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A Policy Brief on from Treatment to Prevention: Integrating CMAM and Dietary Diversity in India

B. Veera Bhadrudu[1], Sadhish Kumar Jain[2]

[1,2]State Program Officer, Vijayavahini Charitable Foundation.

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Abstract

Malnutrition is a global problem, and India is one of the countries with a high burden of malnutrition, particularly acute malnutrition (wasting), and micronutrient deficiencies. In India, 35.5% of children were stunted, 19.3% were wasted, and 32.1% were underweight among children aged below 59 months. Diet quality and diet diversity remain insufficient for a large majority of the population despite increased food availability. In India, only 12.7% of children aged 6 to 23 months receive an adequate diet, ranging from 14.2% in urban areas to 12% in rural areas. Evidence from nutritional research and national dietary assessments show that poor dietary diversity, unaffordable nutrient-rich foods, gendered care burdens, and increasingly unhealthy food environments undermine both prevention and recovery from malnutrition. This document advocates for institutionalizing community-based management of acute malnutrition (CMAM) as a core child nutrition service and integrating it with improved strategies on dietary diversity. Inclusion of CMAM program with care and social protection systems can improve recovery rates, prevent relapse, and support long-term nutrition outcomes.

Key recommendations of the document include establishing CMAM nationally; integrating dietary diversity counselling throughout all phases of the program; capacity building of frontline workers; and improved convergence between health and nutrition departments, including WASH programs.

Burden of Malnutrition in India

Childhood is a significant stage of life and deficiency of nutrients during this period can have a long-term adverse impact on well-being of children. According to WHO[1], around 45% of deaths among children under 5 years of age are linked to undernutrition. Nutrient deficiency impacts the growth of physical and mental health of child. Nutritional deficiency shows negative impact for children aged 0 to 59 months. In India, current data underscores dietary diversity is a critical gap: only 11.1% of breastfeeding children aged 6–23 months receive an adequate diet, while it is 12.7% among non-breastfeeding children in the same age group (NFHS-5, 2019–21)[2].

Corresponding Author: Sadhish Kumar Jain, State Program Officer, Vijayavahini Charitable Foundation.

E-mail: sadhishsj@gmail.com

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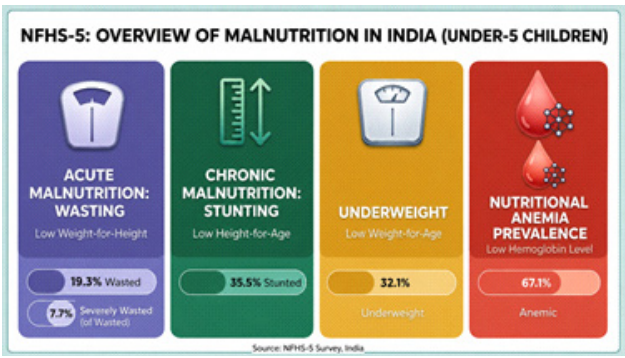
The negative consequences of malnutrition are long-lasting and affect a child's physical and mental development and health, including school performance. Undernourished children have a significantly higher risk of morbidity and mortality. According to NFHS-5 (2019–21), anemia is highly prevalent in India, affecting 67.1% of children aged 6 to 59 months[2]. Facility-based services are limited in their capacity to cover all children to provide necessary timely services and management.

Diet Quality and Dietary Diversity:

Diet diversity is defined as the number of different food groups or foods consumed in a given period. Diverse foods are a good source of various macro and micronutrients and best ensure nutrient adequacy (FAO, 2011)[3]. The ICMR-NIN, "My Plate for the Day", recommends sourcing of macronutrients and micronutrients from a minimum of eight food groups, with vegetables, fruits, green leafy vegetables, roots and tubers forming essentially half the plate of the recommended foods per day. In a large segment of the country's population, the intake of micronutrient-dense foods is found to be lower than the recommended level, whereas the intake of refined cereals is found to be higher. A steady increase in the intake of unhealthy foods among people complicates the matter further. As a result, the majority of the population, including children, suffer from malnutrition and its adverse health outcomes (ICMR-NIN, 2024)[4].



Evidence suggests that dietary diversity is a fundamental determinant of nutritional quality and sustained health. A diversified diet improves nutrient adequacy, enhances overall diet quality, stimulates appetite, and reduces the risk of adverse health outcomes and chronic diseases. Consequently, promoting dietary diversity is recognized as a sustainable food-based strategy for improving nutritional outcomes and can strengthen community-based management of acute malnutrition by supporting recovery and reducing the risk of recurrence (Vijay & Patel, 2021)[5].

