transl Res. 2022 May 25;8(3):224-233. PMID: 35813899; PMCID: PMC9260340.
4. Al Dihan FA, Alghamdi MA, Aldihan FA, Alamer NM, Alshahrani FA, Alqarni A. Knowledge, Attitude, Awareness, and Future Expectations of Robotic Surgery in Patients Attending Surgical Specialties Clinics. Cureus. 2024 Mar 20;16(3):e56523. doi: 10.7759/cureus.56523. PMID: 38646294; PMCID: PMC11027023.
5. Maza G, Sharma A. Past, Present, and Future of Robotic Surgery. Otolaryngol Clin North Am. 2020 Dec;53(6):935-941. doi: 10.1016/j.otc.2020.07.005. Epub 2020 Aug 21. PMID: 32838968.
6. Reddy K, Gharde P, Tayade H, Patil M, Reddy LS, Surya D. Advancements in Robotic Surgery: A Comprehensive Overview of Current Utilizations

and Upcoming Frontiers. Cureus. 2023 Dec 12;15(12):e50415. doi: 10.7759/cureus.50415. PMID: 38222213; PMCID: PMC10784205.

7. Medical Buyer. Over 60,000 robotic-assisted surgeries performed in India annually. Medical Buyer [Internet]. 2024 Sep 27 [cited 2026 Jan 20]. Available from: medicalbuyer.co.in
8. Rojas Burbano, J. C., Ruiz, N. I., Rojas Burbano, G. A., Guacho Inca, J. S., Arragan Lezama, C. A., & González, M. S. (2025). Robot-Assisted Surgery: Current Applications and Future Trends in General Surgery. *Cureus*, *17*(4), e82318. https://doi.org/10.7759/cureus.82318
9. Sharma M. Indigenous & affordable: How robotic-assisted surgeries are finding takers in smaller Indian cities. ThePrint [Internet]. 2024 Aug 28 [cited 2026 Jan 20]. Available from: theprint.in
10. Hesse, Bradford & Nelson, David & Kreps, Gary & Croyle, Robert & Arora, Neeraj & Rimer, Barbara & Viswanath, Kasisomayajula. (2005). Trust and Sources of Health Information: The Impact of the Internet and Its Implications for Health Care Providers: Findings From the First Health Information National Trends Survey. Archives of internal medicine. 165. 2618-24. 10.1001/archinte.165.22.2618.
11. Borges do Nascimento, I. J., Pizarro, A. B., Almeida, J. M., Azzopardi-Muscat, N., Gonçalves, M. A., Björklund, M., & Novillo-Ortiz, D. (2022). Infodemics and health misinformation: a systematic review of reviews. *Bulletin of the World Health Organization*, *100*(9), 544–561. https://doi.org/10.2471/BLT.21.287654
12. Infodemics and misinformation negatively affect people's health behaviours [Internet]. Copenhagen: WHO Regional Office for Europe; 2022 [cited 2025 Dec 21]. Available from:https://www.who.int/europe/news/item/ 01-09-2022-infodemics-and-misinformation-negatively-affect-people-s- health-behaviours--new-who-review-finds
13. Davis, Fred & Davis, Fred. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. MIS Quarterly. 13. 319-. 10.2307/249008.
14. Ielpo B, Podda M, Burdio F, Sanchez-Velazquez P, Guerrero MA, Nuñez J, Toledano M, Morales-Conde S, Mayol J, Lopez-Cano M, Espín-Basany E, Pellino G; ROBOCOSTES Study Collaborators. Cost-Effectiveness of Robotic vs. Laparoscopic Surgery for Different Surgical Procedures: Protocol for a Prospective, Multicentric Study (ROBOCOSTES). Front Surg. 2022 May 6;9:866041. doi: 10.3389/fsurg.2022.866041. PMID: 36227017; PMCID: PMC9549953.
15. Brar G, Xu S, Anwar M, Talajia K, Ramesh N, Arshad SR. Robotic surgery: public perceptions and current misconceptions. J Robot Surg. 2024 Feb 22;18(1):84. doi: 10.1007/s11701-024-01837-6. PMID: 38386115; PMCID: PMC10884196.
16. Hashimoto DA, Rosman G, Rus D, Meireles OR. Artificial Intelligence in Surgery: Promises and Perils. Ann Surg. 2018 Jul;268(1):70-76. doi: 10.1097/SLA.0000000000002693. PMID: 29389679; PMCID: PMC5995666.

**Original Article**

*DOI: https://doi.org/10.37506/1qppph98*

# Time of Last Meal and its Association with Indices of Metabolic Health in Young Indian Adults

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**How to cite this article**: Sharvari Desai, Shobha A Udipi, Jagmeet Madan et. al. Time of Last Meal and its Association with Indices of Metabolic Health in Young Indian Adults. Indian Journal of Public Health Research and Development/Vol. 17 No. 3, July-September 2026.

## Abstract

**Background:** Chrono-nutrition explores the role of meal timing, frequency, and regularity in shaping metabolic health through circadian mechanisms. Evidence indicates that glucose metabolism, insulin secretion, and appetite regulation follow circadian rhythms and are influenced by the temporal distribution of energy intake. Late or evening-skewed eating patterns and circadian misalignment, common in modern lifestyles, are associated with poorer metabolic outcomes. This study examined the association between meal timing, percent body fat, blood glucose, and insulin levels in adolescents and young adults(16-25 years old).

**Methods:** Of 1,313 apparently adolescents and young adults screened, complete data were available for 1,015 participants after applying predefined exclusion criteria. Body composition was assessed using bioelectrical impedance, while fasting and 2-hour post-glucose blood samples were analysed for plasma glucose, insulin, and HbA1c using standard methods. Meal timing was recorded based on the last meal consumed the previous night, and data were analysed using SPSS 27 with $p<0.05$ considered statistically significant.

**Results:** Among the 1,015 participants, 42.6% were males and 57.4% females, with 41.2% aged 16–18 years and 58.8% aged 19–25 years. The mean time of the last meal was 20.57 ± 1.10 h, ranging from 17:00 to 23:30 h. Later meal timing was associated with significantly higher percent body fat, while muscle mass was significantly greater among those who consumed their last meal earlier. Participants in the earliest meal-timing quintile had significantly lower stimulated glucose, fasting and post-glucose insulin levels, and HOMA-IR compared with later

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**Submission date:** February 2, 2026 **Revision date:** February 24, 2026 **Published date:** June 29, 2026

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quintiles. Time of last meal showed positive correlations with percent body fat, glucose and insulin indices, and a negative correlation with muscle mass.

**Conclusion:** Late timing of the last meal was associated with higher insulin levels, increased adiposity, and poorer metabolic profiles among adolescents and young adults. These findings suggest that eating patterns misaligned with circadian rhythms may predispose metabolically healthy youth to future metabolic risk. Promoting earlier meal timing and appropriate redistribution of energy intake during waking hours may serve as a feasible strategy for metabolic health prevention.

**Keywords:** fasting, meal frequency, meal timing, obesity, cardiovascular health, diabetes

## Introduction

Chrono nutrition investigates the health impact of three different dimensions of feeding behaviour like the regularity of meals, frequency and timing of food intake[1]. There is a complex relationship between temporal eating patterns, circadian rhythms, and metabolic health and thus the metabolic health is influenced not just by the food we eat, but also by the timing, regularity, and energy distribution in the 24 h day and across days[2,3]. Meal timings have been found to play an important role in weight loss, regain and maintenance of body weight, as well as insulin resistance and appetite[4].

Glucose metabolism follows a circadian rhythm. Typically, glucose tolerance peaks during day-light hours when humans generally consume food, whereas fasting that occurs during the dark cycle or night time, results in lowering of blood glucose levels. Glucose, insulin and cortisol levels exhibit circadian rhythms which in turn greatly influences glucose metabolism[5,6]. Consequently, when some food or a meal is consumed at a time that is not in consonance with the central sensor - the suprachiasmatic nucleus and peripheral tissue[7], glucose metabolism is affected[8-10].

Many people are required to work at night due to occupational demands. Changing lifestyles have resulted in people keeping awake for long hours and eating at late hours during the night especially in cities[11] which results in their bodies to be out of alignment with the circadian clock, which in turn can have adverse consequences on metabolism[12,13].

Insulin release produces an anorexigenic signal which decreases food intake. Perturbations in insulin secretion and sensitivity could affect hunger and food intake. Several investigators[4,7,14-17] demonstrated that when a larger proportion of energy intake was consumed in the evening, metabolic control was poorer and was associated with weight gain. Eating earlier in the evening, or consuming the main meal around midday or a larger proportion of energy intake earlier have been associated with reduced appetite, weight loss and lower risk of overweight/obesity, glycemic control, better metabolic control[16, 18-20].

In this context, we analysed the data available for meal timings in relation to their percent body fat, blood glucose and insulin levels in adolescents and young adults.

## Method Materials

### Study Design and Sample Selection

This was a cross –sectional study conducted on adolescents and young males and females(16-25 years of age), who were attending various academic institutions in Mumbai city. A total of 1313 young adults had volunteered to undergo screening. However, complete data was available for 1015 persons.

The inclusion criteria were: apparently healthy individuals in the age group of 16-25 years. The exclusion criteria included presence of any known chronic disease, on any specific diet plan, on prescribed medications like steroids, pregnancy and/ or lactation.

Ethical Considerations: The study was approved by the Intersystem Biomedical Ethics Committee, Mumbai, India (ISBEC version 2 dated 12$^{th}$ Aug, 2017) and conducted according to Good Clinical Practices and the Declaration of Helsinki. Informed written consent was taken from each participant and each guardian/parent for participants who were between 16 and 18 years of age.

### Measurements

Each participant first underwent a clinical examination by a physician to assess the general health status. Body composition was measured using the TANITA body composition analyser (Model MC 780 MA).Each measurement was taken thrice and the average was calculated.

**Biological Samples, Collection, Storage and Biochemical Measurements**

Participants were asked to report to the laboratory after fasting overnight for at least 12 hours. Venous blood (10ml) was collected in fasting state and four mlof blood was collected 2 hrs post 75 gms glucose by a trained phlebotomist. Two ml of fasting blood sample was immediately transferred to a BD vacutainer (spray-coated K2EDTA Tubes) for complete blood count (CBC) and HbA1c, two ml of fasting and post glucose blood sample was immediately transferred to a BD vacutainer (spray-coated sodium fluoride Tubes) for estimation of plasma glucose levels. The remaining six ml of fasting blood and 2 ml of post glucose blood were transferred into plain BD vacutainer for separation of serum. The vacutainers were kept in a closed ice box, and transported to the Institute's laboratory. Fluoride and plain vacutainers were centrifuged, fluoride plasma was processed for estimation of plasma glucose levels and serum was processed for insulin levels. The remaining fasting serum was divided into aliquots and stored at -70$^0$C until further analyses.

Glucose tolerance test (fasting and 2-h post 75-g glucose administration) was conducted for all participants. Glucose was measured by the GOD POD method (Accurex Biomedical Pvt Ltd) and insulin was measured by radioimmunoassay using a Beckman Coulter Counter. Glycosylated haemoglobin was measured using Nycocard reader (Alere Technologies, Norway). Among the 1313 participants in the screening exercise prior to the intervention, data on glycosylated haemoglobin levels was available for 673 participants. Participants were said to have dysglycemia, if their fasting glucose levels were between 100-125mg/dL (5.6-6.9 mmol/L) and 2-hour post-glucose value 140-199 mg/dL (7.8-11.0 mmol/L)[21]. Hyperinsulinemia was defined as fasting hyperinsulinemia (≥ 15 mIU/ml) or glucose challenge hyperinsulinemia (≥ 80m IU/ml)[22,23].

**Meal timings:** Prior to collection of the blood sample, each participant was asked to write down the time of her/his last meal on the previous evening or night and they were told to follow their regular time for dinner and not alter the time.

**Statistics:** Descriptive data of participants are reported as means±SD and 95% confidence interval (CI) for continuous variables. Tests applied were Student's 2-tailed t-test and Pearson's Chi Square analysis. Analysis of variance and post-hoc Bonferroni were used for comparison of quintiles. The analysis was performed using STATA(14.2). A p-value <0.05 was set to determine statistically significant differences.

## Results

**Sample Profile:** Among the 1015 participants, 42.6% (n=432) were males and 57.4% (n=583) were females wherein, 41.2% (n=418) were in age group of 16 to 18 years and the remaining 58.8% (n=597) were in the age group of 19 to 25 years. The mean for the time of eating last meal was 20.57±1.10hrs with the earliest time of eating dinner was 17.0 hrs i.e. 5.00pm and latest time of eating the meal was 23.50 hrs i.e. 11.50pm (Figure 1). Among male participants, the mean for last meal was 20.3 pm (SD 1.07, Min-Max-17.00-23.50 hrs, Median 20.50pm), whereas in female participants the mean time for last meal was 20.8 pm (SD 1.07, Min-Max: 17.00-23.5 hours, Median: 21.00pm) with no statistically significant difference. Age and sex of the participant did not show significant difference in time of last meal.

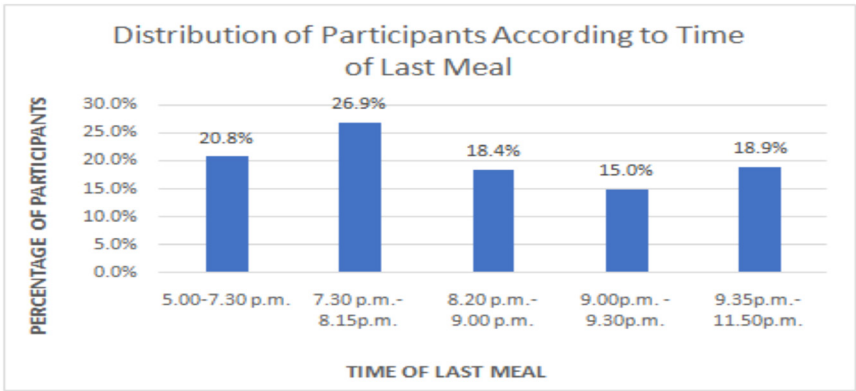



**FIGURE 1: OVERALL DISTRIBUTION OF TIME OF EATING LAST MEAL IN ADOLESCENTS AND YOUNG ADULTS**

*Time of Last Meal, Anthropometric indices and Biochemical measurements:* Significant differences were observed for percent body fat and muscle mass. Percent body fat was significantly higher in participants who ate their last meal later and conversely mean muscle mass was significantly higher in those who ate their last meal earlier as compared to those who ate dinner later. Mean muscle mass of persons in Q1 was approximately 3 kg more than those in Q3 and about 4 to 5 kg more as compared to Q4 and Q5, respectively. When Q1and Q2 were compared, mean muscle mass in Q1 was about 2 kg more than in Q2, although this difference between the two quintiles was not significant (Table 1).

**Table 1: Comparison of Percent Body Fat, Between Quintiles of Time of Consumption of Last Meal**

| Measurement | Quintiles of Time of Last Meal Consumed | | | | | F, p |
|---|---|---|---|---|---|---|
| | Q1 (17.00-19.45) n=211 | Q2 (19.46-20.30) n=273 | Q3 (20.31-21.00) n=187 | Q4 (21.01-21.30) n=152 | Q5 (21.31-23.48) n=192 | |
| % Body fat | 22.0±9.2 | 23.2±9.5 | 26.5±8.6 | 26.2±8.0 | 26.7±7.40 | 12.639, 0.000 |
| Visceral fat | 4.3±3.4 | 4.0±3.4 | 4.2±3.3 | 3.5±2.7 | 3.9±3.1 | 1.622, 0.167 |
| Muscle mass | 42.2±8.8 | 40.3±8.4 | 39.0±8.7 | 36.9±7.9 | 37.9±8.7 | 9.525, 0.000 |

[1] Mean± SD

p <.0.05 was considered significant.

p values based on the ANOVAtest

*Fasting and Stimulated Glucose, Insulin and HbA1c*: Significant differences in the blood glucose and insulin levels were observed between the quintiles of time of consuming the last meal (Table 2). Those who ate earlier had significantly lower mean stimulated glucose levels than those who ate later, although the difference between Q1 and Q2was not significant.

**Table 2: Comparison of Fasting and stimulated blood glucose and insulin, glycosylated haemoglobin between quintiles of time of Consumption of last meal**

| Measurement | Quintiles of Time of Last Meal Consumed | | | | | P value |
|---|---|---|---|---|---|---|
| | Q1 (17.00 to19.45) n=211 | Q2 (19.46 to 20.30) n=273 | Q3 (20.31 to 21.00) n=187 | Q4 (21.01 to21.30) n=152 | Q5 (21.31-23.48) n=192 | |
| Fasting sugar | 80.2±7.7 | 81.4±14.5 | 80.8±9.4 | 82.2±9.5 | 81.6±9.5 | 0.469 |
| 2- hour blood sugar | 87.7±19.2 | 93.5±33.6 | 95.9±20.9 | 96.7±21.7 | 92.9±27.1 | 0.006 |
| Fasting Insulin | 7.8±4.5 | 8.0±4.5 | 8.7±4.1 | 8.9±5.7 | 9.5±8.8 | 0.015 |
| 2-hour insulin | 62.9±51.1 | 72.9±63.5 | 73.5±47.9 | 83.8±66.2 | 73.5±57.1 | 0.022 |
| HbA1c | 5.4±0.5 | 5.4±0.7 | 5.5±0.5 | 5.5±0.5 | 5.4±0.5 | 0.626 |
| HOMA IR | 1.56±1.00 | 1.61±1.07 | 1.72±0.94 | 1.80±1.23 | 1.95±2.03 | 0.019 |

[0.0191] Mean±sd

p <.0.05 was considered significant.

p values based on the ANOVAtest

Similarly, mean 2-hour blood glucose (F=3.611, p=0.006), fasting insulin (F=2.925, p=0.020), stimulated (2-hour) insulin levels (F=3.845, p=0.004) and HOMA IR (F=2.960, p=0.019) in Q1 were significantly lower than in the higher quintiles.

In all five quintiles, a small percentage of persons had fasting glucose levels above the normal range, (Q1-1.2%, Q2-1.5%, Q3-3.1%, Q4-2.1% and Q5-2.0%), with no significant difference between the quintiles ($\chi^2$= 2.985, p=0.394). Similarly, a small percentage of participants had higher than normal levels of blood glucose, 2 hours after consuming 75g of glucose and there was no significant difference between the quintiles ($\chi^2$= 1.767, p=0.622) [Q1-1.5%, Q2-2.5%, Q3-3.1%, Q4-2.1% and Q5-2.3%]. Similar trends were observed for fasting insulin, with no significant difference between the quintiles ($\chi^2$= 5.300, p=0.151), although the percentage of participants with higher-than-normal post glucose, 2-hour insulin was significantly lower in Quintile 1 ($\chi^2$= 9.524, p=0.023) than in the higher quintiles. In Q1, 24.4% of the participants had higher stimulated insulin levels compared to 30.4% in Q2, 35.8% in Q3, 30.7% in Q4 and 30% in Q5, clearly indicating that those who consumed their last meal after 7.45 pm had higher stimulated insulin levels.

Table 3 showed that percent body fat, 2-hr blood sugar, fasting insulin, stimulated insulin and HOMA IR were significantly and positively correlated with time of last meal with later times of eating the meal associated with higher levels of these markers. Also, muscle mass showed a significant negative correlation with time of last meal (Table 3).

**Table 3: Correlation Of Time of Last Meal with Body Composition and Biochemical Measurements**

| Measurements | Time of Last meal | |
|---|---|---|
| | r | P |
| % Body Fat | 0.174** | 0.000 |
| Visceral Fat | -0.053 | 0.117 |
| Muscles Mass | -0.175** | 0.000 |
| Fasting Blood sugar | 0.034 | 0.283 |
| 2-hour blood sugar | 0.068* | 0.031 |
| Fasting Insulin | 0.094** | 0.003 |
| Stimulated Insulin | 0.069* | 0.029 |
| HbA1c | -0.021 | 0.674 |
| HOMA IR | 0.086** | 0.000 |

*Pearson's Correlation,

p <.0.05 was considered significant.

## Discussion

The present study examined the association between timing of the last meal and markers related to metabolic syndrome in a large sample of adolescents and young adults. The findings demonstrate that later timing of the last meal is significantly associated with higher adiposity, reduced muscle mass, and adverse glucose–insulin dynamics, even in a relatively young population with a low prevalence of overt hyperglycaemia. These results highlight meal timing as an important behavioural determinant of early metabolic risk.

Humans are diurnal species with their food consumption and physical activity mostly occurring during the active phase of the 24-hour cycle and in line with the light-dark cycle, although the metabolic interactions can be influenced and altered by epigenetic mechanisms [24].In the present study we observed that more than 50% of the participants ate dinner only after 8.00pm among which 18.9% of the participants had their last meal after 10.00 pm.In a NHANES study involving 15,341 adults from the 2009 to 2014 cycle, the average dinner time was 6:24 p.m., with the average time of the last eating episode being 8:18 p.m[25].However, in urban cities like Mumbai, the extended commuting times, long and inflexible working hours, and a high prevalence of service-sector and shift-based employment delay the return to home, thereby postponing the main evening meal. Further, changes in lifestyle, work patterns and work timings, have led to changes in eating patterns, such that portion sizes/meals are larger than before, the selection of foods veers towards high energy, high fat and/or high sugar and sodium containing foods. It has also been observed that a greater proportion of total daily energy consumption occurs in the late evening or night [26] which could result in circadian misalignment with adverse influence on adiposity as well as (or ill-effects) insulin, glucose control and metabolic health, as well as a substantial increase in the risk of cardiovascular disease [27-32].

One of the key findings of this study is the significant increase in percent body fat with progressively later consumption of the last meal. Participants in the later quintiles (Q3–Q5) had markedly higher body fat percentages compared to those who consumed their last meal earlier (Q1–Q2). Conversely, muscle

mass showed a significant inverse association with meal timing, with individuals in the earliest quintile (by 7.00 pm) having approximately 3–5 kg higher muscle mass compared to those eating after 9:30 pm. These observations are consistent with the concept of circadian regulation of metabolism, wherein nutrient intake aligned with the biological day promotes more efficient substrate utilisation, while late-night eating favours lipogenesis and impairs fat oxidation[33]. Reduced muscle mass among late eaters may reflect prolonged postprandial inactivity, altered hormonal milieu (including suppressed growth hormone secretion), and impaired muscle protein synthesis during late evening hours[34,35]. Importantly, these associations were evident despite no significant differences in visceral fat, suggesting that overall adiposity and lean mass distribution may be more sensitive early markers of metabolic dysregulation in young populations.

While fasting glucose levels did not differ significantly across quintiles, significant differences were observed for stimulated (2-hour) glucose, fasting insulin, stimulated insulin, and HOMA-IR. Participants consuming their last meal earlier exhibited lower post-load glucose and insulin responses, indicating better insulin sensitivity. The progressive rise in fasting insulin, stimulated insulin, and HOMA-IR across later quintiles suggests compensatory hyperinsulinemia, a recognised precursor to insulin resistance and metabolic syndrome.

HbA1c reflects long-term glycaemic exposure and may remain within the normal range despite early metabolic impairments detectable through postprandial measures. This underscores the importance of stimulated glucose and insulin measurements as sensitive indicators of early metabolic risk in adolescents and young adults. Although the prevalence of impaired fasting glucose and impaired glucose tolerance was low and did not differ significantly between quintiles, a clear gradient was observed for elevated stimulated insulin levels. The significantly lower proportion of participants with hyperinsulinaemia in the earliest quintile, compared to those eating after 7:45 pm, reinforces the role of late-night eating in increasing insulin demand. Chronic exposure to such hyperinsulinaemic states may accelerate β-cell stress and progression towards metabolic syndrome over time[36].

Correlation analyses further strengthen the findings, demonstrating significant positive associations between time of last meal and percent body fat, 2-hour glucose, fasting insulin, stimulated insulin, and HOMA-IR. The negative correlation with muscle mass highlights the dual impact of late eating on both adiposity and lean tissue. Together, these findings suggest that meal timing influences multiple components of metabolic health, even in the absence of clinically overt disease.

Late-night food consumption may disrupt the synchrony between peripheral metabolic clocks and the central circadian pacemaker located in the suprachiasmatic nucleus[37]. Peripheral clocks in metabolically active tissues such as the liver, adipose tissue, pancreas, and skeletal muscle are highly responsive to feeding cues[38]. When food intake occurs late in the evening or night, these peripheral clocks may become misaligned with the central circadian rhythm, which is primarily entrained by the light–dark cycle. Such circadian misalignment has been shown to impair insulin signalling pathways, reduce glucose tolerance, and promote compensatory hyperinsulinemia[39]. Over time, this metabolic inefficiency may favour increased fat storage and reduced lipid oxidation, contributing to higher adiposity[39]. The observed association between later timing of the last meal, increased body fat, and elevated insulin resistance in the present study supports the hypothesis that meal timing plays a critical role in maintaining circadian–metabolic alignment, even in young and otherwise healthy individuals. Given the cultural trend towards late dinners, particularly in urban Indian settings, these findings have important public health implications. Encouraging earlier dinner timing may represent a simple, low-cost strategy to improve metabolic health among adolescents and young adults.

The strengths of this study include the large sample size, objective assessment of body composition, and comprehensive evaluation of glucose–insulin dynamics. However, the cross-sectional design limits causal inference. The primary objective of the study was to examine the association between meal timing, particularly the last meal

of the day, and early metabolic risk markers. Emerging evidence from chrononutrition research indicates that evening and late-night eating has a disproportionate impact on glucose metabolism, insulin sensitivity, and circadian alignment compared to other meals[40]. Therefore, the timing of the last meal was selected as a pragmatic and biologically relevant marker of eating rhythm. While overall dietary patterns are important, they were beyond the scope of the present analysis. Additionally, dietary composition, physical activity patterns, sleep duration, and chronotype were not accounted for, all of which may interact with meal timing to influence metabolic outcomes. Future longitudinal and intervention studies are needed to confirm causality and explore mechanisms.

In conclusion, later consumption of the last meal is associated with higher body fat, lower muscle mass, impaired postprandial glucose handling, and increased insulin resistance in adolescents and young adults. These findings emphasise the importance of not only what and how much is eaten, but also *when* food is consumed, in the early prevention of metabolic syndrome.

**Funding Sources** *:* This paper is from the data collected for the screening done for a clinical trial which were supported by Almonds Board of California.

**Ethical Clearance:** The study was approved by the Intersystem Biomedical Ethics Committee, Mumbai, India (ISBEC version 2 dated 12th Aug, 2017)

**Declaration of conflicts of interest statement:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## References

1. Codoñer-Franch P, Gombert M, Martínez-Raga J, Cenit MC. Circadian Disruption and Mental Health: The Chronotherapeutic Potential of Microbiome-Based and Dietary Strategies. Int. J. Mol. Sci. 2023; 24:7579. doi: 10.3390/ijms24087579.
2. Katsi V, Papakonstantinou IP, Soulaidopoulos S, Katsiki N, Tsioufis K. Chrononutrition in Cardiometabolic Health. J. Clin. Med. 2022, 11, 296.
3. Almoosawi S, Vingeliene S, Gachon F, Voortman T, Palla L, Johnston JD, Van Dam RM, Darimont C, Karagounis LG. Chronotype: Implications for Epidemiologic Studies on Chrono-Nutrition and Cardiometabolic Health. Adv. Nutr. 2019, 10, 30–42.
4. Garaulet M, Gomez-Abellan P. Timing of food intake and obesity: a novel association. Physiol Behav. 2014; 134:44–50.
5. Czeisler CA, Klerman EB. Circadian and sleep-dependent regulation of hormone release in humans. Recent Prog Horm Res. 1999; 54:97-130.
6. Froy O. The relationship between nutrition and circadian rhythms in mammals. Frontiers in neuroendocrinology. 2007; 28. 61-71. 10.1016/j.yfrne.2007.03.001.
7. Bandín C, Scheer FA, Luque AJ, Ávila-Gandía V, Zamora S, Madrid JA, Gómez-Abellán P, Garaulet M. Meal timing affects glucose tolerance, substrate oxidation and circadian-related variables: A randomized, crossover trial. Int J Obes (Lond). 2015; 39(5):828-33. doi: 10.1038/ijo.2014.182.
8. Johnston JD. Physiological responses to food intake throughout the day. Nutr. Res. Rev. 2014; 27:107–118.
9. Oike H, Oishi K, Kobori, M. Nutrients, clock genes, and chrononutrition. Curr. Nutr. Rep.2014;3:204–212.
10. Wehrens SMT, Christou S, Isherwood C, Middleton B, Gibbs MA, Archer SN, Skene DJ, Johnston JD. Meal Timing Regulates the Human Circadian System. Curr Biol. 2017; 27(12):1768-1775.e3. doi: 10.1016/j.cub.2017.04.059.
11. Wong PM, Hasler BP, Kamarck TW, Muldoon MF, Manuck SB. Social jetlag, chronotype, and cardiometabolic risk. J. Clin. Endocrinol. Metab. 2015; 100: 4612–4620.
12. Scheer FA, Hilton MF, Mantzoros CS, Shea SA. Adverse metabolic and cardiovascular consequences of circadian misalignment. Proc. Natl Acad. Sci. USA. 2009; 106: 4453–4458.
13. Qian J, Scheer FA. Circadian system and glucose metabolism: implications for physiology and disease. Trends Endocrinol. Metab. 2016; 27:282–293.
14. Hibi M, Masumoto A, Naito Y, Kiuchi K, Yoshimoto Y, Matsumoto M, Katashima M, Oka J, Ikemoto S. Nighttime Snacking Reduces Whole Body Fat Oxidation and Increases LDL Cholesterol in Healthy YoungWomen. Am. J. Physiol. Regul.Integr. Comp. Physiol. 2013; 304, R94–R101.
15. De Castro JM. The Time of Day of Food Intake Influences Overall Intake in Humans. J. Nutr. 2004; 134: 104–111.

16. Wang JB, Patterson RE, Ang A, Emond JA, Shetty N, Arab L. 101. Timing of energy intake during the day is associated with the risk of obesity in adults. J Hum Nutr Diet. 2014;27(suppl 2):255–262. doi: 10.1111/jhn.12141.

17. McHill AW, Phillips AJ, Czeisler CA, Keating L, Yee K, Barger LK, Garaulet M, Scheer FA, Klerman EB. Later Circadian Timing of Food Intake Is Associated with Increased Body Fat. Am. J. Clin. Nutr. 2017; 106, 1213–1219.

18. Garaulet M, Gomez-Abellan P, Alburquerque-Bejar JJ, Lee YC, Ordovas JM, Scheer FA. Timing of food intake predicts weight loss effectiveness. Int J Obes. 2013; 37:604–11. doi: 10.1038/ijo.2012.229.

19. Jakubowicz D, Wainstein J, Ahren B, Bar-Dayan Y, Landau Z, Rabinovitz HR, et al. High-energy breakfast with low-energy dinner decreases overall daily hyperglycaemia in type 2 diabetic patients: a randomised clinical trial. Diabetologia. 2015; 58:912–9. doi: 10.1007/s00125-015-3524-9

20. Beaulieu K, Oustric P, Alkahtani S, Alhussain M, Pedersen H, Quist JS, Færch K, Finlayson G. Impact of Meal Timing and Chronotype on Food Reward and Appetite Control in Young Adults. Nutrients. 2020; 12: 1506.

21. American Diabetes Association; Standards of Medical Care in Diabetes—2019 Abridged for Primary Care Providers. Clin Diabetes. 2019; 37 (1): 11–34.

22. Shringi M, Vaidya RA, Vaidya AB. Insulin resistance in polycystic ovarian syndrome: a study of 90 patients. J Endocrinol Metab. 2003; 1:19–23.

23. Sujith KR, Kiran RH. A cross-sectional study of fasting and post prandial insulin level as a predictor of insulin resistance with hyperinsulinemia with HOMA-IR >2.5 among overweight and obese prepubertal children in a tertiary care Hospital of Bangalore, India. Int J Contemporary Pediatrics. 2018; 5:1382–7. 10.18203/2349-3291.ijcp20182532

24. Pickel L, Sung HK. Feeding Rhythms and the Circadian Regulation of Metabolism. Front Nutr. 2020; 7:39. doi: 10.3389/fnut.2020.00039.

25. Kant A.K., Graubard B.I. 40-year trends in meal and snack eating behaviors of American adults. J. Acad. Nutr. Diet. 2015;115:50–63. doi: 10.1016/j.jand.2014.06.354.

26. Leung GKW, Huggins CE, Bonham MP. Effect of meal timing on postprandial glucose responses to a low glycemic index meal: A crossover trial in healthy volunteers. Clin Nutr. 2019; 38(1):465-471. doi: 10.1016/j.clnu.2017.11.010.

27. Adnan D, Trinh J, Bishehsari F. Inconsistent eating time is associated with obesity: A prospective study. EXCLI J. 2022; 21:300-306. doi: 10.17179/excli2021-4324.

28. Panda S. Circadian physiology of metabolism. Science. 2016;354(6315):1008-1015.

29. Chaix A, Lin T, Le HD, Chang MW, Panda S. Time-restricted feeding prevents obesity and metabolic syndrome in mice lacking a circadian clock. Cell Metab. 2019;29(2):303-319.e4.

30. Parr EB, Devlin BL, Radford BE, Hawley JA. A delayed morning and earlier evening time-restricted feeding protocol for improving glycemic control and dietary adherence in men with overweight/obesity: a randomized controlled trial. Nutrients. 2020;12(2):505.

31. Jamshed H, Beyl RA, Della Manna DL, Yang ES, Ravussin E, Peterson CM. Early time-restricted feeding improves 24-hour glucose levels and affects markers of the circadian clock, aging, and autophagy in humans. Nutrients. 2019;11(6):1234.

32. Moro T, Tinsley G, Bianco A, Marcolin G, Pacelli QF, Battaglia G, Palma A, Gentil P, Neri M, Paoli A. Effects of eight weeks of time-restricted feeding (16/8) on basal metabolism, maximal strength, body composition, inflammation, and cardiovascular risk factors in resistance-trained males. J Transl Med. 2016;14(1):290. doi: 10.1186/s12967-016-1044-0. PMID: 27737674; PMCID: PMC5064803.

33. Alum EU. Circadian nutrition and obesity: timing as a nutritional strategy. J Health PopulNutr. 2025;44(1):367. doi: 10.1186/s41043-025-01102-y. PMID: 41107910; PMCID: PMC12535013.

34. Livelo C, Guo Y, Melkani GC. A Skeletal Muscle-Centric View on Time-Restricted Feeding and Obesity under Various Metabolic Challenges in Humans and Animals. Int J Mol Sci. 2022;24(1):422. doi: 10.3390/ijms24010422. PMID: 36613864; PMCID: PMC9820735.

35. Morrison M, Halson SL, Weakley J, Hawley JA. Sleep, circadian biology and skeletal muscle interactions: Implications for metabolic health. Sleep Medicine Reviews. 2022; 66:101700. https://doi.org/10.1016/j.smrv.2022.101700.

36. Hudish LI, Reusch JE, Sussel L. β Cell dysfunction during progression of metabolic syndrome to type 2 diabetes. J Clin Invest. 2019 Oct 1;129(10):4001-4008. doi: 10.1172/JCI129188. PMID: 31424428; PMCID: PMC6763241.

37. Meléndez-Fernández OH, Liu JA, Nelson RJ. Circadian Rhythms Disrupted by Light at Night and Mistimed Food Intake Alter Hormonal Rhythms and Metabolism. Int J Mol Sci. 2023 Feb 8;24(4):3392. doi: 10.3390/ijms24043392. PMID: 36834801; PMCID: PMC9963929.

38. Hunter AL, Bechtold DA. The metabolic significance of peripheral tissue clocks. Commun Biol. 2025 Mar 26;8(1):497. doi: 10.1038/s42003-025-07932-0. PMID: 40140664; PMCID: PMC11947457.

39. Morris CJ, Yang JN, Garcia JI, Myers S, Bozzi I, Wang W, Buxton OM, Shea SA, Scheer FA. Endogenous circadian system and circadian misalignment impact glucose tolerance via separate mechanisms in humans. Proc Natl Acad Sci USA. 2015;112(17): E2225-34. doi: 10.1073/pnas.1418955112. Epub 2015 Apr 13. PMID: 25870289; PMCID: PMC4418873.

40. Reytor-González C, Simancas-Racines D, Román-Galeano NM, Annunziata G, Galasso M, Zambrano-Villacres R, Verde L, Muscogiuri G, Frias-Toral E, Barrea L. Chrononutrition and Energy Balance: How Meal Timing and Circadian Rhythms Shape Weight Regulation and Metabolic Health. Nutrients. 2025 Jun 27;17(13):2135. doi: 10.3390/nu17132135. PMID: 40647240; PMCID: PMC12252119.

**Original Article**

*DOI: https://doi.org/10.37506/p3yewg90*

# Hypochlorous Acid for Community Level Wound Management: A New Horizon in Public Health

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**How to cite this article**: Suad Sulaiman, Elfadil Osman, Bakri Nour, Mohamed Saud et. al. Hypochlorous Acid for Community Level Wound Management: A New Horizon in Public Health. Indian Journal of Public Health Research and Development/Vol. 17 No. 3, July-September 2026.

**Abstract**

**Background& Objectives**: Hypochlorous acid (HOCl) is a safe antimicrobi aleffective for wound care in areas burdened by chronic infections such as mycetoma. Its broad antimicrobial activity, biofilm disruption, and exceptional tissue compatibility make it well-suited for the long-term management of complex wounds. In mycetoma-endemic regions, HOCl offers a practical assistant for infection control and improved wound healing, providing a low-cost option for strengthening community-level care.

**Methods**: This preliminary field-based humanitarian effectiveness, observational study evaluated the topical application of HOCl on seven patients with mycetoma lesions in Wad Shigidi Village, Sudan. The HOCl intervention was adjunctive and topical, not systemic. Weekly field visits were conducted, and lesion responses were documented using photographic and clinical criteria.

**Results**: Patients demonstrated marked reductions in lesion size, discharge, and pain. No adverse effects were reported.

**Interpretation & Conclusions**: HOCl shows promise as a safe, low-cost topical agent for mycetoma and other wound care at the community level in humanitarian settings. Further studies are warranted.

**Keywords**: COMMUNITY MANAGEMENT, HYPOCHLOROUSACID, MYCETOMA, SUDAN, WOUNDS,

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**Submission date:** January 23, 2026 **Revision date:** February 24, 2026 **Published date:** June 29, 2026

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## Introduction

Mycetoma was first described in the mid-19th century in southern India[1]. The condition was later recognised in many areas of the tropical and subtropical world, with reports of cases from Chad, Ethiopia, India, Mauritania, Mexico, Senegal, Somalia, Sudan, Thailand, Venezuela, and Yemen. Although the causative organisms and their classifications have been characterised[2], the early clinical and pathological observations remain important today as laboratory diagnosis is still difficult and treatment options are limited [3].

Medical antimicrobial interventions often fail given the insusceptibility of the causal, slow-growing fungi and filamentous bacteria commonly associated with the condition, and the toxic side effects of long-term treatment with antifungal therapeutics. Clinical management is further complicated by patients' late presentation, at which point the disease is advanced enough in the disease process to allow these organisms and the granulomatous host responses to become well-entrenched in the nodular masses that characterise mycetomata[4].

The frequent occurrence of the disease in rural areas without ready access to primary healthcare facilities underlies all these complications in its management. The absence of any readily available countermeasures that could enable better patient home or even self-care has been identified as one of the major difficulties in reducing its impact in endemic areas[5], [6].

Hypochlorous acid (HOCl) solutions are proven to be powerfully antimicrobial, including having broad-spectrum antifungal efficacy [9]. When applied topically to a variety of infected lesions, there is compelling evidence that HOCl solutions also provide for enhanced healing, particularly important in the resolution of chronic wounds[7], [8]. Highly stabilised HOCl formulations provide a significant advantage in wound management because they remain chemically stable and do not degrade into harmful chlorine by-products. Many commercially available HOCl solutions lack adequate stabilisation, leading to the formation of hypochlorite and other chlorine species that are unsafe for human tissue and can impair healing. In contrast, properly stabilised HOCl maintains purity, avoids insoluble residues, and preserves extracellular matrix integrity while delivering potent antimicrobial and anti-inflammatory activity. Importantly, HOCl exhibits rapid, non-selective oxidative killing of microorganisms, giving it efficacy against drug-resistant bacteria and other pathogens without contributing to antimicrobial resistance. This residue-free, non-cytotoxic profile allows epithelial and granulation tissues to progress without chemical interference, making stabilised HOCl particularly suitable for chronic and complex wounds requiring frequent cleansing and long-term care [9].

Recent literature provides strong evidence supporting the healing potency of HOCl across chronic, infected, and complex wounds.A 2025 WHO Expert Committee review on the Essential Medicines List (EML) highlights HOCl as a safe, potent wound-cleansing agent with no toxicity to mammalian cells, noting strong evidence for improved healing in diabetic foot wounds and moderate evidence for septic surgical wounds. The same review emphasises that HOCl accelerates tissue restoration and supports the time wound-care framework through antimicrobial action, biofilm disruption, and excellent tissue compatibility[10]. Clinical evidence from an uncontrolled study in India demonstrates HOCl's practical healing impact: all patients with chronic open wounds achieved complete healing within 8–15 weeks using stabilised HOCl for routine wound cleansing[11].

Here, we report observations following topical application of stabilised HOCl to mycetoma lesions in a series of 7 patients in the Gezira area of Sudan. In this study, HOCl was applied only as a topical adjunct to local wound care; no systemic administration was used or intended. Our observations and the patients suggest that there may be beneficial effects worthy of expanded study, given the urgency of present-day needs for improved care options for similar conditions.

## Material & Methods

*Date of study*: This study was conducted from January to early April, immediately preceding the outbreak of conflict on 14 April 2023. During this period, Sudan faced a weakened economy, ongoing political tension following the 2021 military takeover,

frequent public demonstrations, and widespread shortages of electricity, fuel, health services, and essential goods. Despite these challenges, the population did not anticipate a full-scale war, and daily life in many areas remained relatively calm.

*Study location*: All patients were residents in Wad Shigidi Village on the eastern bank of the Blue Nile, a population of 12,000. This rural site was selected because of the frequency of cases reported to the Mycetoma Centre, Wad Madani[12]. Most people in this village are engaged in farming and livestock management (Personal communication). The ongoing violence caused by the civil war complicated the serial evaluation of patient responses by caregivers from the University of El Gezira and the provincial Health Ministry.

*Aim of the study:* The research team, composed of staff from the University of El Gezira and the State Ministry of Health, held a meeting with the village leader, school-teachers, and community members to explain the study and the use of HOCl disinfectant for wounds in patients. The possible benefits of the product were described, emphasising that it had not previously been used in mycetoma patients in Sudan or elsewhere. The HOCl solution was to be applied as a potentially broad-acting disinfectant in One Health-based initiatives targeting wound infection management and antibiotic resistance mitigation in the local environment.

*Patient selection:* Candidates were identified based on their clinical presentation, history, and the limited availability of alternative therapeutic options under the prevailing conflict conditions. None of the patients reported current use of medication for mycetoma. Identification of the causative microbial species was not possible due to the absence of laboratory facilities in or near the village. Patients were therefore monitored by the caregivers weekly to document any clinical improvement associated with repeated topical application of HOCl. In six patients, the infection had persisted for several years, with individuals having previously undergone intermittent courses of antifungal or antibacterial therapy without satisfactory response, and some having been subjected to attempted surgical excision.

*Informed Consent:* All patients were informed about the study procedures by their caregivers prior to application of the HOCl solution. Written informed consent was obtained from each participant, and the signed consent forms were retained in the patients' medical files in accordance with international ethical guidelines and the requirements for inclusion of human participants in public health research.The first patient, an 11-year-old girl, was brought in by her elder brother, and he signed her form.

*HOCl disinfectant solution*: Stable pure HOCl preparations made by Briotech Inc., equivalent to those available commercially in the US from Amazon,were donated for this study. Use of the product for the study was approved by the Sudanese National Medicines & Poisons Board in Khartoum. The proposed study received approval from the Ethical Committee ofthe Sudanese Federal Ministry of Health(Proposal No. 8-3-21, April 2021) and the State Ministry of Health (Ethical permit No. 44 T, January 2024) before the HOCl was used.