Key factors for poor diets and malnutrition:

Nutrition outcomes are interconnected with food systems, household dietary patterns and quality of service delivery.

It can be broadly put into different categories, such as:

- Availability of food groups
- Affordability for nutrient-rich foods for communities
- Increased use of ultra-processed foods
- Lack of knowledge on nutrition and the importance of healthy diets

Together, these factors play a crucial role in determining the status of acute malnutrition.

Community-Based Approaches:

The Community-Based Management of Acute Malnutrition (CMAM) program focuses on early identification of wasting (SAM or MAM) among children before they develop any medical complications and provides community-level treatment for uncomplicated cases and referral of complicated cases to nearby health facilities. Under the program, malnourished children are treated effectively in community settings that enable high recovery rates offering lower costs than facility-based treatment. CMAM program offers maximum coverage and makes services accessible, ensuring timely management. CMAM improves coverage, reduces delays in treatment, and lowers the burden on health facilities. It is particularly relevant in contexts where access to inpatient care is limited.

The CMAM approach aids in creating long-term community-based therapeutic care programme, decentralizes malnutrition care and treatment, increases coverage and ensures that timely and appropriate care is easily accessible to all malnourished children residing even in isolated areas (Mathur M, 2018)[6]. In the year 2023, the Government of India released a comprehensive protocol for

the management of malnutrition in children at the community level (MHFW & MWCD, 2023)[7].

Major components and core principles of the program:

- Regular screening and early detection
- Community-based treatment and follow-up of uncomplicated cases
- Facility-based care for complicated cases
- Community outreach and mobilization
- Post-recovery monitoring and counselling
- Maximum coverage and access
- Timeliness
- Sectoral integration
- Capacity building
- Appropriate care
- Care for as long as needed

Community-based dietary diversity interventions have demonstrated measurable improvements in nutrition outcomes. The Helen Keller International Homestead Food Production programme, implemented in several South and Southeast Asian countries, combined household food production with nutrition education and resulted in improved dietary diversity, reduced anaemia, better nutritional status, and increased household income among participating households. Such evidence highlights the potential of integrating food-based approaches and nutrition counselling within community nutrition programmes to support sustained improvements in child nutrition and household food security (Chaudhary et al., 2022)[8].

Status of implementation of the CMAM program:

So far, 14 states in India are implementing the CMAM program though it is known by different names and implemented in different phases. These states have implemented the CMAM program either fully or partially. In Assam, the CMAM program, known as CP-CMAM, across all districts with standardized screening and supportive supervision. Bihar, however, has limited implementation to selected districts only. Chandigarh is implementing the CMAM in high-risk areas, while Rajasthan delivers the program across all districts under the name of AMMA. Jharkhand has rolled out CMAM in a phased manner through programs such as Johar Poshan and SAAMAR, including pilots of enhanced supplementary foods. The state Chhattisgarh is also expanding its community-based management program across the state in a phased manner. Gujarat, Haryana, Maharashtra, Telangana, Uttar Pradesh and Meghalaya have been implementing the CMAM program across all districts and have reported significant improvements in Severe Acute Malnutrition (SAM) outcomes. (NITI-Aayog; 2023)[9]. In addition, in Andhra Pradesh, the CMAM program has been piloted in a few selected districts since May 2025.These experiences demonstrate that while implementation models vary across states, community-based management is feasible within existing health systems and provides a platform for integrating dietary diversity interventions.

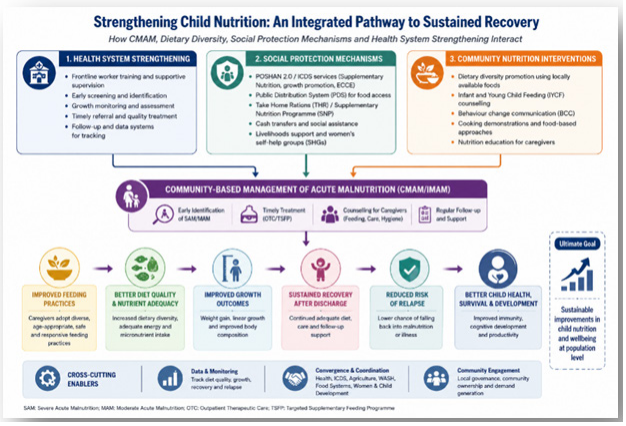
Recovery rates under CMAM program:

The CMAM program resulted in a 54.87% recovery rate among SAM children in Gujarat State during its pilot phase in 2016(NITI-Aayog; 2023)[9]. An independent evaluation of a cohort of 1,322 enrolled children showed that after eight weeks, 42.4% were discharged as cured, and 66.9% were discharged as cured at 12 weeks (Mangal & Sivaraman, 2020)[10]. According to GoR NHM, 2016, 88% of SAM children recovered after eight to 12 weeks of treatment under CMAM program. Differences in recovery rates reflect variations in programme design, follow-up duration, and recovery criteria across implementation settings[11].