*Topical use patterns and observations*: Patients were provided with sufficient HOCl solution to allow for week-long daily applications to the lesions, either as a spray or directly poured onto the open wounds. Spray bottles containing 100 ml of HOCl (100 ppm concentration) were given to each patient. Patients were instructed to apply the disinfectant to their wounds two to three times daily, allow several minutes of contact, apply HOCl to the wound dressing, and then dress the wound using sterile gauze and bandages provided. HOCl bottles were refilled by caregivers as needed.

Examinations and observations by the caregivers were made at intervals when possible, and extensively recorded photographically to capture changes, along with patient comments on any perceived benefits, such as better drainage, reductions in lesion size, granular discharge, malodour, pain, and each patient's willingness to continue HOCl applications.

## Results

***Patient # 1***.

An 11-year-old female presented with an early-stage painless right foot lesion (~2 x 2 cm) of mycetoma accompanied by foul serosanguinous purulent exudation (Figure 1a). There was discharge

of granular material via at least three sinus tracts. Patient's male sibling had a longer- standing mycetoma infection, indicative of the presence of causal organisms in the family environment. Patient was compliant with 3x (TID) daily topical application of the HOCl as the sole therapeutic intervention over the study period. Upon examination weekly, over one month, the lesion showed progressive signs of resolution, including cessation of fluid and granular discharge, drying and shrinkage of the area affected, and ultimately closure of the skin breach and encouraging signs of skin healing. (Figure 1b).



**Figure 1: An 11-year-old girl with an early mycetoma ulcer.**
**1a: 1st presentation 1b: 4 weeks post-HOCl use**

***Patient #2:***

A 25-year-old male, a goat herder, presented with a case of long-standing pedal mycetoma, with numerous sinuses discharging white granules. His history included three surgical interventions over seven years with unsatisfactory outcomes overall. The patient was eager to participate in the evaluation and was compliant with 3x (TID) daily topical HOCl. Two weeks later, he reported a noticeable reduction in swelling and pain, increased mobility, the onset of healing of lesions, closure of some sinuses, and reduced volume of discharged granular material. This led to a willing continuation of the HOCl applications over eight weeks. Serial observations by care providers over that time confirmed beneficial changes. (Figure 2:)



**Figure 2: A case of a long-standing pedal mycetoma**
**2a: At presentation 2b: 8 weeks after using HOCl, less swelling, drylesions with granulation tissueand eschar**

***Patient#3:***

A 20-year-old male who had had the infection for seven years before the study. He presented severe chronic lesions affecting the right thumb, which had undergone several unsuccessful surgeryattempts in previous years. The patient observed a decrease in lesion size, odour, and pain over the course of 8 weeks.

***Patient #4***

A 35-year-old female housewife with a single discharging foot lesion that had been treated both surgically and with antifungal medication for several years. Over the course of HOCl treatment, with intermittent compliance, the sinus discharge ceased, and the lesion closed.

***Patient #5***

A 35-year-old female housewife with a history of pedal mycetoma of more than 20 years duration. Her history included three surgical procedures and serial medication with antifungal agents. She was fully compliant with the HOCl protocol, reporting remarkable improvements in the size of the lesions over the course of 8 weeks, reduced discharge, decreased pain, and recovered mobility of her toes.

***Patient #6***

A 35-year-old father and animal herder with extensive gluteal mycetoma initially presented eight years before the study. He underwent multiple surgical procedures. He was fully compliant, and changes were observed over the course of 8 weeks, indicating a favourable response to HOCl with reduced lesion size as well as drying and cessation of exudation in some of the multiple lesions covering the gluteal region and lower back (Figure 3a, 3b). This patient was seen recently by one of our local team (Prof. Nour), two years after being treated with HOCl (Fig. 3c).



**Figure 3: A patient with extensive gluteal mycetoma**
**3a: before HOCl 3b: 8 weeks 3c: 2 years after using HOCl for 8 weeks**

***Patient #7.***

A 45-year-old housewife with mycetoma of the knee, with multiple open discharging sinuses and two subcutaneous lesions above the knee. Patient confirmed having the lesions for three years, and unsuccessfully attempted antifungal treatment several times, and underwent one surgical procedure. Over the course of serial but intermittent use of HOCl, lesions were observed to have dried, and discharges were reduced.

**Limitations of the Study**

This study involved a small number of village-based patients to obtain preliminary observations on the effect of hypochlorous acid (HOCl) on mycetoma ulcers. Because HOCl is a broad-spectrum, fast-acting disinfectant, we proceeded without identifying the specific causative species, as such identification is normally required to guide antibacterial or antifungal therapy, which was not attempted in this study.

The wide variability of mycetoma lesions made matched control groups impractical; therefore, each patient served as his own control through pre- and post-treatment comparison. Plans to expand the study and conduct closer monitoring and compliance at the Madani Mycetoma Centre were interrupted by the conflict that began on 15 April 2023, which also prevented systematic follow-up of the study patients.

Long-term follow-up was limited, and only one patient (Patient #6) could be traced two years after treatment because of displacement and regional instability.

Despite these limitations, our findings suggest that HOCl may support wound improvement in mycetoma patients and merit further controlled evaluation in hospital settings.

**Table 1: Summary of patients' presentations and findings after applying HOCl during the study**

| Pt # Age (yrs) | Sex Occupation | Site of wound | Duration of infection | Ulcers size | No. of sinuses | Colour Ofgrains | Observed Improvement |
|---|---|---|---|---|---|---|---|
| # 1 / 11 | Female / Student | Top Rt foot | 2 months No treatment | ~2 x 2 cm | 3 with discharge | Black | Ulcer healed on 4$^{th}$wk of using HOCl |
| # 2 / 25 | Male / Goat herder | Top of Rt foot | 7 years three surgeries | Dorsal aspect of the foot | Numerous with discharge | White | Dry lesions, less swelling & pain, no discharge, granulation of wounds |
| # 3 / 25 | Male / Shop-keeper | Rt hand & severe lesions on the thumb | 7 years, Several surgeries | Severe lesions & thumb contraction | Several on both sides of the hand | Black | Decrease in lesions' size, odour & pain |
| # 4 / 35 | Female/ House-wife | Dorsum of the right foot | >15 Yrs Several surgeries & medication | Single lesion with discharge | Single discharging sinus | Black | Ceased discharge & lesion closed |
| # 5 / 35 | Female/ House-wife | Dorsum of the left foot | >18 yrs, several surgeries | Single extended lesion with discharge | Many sinuses with ulceration | Black | Sinuses closed, reduced discharge. Start of healing |
| # 6 / 35 | Male/ Animal herder | Extensive gluteal ulcers | >8 yrs Multiple surgeries | Several extended lesions | Many discharging | Black | Reduced lesion size with drying, less exudate in many lesions. Most lesions dried, forming dark, dry crust 2 yrs after using HOCL |

Continue.....

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| #7 / 45 | Female/ House-wife | Upper side of right knee | >3 yr unsuccessful antifungal drugs | Many ulcers & 2 subcutaneous lesions above the knee | Several discharging sinuses | Black | Lesions dried and discharge reduced |

## Discussion

Although the patients involved in this preliminary evaluation adhered to the recommended protocol for HOCl application to varying degrees, there was no indication that topical use resulted in adverse effects, which would have caused rejection or failure to comply. On the contrary, observable benefits led to enthusiasm for the continuation of treatment in the seven patients. It does not appear, therefore, that self-administration of topical HOCl by patients suffering from mycetoma would result in anything other than possible benefits. These findings encourage the pursuit of further, longer-term usage.

The resolution of an early lesion observed in patient #1 encourages the inference that the simple intervention method employed could help provide a measure of support for home care by patients themselves. Such treatment might complement therapeutic regimens conventionally employed in case management. The changes recorded in the other patients with more established and long-standing disease lesions, including declines in discharge volumes and frequency, reduction of overall lesion swelling, reduction in malodour release, pain, and reported improvements from patients and caregivers, are also supportive of the potential value of exposure of mycetoma lesions to HOCl in this way. The absence of any available means whereby patients could self-medicate has long been recognized as a serious shortcoming in the armamentarium available to health care providers confronting the chronicity of this condition in rural environments[4,6]. The simplicity of the measure used here favours adoption and compliance by those afflicted. Even if the overall effects are no more than complementary to the typical processes involved in case management, there are likely benefits that will accrue from the ongoing broad-spectrum antimicrobial efficacy of the HOCl solution (as seen in patient no. 6, 2 years post-use). With the advent of pure, stable formulations of HOCl using contemporary manufacturing methods, there is good reason to think that it will retain high levels of effectiveness even in the demanding circumstances posed by tropical environments typified by the conditions in Sudan[13].

Conditions resembling mycetoma in domestic livestock—caused by microorganisms essentially identical to those responsible for human disease—are widespread in the same rural environments where human infections are common[14]. Whether or not these instances, particularly but not exclusively in ruminants, contribute to the propagation of causal opportunistic pathogens responsible for human disease may be worthy of further investigation. However, the occurrence of pathological changes in domestic animals that mimic those seen in human patients provides an opportunity for evaluation of topical HOCl in ways that could be helpful to our understanding of its full potential as an intervention. Protocols of regular infusion of aqueous HOCl into sinuses, draining such lesions, might well enable conclusions to be drawn about the utility of that kind of measure in human cases. Topical use of stable gels of HOCl, especially when used in combination with liquid HOCl, may provide for an effective delivery system, especially since HOCl solutions have an immediate cleansing, debridement-like effect on dead tissue accumulations in chronic wounds[15]. Emerging evidence for significantly higher levels of antimicrobial efficacy ofhypobromous acid solutions versus HOCl could also be put to the test in patterns applied to domestic animal lesions[16].

Overall, however preliminary these observations may be, they open possibilities for improvement of home care that may prove valuable and appear worthy of further evaluation. This is particularly fitting given the seriousness of occurrences of mycetoma in populations that often have limited access to the care that such cases merit and require. Management of early infections at the community level may prove useful in confronting the increasing prevalence of mycetoma in younger age groups[17].

A critical challenge remains the sustainable supply of HOCl. Given the considerable number of patients requiring ongoing care, the reliance on imported supplies is neither cost-effective nor logistically feasible. There is an urgent need to establish local production capacity to ensure consistent availability. Efforts are underway to develop compact, low-cost devices capable of generating stable HOCl on-site. These efforts could transform wound care delivery in low-resource settings, enabling early and community-led treatment models.

Due to the conflict in Sudan since April 2023 and the wide displacement of people to different parts of the country, it was not possible to trace the patients included in the study, except for Patient 6.

**Acknowledgements**: We acknowledge with deep gratitude the late Professor Omer Z. Baraka, Faculty of Medicine, University of Khartoum, for his pivotal role as Clinical Lead and his contributions to the study design before his passing in 2024. His involvement reflects a lifelong dedication to advancing the management of neglected tropical diseases and continues to shape the scientific vision of this work.

Our sincere appreciation is extended to Dr E. Rasmussen and Briotech for the generous donation of HOCl, which enabled the successful implementation of this study. We also gratefully acknowledge the team from the University of El Gezira for their invaluable support during the weekly visits to Wad Shigidi village. Special thanks are due to Prof. J. F. Williams, whose personal contribution covered the field expenses—his support is deeply appreciated.

**Competing Interests:** The authors declare that they have no competing interests related to this study. No financial, personal, or professional affiliations influenced the design, execution, or reporting of the research.

**Funding:** This study was made possible through a generous personal donation from Prof. J. Williams, whose support was instrumental to its execution. Briotech Inc. provided BrioHOCl for the study, with assistance fromDr E. Rasmussen. Freight costs for transporting the HOCl to Khartoum were covered by Sudanese colleagues residing in the United States. In-kind support was provided by the Sudanese National Academy of Science, the University of El Gezira, and the State Ministry of Health, who contributed logistical and institutional resources essential to the study's implementation.

**Institutions**: The study was organised and implemented under the umbrella of the Sudanese National Academy of Sciences (SNAS) organized & directed by Prof. Suad Sulaiman.

Researchers from the University of Gezira and the State Ministry of Health partnered in the study, assisted in the logistics & obtained the ethical clearance for the study.

## References

1. Sran HS, Narula IMS, Agarwal RK, et al. History of mycetoma. Indian J Hist Med. 1972; 17:1–7.
2. World Health Organisation, 2022. https://www.who.int/news-room/fact- sheets/detail/mycetoma
3. Hay, R.J. (2021): Mycetoma – a history of the first contributions to the description of the disease and its pathogenesis. Transactions of The Royal Society of Tropical Medicine and Hygiene, Volume 115, Issue 4, April 2021, Pages 283–286, https://doi.org/10.1093/trstmh/traa134
4. Hussein SME, Saeed AA, Fahal AH. (2025): Mycetoma management: Therapeutic challenges and the role of pharmacovigilance. PLoSNegl Trop Dis 2025; 19:e0012827.
5. Esraa Abdelgadir Musa, Iman Hassan Abdoon, Sahar Mubarak Bakhiet, Bashier Osman, Safa A Abdalla, Ahmed Hassan Fahal 2022. Mycetoma management and clinical outcomes: the Mycetoma Research Center experience: Transactions of The Royal Society of Tropical Medicine and Hygiene, № 1, p. 12-21 https://doi.org/10.1093/trstmh/trac069
6. Ahmed Fahal , Dallas J Smith , Borna Nyaoke , Kingsley Asiedu, Fabiana Falves, Supriya Warusavithanas, Daniel Argaw, Roderick Hay (2024): Towards enhanced control of mycetoma: a roadmap to achieve the UN's sustainable development goals by 2030 : Transactions of The Royal Society of Tropical Medicine and Hygiene, Volume 118, Issue 10, October 2024, Pages 646–651, https://doi.org/10.1093/trstmh/trae016
7. Sakarya S, Gunay N, Karakulak M et al. Hypochlorous Acid (2014) : An Ideal Wound Care Agent with Powerful Microbicidal, Anti-biofilm, and Wound Healing Potency. Wounds 2014;26.

8. Lori Robins, Philip Gafken, Chenwei Lin, Lisa Jones, Sarah Hooper. Dissecting HOCl Action in Chronic Wound Biofilms: Proteomic Insights From a Host- Relevant Model of Pseudomonas aeruginosa. Microbiology Open, 2025 Dec;14(6):e70181. https://doi.org/10.1002/mbo3.70181

9. Dirk Boecker, Zhentian Zhang, Roland Breves, Felix Herth, Axel Kramer, Clemens Bulitta. Antimicrobial efficacy, mode of action and in vivo use of hypochlorous acid (HOCl) for prevention or therapeutic support of infections PMCID: PMC10073986 PMID: 37034111 (2023)

10. 25th WHO Expert Committee on 'Selection and Use of Essential Medicines Expert review: A.16 Hypochlorous acid' – EML and EMLc 2025 https://www.who.int/publications/i/item/B09544

11. Jalem S. and Usharani P. (2024): Effect of hypochlorous acid in open wound healing: Bioinformation 20(11): 1619-1622 (2024). https://bioinformation.net

12. Ahmed EA, Nour BYM, Abakar AD, Hamid S, Mohamadani AA, Daffalla M, et al. (2020) The genus Madurella: Molecular identification and epidemiology in Sudan. PLoS Negl Trop Dis 14(7):e0008420. https://doi.org/10.1371/journal.pntd.0008420

13. Elsheikh, M., Trueba, M. & Zaman, S. Traditional healing and mycetoma management in East Sennar State (Sudan): a qualitative exploration. Int J Equity Health 24, 296 (2025). https://doi.org/10.1186/s12939-025-02641-w

14. Mahmoud NA. Mycetoma in Animals: A Review of Cases Reported From 1925-2022, Epidemiology and Management Strategies. Qeios 2024, DOI: 10.32388/zld37v.

15. Herruzo R, Fondo Alvarez E, Herruzo I et al. Hypochlorous acid in a double formulation (liquid plus gel) is a key prognostic factor for healing and absence of infection in chronic ulcers. A nonrandomized concurrent treatment study. 2023, DOI: 10.1002/hsr2.1497.

16. Schmidt JW, Wang R, Kalchayan and N et al. Efficacy of hypobromous acid as a hide-on carcass antimicrobial intervention. J Food Prot 2012; 75:955–8.

17. Fahal AH, Sabaa AHA. Mycetoma in children in Sudan. Trans R Soc Trop Med Hyg 2010; 104:117–21.

**Original Article**

*DOI: https://doi.org/10.37506/9n63as32*

# Oral Health Alterations Associated With Menopause: A Comparative Analysis of Pre- and Post-Menopausal Women

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**How to cite this article**: Sujal R Chorge, Kamala KA, S. Sankethguddad et. al. Oral Health Alterations Associated With Menopause: A Comparative Analysis of Pre- and Post-Menopausal Women. Indian Journal of Public Health Research and Development/Vol. 17 No. 3, July-September 2026.

**Abstract**

**Background:** Menopause is a natural physiological transition characterized by a decline in estrogen and progesterone levels, which can influence both systemic and oral health. The presence of estrogen receptors in oral tissues renders them susceptible to hormonal fluctuations, leading to various oral complaints. However, these manifestations are often under-recognized in clinical practice. The present study aimed to evaluate and compare oral health alterations, including oral and psychological symptoms, dental status, periodontal health, and clinical findings, between premenopausal and postmenopausal women.

**Materials and Methods:** A cross-sectional comparative study was conducted among 200 women, comprising 100 premenopausal and 100 postmenopausal participants. Data were collected using a structured questionnaire covering demographic details, oral and psychological symptoms, and oral hygiene practices. Clinical examination assessed dental status, periodontal condition, and oral mucosal changes. Statistical analysis was performed using descriptive statistics and Chi-square test, with $p < 0.05$ considered statistically significant.

**Results:** Postmenopausal women demonstrated a significantly higher prevalence of oral symptoms such as xerostomia (48% vs. 18%), burning mouth sensation (20% vs. 2%), altered taste (45% vs. 19%), halitosis (38% vs. 12%), orofacial pain (43% vs. 6%), and dysphagia (40% vs. 5%) ($p < 0.05$). Psychological symptoms including depression, anxiety, sleep disturbances, and memory impairment were also more frequent. Furthermore, postmenopausal women exhibited reduced dentition, increased prosthetic needs, poorer oral hygiene practices, and higher occurrence of mucosal conditions.

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**Submission date:** April 30, 2026 **Revision date:** June 2, 2026 **Published date:** June 29, 2026

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**Conclusion:** Postmenopausal women experience significantly greater oral and psychological health alterations compared to premenopausal women, highlighting the importance of targeted preventive and therapeutic oral healthcare strategies during menopause.

**Keywords:** Menopause, oral health, xerostomia, oral diseases, psychological symptoms, tooth loss

## Introduction

Menopause is a physiological event characterized by the permanent cessation of menstruation resulting from the loss of ovarian follicular activity, usually occurring between 45 and 55 years of age.[1] With increased life expectancy, women spend a substantial portion of their lives in the postmenopausal period, making menopause-related health concerns an important public health issue.[2] The menopausal transition is associated with a decline in estrogen and progesterone levels, leading to various systemic, psychological, and oral changes.[3]

Estrogen plays an important role in maintaining the integrity of oral mucosa, salivary gland function, and periodontal health. Estrogen receptors are present in oral tissues, including the gingiva, periodontal ligament, oral mucosa, and salivary glands.[4] Reduced estrogen levels during menopause may therefore contribute to oral manifestations such as xerostomia, burning mouth sensation, altered taste perception, halitosis, mucosal changes, periodontal disease, and tooth loss.[5,6] In addition, reduced salivary flow and changes in salivary composition may compromise oral defense mechanisms, increasing susceptibility to dental caries and oral infections.[6]

Hormonal fluctuations during different phases of a woman's life, including puberty, pregnancy, and menopause, are known to influence periodontal tissues and inflammatory responses.[7] Postmenopausal estrogen deficiency has been associated with increased periodontal inflammation, attachment loss, and alveolar bone resorption, thereby affecting overall oral health status.[8] Psychological disturbances such as anxiety, depression, sleep disorders, and cognitive difficulties are also frequently reported during menopause and may further influence oral hygiene practices and quality of life.[9]

Although previous studies have investigated oral manifestations associated with menopause, comparative data evaluating oral health differences between premenopausal and postmenopausal women in the Indian population remain limited. Therefore, the present study was undertaken to assess and compare oral symptoms, psychological manifestations, periodontal status, oral hygiene practices, and oral clinical findings among premenopausal and postmenopausal women attending a dental institution in Maharashtra, India.

## Materials and Methods

### Study Design and Setting

A cross-sectional comparative study was conducted among women attending the Outpatient Department of Oral Medicine and Radiology at the School of Dental Sciences, Krishna Vishwa Vidyapeeth (Deemed to be University), Karad, Maharashtra, India. The study was carried out over a period of ten months from June 2025 to March 2026.

### Study Population

The study included a total of 200 women, comprising 100 premenopausal women and 100 postmenopausal women. Premenopausal women aged 35–45 years with regular menstrual cycles were included in Group I, whereas postmenopausal women aged 45–60 years with cessation of menstruation for at least 12 consecutive months were included in Group II.

### Inclusion and Exclusion Criteria

Women who fulfilled the age criteria and were willing to participate in the study were included after obtaining written informed consent.

Women with systemic conditions known to affect oral health, such as uncontrolled diabetes mellitus, autoimmune disorders, salivary gland diseases, or severe systemic illnesses, were excluded. Participants receiving hormone replacement therapy or medications affecting salivary flow, as well as those with a history of head and neck radiotherapy or chemotherapy, were also excluded from the study.

**Data Collection**

Data were collected using a structured and prevalidated questionnaire followed by a comprehensive clinical oral examination. The questionnaire included demographic details, menstrual history, oral symptoms, psychological symptoms, and oral hygiene practices.

Oral symptoms assessed included xerostomia, burning mouth sensation, altered taste, halitosis, orofacial pain, and difficulty in swallowing. Psychological symptoms included depressed mood, anxiety, sleep disturbances, and memory or concentration difficulties.