Strategies for Sustained Recovery and Scale-up:

Acute malnutrition is both a clinical condition and a manifestation of chronic dietary and systemic deprivation. Children frequently relapse to malnutrition when underlying factors such as poor diet remain. Diet diversity with adequate intake of both macro and micro nutrients plays a vital role for physical and cognitive development of children. Under the community-based management, children are provided with energy-dense nutritious food that enables rapid weight gain and helps to recover from wasting. A key lesson from CMAM implementation in India is that sustained recovery requires more than therapeutic treatment alone. Regular follow-up, caregiver counselling, and promotion of dietary

diversity using locally available foods are essential to prevent relapse and improve long-term nutritional outcomes.



CMAM program offers frequent engagementwith children and their caregivers during the program like screening, follow-up visits and discharge. These interactions create opportunities to:

- Assess household food access and diet patterns.
- Deliver practical, food-based dietary diversity counselling.
- Support caregivers to plan diverse meals using locally available and affordable foods.

Emerging evidence supports integrating dietary diversity counselling within community-based management programmes. A multi-country study reported that higher household dietary diversity was significantly associated with improved recovery from wasting among children, highlighting diet quality as an important determinant of nutritional recovery beyond therapeutic foods alone (Tsegaye et al., 2022)[12]. Similarly, a randomized controlled trial in Kenya demonstrated that structured caregiver counselling on locally available nutrient-rich foods significantly improved children's dietary diversity and weight gain compared with standard care (Mutai et al., 2025)[13]. These findings strengthen the case for integrating dietary diversity counselling throughout CMAM from enrolment to post-discharge follow-up to support sustained recovery and reduce relapse.

A continuum of prevention and treatment services:

Evidence from CMAM implementation in India demonstrates its potential to improve recovery among children with severe acute malnutrition (SAM). An early CMAM programme reported a low mortality rate (0.8%) and a cure rate of 57.4% among non-defaulting children. Building on this experience, Rajasthan's POSHAN I initiative (2015–2016) achieved an 88% recovery rate among children aged 6 to 59 months with SAM after 8 to 12 weeks of treatment, leading to the scale-up of the approach as Integrated Management of Acute Malnutrition (IMAM)[11]. These experiences highlight that community-based screening, early identification, and decentralized care can substantially improve programme coverage and recovery outcomes. They also provide an important platform for integrating dietary diversity counselling and improved feeding practices to support sustained recovery and reduce the risk of relapse.

Integration of the dietary diversity component into the CMAM program changes its focus from short-term to long term. CMAM program functions as a cradle for the prevention and management of malnourished children, especially for SAM and MAM at community level with cost- effectiveness and higher rates of recovery and reducing relapses.

Policy gaps:

India is well positioned to scale up an integrated CMAM and dietary diversity approach through existing nutrition platforms and the experience gained from states implementing CMAM in different forms. However, several implementation gaps need to be addressed to achieve sustained recovery and long-term improvements in child nutrition:

- Limited integration of dietary diversity and food-based interventions within CMAM to support sustained recovery and prevent relapse.
- Programme performance is primarily assessed through anthropometric recovery, while post-discharge dietary practices, growth outcomes, and relapse are seldom monitored.
- Uneven implementation and coverage of CMAM across states and districts disrupts the continuity of integrated care, limiting opportunities to deliver consistent dietary diversity counselling and follow-up support across programme phases.
- Frontline workers require additional operational support and training to provide

effective dietary diversity counselling and behaviour change communication.

- Mechanisms for sustaining recovery beyond programme discharge, including continued follow-up and relapse monitoring, remain limited.

Policy Recommendations:

Actions required with immediate effect:

- Universal Coverage of CMAM program: (I): Expand the CMAM program to all districts and integrate it with existing health and nutrition platforms such as POSHAN Abhiyaan and the National Health Mission (NHM). Ensure that CMAM is included in routine service delivery, planning and reporting mechanisms. (II): Enhance Growth Monitoring efficacy through regular screening, during VHSND's and outreach sessions for early detection and timely management.
- Strengthen sustainable financing mechanisms by integrating CMAM into routine state and district health and nutrition planning to support programme expansion, quality implementation, capacity building, and long-term monitoring.
- Capacity Building for Frontline workers: Provide standardized training and periodical refreshers to ensure adherence to CMAM protocols supported by simple checklists and use visual job aids, manuals and e-learning platforms.
- Establishing Systems for Referrals and Linkages: Establishing strong convergence between community platforms, health facilities and Nutrition Rehabilitation Centres (NRCs) and with tracking systems to monitor referrals and treatment outcomes.

System strengthening and Quality Improvement:

- Supportive Supervision: Introduce supportive supervision to monitor, handholding support, performance feedback, promote quality service delivery, for frontline workers to improve adherence to CMAM protocols
- Behavioural Change Communication(BCC): Focus on intensified behavior change in communities on dietary diversity, age-appropriate complementary feeding, hygiene, care practices using community platforms, and culturally appropriate BCC campaigns
- Strengthen supply chain systems: To ensure the uninterrupted availability of therapeutic foods, supplementary nutrition products, medicines, and reporting formats through improved procurement, distribution, and supportive supervision.
- Use of Data for Decision Making: Establish and strengthen MIS systems to track, and access CMAM coverage and outcomes for timely actions at project, district and state levels.
- Integrate Dietary Diversity into CMAM: Institutionalize dietary diversity counselling, practical food demonstrations, and promotion of locally available nutrient-rich foods throughout screening, treatment, follow-up, and discharge phases to support sustained recovery and reduce relapse.

Sustainability:

- Success Stories: Adapt successful CMAM community-based models and replicate in new locations for piloting before scale-up for sustainability.
- Use of digital tools: Introducing innovations like use of mobile based applications for screening, follow-ups, referrals and timely reporting.
- Integrate with Social Protection Schemes: Linking of vulnerable and marginalised households to social protection schemes/ programs to address underlying determinants of malnutrition.
- Identify Nutrition Champions: Identify and train active community members like SHG women, mothers of children and community volunteers as nutrition champions and seek their support in counselling sessions and peer learning.

Conclusion

Addressing acute malnutrition among children in India requires a paradigm shift from facility-based treatment to community-based management with comprehensive coordination, with integration of systems for timely identification to treatment.

Convergence of CMAM program within health and nutrition strategies for improving dietary diversity, food environments and appropriate caregiver practices can reduce relapse and improve child development. Integrating dietary diversity counselling within CMAM offers a practical, scalable, and sustainable strategy for achieving long-term improvements in child nutrition in India.

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Short Communication

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A New Step in Public and Patient Involvement (PPI) in Clinical Research in India: A Patient Led Collaborative Good Clinical Practice (GCP) Workshop

Pooja Sharma[1], Poonam Bagai[2], Khushboo Sharma[3], Rhea Aggarwal[4], Adarsh Keshari[5]

[1]MBBS, MD (Gyn), Founder & CEO, APAR Health, Gurugram, Program Lead, PACER, (Patient Advocates for Clinical Research) India, [2]BA, Founder Chairman, CanKids KidsCan, Delhi, Program Lead, PACER (Patient Advocates, for Clinical Research) India, [3] MSc, Assistant Manager, Paediatric Cancer Research Institute, CanKids KidsCan, New, Delhi, Program Co-ordinator, PACER-India, [4]MBBS, Co-Founder APAR health, Gurugram, Patient Advocate, PACER-India, [5]Doctor of Pharmacy, Research Scientist -I , APAR Health, Gurugram, Patient Advocate, PACER-India

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Executive Summary

This patient-centric **Good Clinical Practice (GCP) workshop** brought together patients, advocates, clinicians, researchers, and ethics experts. Key discussions focused on Public and patient Involvement, ethical and good patient participation, clinical trials as a care option, simple & clear communication, reinforcing the importance of meaningful patient engagement in advancing ethical and patient-centric research.

A Step Towards Patient-Centred Clinical Research

Public and patient Involvement in Clinical Research in India took a positive new step with the two-day workshop on *"Good Clinical Practice (GCP) for Patients: Strengthening Ethical Participation in Clinical Research"* (24–25th April 2026) in New Delhi.

With funding support from the Indian Council of Medical Research (ICMR) Workshop Grant, this first-of-its-kind initiative in India focused on strengthening patient and patient advocate engagement within the framework of Good Clinical Practice. The workshop was organised by Patient Advocates for Clinical Research (PACER)[1] in collaboration with Amrita Hospital (Faridabad), CanKids KidsCan, and APAR Health.