Clinical examination was performed using a mouth mirror and Community Periodontal Index (CPI) probe under standard infection control precautions. Dental status, including the number of teeth present and prosthetic status, was recorded. Periodontal condition was categorized as healthy gingiva, gingivitis, or periodontitis based on clinical findings. Oral mucosal examination included assessment of xerostomia, fissured tongue, bald tongue, lichenoid reactions, ulcerative lesions, and tobacco pouch keratosis.

**Ethical Considerations**

The study protocol was reviewed and approved by the Institutional Ethical Committee of Krishna Vishwa Vidyapeeth (Deemed to be University), Karad. Written informed consent was obtained from all participants prior to enrollment, and confidentiality of participant information was maintained throughout the study.

**Statistical Analysis**

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software version XX. Descriptive statistics were used to summarize the data. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation. The Chi-square test was applied to compare categorical variables between the two groups. A p-value of less than 0.05 was considered statistically significant.

## Results

**Demographic Characteristics**

The mean age of the participants was 41 ± 5 years in the premenopausal group and 54 ± 5 years in the postmenopausal group (Table 1). A higher proportion of premenopausal women resided in urban areas (56%), whereas postmenopausal women were predominantly from rural areas (58%). Educational attainment was comparatively higher among premenopausal women, while 28% of postmenopausal women had no formal education. Employment was more common among premenopausal women (57%), whereas the majority of postmenopausal women were homemakers (72%). The mean age at menopause among postmenopausal women was 46 ± 4 years.

**Table 1: Demographic Characteristics of Premenopausal and Postmenopausal Women**

| Demographic Charecteristics | Premenopausal (n=100) | Postmenopausal (n=100) |
|---|---|---|
| Age (years), Mean ± SD | 41+-5 | 54+-5 |
| Current Residence, n (%) | | |
| Urban | 56 (56%) | 42 (42%) |
| Rural | 44 (44%) | 58(58%) |
| Educational Qualification, n (%) | | |
| No formal education | 0 (%) | 28(28%) |
| Primary school | 42 (42%) | 5 (5%) |
| Secondary school | 36 (36%) | 18(18%) |
| Higher Education | 22(22%) | 0(0%) |
| Occupation, n (%) | | |
| Employment (Full-time/ Part time | 57 (57%) | 9(9%) |
| Retired | 0(0%) | 19(19%) |
| Homemaker | 43 (43%) | 72(72%) |
| Age at Menopause (years), Mean ± SD | - | 46+ |

SD = Standard Deviation

**Oral and Psychological Symptoms**

Postmenopausal women exhibited a significantly higher prevalence of oral symptoms compared to premenopausal women (Table 2). The most commonly reported symptoms among postmenopausal women were dry mouth (48% vs. 18%), burning mouth sensation (20% vs. 2%), altered taste (45% vs. 19%), halitosis (38% vs. 26%), orofacial pain (43% vs. 6%), and difficulty in swallowing (40% vs. 5%). All observed differences were statistically significant ($p < 0.001$).

Psychological symptoms were also significantly more prevalent among postmenopausal women. Depressed mood was reported by 35% of postmenopausal women compared to 7% of premenopausal women. Similarly, memory/ concentration difficulties (60% vs. 18%), anxiety/ fear (47% vs. 14%), and sleep disturbances (58% vs. 21%) were more frequently observed in the postmenopausal group. These differences were statistically significant ($p < 0.001$).

**Table 2. Comparison of Oral and Psychological Symptoms Between Premenopausal and Postmenopausal Women**

| Symptoms | Premenopausal women (n=100) | | Postmenopausal women (n=100) | | p- value |
|---|---|---|---|---|---|
| | Present n (%) | Absent n (%) | Present n (%) | Absent n (%) | |
| Dry mouth | 18 (18%) | 82(82%) | 48(48%) | 52(52%) | 0.000013 |
| Burning mouth sensation | 2(2%) | 98(98%) | 20(20%) | 80(80%) | 0.000122 |
| Altered taste | 19(19%) | 81(81%) | 45(45%) | 55(55%) | 0.000151 |
| Halitosis (Altered Breath) | 12(12%) | 74(74%) | 38 (38%) | 62(62%) | 0.000045 |
| Oro-facial pain | 6(6%) | 94(94%) | 43(43%) | 57(57%) | <0.000001 |
| Difficulty in swallowing | 5(5%) | 95(95%) | 40(40%) | 60(60%) | <0.000001 |
| Depressed mood | 7(7%) | 93(93%) | 35(35%) | 65(65%) | 0.000003 |
| Memory / Concentration difficulty | 18(18%) | 82(82%) | 60(60%) | 40(40%) | <0.000001 |
| Anxiety/ Fear | 14(14%) | 86(86%) | 47 (47%) | 53(53%) | 0.000001 |
| Sleep Disturbances | 21(21%) | 79(79%) | 58(58%) | 42(42%) | <0.000001 |

Chi-square test; $p < 0.05$

**Dental Status, Periodontal Health, and Oral Hygiene Practices**

Premenopausal women demonstrated better dental status compared to postmenopausal women (Table 3). A significantly higher proportion of premenopausal women had more than 20 natural teeth (90% vs. 70%, $p = 0.001$), whereas tooth loss (<20 teeth) was more prevalent among postmenopausal women (30% vs. 10%, $p = 0.001$). The use of removable partial dentures and fixed partial dentures was significantly more common among postmenopausal women ($p < 0.01$).

With respect to periodontal health, healthy periodontal status was observed more frequently among premenopausal women (50% vs. 30%, $p = 0.01$). Although gingivitis and periodontitis were more prevalent in postmenopausal women, the differences were not statistically significant.

Oral hygiene practices also differed between the two groups. Brushing less than once daily was significantly more common among postmenopausal women (15% vs. 5%, $p = 0.03$). In addition, a higher proportion of postmenopausal women visited the dentist only when experiencing dental complaints (60% vs. 40%, $p = 0.005$), whereas regular annual dental visits were more common among premenopausal women (45% vs. 30%, $p = 0.02$).

**Table 3: Comparison of dental status, periodontal diagnosis, and oral hygiene practices between premenopausal and postmenopausal women**

| Characteristics | Premenopausal women (n=100) | | Postmenopausal women (n=100) | | p- value |
|---|---|---|---|---|---|
| | Present n (%) | Absent n (%) | Present n (%) | Absent n (%) | |
| No. of teeth Present(>20) | 90 (90%) | 10(10%) | 70 (%) | 30 (30%) | 0.001 |
| No. of teeth Absent (<20) | 10(10%) | 90(90%) | 30 (30%) | 70 (%) | 0.001 |
| Presence of Removable Partial Denture (RPD) | 10(10%) | 85(85%0 | 35(35%) | 65(65%) | 0.005 |
| Presence of Fixed Partial Denture (FPD) | 50(50%) | 90(90%) | 25(25%) | 75(75%) | 0.002 |
| Periodontal Diagnosis | | | | | |
| Healthy periodontium | 50(50%) | 50(50%) | 30 (30%) | 70 (%) | 0.01 |
| Gingivitis | 30 (30%) | 60(60%) | 40 (40%) | 60(60%) | 0.20 |
| Periodontitis | 20(20%) | 80(80%) | 30 (30%) | 70 (%) | 0.10 |
| Tooth brush frequency | | | | | |
| <1 time/day | 5(5%) | 95(95%) | 15(15%) | 85(85%) | 0.03 |
| Once daily | 60(60%) | 40(40%) | 50(50%) | 50(50%) | 0.10 |
| ≥2 times/day | 35(35%) | 65 (65%) | 35(35%) | 65(65%) | 1.00 |
| Dental visit frequency | | | | | |
| Only during dental complaint | 40(40%) | 60(60%) | 60(60%) | 40(40%) | 0.005 |
| Once yearly | 45(45%) | 55(55%) | 30 (30%) | 70 (%) | 0.02 |
| Twice yearly | 15(15%) | 85(85%) | 10(10%) | 90(90%) | 0.40 |

RPD = Removable Partial Denture; FPD = Fixed Partial Denture.Chi-squaretest ; $p < 0.05$

**Oral Clinical Findings**

Postmenopausal women demonstrated a significantly higher prevalence of several oral clinical findings compared to premenopausal women (Table 4). Xerostomia was observed in 42% of postmenopausal women compared with 20% of premenopausal women ($p = 0.0038$). Similarly, halitosis (38% vs. 3%, $p < 0.0001$) and fissured tongue (18% vs. 3%, $p = 0.0093$) were significantly more common among postmenopausal women.

Although bald tongue, lichenoid reactions, ulcerative lesions, and tobacco pouch keratosis were observed in both groups, the differences were not statistically significant ($p > 0.05$).

**Table 4: Comparison of oral clinical findings between premenopausal and postmenopausal women.**

| Oral Clinical Findings | Premenopausal women (n=100) | | Postmenopausal women (n=100) | | p value |
|---|---|---|---|---|---|
| | Present n (%) | Absent n (%) | Present n (%) | Absent n (%) | |
| Xerostomia | 20(20%) | 80 (80%) | 42(42%) | 58(58%) | 0.0038 |
| Halitosis | 3(3%) | 97 (97%) | 38(38%) | 62(62%) | <0.0001 |
| Bald tongue | 0 (0%) | 100(100%) | 2(2%) | 98(98%) | 0.1556 |
| Fissured Tongue | 3(3%) | 97(97%) | 18(18%) | 82(82%) | 0.0093 |
| Oral Mucosal Lesions | | | | | |
| Lichenoid reaction | 1(1%) | 99(99%) | 3(3%) | 97(97%) | 0.6212 |
| Ulcerations | 15(15%) | 85(85%) | 10(10%) | 90(90%) | 0.38 |
| Tobacco pouch keratosis | 1(1%) | 99(99%) | 6(6%) | 94(94%) | 0.054 |

## Discussion

Menopause is a physiological transition associated with progressive decline in ovarian hormones, particularly estrogen, resulting in multiple systemic and oral health alterations. The findings of the present study demonstrated that postmenopausal women experienced significantly greater oral symptoms, adverse oral clinical findings, poorer dental status, and compromised oral hygiene practices compared to premenopausal women. These observations support the important role of hormonal changes in influencing oral health during the menopausal period.

The mean age of menopause observed in the present study was 46 years, which is consistent with previous Indian studies reporting menopause between 44 and 47 years of age.[1,4,6] Earlier menopause among Indian women compared to Western populations may be influenced by genetic predisposition, nutritional factors, socioeconomic conditions, and lifestyle variations.[10-12]

Sociodemographic findings in the present study showed lower educational status and higher homemaker prevalence among postmenopausal women. Lower literacy levels and socioeconomic status may contribute to inadequate oral health awareness, irregular dental visits, and poor oral hygiene practices.[13] These factors can further aggravate oral health problems during menopause.

Postmenopausal women in the present study reported significantly higher prevalence of xerostomia, burning mouth sensation, altered taste, halitosis, and orofacial pain. Estrogen deficiency plays an important role in these manifestations because estrogen receptors are present in salivary glands and oral mucosal tissues. Reduced estrogen levels may impair salivary gland secretion, alter salivary composition, and decrease mucosal lubrication, resulting in xerostomia and oral discomfort.[13,14] Saliva performs essential protective functions including lubrication, buffering capacity, antimicrobial activity, and maintenance of oral microbial balance. Therefore, reduction in salivary flow may increase susceptibility to dental caries, mucosal irritation, halitosis, and opportunistic infections.[15,16]

Psychological symptoms such as anxiety, depressed mood, memory difficulties, and sleep disturbances were also significantly more common among postmenopausal women. Hormonal fluctuations during menopause can influence neurotransmitter activity, particularly serotonin and gamma-aminobutyric acid pathways, contributing to psychological disturbances.[17,18] These psychological factors may indirectly affect oral health by reducing motivation for oral hygiene maintenance, increasing stress-related parafunctional habits, and negatively influencing healthcare-seeking behavior.[19]

The present study also demonstrated poorer dental status among postmenopausal women, including greater tooth loss and increased prosthetic rehabilitation needs. Estrogen plays a crucial role in maintaining bone metabolism by regulating osteoblastic and osteoclastic activity. Declining estrogen levels during menopause enhance osteoclastic bone resorption and reduce bone mineral density, including alveolar bone supporting the teeth.[20, 21] Increased alveolar bone loss may predispose postmenopausal women to tooth mobility, periodontal attachment loss, and eventual tooth loss. Similar findings of increased tooth loss and prosthetic needs among postmenopausal women have been reported in previous studies.[20,21]

Although differences in gingivitis and periodontitis were not statistically significant, postmenopausal women showed a comparatively higher prevalence of periodontal disease. Estrogen deficiency may influence periodontal tissues through altered inflammatory responses, impaired collagen synthesis, vascular changes, and decreased tissue repair capacity.[22,23] Furthermore, increased production of inflammatory cytokines such as interleukin-1 and tumor necrosis factor-alpha during estrogen deficiency may contribute to periodontal tissue destruction and alveolar bone resorption.[22,23]

Clinical findings such as xerostomia, halitosis, and fissured tongue were significantly more prevalent among postmenopausal women, which is consistent with previous reports.[24,25] Reduced salivary secretion and mucosal atrophy associated with estrogen deficiency may impair mucosal integrity and epithelial turnover, leading to these clinical manifestations. However, no significant differences were observed for lichenoid reactions, ulcerative lesions, and tobacco pouch keratosis,

suggesting that additional factors such as tobacco use, nutritional deficiencies, systemic diseases, and local irritants may also influence the occurrence of oral mucosal lesions.[24,25]

Poorer oral hygiene practices and reduced utilization of preventive dental services were also observed among postmenopausal women. Many participants sought dental treatment only when symptomatic, which may be attributed to lack of awareness, financial limitations, cultural beliefs, and neglect of oral health during aging.[5,10] These findings highlight the need for greater oral health education and preventive strategies targeted toward menopausal women.

Overall, the present study emphasizes that oral health changes during menopause are multifactorial and influenced by hormonal, biological, psychological, and socioeconomic factors. Postmenopausal women appear more vulnerable to oral health problems and therefore require comprehensive preventive and therapeutic care. Integration of oral health assessment into routine menopausal healthcare, along with regular dental check-ups, oral hygiene education, dietary counseling, and management of xerostomia, may improve quality of life and oral health outcomes. Interdisciplinary collaboration among dentists, gynecologists, and primary healthcare professionals is essential for early diagnosis, prevention, and holistic management of oral health problems in menopausal women.[1,2,6]

## Conclusion

The present study demonstrated that postmenopausal women experience a significantly higher prevalence of oral symptoms, psychological disturbances, adverse oral clinical findings, tooth loss, and compromised periodontal health compared to premenopausal women. Xerostomia, halitosis, altered taste, fissured tongue, and poor oral hygiene practices were notably more common among postmenopausal women. These findings highlight the important influence of estrogen deficiency and age-related physiological changes on oral health during menopause.

Menopausal women require increased attention toward preventive oral healthcare, regular dental evaluation, maintenance of oral hygiene, and early management of oral symptoms to improve overall health and quality of life. Integration of oral health assessment into routine menopausal healthcare and interdisciplinary collaboration among dentists, gynecologists, and primary healthcare providers may contribute to early identification and effective management of menopause-associated oral conditions.

**Limitations and Future Perspectives**

The present study has certain limitations. As the study was cross-sectional in design, causal relationships between menopause and oral health changes could not be established. In addition, the study population was limited to a single institution and specific geographic region, which may restrict the generalizability of the findings to the wider population.

Future longitudinal and multicentric studies involving larger and more diverse populations are recommended to further evaluate the long-term effects of menopause on oral health. Further research should also focus on the role of hormonal factors, salivary biomarkers, bone metabolism, and interdisciplinary preventive strategies in improving oral health outcomes among menopausal women.

**Financial support and sponsorship:** Nil.

**Conflicts of interest:** Authors declare no conflict of interests.

**Ethical Clearance:** The study was designed and implemented following the Declaration of Helsinki, and the protocol was reviewed and approved by the Institutional Ethics Committees of Krishna Vishwa Vidyapeeth Dee,med to beUniversity, Karad, with Ref. No. KVV/ IEC/04/2025; Protocol No:1064/2024-2025.

## References

1. Chand P, Dutt P, Jurel SK, Dasgupta S, Gautham H, Shetye AG. Assessment of effect of menopause on oral health and its awareness in population visiting dental OPD: a hospital-based study. Int J Community Med Public Health. 2023;10:3189-95.
2. Ekanayake CD, Atapattu P, Dissanayake M, Akmeemana S, Perera H, Gunaratne MD, et al. Health

issues of postmenopausal women in Sri Lanka: A community-based pilot study. J Mid-life Health. 2025;16:272-7.

3. Pal S. A community-based comparative study on menopausal health issues of urban and rural women of Tripura, North-East India. Indian J Physiol Allied Sci. 2023;75:12-18.
4. Khan S, Shukla MK, Priya N, Ansari MA. Health seeking behaviour among post-menopausal women: A knowledge, attitude and practices study. Int J Community Med Public Health. 2016;3:1777-82.
5. Shobhana M, Chandran JR, Aggarwal N, Sharma S, Jankiram R, Soni A, et al. Incidence of hot flashes among peri- and post-menopausal women in India: A clinico-demographic analysis. J Mid-life Health. 2025;16:32-7.
6. Chand P, Dutt P, Jurel SK, Dasgupta S, Gautham H, Shetye AG. Assessment of effect of menopause on oral health and its awareness in population visiting dental OPD: a hospital-based study. Int J Community Med Public Health. 2023;10:3189-95.
7. Hussein MJ, Salman FD, Hussein SR. Comparison of pre- and post-menopausal women's oral health status in Erbil city. Acta Sci Med Sci. 2023;7:03-09.
8. Singh N, Verma SK, Sharma NK, Gupta V, Jha AK, Priyank H. Comparative evaluation of periodontal health status of pre and postmenopausal females. J Educ Health Promot. 2023;12:211.
9. Katage G, Dhawale PV, Kamble A. Silent bone loss: Estimating osteoporosis risk among postmenopausal Indian women using a self-assessment tool. J Mid-life Health. 2025;16:295-300.
10. Shrivastava S. Menopause and oral health: Clinical implications and preventive strategies. J Midlife Health. 2024;15:135-41.
11. Singh P, Vyas S, Vallabh V, Nautiyal R, Srivastava A, Semwal J. A study to assess the prevalence and factors affecting menopausal symptoms among middle-aged females in the Garhwal region of Uttarakhand. J Midlife Health. 2023;14(4):237-245.
12. Buencamino MCA, Palomo L, Thacker HL. How menopause affects oral health, and what we can do about it. Cleveland Clinic Journal of Medicine. 2009;76(8):467-75.
13. Gautam DK, Vikas J, Amrinder T, Rambhika T, Bhanu K. Evaluating dental awareness and periodontal health status in different socioeconomic groups in the population of Sundernagar, Himachal Pradesh, India. J Int Soc Prev Community Dent. 2012 ;2(2):53–57.
14. Dutt P, Chaudhary SR, Kumar. Oral health and menopause: A comprehensive review on current knowledge and associated dental management. Ann Med Health Sci Res. 2013;3(3):320–323.
15. Kogo M, Inoue M, Shirasuna K. Oral symptoms in postmenopausal women. J Oral Rehabil. 2003;30(6):563-568.
16. Minicucci EM, Pires RBC, Vieira RA, Miot HA, Sposto MR. Assessing the impact of menopause on salivary flow and xerostomia. Aust Dent J. 2013;58:230–4.
17. Labunet A, Objelean A, Kui A, Rusu L, Vigu A, Sava S. Oral manifestations in menopause: a scoping review. Medicina (Kaunas). 2025;61(5):837.
18. Meurman JH, Tarkkila L, Tiitinen A. The menopause and oral health. Maturitas 2009;63(1):56-62.
19. Yakar N, Turedi A, Emingil G, **Şahin** C, Kose T, Silbereisen A et al. Oral health and emotional wellbeing in premenopausal and postmenopausal women: a crosssectional cohort study. BMC Womens Health. 2021;21:338.
20. Areal-Quecuty V, Segura-Egea JJ, Simón-Soro A, León-López M, Cantiga-Silva C, Martín-González J et al . Dental caries status in postmenopausal women: systematic review and meta-analysis. J Clin Med. 2025;14:1837.
21. Hariri R, Alzoubi EE. Oral manifestations of menopause. J Dent Health Oral Disord Ther. 2017;7(4):306-309.
22. Palanisamy S. The impact of estrogen on periodontal tissue integrity and inflammation—a mini review. Front Dent Med. 2025;19;6:1455755.
23. Jayusman PA, Nasruddin NS, Baharin B, Ibrahim NI, Ahmad Hairi H, Shuid AN. Overview on postmenopausal osteoporosis and periodontitis: the therapeutic potential of phytoestrogens against alveolar bone loss. Front Pharmacol. 2023;23;14:1120457.
24. Muneshwar SS, Ashwinirani SR, Gole AA, Suragimath G. Oral manifestation in postmenopausal women of Maharashtra, Western region. J Midlife Health. 2023;14:28-33.
25. Rajpal N, Patel S, Pathak JR, Swain N, Bhor K. Prevalence of Oral Manifestations in Menopausal and Postmenopausal Women: A Systematic Review and Meta-Analysis. J Orofac Sci. 2025;17:40-50.

**Original Article**

*DOI: https://doi.org/10.37506/kby41w30*

# Psychometric Properties of "Pragati Pustak": A Parent Oriented Screening Tool for Developmental Delay

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**How to cite this article**: Suvarna S. Ganvir, Chetna Kunde, Jasmine A. Shaikh et. al. Psychometric Properties of "Pragati Pustak": A Parent Oriented Screening Tool for Developmental Delay. Indian Journal of Public Health Research and Development/Vol. 17 No. 3, July-September 2026.

**Abstract**

**Background**: Early identification of developmental delay in infancy is crucial for timely intervention, especially in low-resource settings. Pragati Pustak, a culturally adapted parent-reported screening tool, addresses gaps in community-based surveillance for children up to 2 years.

**Objectives**: To develop and validate face/content validity and reliability of Pragati Pustak for detecting developmental delays.

**Methodology**: Iterative development via stakeholder focus groups and expert reviews yielded a bilingual, pictorial Yes/No booklet (milestones 3-24 months; warning signs 3-15 months). Face validity used 4-point Likert scales (15 experts, 15 parents). Content validity applied CVI metrics. Reliability assessed KR-20 internal consistency and Cohen's kappa test-retest (n=6998, 14-day interval).