The interaction among clinicians, clinical researchers, patient advocates and patients, many of whom have overlapping roles, highlighted the importance of collaboration and communication.

The keynote address a healthcare leader from, Amrita Hospital emphasised communication as the critical pillar in clinical research. Clear, simple, and appropriate communication was highlighted as essential to ensuring informed consent, participant understanding, and the ethical conduct of clinical trials.

Corresponding Author: Pooja Sharma, Founder & CEO, APAR Health, India Program Lead, PACER-India.

E-mail: drpooja.apar@gmail.com

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The Keynote by patient advocacy leader from, Cankids focused on trust and patient empowerment, highlighting that collaboration among patients, clinicians, and researchers is essential for strengthening clinical research. The role of patient advocates was highlighted as a vital bridge between patients and researchers, facilitating communication, building trust, and promoting meaningful patient engagement throughout the research process.

A senior clinical researcher from APAR Health, highlighted the importance of creating "expert" patients in clinical research through capacity building. The session also introduced the OSKE-R (Objective Structured Knowledge Examination–Research) pedagogy, in which 'expert patients' participate as active partners in practical patient-centricity training and evaluation of clinical researchers.

A senior pharmaceutical industry leader from Sun Pharma and Hon. General Secretary of the Indian Society of Clinical Research, identified Good Patient Participation (GPP)[2] as a fundamental component of ethical clinical research and emphasised the need to develop GPP frameworks tailored to clinical trials in India.

The workshop also highlighted the growing importance of Patient and Public Involvement (PPI) in clinical research. Beyond participation as trial subjects, PPI emphasises the active involvement of patients and the public in shaping research priorities, study design, informed consent processes, dissemination of findings, and policy development. Discussions underscored the need to develop culturally appropriate and sustainable PPI frameworks in India.

Legal and ethical dimensions related to patient protection, insurance (including clinical trial insurance, personal insurance, and health insurance), and data confidentiality were comprehensively discussed by an expert in the field. Senior Clinical Researcher from Medanta Super Speciality Hospital, Lucknow, provided valuable insights into access to clinical trials with particular emphasis on the Clinical Trials Registry of India (CTRI)[3], including its navigation, and role in facilitating patient participation.

A renowned paediatric oncologist from AIIMS, New Delhi emphasised that *"clinical trials are safe,"* and explained the safeguards that regulators, investigators and sponsors implement in India to ensure participant safety. He also discussed the responsibility of patients in this journey including their role in drug side effect reporting.

An expert panel discussion on "Balancing hope, risk and information" highlighted the importance of transparent communication and ethical decision-making in clinical trials, ensuring patients are well informed while maintaining realistic expectations from trials.

A Senior Consultant, Paediatric Oncology & Haematology at Apollo Cancer Centres, Delhi introduced the concept of *Clinical Research as a Care Option (CRAACO)*[4], an emerging paradigm in clinical research.

The voice of a Patient Advocate from a Patient Advocate Group (PAG) discussed the defining attributes of a "good patient" within the clinical research ecosystem.[5]

The importance of patient feedback on their participation in clinical trials in improving patient experience and strengthening ethical practices, was highlighted by a layperson from the ethics committee of Fortis Gurugram.

Another ethics committee member and administrator from Goa emphasised the need for clear and simple language in the Participant Information Sheet (PIS), along with effective communication of trial outcomes to participants at the conclusion of clinical trials.

Overall, the workshop reinforced that Clinical trials in India are safe, supported by robust participant protection mechanisms.[6] Strengthening patient understanding of clinical research processes, fostering practical patient-centricity among researchers, and presenting research as a care option can improve access to trials. Clear communication before, during, and after trials, in simple language complemented by participant feedback are essential for ethical and patient-centred research.

Figure 1: Day 1 of the workshop on Good Clinical Practice (GCP).

Figure 2: Day 2 of the workshop on Good Clinical Practice (GCP).

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Narrative Review Article

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From Classroom to Community: Mentorship Models for Medical Education and Primary Healthcare Workforce Strengthening in India

Alajangi Bhargavi

Senior Resident, Department of Community Medicine, Gayatri Vidya Parishad Institute of Health Care and Medical Technology, Visakhapatnam, Andhra Pradesh.

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Abstract

Background: Mentorship is increasingly recognized as an important strategy for professional development, competency building, and workforce strengthening in healthcare. In India, challenges such as uneven distribution of skilled personnel, limited supportive supervision, and the transition gap between classroom learning and field practice highlight the need for structured mentorship across medical education and primary healthcare systems.

Methods: A narrative review was conducted using PubMed, Scopus, Google Scholar, and grey literature sources including the World Health Organization, Ministry of Health and Family Welfare, and National Health Systems Resource Centre. Literature published on healthcare mentorship, faculty development, digital mentoring, and Indian workforce-strengthening initiatives was reviewed and synthesized thematically.

Results: Multiple mentorship models were identified, including dyadic, peer, group, cascade, competency-based, and digital mentoring approaches. Theoretical frameworks such as Kram's phases model, the GROW model, and competency-based mentoring were found relevant to healthcare training and faculty development. Indian initiatives including the ASHA facilitator model, Mobile Academy, and Project ECHO demonstrated improvements in knowledge, communication skills, confidence, and service readiness among frontline health workers and trainees. Major barriers included lack of structured programs, inadequate mentor training, time constraints, and weak evaluation systems.

Conclusion: Mentorship represents a scalable and human-centered strategy for strengthening medical education, faculty development, learner support, and primary healthcare workforce capacity in India. Integrating structured mentorship into competency-based medical education and public health programs may enhance professional growth, workforce retention, and quality of healthcare delivery.

Keywords: Mentorship, Primary healthcare, Health workforce, Medical education, Community health workers, India, Tele-mentoring

Corresponding Author: Alajangi Bhargavi, Senior Resident, Department of Community Medicine, Gayatri Vidya Parishad Institute of Health Care and Medical Technology, Visakhapatnam, Andhra Pradesh

E-mail: nandini02soni04@gmail.com

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Introduction

Mentorship is an important strategy for strengthening healthcare workforce capacity, improving quality of care, and enhancing patient outcomes. It is defined as a sustained developmental relationship in which a more experienced person provides guidance, knowledge, and psychosocial support to a less experienced colleague to promote professional growth.[1] Unlike supervision, which emphasizes accountability, or coaching, which focuses on specific skills, mentorship adopts a broader long-term developmental approach.

Historically, mentorship evolved from traditional apprenticeship systems and teacher–learner relationships into structured professional development models used in medicine, nursing, academia, and management.[2–4] In recent decades, mentoring has expanded further through peer mentoring, reverse mentoring, and digital platforms such as tele-mentoring.[5]

Globally, healthcare systems face increasing challenges due to rising disease burden, rapid expansion of medical knowledge, and shortages of skilled human resources for health.[6]Mentorship can support lifelong learning, improve competence, ease transition to practice, and enhance job satisfaction and retention.[7,8]

Its relevance is particularly high in low- and middle-income countries such as India, where frontline workers including Accredited Social Health Activists (ASHAs), Auxiliary Nurse Midwives (ANMs), and Community Health Officers (CHOs) are central to primary healthcare delivery under Ayushman Bharat.[9] However, these cadres often face limited on-site support, high workload, and difficulty translating training into field practice.[10] Structured mentorship can bridge this theory–practice gap through continuous guidance and problem-solving support.

Indian examples such as the ASHA facilitator model, Mobile Academy, and Project ECHO demonstrate the potential of mentorship to improve knowledge, service delivery, and workforce motivation.[11–13] However, mentorship efforts remain fragmented, with limited standardization and inadequate evaluation.

This narrative review synthesizes concepts, models, evidence, and implementation lessons related to mentorship in healthcare, with special reference to India.

Materials and Methods

A narrative review was conducted to synthesize evidence on mentorship in healthcare, with emphasis on models, implementation approaches, and relevance to the Indian health system.

A literature search was performed using PubMed, Google Scholar, and Scopus, along with grey literature from the World Health Organization, Ministry of Health and Family Welfare, and National Health Systems Resource Centre. Searches were conducted between January 2025 and March 2026.

Key search terms included "mentorship in healthcare," "health workforce mentoring," "medical mentorship models," "ASHA mentoring India," "community health officer mentoring," "Project ECHO," "telementoring," and "mentorship evaluation."

Peer-reviewed articles, policy documents, reports, and relevant publications describing mentorship models, healthcare workforce mentoring, or Indian program experiences were included. Articles focusing solely on supervision or coaching without a mentorship component, non-English publications, and reports lacking adequate detail were excluded.

Data were extracted and synthesized thematically under the following domains: concept and evolution of mentorship, mentorship models, Indian experiences, evaluation approaches, challenges, and future directions.

As a narrative review, this paper aimed to provide a contextual synthesis rather than an exhaustive systematic review.[14]

Concept and Core Principles of Mentorship

Mentorship is a developmental relationship in which an experienced individual supports the growth of a less experienced colleague through guidance, feedback, role modelling, and psychosocial support.[1] In healthcare, mentorship helps strengthen competence, confidence, professionalism, and teamwork.