**Results**: Face validity showed ≥80% endorsement. I-CVI ≥0.90; S-CVI/Ave=0.98. KR-20 ranged 0.60-0.95; kappa >0.85 (almost perfect).

**Conclusion**: Pragati Pustak offers robust psychometrics, enabling reliable parent-led screening in primary care.

**Keywords**: Developmental Delay, Pragati Pustak, Validity, Reliability, Developmental Milestones, Warning Signs.

## Introduction

Developmental delay affects a significant proportion of children under 2 years of age, with an estimated prevalence of 1.5%–2.5% in India[1]. Such impairments have far-reaching consequences, impacting not only the affected child and family but

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**Submission date:** Jan 23, 2026 **Revision date:** April 25, 2026 **Published date:** June 29, 2026

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also society at large. The long-term burden includes increased health-care expenditure, the need for specialized educational support, and a compromised quality of life[2, 3]. Evidence consistently demonstrates that early identification of developmental impairments, followed by timely intervention, plays a crucial role in minimizing functional limitations and reducing disability-related complications[4].early intervention is particularly important in resource-limited settings, where delayed access to appropriate health-care services can exacerbate developmental outcomes. Studies from the United States of America indicate that only approximately one-third of children with developmental delays are identified before reaching school age, thereby limiting opportunities for intervention during the most critical period of neurodevelopment[5]

Timely developmental surveillance and screening during early childhood may therefore serve as key strategies in reducing both the individual and societal burden of disability[6].

Early detection allows for prompt initiation of intervention when developmental plasticity is at its maximum, potentially decreasing the long-term costs associated with health care, rehabilitation, and special education services. Consequently, there is a strong need for accessible, community-based screening tools that facilitate early identification and referral of children at risk for developmental delay[7]. Developmental surveillance is defined as a flexible, longitudinal, and continuous process through which potential risk factors for developmental and behavioural disorders can be systematically identified[9]. Parents serve as the first and most critical point of contact in the longitudinal process of developmental surveillance, as they are a primary and reliable source of information regarding their child's development. Their observations play a vital role in accurate documentation and early recognition of developmental concerns[8]. Evidence-based initiatives such as the Learn the Signs. Act Early. campaign emphasize parental education as an effective strategy for improving awareness of typical developmental milestones and early warning signs of delay[9] The impact of disability is significantly greater among children with multiple impairments or those diagnosed with conditions such as cerebral palsy, epilepsy, growth and developmental delays, and emotional or behavioural disorders. In this context, previous studies have consistently demonstrated that parental reports regarding their child's development, learning, and behaviour provide valuable and valid information for developmental assessment and screening[10]

An ideal developmental screening method should therefore incorporate a standardized and validated tool with well-established psychometric properties. Additionally, such a tool should be easy to administer and interpret, cost-effective, and suitable for use in community and primary health-care settings to facilitate early identification and timely intervention[11]

Early identification of children at risk for developmental delay is essential to minimize the likelihood of long-term complications and disability. Parents, as primary caregivers and continuous observers of their child's growth and development, are uniquely positioned to contribute reliable and meaningful information for early identification[12].

Recognizing this, a community-oriented and parent-friendly screening tool, **Pragati Pustak**, was developed. This research report describes the development & validation of this tool through a standard procedure.

## Methodology

### Study Design and Setting

This study was designed as **a development and validation study** of a parent-oriented developmental screening tool.The Sample Size was not determined at the beginning of research study.The Saturation Principle was applied here.As the visits were made to the villages, the data was recorded & the final number is noted here.7 Villages near the Physiotherapy OPD were targeted & data was collected **(n-6998).**

### Development of the Screening Tool

The development process began with a focused group discussion (FGD) involving key stakeholders, including a paediatrician, physiotherapist, social workers, and parents of children with developmental delay. Inputs obtained from all stakeholders were used to identify and finalize the components to

be included in the screening tool. Based on these discussions, a preliminary draft was developed and subsequently circulated among stakeholders for review and feedback. The initial draft comprised four pages detailing age-appropriate developmental milestones presented at three-month intervals.

Item generation was informed by a review of established developmental screening instruments, including the Denver II Developmental Screening Test, Bayley Scales of Infant and Toddler Development, Ages and Stages Questionnaire, Korean Developmental Screening Test, and existing Indian parent-reported tools[12]. The items were adapted to the local language and sociocultural context. Draft items were refined through iterative expert consultations involving a paediatrician, developmental paediatrician, physiotherapist, and neonatologists[12]. Cognitive interviews with parents were conducted to ensure clarity, cultural relevance, and feasibility for use in primary care and community settings[12].

The preliminary version of the tool consisted predominantly of detailed textual descriptions and required approximately 7–8 minutes to complete. During a second round of stakeholder consultation, concerns were raised regarding the length of the document and its limited suitability for parents with low literacy levels. Stakeholders recommended simplifying the format by incorporating pictorial representations supported by minimal text and including only key developmental milestones to improve feasibility and usability[12].

In response to these recommendations, the screening tool was refined into a concise two-page card format incorporating pictorial depictions of major developmental milestones from birth to 24 months of age[12]. Following consensus and approval from all focus group members, an initial batch of 20 copies was produced. The finalized tool was named *Pragati Pustak* (Progress Card), reflecting its purpose of systematically documenting a child's developmental progress, analogous to academic progress records used for school-going children[12].

**Pragati Pustak** is a dichotomous (Yes/No) parent-reported screening booklet designed to identify developmental delays and early warning signs in infants and young children[12]. Part A includes age-appropriate developmental milestones from 3 to 24 months, categorized into six age bands (3–4, 5–7, 8–10, 11–12, 13–18, and 19–24 months). Part B includes developmental warning signs from 3 to 15 months, divided into five age bands[12].

**Face Validity**

Face validity was assessed to evaluate the readability, feasibility, consistency of formatting and style, and clarity of language used in the screening tool[1, 9,] **Pragati Pustak** was evaluated independently by experts and parents to identify areas for improvement and potential additions[1, 9, 20]Fifteen experts (paediatricians, developmental specialists, paediatric physiotherapists, child psychologists, and speech pathologists) and 15 parents of children aged 3–24 months completed a standardized 4-point Likert-scale review form evaluating five core criteria, clarity, relevance ,ease of understanding, layout, and overall usability of the tool. Ratings of 3 ("quite") or 4 ("highly") indicated endorsement, with face validity expressed as percentage agreement (% endorsement) per item and overall.

All developmental milestone items (Part A) and warning sign items (Part B) were rated by both panels, with results visualized in Figures 10–13 showing item-level % endorsement across sequential items.

**Content Validity**

Following face validation, Pragati Pustak was reviewed for content validity by a panel of experts with experience in research methodology and child development, including professors and doctoral-level researchers[4, 6, 7, 8]. Content validity was quantified using the Content Validity Index (CVI) at both the item level (I-CVI) and scale level (S-CVI), following the methods proposed by Lynn and Polit & Beck[4,6,7,8]. The I-CVI was calculated as the proportion of experts who rated an item as relevant (score of 3 or 4 on a 4-point relevance scale), and the S-CVI was calculated as the average of the I-CVIs across all items (S-CVI/Ave) [4,6,7,8]. Experts evaluated the tool for readability, clarity, comprehensiveness, and relevance, and consensus was achieved

**Reliability Assessment**

Internal consistency of the dichotomous (Yes/No) items within each age band was assessed using the Kuder–Richardson Formula 20 (KR-20), which is equivalent to Cronbach's alpha for dichotomous data[4,6,7,8]. Test–retest reliability was assessed at the item level using Cohen's kappa coefficient[4,6,7,8] Agreement was interpreted according to Landis and Koch criteria: ≤0.40 poor to fair, 0.41–0.60 moderate, 0.61–0.80 substantial, and ≥0.81 almost perfect agreement[4,6,7,8] the sample (n=6998) was reassessed after a fixed interval of 14 days to estimate test–retest reliability. [1, 2,3,4,5]



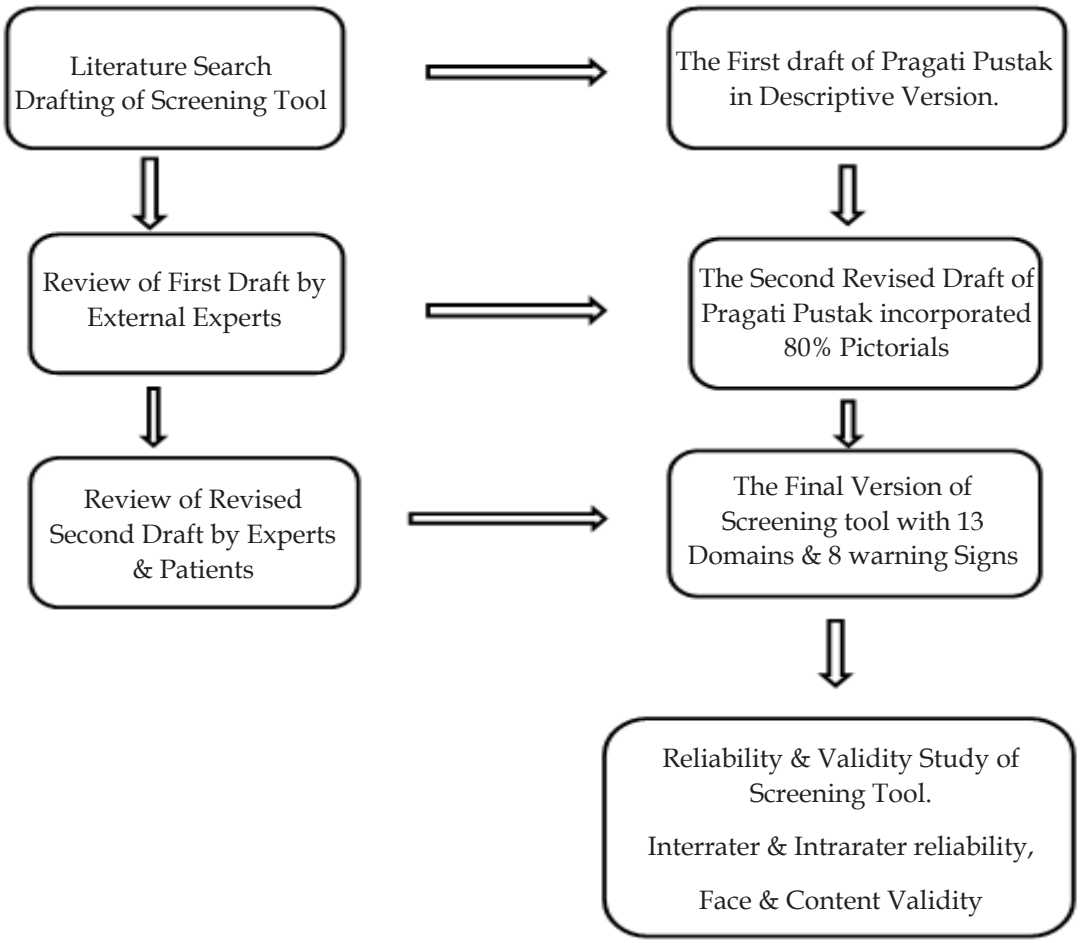



**Fig. 1 Flow Chart outlining the development and validity of the questionnaire.**

**Statistical Analysis**

All analyses were performed using IBM Statistical Package for Social Sciences V.25 software; KR-20 ≥0.70 and kappa ≥0.60 were considered acceptable thresholds based on developmental screening literature. Graphical displays (bar charts) were prepared to visually summarize I-CVI values for representative items and KR-20 values across age-bands for publication. [2, 4, 8]

Sensitivity and specificity analysis could not be performed due to absence of comparison with a gold standard tool.

## Results

### Face validity

Expert's demonstrated high endorsement across all items, with minor dips observed for specific items (Item 3 and Item 5 in developmental milestones; Items 2, 4, and 7 in warning signs).

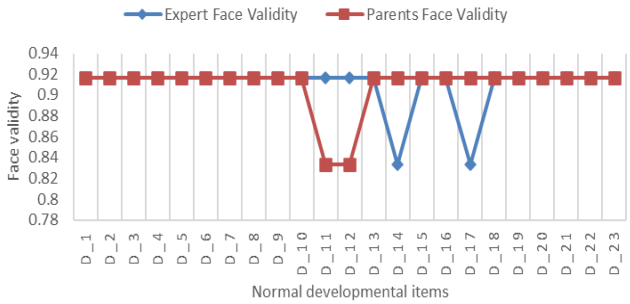



**Figure 1: Face validity for normal developmental milestones**

**Figure 1.** Experts' face validity ratings for developmental milestone items (all ≥80%, Item 3=82%, Item 5=85%) & Parents' face validity ratings for developmental milestone items (all ≥80%, Item 3=80%)

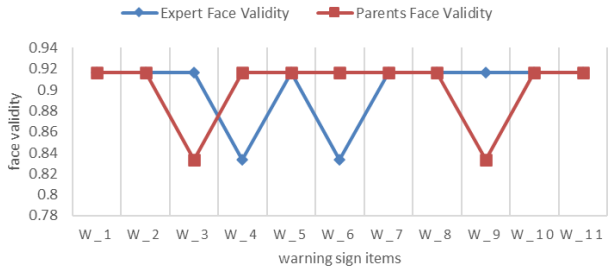



**Figure 2: Face validity for warning signs**

**Figure 2.** Experts' face validity ratings for warning sign items (all ≥80%, Items 2/4/7=80–86%) & Parents' face validity ratings for warning sign items (Items 2/4/8=78–82%).

### Parent Panel (n = 15)

Parents showed consistently high endorsement, with slightly lower ratings for one developmental milestone item (Item 3) and three warning sign items (Items 2, 4, 8). Parental ratings validate the tool's acceptability for primary caregivers across literacy and socioeconomic levels.

### Interpretation and Revisions

All 42 items (21 developmental milestones + 21 warning signs) achieved ≥80% endorsement from both panels, meeting established face validity thresholds. Items with borderline ratings (80–85%) received minor wording revisions based on qualitative feedback.

The final Pragati Pustak demonstrates excellent face validity (overall ≥90% endorsement) from both expert and end-user perspectives, supporting progression to content validity and psychometric testing phases.

### Content Validity

Experts rated all developmental and warning-sign items as highly relevant to age-appropriate neurodevelopment and early detection of delay. At expert level, item-level CVI (I-CVI) for all items was ≥0.90, and the scale-level CVI (S-CVI/Ave) was 0.98, exceeding the commonly recommended minimum of 0.78–0.80 for I-CVI and 0.90 for S-CVI. [2,4,6,8]

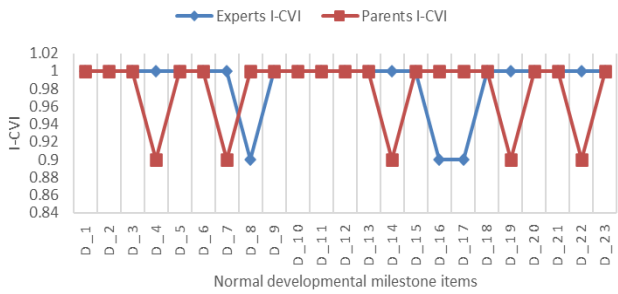



**Figure 3: I-CVI for Developmental Milestones**

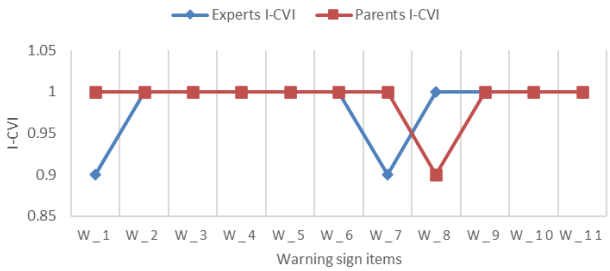



**Figure 4: I-CVI for warning signs**

Parents of newborns and young children similarly endorsed the clarity and relevance of items, with I-CVI ≥0.90 and S-CVI = 0.98 for the parent panel, supporting face and content validity from the end-user perspective. These indices are comparable to or higher than values reported for established parent-completed developmental tools such as the Ages and Stages Questionnaire and culturally adapted developmental screening tools. [1,3,5]

### Reliability

Internal consistency of the dichotomous items within each age-band was excellent, with KR-20 values ≥0.90 except age-band 8-10 months & 13-18 months across all 3–24-month age sections. These coefficients are similar to or higher than those reported for other standardized developmental screening tools such as the Korean Developmental Screening Test and parent-completed questionnaires used in primary care. [2,4,8,9]

Test–retest reliability at item level was very high, with Cohen's kappa exceeding 0.85 for all items, indicating almost perfect agreement over the retest interval. Such kappa values are well above the thresholds typically reported in developmental tool validation studies, where values in the 0.60–0.80 range are often considered adequate.[2, 3, 8]

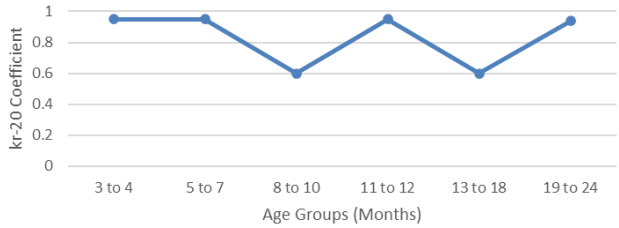



**Figure 5: Normal Developmental items KR-20 coefficient**

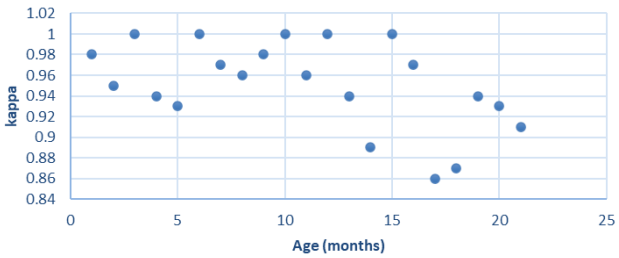



**Figure 6: Test-retest reliability of normal developmental items**

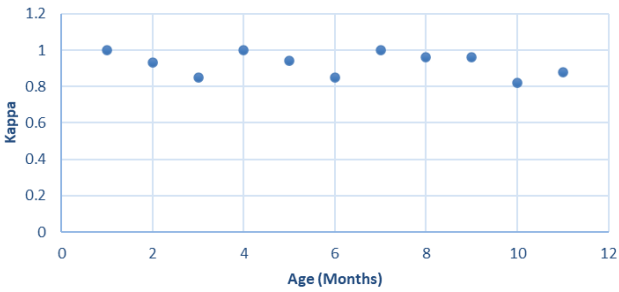



**Figure 7: Test-retest reliability of warning signs**

Kappa values above 0.85 indicate almost perfect stability and suggest that responses are not substantially influenced by random error or day-to-day variation in parental reporting.[8]

## Discussion

Pragati Pustak emerged from an iterative, participatory process initiated through focus group discussions with pediatricians, physiotherapists, social workers, and parents etc. This multidisciplinary approach mirrors the expert-driven framework of the Denver Developmental Screening Screening Test (DDST-II) [46] where clinicians guided milestone selection, content verification, and refinement based on clinical judgment and population-specific patterns. As in DDST-II, expert consensus ensured milestones captured meaningful, observable functions, avoiding culturally biased or ambiguous items.

The initial text-heavy draft evolved into a concise, bilingual, pictorial screening card following expert feedback—a progression akin to the Korean Developmental Screening Test (K-DST) [47]which prioritized clarity, feasibility, and parental comprehension. The final tool features dichotomous (yes/no) items across six age bands (3–4, 5–7, 8–10, 11–12, 13–18, and 19–24 months) for milestones and five bands (3–15 months) for red flags, enabling precise monitoring during rapid developmental phas**es.**

Pragati Pustak experts iteratively verified developmental appropriateness in motor, social, and communication domains, aligning with expected trajectories while addressing sociocultural variability. Cultural adaptation incorporated parent cognitive interviews, as in

K-DST[47] To enhance interpretability and minimize response errors. Pictorial elements, informed by expert insights from DDST-II cross-cultural adaptations[48]. addressed literacy and caregiver education barriers, compensating for absent professional observation while retaining core developmental intent.

This framework aligns with Mukherjee et al. for embedding developmental surveillance in Indian primary care via low-literacy, culturally responsive tools for rural settings. By synthesizing expert-driven validation from DDST-II & and K-DST[47,48]. with parent-oriented feasibility, Pragati Pustak builds a strong psychometric foundation for scalable community screening.

**Content validity**

Pragati Pustak was robustly supported by high relevance ratings from expert and parent panels. All items achieved excellent item-level content validity indices (I-CVI) of 0.90–1.00, yielding a scale-level content validity index (S-CVI/Ave) of 0.98—exceeding recommended thresholds of I-CVI ≥0.78–0.80 and S-CVI/Ave ≥0.90. These metrics indicate strong consensus on milestone and red flag relevance, mirroring expert-driven validation in the Denver Developmental Screening Test-II (DDST-II) and culturally adapted parent-report tools.

Comparable to Hindi adaptations for 0–2-year-olds, Pragati Pustak's expert panels confirmed milestone appropriateness, with parental endorsement enhancing caregiver comprehension and acceptability. For newborns to 6 months, pictorial red flags (e.g., absent head control, poor social responsiveness) scored perfect I-CVIs, underscoring visual cues' role in boosting face and content validity for low-literacy parents—akin to Ages and Stages Questionnaire (ASQ) adaptations. These indices affirm Pragati Pustak's integration of expert knowledge, cultural adaptation, and parent-centered design, positioning it for effective early screening in rural Indian primary care[16].

**Internal consistency**

Pragati Pustak was assessed using the Kuder–Richardson Formula 20 (KR-20), appropriate for dichotomous response formats. KR-20 coefficients ranged from 0.60 to 0.95 across the 3–24-month age bands, with the majority of age groups demonstrating values above 0.90. These findings indicate strong internal consistency and unidimensionality of items assessing gross motor, fine motor, and developmental warning signs, supporting the coherence of the construct being measured.

Notably, the highest internal consistency was observed in the 3–7-month age bands, where KR-20 values reached 0.95. This period represents a critical window for early developmental surveillance, and the observed reliability is comparable to domain-level Cronbach's alpha coefficients reported for the Korean Developmental Screening Test (K-DST), which consistently exceed 0.70 for infants younger than 24 months. Such comparability reinforces the robustness of Pragati Pustak during early infancy, when subtle developmental deviations are most clinically significant.

Lower KR-20 values observed in the 8–10 and 13–18-month age bands likely reflect minor heterogeneity in developmental domains due to rapid skill acquisition and greater variability in milestone attainment during mid-infancy and early toddlerhood. Similar fluctuations in internal consistency have been reported in established parent-report screening tools, particularly in low- and middle-income country (LMIC) settings. Importantly, all coefficients met or exceeded acceptable benchmarks for developmental screening instruments, affirming the reliability of Pragati Pustak as a parent-administered screening tool for children aged 0–2 years.

**Test–Retest Reliability**

Test–retest reliability of Pragati Pustak demonstrated excellent temporal stability, with item-level Cohen's kappa coefficients exceeding 0.85 and reaching up to 1.00 over a 14-day interval. According to established interpretative guidelines, these values indicate near-perfect agreement and suggest that parental responses remained highly consistent over time, with minimal influence from recall bias or day-to-day variability in caregiver observation.

Particularly high agreement was observed for early developmental milestones in the 3–4-month age band, such as attainment of social smile and initiation of rolling, where kappa values ranged from 0.95 to 1.00. These findings exceed those reported in DDST-II validation studies conducted among Tehran infants aged 0–6 months, where test–retest kappa values typically ranged between moderate and substantial agreement (0.40–0.80). The superior stability observed in Pragati Pustak may be attributed to its pictorial format and simplified yes/no response structure, which enhances parental clarity and reduces interpretative ambiguity.

High test–retest reliability was also maintained for developmental red flags assessed up to 15 months of age, indicating consistent parental identification of concerning signs across time. This level of stability is comparable to that reported in Indian parent-oriented screening tools such as the Track & Act program, where repeated assessments

among toddlers demonstrated similarly high retest agreement. Collectively, these findings support the robustness of Pragati Pustak as a reliable parent-administered screening instrument capable of producing stable results across repeated administrations in early childhood.

**Comparison to Established Tools**

| Tool | Age Range | KR-20/Alpha (Infants 0-24Months) | Kappa/Test-Retest | CVI/SCVI |
|---|---|---|---|---|
| Pragati Pustak | 3-24 months | 0.60-0.95 | >0.85 | 0.98 |
| ASQ(Indian)[37] | 4-60 months | 0.75-0.90 | 0.70-0.80 | 0.90 |
| K-DST[38] | 3-71 months | 0.70-0.92 | 0.80(2-4 wk) | Not reported |
| Hindi DSQ[37] | 0-6 yr | 0.85-0.95 | 0.75 | High Expert |
| DDST-II Persian[39] | 0-6 yr | 0.70-0.85 | 0.60-0.75 | Moderate |

Pragati Pustak matches or exceeds peers in reliability for 0-2 years, particularly in pictorial format suiting newborns' milestones.

**Strengths for Newborns to 2 Years**

Focusing on 0-12 months, Pragati Pustak excels in depicting primitive reflexes, head lag, and smiling (3-4 month band, KR-20=0.95), addressing high-risk periods where 70% of delays emerge.[11] Parent endorsements (ICVI=0.90+) confirm usability, unlike text-heavy tools failing low-literacy groups.[9] Field use identified 57 delays in 1020 infants across villages, with 49 referred timely, reducing long-term morbidity as in K-DST VLBW validations.[41]

Although Pragati Pustak was developed as a screening tool, its content framework was derived from established developmental assessment tools including **Denver Developmental Screening Test-II (DDST-II)** and **Bayley Scales of Infant and Toddler Development (BSID-II)**. However, **criterion validity against a gold standard tool (e.g., BSID-II)** was not performed in the present study, which is acknowledged as a limitation.

Despite high reliability and validity indices, screening tools are inherently associated with **false positive and false negative outcomes**. False positives may lead to unnecessary parental anxiety and additional referrals, whereas false negatives may delay early intervention in children with subtle developmental delays. The absence of criterion validation limits the ability to quantify these errors in the present study.

**Limitations**

Pragati Pustak shows reduced internal consistency (KR-20 <0.85) in mid-infancy bands (8–12 months), potentially due to rapid milestone variability. Absence of criterion validity against gold standards like Bayley Scales of Infant Development-II (BSID-II) limits confirmation of delay detection rates. Peer studies of parent-report tools report analogous gaps, advocating concurrent BSID administration for 0–24 month cohorts.

**Future Directions**

A revised Pragati Pustak is underway, incorporating additional warning signs across age bands (e.g., enhanced red flags for motor and social delays in 13–24 months) and provisions for repeated entries directly in the document for longitudinal tracking. Parallel validation of a digital app version is in process, though its reach remains limited by connectivity in rural areas; thus, the paper format will continue as the primary tool for community-based screening in low-resource Indian settings. Longitudinal sensitivity/specificity trials in diverse newborn cohorts will further enhance scalability across LMICs.

**Ethics Approval and Consent**

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical clearance was obtained from the Institutional Review Board (IRB) of **Dr. Vithalrao Vikhe Patil Foundation's College of Physiotherapy**.

Written informed consent was obtained from all parents or legal guardians prior to inclusion in the study. Parents were informed about the purpose of the study, confidentiality of data, voluntary participation.

**Financial Support and Sponsorship**: Nil.

**Conflicts of Interest:** There are no conflicts of interest.

## References


1. Girish GB, Anshita AA, Mamta MJ, Shahzadi SM. Impact of Hyperbilirubinemia on Neurodevelopmental Outcomes in Term and Late Preterm Neonates: A Prospective Observational Study in A Tertiary care NICU. Journal of Contemporary Clinical Practice. 2025 May; 11(5):496-503.
2. Kang, S. K., & Kadam, S. D. (2015). Neonatal Seizures: Impact on Neurodevelopmental Outcomes. Frontiers in pediatrics, 3, 101. https://doi.org/10.3389/fped.2015.00101
3. Anitha SR, Thomas T, Kumari SK, et al. Early intervention in developmental delay: A community-based study from rural South India. Indian J Pediatr. 2018;85(10):873-8. doi:10.1007/s12098-018-2702-5.
4. Centers for Disease Control and Prevention. Early intervention for autism spectrum disorder: What every pediatrician should know. Pediatrics. 2014;134(3):e755-9. doi:10.1542/peds.2014-2148.
5. Zwaigenbaum, L., Bauman, M. L., Stone, W. L., Yirmiya, N., Estes, A., Hansen, R. L., McPartland, J. C., Natowicz, M. R., Choueiri, R., Fein, D., Kasari, C., Pierce, K., Buie, T., Carter, A., Davis, P. A., Granpeesheh, D., Mailloux, Z., Newschaffer, C., Robins, D., Roley, S. S.,Wetherby, A. (2015). Early Identification of Autism Spectrum Disorder: Recommendations for Practice and Research. Pediatrics, 136 Suppl 1(Suppl 1), S10–S40. https://doi.org/10.1542/peds.2014-3667C
6. Segre G, Cargnelutti C, Bersani C, Njogu W, Roberti E, Campi R, et al. Early detection of neurodevelopmental disorders in African children living in informal settlements in Nairobi. BMJ Paediatrics Open. 2023;7:e002117. https://doi.org/10.1136/bmjpo- 2023-002117
7. Poon, Jennifer & LaRosa, Angela & Pai, Shashidhar. (2010). Developmental Delay: Timely Identification and Assessment. Indian pediatrics. 47. 415-22. 10.1007/s13312-010-0077-3.
8. Centers for Disease Control and Prevention. Learn the Signs. Act Early. Program overview. Atlanta: CDC; 2023. Available from:https://www.cdc.gov/ncbddd/actearly/index.html
9. Glascoe F. P. (1997). Parents' concerns about children's development: prescreening technique or screening test?. Pediatrics, 99(4), 522–528. https://doi.org/10.1542/peds.99.4.522
10. Shevell, M., Ashwal, S., Donley, D., Flint, J., Gingold, M., Hirtz, D., Majnemer, A., Noetzel, M., Sheth, R. D., Quality Standards Subcommittee of the American Academy of Neurology, & Practice Committee of the Child Neurology Society (2003). Practice parameter: evaluation of the child with global developmental delay report of the Quality Standards Subcommittee of the American Academy of Neurology and The Practice Committee of the Child Neurology Society. Neurology, 60(3), 367–380. https://doi.org/10.1212/01.wnl.0000031431.81555.16
11. van der Linde, J., Swanepoel, deW., Glascoe, F. P., Louw, E. M., & Vinck, B. (2015). Developmental screening in South Africa: comparing the national developmental checklist to a standardized tool. African health sciences, 15(1), 188–196. https://doi.org/10.4314/ahs.v15i1.25
12. Pitchik, H. O., Tofail, F., Akter, F., Shoab, A. K. M., Sultana, J., Huda, T. M. N., Rahman, M., Winch, P. J., Luby, S. P., & Fernald, L. C. H. (2023). Concurrent validity of the Ages and Stages Questionnaire Inventory and the Bayley Scales of Infant and Toddler Development in rural Bangladesh. BMC pediatrics, 23(1), 93. https://doi.org/10.1186/s12887-022-03800-6
13. Gupta, S., Shrivastava, P., Samsuzzaman, M., Banerjee, N., & Das, D. K. (2021). Developmental delay among children under two years of age in slums of Burdwan Municipality: A cross-sectional study. Journal of family medicine and primary care, 10(5), 1945–1949. https://doi.org/10.4103/jfmpc.jfmpc_1926_20
14. Bhattacharya T, Ray S, Das DK. Developmental delay among children below two years of age: a cross-sectional study in a community development block of Burdwan district, West Bengal. Int J Community Med Public Health . 2017 Apr. 24;4(5):1762-7. Available from: https://www.ijcmph.com/index.php/ijcmph/article/view/122
15. Venugopal GS, M. S. G, T. K. G, Jayan G, Binu GJ, Lawrence T. Prevalence and determinants of developmental delay among children below two years of age visiting an immunization clinic of a tertiary care centre in South India. Int J Contemp Pediatr . 2024 Sep. 24 ;11(10):1406-13. Available from: https://www.ijpediatrics.com/index.php/ijcp/article/view/6252
16. Mukherjee, S. B., Aneja, S., Krishnamurthy, V., & Srinivasan, R. (2014). Incorporating developmental screening and surveillance of young children in office practice. Indian Pediatrics, 51(8), 627–635. https://doi.org/10.1007/s13312-014-0465-1

17. Juneja, M., Mohanty, M., Jain, R., & Ramji, S. (2012). Ages and Stages Questionnaire as a screening tool for developmental delay in Indian children. Indian pediatrics, 49(6), 457–461. https://doi.org/10.1007/s13312-012-0074-9

18. Halek, M., Holle, D., & Bartholomeyczik, S. (2017). Development and evaluation of the content validity, practicability and feasibility of the Innovative dementia-oriented Assessment system for challenging behaviour in residents with dementia. BMC health services research, 17(1), 554. https://doi.org/10.1186/s12913-017-2469-8

19. Faruk, T., King, C., Muhit, M., Islam, M. K., Jahan, I., Baset, K. U., Badawi, N., & Khandaker, G. (2020). Screening tools for early identification of children with developmental delay in low- and middle-income countries: A systematic review. BMJ Open, 10(11), e038182. https://doi.org/10.1136/bmjopen-2020-038182

20. Du, W., Alias, B. S., & Wahab, J. L. A. (2025). Content validation and content validity index calculation for teacher innovativeness instrument among Henan private universities in China. Communications on Applied Nonlinear Analysis, 32(10s), 175–187. https://doi.org/10.52783/cana.v32.4705

21. Handage, S., & Chander, M. (2021). Development of an instrument for measuring the student learning outcomes: A content validation process. Indian Journal of Extension Education, 57(3), 1–7. https://doi.org/10.48165/IJEE.2021.57302

22. Nur A. M. L. Hakim, M. R. Pairan, & M. I. Zakaria. (2025). Step-by-step guide to calculating content validity index (CVI) for single constructs using Excel. International Journal of Research and Innovation in Social Science, 9(3), 1717–1726. https://doi.org/10.47772/IJRISS.2025.90300135

23. Kim, C. Y., Jung, E., Lee, B. S., Kim, K. S., & Kim, E. A. (2019). Validity of the Korean Developmental Screening Test for very-low-birth-weight infants. Korean journal of pediatrics, 62(5), 187–192. https://doi.org/10.3345/kjp.2018.07381

24. Ganvir, Suvarna; Kunde, Chetana; Harishchandre, Maheshwari; Ganvir, Shyam1. Pragati Pustak – A parent-oriented screening tool for identification of developmental delay in children till 2 years of age. Physiotherapy - The Journal of Indian Association of Physiotherapists 13(1):p 5-8, Jan–Jun 2019. | DOI: 10.4103/PJIAP.PJIAP_29_18

25. Radecki L, Sand-Loud N, O'Connor KG, Sharp S, Olson LM. Trends in the use of standardized tools for developmental screening in early childhood: 2002–2009. Pediatrics. 2011 Jul 1;128(1):14-9.

26. Al-Madaney, M. M., & Fässler, M. (2023). Development and validation of a tool to assess researchers' knowledge of human subjects' rights and their attitudes toward research ethics education in Saudi Arabia. BMC medical ethics, 24(1), 94. https://doi.org/10.1186/s12910-023-00968-z

27. Bailey, D. B., Jr, Hebbeler, K., Scarborough, A., Spiker, D., & Mallik, S. (2004). First experiences with early intervention: a national perspective. Pediatrics, 113(4), 887–896. https://doi.org/10.1542/peds.113.4.887

28. Rahi, J. S., Manaras, I., Tuomainen, H., & Hundt, G. L. (2004). Meeting the needs of parents around the time of diagnosis of disability among their children: evaluation of a novel program for information, support, and liaison by key workers. Pediatrics, 114(4), e477–e482. https://doi.org/10.1542/peds.2004-0240

29. Sices, L., Egbert, L., & Mercer, M. B. (2009). Sugar-coaters and straight talkers: communicating about developmental delays in primary care. Pediatrics, 124(4), e705–e713. https://doi.org/10.1542/peds.2009-0286

30. Schonwald, A., Huntington, N., Chan, E., Risko, W., & Bridgemohan, C. (2009). Routine developmental screening implemented in urban primary care settings: more evidence of feasibility and effectiveness. Pediatrics, 123(2), 660–668. https://doi.org/10.1542/peds.2007-2798

31. Glascoe F. P. (2003). Parents' evaluation of developmental status: how well do parents' concerns identify children with behavioral and emotional problems?. Clinical pediatrics, 42(2), 133–138. https://doi.org/10.1177/000992280304200206

32. Benasich, A. A., & Brooks-Gunn, J. (1996). Maternal attitudes and knowledge of child-rearing: associations with family and child outcomes. Child development, 67(3), 1186–1205.

33. Pinto-Martin, J. A., Dunkle, M., Earls, M., Fliedner, D., & Landes, C. (2005). Developmental stages of developmental screening: steps to implementation of a successful program. American journal of public health, 95(11), 1928–1932. https://doi.org/10.2105/AJPH.2004.052167

34. Berry, A. D., Garzon, D. L., Mack, P., Kanwischer, K. Z., & Beck, D. G. (2014). Implementing an early childhood developmental screening and surveillance program in primary care settings: lessons learned from a project in Illinois. Journal of pediatric health care : official publication of National Association of Pediatric Nurse

Associates & Practitioners, 28(6), 516–525. https://doi.org/10.1016/j.pedhc.2014.04.008

35. King, T. M., Tandon, S. D., Macias, M. M., Healy, J. A., Duncan, P. M., Swigonski, N. L., Skipper, S. M., & Lipkin, P. H. (2010). Implementing developmental screening and referrals: lessons learned from a national project. Pediatrics, 125(2), 350–360. https://doi.org/10.1542/peds.2009-0388
36. Bailey, D. B., Jr, Hebbeler, K., Scarborough, A., Spiker, D., & Mallik, S. (2004). First experiences with early intervention: a national perspective. Pediatrics, 113(4), 887–896. https://doi.org/10.1542/peds.113.4.887
37. Jain, R., Arora, A., Anand, R., Malhotra, S., Mittal, M., & Juneja, M. (2017). Designing and Validation of a Hindi-language Parent Self-report Developmental Screening Tool. Indian pediatrics, 54(7), 550–555. https://doi.org/10.1007/s13312-017-1066-6
38. Chung, H. J., Yang, D., Kim, G. H., Kim, S. K., Kim, S. W., Kim, Y. K., Kim, Y. A., Kim, J. S., Kim, J. K., Kim, C., Sung, I. K., Shin, S. M., Oh, K. J., Yoo, H. J., Yu, H. J., Lim, S. J., Lee, J., Jeong, H. I., Choi, J., Kwon, J. Y., … Eun, B. L. (2020). Development of the Korean Developmental Screening Test for Infants and Children (K-DST). Clinical and experimental pediatrics, 63(11), 438–446. https://doi.org/10.3345/cep.2020.00640
39. Shahshahani, S., Vameghi, R., Azari, N., Sajedi, F., & Kazemnejad, A. (2010). Validity and Reliability Determination of Denver Developmental Screening Test-II in 0-6 Year-Olds in Tehran. Iranian journal of pediatrics, 20(3), 313–322.
40. Fischer, V. J., Morris, J., & Martines, J. (2014). Developmental screening tools: Feasibility of use at primary healthcare level in low- and middle-income settings. Journal of Health, Population and Nutrition, 32(2), 314–326. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4216967/
41. Ganvir, S., Rai, S., Harishchandre, M., Ganvir, S., & Kunde, C. (2023). 'Pragati Pustak' A parent-oriented screening tool for identification of developmental delay: Utility and efficacy (7-year longitudinal study) [Poster presentation]. World Physiotherapy Congress 2023, Dubai, United Arab Emirates. World Physiotherapy. https://world.physio/congress-proceeding/pragati-pustak-parent- oriented-screening-tool-identification-development-delay
42. Chandrasekar, K., Venkatesh, L., Ramkumar, V., Subramaniyan, B., & Varadharajan, V. (2023). Validation of a developmental screening tool from a national health program in India for screening speech-language disorders among children. Wellcome Open Research, 8, 576. https://doi.org/10.12688/wellcomeopenres.20103.1
43. Ganz, J. B., Morin, K. L., Foster, M. J., Vannest, K. J., Genç Tosun, D., Gregori, E. V., & Gerow, S. L. (2017). High-technology augmentative and alternative communication for individuals with intellectual and developmental disabilities and complex communication needs: a meta-analysis. Augmentative and alternative communication (Baltimore, Md. : 1985), 33(4), 224–238. https://doi.org/10.1080/07434618.2017.1373855
44. Bornman, J., Romski, M., King, M., Madima, V., & Sevcik, R. A. (2020). Supporting Early Communication Skills of Children with Developmental Disorders in South Africa: Caregiver and Clinician Perspectives about Mobile Health Applications. Infants and young children, 33(4), 313–331. https://doi.org/10.1097/iyc.0000000000000177
45. Moon, S. J., Hwang, J., Hill, H. S., Kervin, R., Birtwell, K. B., Torous, J., McDougle, C. J., & Kim, J. W. (2020). Mobile device applications and treatment of autism spectrum disorder: a systematic review and meta-analysis of effectiveness. Archives of disease in childhood, 105(5), 458–462. https://doi.org/10.1136/archdischild-2019-318258
46. Frankenburg, W. K., Dodds, J., Archer, P., Shapiro, H., & Bresnick, B. (1992). The Denver II: a major revision and restandardization of the Denver Developmental Screening Test. Pediatrics, 89(1), 91–97.
47. Kim, D., Choe, Y. J., Durrani, B. A. Z., Kim, E., Byeon, J., & Eun, B. L. (2023). Korean Developmental Screening Test for Infants and Children (K-DST): development, applications, and implications for future early childhood development interventions. Clinical and experimental pediatrics, 66(7), 288–293. https://doi.org/10.3345/cep.2022.00906
48. Kuralbayeva, A. & Pilten, Gülhiz & Tasova, A. & Ibragimova, A.. (2025). DENVER II AND OTHER DEVELOPMENTAL SCREENING TESTS' SIGNIFICANCE IN ASSESSING CHILD DEVELOPMENT. BULLETIN SERIES OF PEDAGOGICAL SCIENCES. 85. 10.51889/2959-5762.2025.85.1.030.
49. Chattopadhyay, Nandita; Mitra, Kaninika1; Basu, Swati; Pal, Ranabir; Ghosh, Amrita. Risk Factors of Impediment of the Early Childhood Development in Rural Bengal. Journal of Applied Sciences and Clinical Practice 5(2):p 85-90, May–Aug 2024. | DOI: 10.4103/jascp.jascp_19_24

50. Walker, S. P., Wachs, T. D., Grantham-McGregor, S., Black, M. M., Nelson, C. A., Huffman, S. L., Baker-Henningham, H., Chang, S. M., Hamadani, J. D., Lozoff, B., Gardner, J. M., Powell, C. A., Rahman, A., & Richter, L. (2011). Inequality in early childhood: risk and protective factors for early child development. Lancet (London, England), 378(9799), 1325–1338. https://doi.org/10.1016/S0140-6736(11)60555-2

51. Faruk, T., King, C., Muhit, M., Islam, M. K., Jahan, I., Baset, K. U., Badawi, N., & Khandaker, G. (2020). Screening tools for early identification of children with developmental delay in low- and middle-income countries: a systematic review. BMJ open, 10(11), e038182. https://doi.org/10.1136/bmjopen-2020-038182

52. Warren, R., Kenny, M., Bennett, T., Fitzpatrick-Lewis, D., Ali, M. U., Sherifali, D., & Raina, P. (2016). Screening for developmental delay among children aged 1-4 years: a systematic review. CMAJ open, 4(1), E20–E27. https://doi.org/10.9778/cmajo.20140121

53. Aldharman, S. S., Al-Jabr, K. H., Alharbi, Y. S., Alnajar, N. K., Alkhanani, J. J., Alghamdi, A., Abdellatif, R. A., Allouzi, A., Almallah, A. M., & Jamil, S. F. (2023). Implications of Early Diagnosis and Intervention in the Management of Neurodevelopmental Delay (NDD) in Children: A Systematic Review and Meta-Analysis. Cureus, 15(5), e38745. https://doi.org/10.7759/cureus.38745

54. Shin, Y., Park, E. J., & Lee, A. (2025). Early Intervention for Children With Developmental Disabilities and Their Families via Telehealth: Systematic Review. Journal of medical Internet research, 27, e66442. https://doi.org/10.2196/66442.