Effective mentorship is characterized by several key principles. It emphasizes guidance over control, fostering learning rather than directing actions. Mutual respect and trust are essential, recognizing the collaborative nature of the relationship. Mentorship focuses on long-term development, addressing both immediate skill gaps and broader professional identity. Lastly, it requires a personalized approach that adapts to the mentee's goals, learning style, and challenges.[15]

In healthcare settings, mentorship helps bridge the persistent gap between classroom learning and workplace realities. Newly graduated doctors, nurses, and community health workers frequently encounter "transition shock" when expected to independently apply theoretical learning in complex clinical or field environments.[7]

Table 1. Common types of mentorship in healthcare

Type	Description	Example
Formal	Structured institutional programme	Faculty mentorship
Informal	Naturally developed relationship	Senior guiding junior
Dyadic	One mentor–one mentee	Consultant–resident
Group	One mentor with many mentees	Skills workshop
Peer	Same-level mutual support	Junior doctor peer group
Reverse	Junior mentors senior in niche skill	Digital training
E-mentoring	Remote mentoring through technology	Project ECHO

Types of Mentorship:

There are various forms of mentorship, each serving distinct purposes and catering to different needs. As summarized in Table 1, mentorship types range from formal, institutional arrangements to informal, naturally evolving relationships. Formal mentorship programs are structured around defined goals, regular meeting schedules, and documented outcomes, making them more amenable to evaluation and quality assurance[15,16]. Informal mentorship, by contrast, emerges organically from professional relationships and may be particularly meaningful for socialization and professional identity formation. Peer mentorship—where colleagues at similar career stages provide mutual support—has been shown to reduce professional isolation and improve job satisfaction, particularly among junior doctors and nursing staff[16]. Reverse mentorship, where a less experienced individual mentors a more senior colleague in specific skills such as digital literacy, is increasingly valued in rapidly evolving healthcare environments. E-mentoring through digital platforms has dramatically expanded access to expert guidance, making it especially relevant for health workers in remote or resource-limited settings. By understanding these distinctions, healthcare institutions can select and combine mentorship models that best align with workforce development goals.

Several operational models are used in healthcare. Traditional dyadic mentoring remains common in academic medicine. Multiple-mentor models allow different mentors for clinical, research, and career needs. Competency-based mentoring aligns support with milestones and assessments, while cascade mentoring creates chains of capacity building where mentees later mentor others.[16,17]

Theoretical Frameworks of Mentorship

Theoretical models help explain how mentoring relationships develop and why they succeed or fail.

Table 2. Major theoretical models of mentorship and their relevance to healthcare

Model	Key Components	Underlying Theory	Relevance in Healthcare
Kram's Phases Model[4]	Initiation, Cultivation, Separation, Redefinition	Adult development, social exchange	Explains mentor–mentee relationship over training period
GROW Model[18]	Goal, Reality, Options, Will	Goal-setting theory	Useful in performance discussions and career planning

Cont.....

Developmental Model[2]	Dependence → Independence → Autonomy	Lifelong learning theory	Suitable for progression from student to independent practitioner
Competency-Based Model[5]	Milestones, feedback, assessment	Competency-based education	Residency, nursing, CHO training
Cultural Competence Model[19]	Awareness, sensitivity, inclusion	Cross-cultural communication	Diverse healthcare workforce and patient populations

Abbreviations: GROW, Goal, Reality, Options, Will; CHO, Community Health Officer; CFIR, Consolidated Framework for Implementation Research.

Mentorship across healthcare levels and evidence from India

Mentorship is relevant across all levels of the health system—from students and trainees to frontline workers, managers, and specialists. The objectives differ by level: early-stage mentorship focuses on skill acquisition and professional identity, while workforce mentorship emphasizes service quality, confidence, retention, and leadership.

In India, mentorship has been integrated into several public health and workforce-strengthening initiatives. These experiences suggest that structured mentoring can improve knowledge, motivation, reporting quality, service uptake, and confidence of health personnel.