**Original Article**

*DOI: https://doi.org/10.37506/ccxd2a65*

# Examining how Nudge Theory-Based Interventions can Positively Affect Diabetes Patients on AKAP in Sikkim

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**How to cite this article**: Swastika Thapa, Manesh Choubey. Examining how Nudge Theory-Based Interventions can Positively Affect Diabetes Patients on AKAP in Sikkim. Indian Journal of Public Health Research and Development/ Vol. 17 No. 3, July-September 2026.

## Abstract

**Introduction:** Diabetes mellitus, a lifestyle illness, is a major public health problem around the world, and its numbers are growing in India, and Sikkim, a northeastern state, is no exception**.** Sikkim, often known to have a pristine environment where people come for rejuvenation, also shares the same burden when it comes to the incidence of lifestyle diseases such as diabetes mellitus. Hence, effective management is very crucial, and itlargely depends on patients' awareness, knowledge, attitude, and practices (AKAP) regarding the condition.

**Aim:** This study aimed to examine the impact of interventions such as telephonic reminders based on nudge theory combined with ambassadors on the AKAP of diabetes patients in Sikkim.

**Methods:** This study selected 160 diabetes patients from Sikkim via purposive sampling (80 experimental, 80 control). Both groups were asked to complete a 5-point Likert scale questionnaire to assess the Awareness, Knowledge, Attitude, and Practices (AKAP) before any intervention. The experimental group then received an intervention in the form of whatsaap messaging, telephonic calls combined with an ambassador, while the control group did not. Both the groups re-completed the AKAP questionnaire post the intervention. Data were analysed using SPSS 25, using paired t-tests for within-group comparisons and ANCOVA to study the impact between-groups.

**Results:** Paired t-test results showed that there was no significant changein pre- and post-intervention AKAP scores for diabetes patients in the control group. Conversely, the treatment group showed a significant increase in their mean scores for awareness, knowledge, attitude, and practices related to diabetes from pre- to post-intervention. Aditionally, the ANCOVA results validated that the nudge theory-based intervention, combined with consultation, had a positive and significant impact on the awareness, knowledge, attitudes, and practices of diabetes patients.

**Implications:** This study highlights the effectiveness of using nudge theory as an approach to improve health behaviours amongst people in Sikkim, indicating that subtle cues and consultations empower patients to make better health choices. It highlights the importance of ongoing telephonic interventions combined with ambassador or consultation for improving AKAP, resulting in enhanced self-care and reduced complications. Policymakers and healthcare providers can use these nudge based results to create health initiatives that are scalable and culturally appropriate.

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**Submission date:** January 26, 2026 **Revision date:** March 9, 2026 **Published date:** June 29, 2026

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**Conclusion:** This study shows how nudge theory-based interventions, when combined with ambassadors, can significantly improve the awareness, knowledge, attitude, and practices of diabetes patients in Sikkim. These results indicate that such interventions can act as an effective approach to improve diabetes self-care attitude and patient's health behaviour.

**Keywords:** Behavioural Intervention, Patient Education & Diabetes Management, Nudge Theory, Local Ambassador, Sikkim

## Introduction

Lifestyle diseases are illnesses that have become linked to behavior. Health behaviors have emerged as a significant subject for investigation. Behavioral problems are causing most diseases to go worse. Nudge theory is one of the new theories that tries to change how people act without taking away their ability to choose. Diabetes is one of the diseases that can be cured by changing ones behavior. As it is a disease moving to distant regions with various cultures, like Sikkim, it is important to investigate it. Type 2 diabetes is rising quickly across the country, and the Northeast region is more vulnerable because of differences in income, culture, healthcare infrastructure, and diet and is no longer just a problem for those who live in cities or are wealthy. It is also affecting rural and tribal communities, many of which don't have access to the right information, quick diagnosis, or good management methods[1]. In Sikkim, the convergence of lifestyle changes, genetic factors, and insufficient awareness and dependence on herbal home remedies has intensified the prevalence of diabetes. Even while many people employ traditional healing methods and herbal medicines[2-4,] and some of them have been shown to help with diabetes, there is still not much scientific research on preventative healthcare[5]. Traditional wisdom, although beneficial, is also accompanied with cultural misconceptions[6] that may impede adherence to evidence-based treatment. For instance, research in comparable Northeastern settings indicates that certain tribal people depend on food taboos or herbal alternatives, frequently overlooking therapeutic interventions.[7]

Alcohol use and anexcessive non-vegetarian diet which are known contributors of lifestyle diseases are not new in Sikkim when it comes to food habits. They are part of festivities and everyday life. The 2015 National Family Health Survey (NFHS-5) shows that Sikkimese women are now ranked second while male counterparts are ranked third across the country in alcohol consumption[8].

Lifestyle diseases such as diabetes and its poor management result in consequences or complications such as retinopathy, neuropathy and cardiovascular.[9] Lifestyle patients pursue care like ophthalmic care[10] solely after the onset of vision loss, despite prior awareness of diabetic problems, highlighting a discrepancy between awareness[11] and prompt action.[12-16] This gap definitely shows how important it is to come up with new ways to share knowledge that go beyond just information dissemination. One way could be to utilize nudge-based interventions, which are behaviorally informed methods that gently push people to make healthier choices without forcing them to do so. Nudges have demonstrated efficacy in facilitating lifestyle changes, encouraging regular check-ups, and ensuring drug compliance in chronic disease management by simplifying options, reinforcing prompts, or providing timely reminders. There are evidences where interventions such as mobile phone messaging and smartphones, and sustained education and support[17-21] have been successful in managing lifestyle diseases[22-23] Conclusions were derived that lessons from behavioural economics could improve incentive-program design, thus giving scope for further research.[24] Nonetheless, their utilization within diabetic populations in North eastern India, especially in Sikkim, is still in adequately investigated.

This study seeks to fill this research gap by pursuing three distinct objectives. First, it looks at the socio-demographic characteristics of people with diabetes in the state. It is important to understand how education level and income level affect each other in order to put intervention results in context. Second, the study evaluates the effect of a nudge-based intervention combined with ambassadors on the AKAP of these patients. This is vital, as previous research indicates significant gaps in knowledge, with

rural and less educated populations exhibiting less awareness and inadequate preventive behaviors.[25-26] Third, the study examines the correlation between differences in AKAP levels and several socio-economic groups. This project aims to offer evidence-based insights into the enhancement of diabetes control in Sikkim through behaviorally informed treatments. The project seeks to merge cultural sensitivity with behavioral science to connect awareness and action, thereby enhancing public health initiatives for non-communicable disease management in Northeast India.

**Need and Significance of the study**

Diabetes is becoming a bigger public health problem in India, especially in places like Sikkim that don't have enough health care and information for patients. Diagnosis and access to excellent diabetes care continue to pose substantial obstacles, with a considerable percentage of cases remaining undiagnosed, particularly in rural regions.[27] To find vulnerable populations and make sure that strategies are appropriate for them, it is important to know the socio-demographic and clinical profile of diabetes patients in Sikkim. Even if treatment is available, patients typically have inadequate awareness, knowledge, attitude, and practices (AKAP), which makes it hard to manage their disease well.

This study is important because it uses a behavioral science strategy called a "nudge" to help people take better care of their diseases. Studies have often mentioned about the importance of self management in case of diabetes.[28-29] indicating that self-care activities and behavioural interventions plays an important role.[30-32] Nudge methods[33-34] are one of those methods known to help in self care and assist patients in making healthier choices about their lifestyles and treatments by quietly affecting their decision-making without limiting their options. Examining the feasibility of such an intervention provides evidence-based information regarding its potential for widespread public health applications. Interventions may include reminders, appealing nomenclatures, awareness initiatives, incentivized programs, mass media campaigns and so on.[35-36]

Additionally, by analyzing variations in AKAP levels among different socio-economic backgrounds, the study underscores health inequities and aids in the formulation of targeted, inclusive initiatives. The findings will supplement academic research and inform local health policy by providing a context-specific, cost-effective behavioral intervention to improve diabetes care outcomes in Sikkim.

**Objectives of the study**

1. To examine the socio-demographic profile of diabetes patients in Sikkim.
2. To assess the impact of a nudge-based intervention on the awareness, knowledge, attitude, and practices (AKAP) of diabetes patients in Sikkim using telephonic reminders as intervention.
3. To analyse variations in AKAP levels among diabetes patients across different SES groups.

**Research Gap**

While current research thoroughly elucidates the prevalence, risk factors, and ethnobotanical practices associated with diabetes in Northeast India, particularly in Sikkim, there is a paucity of empirical evidence investigating the synergistic impact of nudge-based interventions on the awareness, knowledge, attitudes, and practices (AKAP) of diabetes patients. Furthermore, while socio-demographic factors affecting illness prevalence have been investigated, a comparative analysis of AKAP levels across various socio-demographic backgrounds is still insufficiently examined in the context of Sikkim.

**Research Methodology**

This quasi-experimental study employed a quantitative approach to assess the impact of a nudge-based intervention on the awareness, knowledge, attitude, and practice (AKAP) of Diabetes patients in Sikkim. A total of 160 samples 80 in the control group (CG) and 80 in the experimental group (EG) were selected using purposive sampling. Data was collected using a self-developed questionnaire administered in both online and offline formats during pre- and post-intervention phases. Between these phases, EG received an eight-week structured nudge intervention grounded in behavioral economics. The intervention consisted of:

- SMS reminders, whatsapp messages to encourage timely blood sugar monitoring

and medication adherence. In this method, there were creative and educational messages about healthy eating, meaning of HBA1C test, importance of urine albumin test for early signs of kidney health, importance of nutritional diet and physical activity were sent via whatsapp

- Visual cues like posters reinforcing healthy eating and lifestyle tips : the same messages as above but in creative posters and short educative videos were sent
- Ambassador supported telephonic calls: Here the ambassador was a renowned doctor associated with STNM hospital which helped us to get credibility and gain trust from the patients when calls were made referring his name. Also, the messages that were sent was validated by the ambassador. As Sikkim is a small state where social ties, acquaintances and social relationships are high, being associated with such personnels made the research process slightly easier. A similar study was conducted by JPAL when researches combined with local renowned ambassador helped in reaching more population as compared to without one. Sikkim is a close-knit society where local ambassadors are valued, which is why this strategy was chosen.
- The frequency of messages were atleast once a week but aimed to sentatleastonce in every 3 days.

These nudges aimed to influence patient behavior subtly, without limiting choices or using financial incentives. Following the intervention, post-test data was collected from both groups. The data was cleaned, coded, and analyzed using frequency distribution, paired t-tests, and ANCOVA through SPSS software.

## Data Analysis and Interpretation

### Socio-Demographic Characteristics of Diabetes Patients (n = 160)

**Table 1: Socio-Demographic Characteristics of Diabetes Patients (n = 160)**

| Variable wise category | | CG (n=80) | EG (n=80) | Total (n=160) |
|---|---|---|---|---|
| Age | 21–30 | 9 (11.3%) | 13 (16.3%) | 22 (13.8%) |
| | 31–40 | 20 (25.0%) | 16 (20.0%) | 36 (22.5%) |
| | 41–50 | 24 (30.0%) | 23 (28.7%) | 47 (29.4%) |
| | 51–60 | 21 (26.3%) | 20 (25.0%) | 41 (25.6%) |
| | 60+ | 6 (7.5%) | 8 (10.0%) | 14 (8.8%) |
| | Total | 80 (100.0%) | 80 (100.0%) | 160 (100.0%) |
| Gender | Male | 62 (77.5%) | 63 (78.8%) | 125 (78.1%) |
| | Female | 18 (22.5%) | 17 (21.3%) | 35 (21.9%) |
| | Total | 80 (100.0%) | 80 (100.0%) | 160 (100.0%) |
| Socio-Economic Status | Lower | 21 (26.3%) | 26 (32.5%) | 47 (29.4%) |
| | Upper Lower | 8 (10.0%) | 2 (2.5%) | 10 (6.3%) |
| | Lower Middle | 39 (48.8%) | 40 (50.0%) | 79 (49.4%) |
| | Upper Middle | 12 (15.0%) | 12 (15.0%) | 24 (15.0%) |
| | Total | 80 (100.0%) | 80 (100.0%) | 160 (100.0%) |
| Education | Primary | 15 (18.8%) | 14 (17.5%) | 29 (18.1%) |
| | Secondary | 10 (12.5%) | 8 (10.0%) | 18 (11.3%) |
| | Intermediate | 27 (33.8%) | 26 (32.5%) | 53 (33.1%) |
| | Graduation | 12 (15.0%) | 15 (18.8%) | 27 (16.9%) |
| | Post-Graduation | 10 (12.5%) | 11 (13.8%) | 21 (13.1%) |
| | Technical | 5 (6.3%) | 5 (6.3%) | 10 (6.3%) |
| | Other | 1 (1.3%) | 1 (1.3%) | 2 (1.3%) |

Continue.....

| | | | | |
|---|---|---|---|---|
| | Total | 80 (100.0%) | 80 (100.0%) | 160 (100.0%) |
| Patient Income | < ₹15,000 | 28 (35.0%) | 19 (23.8%) | 47 (29.4%) |
| | ₹15k–30k | 26 (32.5%) | 28 (35.0%) | 54 (33.8%) |
| | ₹30k–45k | 13 (16.3%) | 11 (13.8%) | 24 (15.0%) |
| | ₹45k–60k | 5 (6.3%) | 7 (8.8%) | 12 (7.5%) |
| | ₹60k–75k | 0 (0.0%) | 5 (6.3%) | 5 (3.1%) |
| | > ₹75,000 | 0 (0.0%) | 4 (5.0%) | 4 (2.5%) |
| | No Income | 8 (10.0%) | 6 (7.5%) | 14 (8.8%) |
| | Total | 80 (100.0%) | 80 (100.0%) | 160 (100.0%) |
| Family Income | < ₹15,000 | 7 (8.8%) | 2 (2.5%) | 9 (5.6%) |
| | ₹15k–30k | 10 (12.5%) | 9 (11.3%) | 19 (11.9%) |
| | ₹30k–45k | 14 (17.5%) | 9 (11.3%) | 23 (14.4%) |
| | ₹45k–60k | 30 (37.5%) | 25 (31.3%) | 55 (34.4%) |
| | ₹60k–75k | 15 (18.8%) | 13 (16.3%) | 28 (17.5%) |
| | > ₹75,000 | 4 (5.0%) | 22 (27.5%) | 26 (16.3%) |
| | Total | 80 (100.0%) | 80 (100.0%) | 160 (100.0%) |
| Permanent Location | Urban | 19 (23.8%) | 31 (38.8%) | 50 (31.3%) |
| | Rural | 58 (72.5%) | 48 (60.0%) | 106 (66.3%) |
| | Semi-Urban | 3 (3.8%) | 1 (1.3%) | 4 (2.5%) |
| | Total | 80 (100.0%) | 80 (100.0%) | 160 (100.0%) |

**Interpretation:** The age group 41–50 years was most represented (29.4%), followed by 51–60 years (25.6%) across both groups. Males constituted a significant majority (78.1%). Nearly half the respondents belonged to the lower-middle socio-economic class (49.4%). Most had education up to intermediate level (33.1%), and only 6.3% were technically or professionally qualified. Patient income was highest in the ₹15,001–30,000 range (33.8%), and 8.8% reported no income. A large share of families earned between ₹45,001–60,000 (34.4%), with EG showing a higher concentration in the >₹75,000 category. Rural residents dominated the sample (66.3%), though urban representation was higher in the experimental group

**Paired Sample T-Test: Comparing Pre- and Post-Intervention Level of Awareness, Knowledge, Attitude, and Practice Among Diabetes Patients in the Control Group (n=80)**

- **$H_0$ 1:** There is no significant difference in the awareness levels between pre- and post-intervention phases among Diabetes patients in the control group.
- **$H_0$ 2:** There is no significant difference in the knowledge levels between pre- and post-intervention phases among Diabetes patients in the control group.
- **$H_0$ 3:** There is no significant difference in the attitude between pre- and post-intervention phases among Diabetes patients in the control group.
- **$H_0$ 4:** There is no significant difference in the practice levels between pre- and post-intervention phases among Diabetes patients in the control group.

**Table 2: Comparing Pre- and Post-Intervention Level of Awareness, Knowledge, Attitude, and Practice Among Diabetes Patients in the Control Group (n=80)**

| Paired Samples Statistics[a] | | | | | Correlations | | Paired Differences | |
|---|---|---|---|---|---|---|---|---|
| | | Mean | N | Std. D | r | sig | T | Sig |
| Pair 1 | Awareness (Pre-Intervention) Scale | 1.72 | 80 | .44 | .937 | .000 | 1.423 | .159 |
| | Awareness (Post-Intervention) Scale | 1.75 | 80 | .43 | | | | |
| Pair 2 | Knowledge (Pre-Intervention) Scale | 1.95 | 80 | .27 | .815 | .000 | 1.423 | .159 |
| | Knowledge (Post-Intervention) Scale | 1.97 | 80 | .22 | | | | |
| Pair 3 | Attitude (Pre-Intervention) Scale | 1.68 | 80 | .46 | .971 | .000 | 1.000 | .320 |
| | Attitude (Post-Intervention) Scale | 1.70 | 80 | .46 | | | | |
| Pair 4 | Practice (Pre-Intervention) Scale | 1.86 | 80 | .41 | .963 | .000 | 1.000 | .320 |
| | Practice (Post-Intervention) Scale | 1.87 | 80 | .40 | | | | |
| a. Respondents = Control Group | | | | | | | | |

**Interpretation:**

- **Pair 1 –Awareness:** The mean awareness score increased marginally from 1.72 ± 0.44 (pre-intervention) to 1.75 ± 0.43 (post-intervention). A very strong positive correlation was found between the two time points ($r = .937$, $p < .001$), indicating consistency in responses. However, the t-value = 1.423 and $p = .159$, which is greater than the 0.05 significance threshold. Thus, the result is not statistically significant, and $H_0$ 1 is accepted, indicating no significant difference in awareness levels pre- and post-intervention in the control group.
- **Pair 2 –Knowledge:** The average knowledge score rose slightly from 1.95 ± 0.27 to 1.97 ± 0.22 after the intervention. The correlation between the scores was strong ($r = .815$, $p < .001$), yet the t-value = 1.423 and $p = .159$, again exceeding the 0.05 threshold. Hence, the change is statistically insignificant, and $H_0$ 2 is accepted, confirming no significant improvement in knowledge within the control group.
- **Pair 3 – Attitude:** Attitude scores showed a minor increase from 1.68 ± 0.46 to 1.70 ± 0.46. A very strong correlation was observed ($r = .971$, $p < .001$), but the t-value = 1.000 and $p = .320$ are not statistically significant. Therefore, $H_0$ 3 is accepted, suggesting no significant change in attitude due to the intervention among the control group participants.
- **Pair 4 –Practice:** Practice levels increased slightly from 1.86 ± 0.41 to 1.87 ± 0.40. The correlation was again very strong ($r = .963$, $p < .001$), but the t-value = 1.000 and $p = .320$ indicate no statistical significance. Consequently, $H_0$ 4 is accepted, meaning no significant improvement in practice scores post-intervention.

## Summary

Across all four AKAP dimensions, the control group demonstrated very high correlations between pre- and post-intervention scores, indicating consistent responses. However, none of the differences were statistically significant, as all p-values exceeded 0.05. Therefore, all null hypotheses ($H_0$ 1 to $H_0$ 4) were accepted, confirming that the in the absence of intervention there is no significant impact on awareness, knowledge, attitude, or practice among diabetes patients in the control group.

**Paired Sample T-Test: Comparing Pre- and Post-Intervention Level of Awareness, Knowledge, Attitude, and Practice Among Diabetes Patients in the Experimental Group (n=80)**

- **$H_0$ 1:** There is no significant difference in the awareness levels between pre- and post-intervention phases among Diabetes patients in the experimental group.
- **$H_0$ 2:** There is no significant difference in the knowledge levels between pre- and post-intervention phases among Diabetes patients in the experimental group.

- **$H_0$ 3:** There is no significant difference in the attitude between pre- and post-intervention phases among Diabetes patients in the experimental group.
- **$H_0$ 4:** There is no significant difference in the practice levels between pre- and post-intervention phases among Diabetes patients in the experimental group.

**Table 3: Comparing Pre- and Post-Intervention Level of Awareness, Knowledge, Attitude, and Practice Among Diabetes Patients in the Experimental Group (n=80)**

| Paired Samples Statistics[a] | | | | | Correlations | | Paired Differences | |
|---|---|---|---|---|---|---|---|---|
| | | Mean | N | Std. D | r | Sig | T | sig |
| Pair 1 | Awareness (Pre-Intervention) Scale | 1.75 | 80 | .46 | .105 | .353 | 34.723 | .000 |
| | Awareness (Post-Intervention) Scale | 3.97 | 80 | .38 | | | | |
| Pair 2 | Knowledge (Pre-Intervention) Scale | 1.92 | 80 | .26 | .021 | .854 | 32.944 | .000 |
| | Knowledge (Post-Intervention) Scale | 4.03 | 80 | .51 | | | | |
| Pair 3 | Attitude (Pre-Intervention) Scale | 1.63 | 80 | .48 | -.098 | .385 | 31.145 | .000 |
| | Attitude (Post-Intervention) Scale | 4.01 | 80 | .43 | | | | |
| Pair 4 | Practice (Pre-Intervention) Scale | 1.82 | 80 | .38 | .035 | .761 | 31.011 | .000 |
| | Practice (Post-Intervention) Scale | 4.11 | 80 | .55 | | | | |
| a. Respondents = EG | | | | | | | | |

**Interpretation:**

- **Pair 1 – Awareness:** The mean awareness score significantly increased from 1.75 ± 0.46 (pre-intervention) to 3.97 ± 0.38 (post-intervention). The correlation between pre- and post-scores was weak (r = .105, p = .353), indicating low linear consistency, likely due to the marked improvement. The t-value = 34.723 and p = .000, which is well below the 0.05 threshold, demonstrate a highly significant difference. Therefore, $H_0$ 1 is rejected, confirming that the intervention had a statistically significant effect on improving awareness.
- **Pair 2 – Knowledge:** Participants' knowledge levels increased from 1.92 ± 0.26 to 4.03 ± 0.51. The correlation was very weak (r = .021, p = .854), possibly reflecting a substantial shift in responses post-intervention. The t-value = 32.944 and p = .000 confirm this improvement is statistically significant. Hence, $H_0$ 2 is rejected, indicating a significant gain in knowledge due to the intervention.
- **Pair 3 – Attitude:** The attitude score rose from 1.63 ± 0.48 to 4.01 ± 0.43, reflecting a substantial shift in perception. The correlation was slightly negative and non-significant (r = –.098, p = .385), suggesting variable response patterns. However, the t-value = 31.145 and p = .000 show a strong statistically significant difference. Therefore, $H_0$ 3 is rejected, indicating a significant positive change in attitude post-intervention.
- **Pair 4 –Practice:** Practice scores improved from 1.82 ± 0.38 to 4.11 ± 0.55, indicating enhanced health-related behavior. The correlation between scores was negligible (r = .035, p = .761), but the t-value = 31.011 and p = .000 reveal a statistically significant difference. Hence, $H_0$ 4 is rejected, confirming a significant improvement in practice among participants after the intervention.

## Summary

All four variablesawareness, knowledge, attitude, and practiceshowed statistically significant improvements in the experimental group, as indicated by high t-values and p-values < .001. Despite weak or insignificant correlations, the intervention produced substantial gains across all domains. Therefore, all null hypotheses ($H_0$ 1 to $H_0$ 4) are rejected, establishing that the nudge-based intervention was highly effective in enhancing AKAP among diabetes patients in the experimental group.

**Analysis of Covariance (ANCOVA): Awareness, Knowledge, Attitude and Practice of Diabetes Patients of 4 Socio- Economic Status (SES) Groups**

- **$H_0$ 1:** There is no significant difference between adjusted mean scores of Awareness of Diabetes Patients of 4 SES Groups by considering their Awareness Score (pre-intervention) as covariate.
- **$H_0$ 2:** There is no significant difference between adjusted mean scores ofKnowledge of Diabetes Patients of 4 SES Groups by considering their Knowledge Score (pre-intervention) as covariate.
- **$H_0$ 3:** There is no significant difference between adjusted mean scores of Attitudes of Diabetes Patients of 4 SES Groups by considering their Attitude Score (pre-intervention) as covariate.
- **$H_0$ 4:** There is no significant difference between adjusted mean scores of Practices of Diabetes Patients of 4 SES Groups by considering their Practice Score (preintervention) as covariate.

**Table 4: Awareness, Knowledge, Attitude and Practice of Diabetes Patients of 4 Socio- Economic Status (SES) Groups**

| Variable | Socio-Economic Status | Mean ± SD | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|
| Awareness (Post) | Lower Class (n=26) | 3.58 ± 0.64 | 7.361 | .000 | .227 |
| | Upper Lower Class (n=2) | 4.00 ± 0.00 | | | |
| | Lower Middle Class (n=40) | 4.15 ± 0.58 | | | |
| | Upper Middle Class (n=12) | 4.42 ± 0.51 | | | |
| | Total (n=80) | 4.00 ± 0.66 | | | |
| Knowledge (Post) | Lower Class (n=26) | 3.92 ± 0.39 | .629 | .599 | .025 |
| | Upper Lower Class (n=2) | 4.00 ± 0.00 | | | |
| | Lower Middle Class (n=40) | 4.03 ± 0.53 | | | |
| | Upper Middle Class (n=12) | 4.17 ± 0.72 | | | |
| | Total (n=80) | 4.01 ± 0.52 | | | |
| Attitude (Post) | Lower Class (n=26) | 3.88 ± 0.43 | 1.990 | .123 | .074 |
| | Upper Lower Class (n=2) | 4.50 ± 0.71 | | | |
| | Lower Middle Class (n=40) | 4.05 ± 0.39 | | | |
| | Upper Middle Class (n=12) | 4.08 ± 0.51 | | | |
| | Total (n=80) | 4.01 ± 0.44 | | | |
| Practice (Post) | Lower Class (n=26) | 3.88 ± 0.52 | 9.061 | .000 | .266 |
| | Upper Lower Class (n=2) | 4.00 ± 0.00 | | | |
| | Lower Middle Class (n=40) | 4.13 ± 0.46 | | | |
| | Upper Middle Class (n=12) | 4.75 ± 0.45 | | | |
| | Total (n=80) | 4.14 ± 0.55 | | | |

**Interpretation:**

- **Awareness (Post-Intervention):** The ANCOVA results revealed a **statistically significant difference** in the adjusted mean scores of *awareness* among the four SES groups after controlling for pre-intervention awareness scores (**F = 7.361**, **p = .000**, **Partial Eta Squared = .227**). This suggests that socio-economic status had a considerable effect on patients' awareness levels post-intervention. Specifically, the mean ± SD scores increased with higher SES: Lower Class (3.58 ± 0.64), Upper Lower Class (4.00 ± 0.00), Lower Middle Class (4.15 ± 0.58), and Upper Middle Class (4.42 ± 0.51). Since $p < .05$, **H0 1 is rejected**, indicating a significant difference in awareness across SES groups.
- **Knowledge (Post-Intervention):** There was **no statistically significant difference** in the adjusted mean knowledge scores

among the SES groups (**F = 0.629**, **p = .599**, **Partial Eta Squared = .025**) after controlling for pre-intervention knowledge. The post-intervention mean ± SD scores were: Lower Class (3.92 ± 0.39), Upper Lower Class (4.00 ± 0.00), Lower Middle Class (4.03 ± 0.53), and Upper Middle Class (4.17 ± 0.72). As the p-value is greater than .05, **H0 2 is accepted**, meaning socio-economic status did not significantly influence knowledge scores after the intervention.

- **Attitude (Post-Intervention):** For *attitude*, the ANCOVA results showed **no statistically significant difference** in the adjusted mean scores among SES groups (**F = 1.990**, **p = .123**, **Partial Eta Squared = .074**) when pre-intervention attitude scores were controlled. The mean ± SD scores were: Lower Class (3.88 ± 0.43), Upper Lower Class (4.50 ± 0.71), Lower Middle Class (4.05 ± 0.39), and Upper Middle Class (4.08 ± 0.51). Although slight differences in mean scores exist, especially with the Upper Lower Class scoring highest, the difference was not statistically significant. Therefore, **H0 3 is accepted**.
- **Practice (Post-Intervention):** The analysis revealed a **statistically significant difference** in the adjusted mean practice scores among the SES groups (**F = 9.061**, **p = .000**, **Partial Eta Squared = .266**) after controlling for pre-intervention scores. Mean ± SD scores were: Lower Class (3.88 ± 0.52), Upper Lower Class (4.00 ± 0.00), Lower Middle Class (4.13 ± 0.46), and Upper Middle Class (4.75 ± 0.45). The increasing trend in mean scores from lower to upper SES groups indicates that patients from higher SES backgrounds adopted better practices after the intervention. Since $p < .05$, **H0 4 is rejected**, confirming a significant difference in practice across SES groups.

## Conclusion

The experimental group that received the nudge-based intervention, had big improvements in all four areas(AKAP) that were examined. At first, both the control and experimental groups had similar AKAP ratings. After the intervention was given, however, the two groups showed different patterns. The control group, which did not receive any nudge, had minimal to no variation in their AKAP levels following the intervention, indicating that the behavioural signals built into the intervention worked to raise awareness of diabetes and encourage better behaviours. It supports the idea that people with lifestyle diseases like diabetes may not change their health-related attitudes and behaviors over time unless they are given specific behavioural triggers or informational reinforcement. When nudges fit nicely into the daily job of important decision-makers, they are more likely to work.[37]

These results indicate that low-cost, scalable interventions, as simple as telephonic calls and reminders in the form of subtle nudges, might significantly enhance illness self-management, particularly in areas like Sikkim where health infrastructure and outreach may be constrained but social ties are very strong. The findings are consistent with behavioral science literature that endorses the utilization of nudges to affect decision-making by gradually modifying the choice environment while preserving individual autonomy.

Additionally, the study explored the influence of socio-economic status (SES) on the intervention's impact. While knowledge and attitude did not significantly differ across SES categories, the analysis revealed meaningful disparities in awareness and practice. Participants from higher socio-economic backgrounds demonstrated relatively more improvement in these two areas, potentially due to better access to health resources, stronger health literacy, and greater environmental support. Taken together, the study confirms that behavioral interventions have the capacity to create measurable improvements in lifestyle disease management. However, to maximize their impact, such efforts must be context-sensitive and responsive to the lived realities of different population subgroups. These insights offer valuable guidance for policymakers, public health practitioners, and healthcare providers aiming to develop behaviorally informed and equity-centered diabetes management programs. However, in this study, it is vital to stress that research conducted on an individual basis may encounter trust issues and operational challenges. The same studies conducted in collaboration with a recognized local figure, dignitary, or expert might facilitate confidence and ease in the study process. However, to choose this strategy, it is also vital to know how the group does things culturally.

**Implications**

The study's findings have important effects on many people who are active in diabetes care and policy implementation in Sikkim:

1. Health Authorities: Nudge programmes can help diabetic patients become more aware, knowledgeable, and positive about their condition and change their behavior. Public health departments should add these behavioural tactics to community-based health programs while considering social and economic status to ensure better results.
2. Healthcare Providers: Behavioral nudges, like reminders, visual cues, and individualized counsel can be adopted by healthcare providers to help patients maintain healthy practices. Customizing communication according to the patient's socio-economic background can enhance outcomes by rendering the intervention more relatable and actionable.
3. Policymakers: The study underscores the significance of behavioral science in public health planning. Policy makers can also use behavioral nudges to help people achieve better health outcomes. Programs should be funded and designed with an equity lens to address their varied impacts on different socio-economic groups.
4. NGOs and Community Organizations: Local non-profit organizations can also contribute in bringing these interventions to the people who need them most. Community health workers can be taught to effectively implement nudges, especially in poor areas where notable gaps in awareness and practice have been identified.
5. Researchers and Academics: This study paves the way for new researchers in this field. Collaborations with skilled and trained specialists can help researchers gain credibility in their work by identifying ground problems.
6. Patients and their caregivers: Knowing how well behavioral cues work might help patients and caregivers make tiny changes to their routines that help them better control their diabetes.

**Recommendations**

The study suggest the below recommendations to enhance diabetes awareness and management among patients in Sikkim:

1. Develop and disseminate culturally appropriate health education materials in local languages to increase awareness, symptoms and prevention strategies, in rural and semi-urban areas.
2. Leverage existing community health initiatives like ASHA and ANM outreach to include regular diabetes screening and counselling as part of routine visits.
3. Organize regular community-based workshops in collaboration with local NGOs and healthcare institutions to promote healthy eating, exercise and stress management.
4. Improve the availability of affordable diagnostic and treatment services in primary health centres and district hospitals, particularly for underserved populations.
5. Use mobile applications, social media, and SMS alerts to provide reminders for screening, medication adherence, and healthy lifestyle tips targeting younger and tech-savvy populations.
6. Conduct periodic training sessions for health professionals and frontline workers to update their knowledge and improve diabetes counselling skills.
7. Encourage family-based and peer-support interventions to improve adherence to diabetes management practices.

**Limitations and Future scope of study**

This study was constrained by its cross-sectional design, which limits causal inferences, and its dependence on self-reported data that may be subject to recall or social desirability bias. Subsequent research may implement a longitudinal design to evaluate temporal changes, investigate intervention-based models to enhance diabetes knowledge and practices, broaden the sample to encompass additional northeastern states for greater generalizability, and analyse the influence of digital tools in diabetes awareness and management. This research was structured as an experimental, single-site study executed over a brief period and a smaller

sample size, hence constraining the generalizability of the findings. The findings offer significant preliminary insights into behavioural determinants and their associated effects; nonetheless, they should be regarded as hypothesis-generating rather than definitive. Changes in behaviour and health typically happen over time, and the short follow-up period in this study may not show all the long-term impacts. Subsequent research utilizing multi-site methodologies with bigger samples and prolonged follow-up durations is essential to corroborate and enhance these findings, as well as to evaluate the durability of the reported behavioural and health consequences. It is also crucial to highlight that the effect of the study without the ambassador has not been researched.

**Informed Consent:** Informed consent was taken from all participants included in the study, where they were informed about the purpose of the research, confidentiality of their responses, and the right to withdraw from the study without any consequences.

**Ethical Clearance:** Ethical Clearance was obtained from the Institutional Ethics Committee of Sikkim University as well as from the study area. The study was conducted within the guidelines of the institutional ethics committee. *Prof Satyananda Panda Member secretary ,IEC committee 19/11/2025 No.SU/ REG/F-1/103/2019/Vol- II/782; STNM hospital Health and Family welfare department30/10/2025 730/STNM/ Adm-2025*

**Acknowledgements:** I would like to express my sincere gratitude to all the participants who shared their time and responses, the officers of the Health & Family Welfare Department, Principal Secretary Mr. S.D. Dhakal and the doctors of STNM hospital, Gangtok for providing support, guidance and encouragement during my study.

**Funding Sources***: NA*

**Declaration of conflicts of interest :** None

## References

1. Dutta A, Dutta PK, Baruah SM, Dihingia P, Ray A, Bhat DS, Patki SW, Tiwari P, Deshmukh M, Wagh R, Mulchandani R. Non-autoimmune diabetes in young people from Assam, India: the PHENOEINDY-2 study. Diabetologia. 2025 Oct;68(10):2179-93.
2. Kharsati N, Kulkarni M. Living with diabetes in Northeast India: An exploration of psychosocial factors in management. Dialogues in Health. 2024 Jun 1;4:100180.
3. Muksor, A., & Parmar, D. (2023). Cultural Beliefs and Practices in Self-Management of Diabetes Among Pnar Women in Meghalaya, India. The Science of Diabetes Self-Management and Care, 49(6), 462-476. https://doi.org/10.1177/26350106231208155
4. Gogoi H, Borah L, Hussain I, Dutta SR, Kalita N, Teron C, Saikia P, Rongpi S. A review on indigenous medicinal plants of north eastindia used as antidiabetic. Asian Journal of Pharmaceutical and Health Sciences. 2023;13(4).
5. Byahut A, Bag A. An update on medicinal plants traditionally used to treat diabetes in southeast Sikkim, India. Proceedings of the Indian National Science Academy. 2022 Jun;88(2):186-96.
6. Perme O, Komut O, Boruah M. Knowledge, Attitude and Practice of Diabetes among School Teachers in Upper Siang District of Arunachal Pradesh: A Cross-sectional Study. Journal of Clinical & Diagnostic Research. 2022 Oct 1;16(10).
7. Muksor A, Parmar D. Living with Diabetes in times of COVID-19 pandemic: A Qualitative Study from West Jaintia Hills, Meghalaya, India. Journal of North East India Studies. 2022 Jan 1;12(1):8-32.
8. Rai P, Firdos S. Exploring the Trends, Patterns, and Prevalence of Alcohol Consumption in Sikkim: Insights from the National Family Health Survey (NFHS). Global Social Welfare. 2025 Mar 7:1-7.
9. Ansari T, Sami W, Alsubaie N, Althaqib AA, Alenezi AA, Almutairy AN, Alshamrani MA, Alanazi MA, Almutairi MA. Assessment of knowledge, attitude, and practice of dietary pattern in patients with type 2 diabetes mellitus: a locality-based perspective study. International Journal of Medicine in Developing Countries. 2019 Apr 4;3(7):581-5.
10. Dhakal D, Belinda N, Chanu KJ, Laishram S, Singh AV, Ranabir.S. Hypoglycemia Awareness In Diabetes Mellitus Patients Attending A Tertiary Care Centre In North-East India. Int J Acad Med Pharm. 2024;6(6):241-5.
11. Malik BK, Goyal AK, Maiti S, Mohanty SK. Care cascades of diabetes and hypertension among late adolescents in India. Journal of Global Health. 2025 Mar 7;15:04101.
12. Satapathy J, Minj A, Chakrabarti K, Gupta P. Knowledge, Awareness and Prevalence of Diabetic Retinopathy among Patients of Type 2 Diabetes

Mellitus on Their First Visit to Eye Department in a Tertiary Health Care Centre-A Hospital Based Cross Sectional Study. J Evid Based Med Healthc. 2020;7(34):1770-5.

13. Pal R, Pal S, Barua A, Ghosh MK. Health education intervention on diabetes in Sikkim. Indian journal of endocrinology and metabolism. 2010 Jan 1;14(1):3-7.
14. Shriraam V, Mahadevan S, Anitharani M, Jagadeesh NS, Kurup SB, Vidya TA, Seshadri KG. Reported hypoglycemia in Type 2 diabetes mellitus patients: Prevalence and practices-a hospital-based study. Indian journal of endocrinology and metabolism. 2017 Jan 1;21(1):148-53.
15. Hood KK, Hilliard M, Piatt G, Ievers-Landis CE. Effective strategies for encouraging behavior change in people with diabetes. Diabetes Management (London, England). 2015;5(6):499.
16. Anitha Rani M, Shriraam V. Are patients with type 2 diabetes not aware or are they unable to practice self-care? A qualitative study in rural South India. Journal of primary care & community health. 2019 Aug;10:2150132719865820.
17. Gadewar, O. B., & Kaur, J. (2023). A Study to Assess the Effectiveness of Structured Teaching Program on Practice and Attitude of Behavioral Risk Factors of Diabetes and Hypertension in Adults of Selected area of Pune City. DOI: https://dx.doi.org/10.21275/SR231125152612
18. Shukla R, Yagnik D, Agarwal N, Gupta M, Ganguli B, Shukla S, Bajpai A. Diabetes Educational Intervention in Society to Improve (DESI) Quality of Life. Journal of Diabetology. 2021 Apr 1;12(2):186-90.
19. Vaghela, J. F., Roy, M., Vaish, K., Mishra, R., & Mangal, A. (2019). Integrated Health Unit of a Community Health Department Creating Awareness on Nutrition, Hypertension, Diabetes and Mental Health in a Slum and Resettlement Colony in Delhi. Int. J. HealthCare Edu. & Med. Inform, 6(2), 2. DOI: https://doi.or
20. Mohamed SS, Mohamed RF, Mohamed SH. Impact of educational intervention program on diabetic retinopathy patient's compliance. American Journal of Nursing. 2019;7(6):1000-8.
21. Chawla, Sumit Pal Singh1; Kaur, Sarabjot1; Bharti, Aman1; Garg, Ravinder1,; Kaur, Manjeet1; Soin, Divya1; Ghosh, Amrita2; Pal, Ranabir3. (2019). Impact of health education on knowledge, attitude, practices and glycemic control in type 2 diabetes mellitus. Journal of Family Medicine and Primary Care 8(1):p 261-268.
22. Ramachandran, A., & Snehalatha, C. (2009). Current scenario of diabetes in India. Journal of diabetes, 1(1), 18-28
23. Wang J, Cai C, Padhye N, Orlander P, Zare M. A behavioral lifestyle intervention enhanced with multiple-behavior self-monitoring using mobile and connected tools for underserved individuals with type 2 diabetes and comorbid overweight or obesity: pilot comparative effectiveness trial. JMIR mHealth and uHealth. 2018 Apr 10;6(4):e4478.
24. Volpp KG, Asch DA, Galvin R, Loewenstein G. Redesigning employee health incentives—lessons from behavioral economics. New England Journal of Medicine. 2011 Aug 4;365(5):388-90.
25. Agrawal S, Kritika, Pal R. Awareness on diabetes among individuals attending Urban Health Training Centre of a medical college of eastern Bihar, India.
26. Muthukumar A, Vasuki G, Oviya JP, Shahil VS, Bharath RV, Bose MM. Clinical review on diabetic awareness and knowledge among urban and rural population in Coimbatore zone. Drug Invention Today. 2020 Jul 15;14(7).
27. Muralidharan S. Diabetes and current Indian scenario: a narrative review. Journal of Diabetology. 2024 Jan 1;15(1):12-7.
28. Shilubane HN, Potgieter E. Patients' and family members' knowledge and views regarding diabetes mellitus and its treatment. Curationis. 2007 Sep 28;30(2):58-65.
29. Durai V, Samya V, Akila GV, Shriraam V, Jasmine A, Muthuthandavan AR, Gayathri T, Mahadevan S. Self-care practices and factors influencing self-care among type 2 diabetes mellitus patients in a rural health center in South India. Journal of education and health promotion. 2021 May 20;10:151.
30. Pal R, Pal S, Barua A, Ghosh MK. Health education intervention on diabetes in Sikkim. Indian journal of endocrinology and metabolism. 2010 Jan 1;14(1):3-7.
31. Shriraam V, Mahadevan S, Anitharani M, Jagadeesh NS, Kurup SB, Vidya TA, Seshadri KG. Reported hypoglycemia in Type 2 diabetes mellitus patients: Prevalence and practices-a hospital-based study. Indian journal of endocrinology and metabolism. 2017 Jan 1;21(1):148-53.
32. Hood KK, Hilliard M, Piatt G, Ievers-Landis CE. Effective strategies for encouraging behavior change in people with diabetes. Diabetes Management (London, England). 2015;5(6):499.

33. Vlaev I, King D, Dolan P, Darzi A. The Theory and Practice of "Nudging": Changing Health Behaviors. Public Adm. Rev. 2016;76(4): 550–61

34. Vande Velde F, Overgaard HJ, Bastien S. Nudge strategies for behavior-based prevention and control of neglected tropical diseases: A scoping review and ethical assessment. PLOS Neglected Tropical Diseases. 2021 Nov 1;15(11):e0009239.

35. Wansink B, Just DR, Payne CR, Klinger MZ. RETRACTED: Attractive names sustain increased vegetable intake in schools.

36. Beaudoin, C. E., Fernandez, C., Wall, J. L., & Farley, T. A. (2007). Promoting healthy eating and physical activity: short-term effects of a mass media campaign. American journal of preventive medicine, 32(3), 217-223.

37. Harrison, J. D., & Patel, M. S. (2020). Creating nudges that work in health care. The AMA Journal of Ethics, 22(9), 796–801.

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