Table 3: Mentorship applications across healthcare levels with selected evidence from India

Level / Cadre	Purpose of Mentorship	Indian Example	Reported Benefits
Medical / Nursing students	Clinical skills, professionalism, transition to practice	Faculty and senior resident mentoring in teaching institutions	Better confidence, smoother transition
Junior doctors / residents	Decision-making, research, career guidance	Departmental faculty mentorship	Academic growth, skill development
ASHAs	Community mobilization, counseling, reporting	ASHA Facilitator model	Better retention, improved reporting, increased institutional deliveries[13]
ASHAs	Refresher learning through mobile platform	Mobile Academy	Improved communication and maternal danger sign knowledge[12]
CHOs	Primary care skills, NCD care, referrals	Competency-based mentoring under Ayushman Bharat HWCs	Improved confidence and service readiness[9]
CHOs / Rural providers	Specialist guidance through tele-mentoring	Project ECHO	Better knowledge, case management confidence[11]
Program managers / administrators	Leadership, planning, supervision	NHM review and mentoring systems	Improved coordination and accountability

Abbreviations: ASHA, Accredited Social Health Activist; CHO, Community Health Officer; NCD, Non-Communicable Disease; HWC, Health and Wellness Centre; NHM, National Health Mission; ECHO, Extension for Community Healthcare Outcomes.

Key Lessons from Indian Experience and Implications for India

Mentorship is most effective when integrated into existing health systems like the National Health Mission (NHM) and Ayushman Bharat, enhancing scalability. Digital mentoring can bridge geographical gaps, especially in rural areas, while peer and cascade mentoring allow experienced workers to support

new staff cost-effectively. Although evidence shows improvements in knowledge and self-confidence, robust long-term data on patient outcomes and cost-effectiveness is still limited. Given shortages and uneven distribution of skilled health personnel, mentorship should be recognized as a strategic health systems intervention. Structured mentoring pathways for Accredited Social Health Activists (ASHAs), Community Health Officers (CHOs), nurses, and young doctors may strengthen primary healthcare delivery and support universal health coverage goals.

EVALUATION OF MENTORSHIP, CHALLENGES AND FUTURE DIRECTIONS

Evaluation of Mentorship

Assessment of mentorship programs should extend beyond participant satisfaction and include learning, behavior change, service outcomes, and sustainability. Commonly used frameworks include the Kirkpatrick model, RE-AIM framework, and Consolidated Framework for Implementation Research (CFIR).

The **Kirkpatrick model** evaluates four levels: reaction (satisfaction), learning (knowledge or skills gained), behavior (application in practice), and results (organizational or health outcomes). It is useful for training-linked mentorship programs.[20]

The **RE-AIM framework** examines reach, effectiveness, adoption, implementation, and maintenance, making it relevant for public health scale-up.[21]

The **CFIR framework** assesses contextual factors influencing implementation, including intervention design, inner setting, outer setting, individuals, and process.[22]

In practice, mentorship may be monitored using simple indicators such as mentor–mentee meeting frequency, competency assessments, retention rates, service indicators, and participant feedback.

Challenges in Mentorship

Barriers to effective mentoring can be categorized into individual, institutional, and system-level challenges. At the individual level, factors such as limited time due to workloads, poor mentor matching, and a lack of motivation can hinder progress. Institutional challenges include the absence of structured programs, inadequate mentor training, and insufficient recognition for mentors. Additionally, system-level issues like staff shortages, funding constraints, and poor digital connectivity further complicate the mentoring landscape, all of which require attention to create a more effective mentoring environment.[10,23]

Future Directions

Strengthening mentorship within Indian medical education and primary healthcare will require deliberate attention to the factors that make such programs succeed rather than remain aspirational. Several facilitators consistently emerge across the evidence reviewed. Institutional commitment—reflected in protected time, formal recognition, and incorporation of mentorship into faculty appraisal and career advancement—creates the enabling environment without which voluntary efforts tend to falter. Structured mentor training and orientation, covering communication, feedback, and goal-setting skills, helps standardize quality and reduces dependence on individual aptitude alone. Deliberate matching of mentor and mentee based on goals, discipline, and interpersonal fit, combined with clearly defined expectations and meeting schedules, improves continuity and satisfaction on both sides. Embedding mentorship within existing platforms such as the National Health Mission, Ayushman Bharat Health and Wellness Centres, and competency-based medical education curricula allows programs to draw on existing administrative and financial structures rather than competing for new resources. Digital and tele-mentoring platforms, exemplified by Project ECHO, offer a practical means of extending specialist mentorship to rural and remote cadres where in-person contact is limited. Finally, routine monitoring using simple indicators—meeting frequency, competency milestones, and participant feedback—paired with periodic programmatic review, allows early identification of gaps and supports continuous improvement.

Looking forward, future work should prioritize standardized, ideally national, frameworks for mentor training and certification across medical colleges and health system cadres, so that quality

does not depend on local initiative alone. There is also a need for rigorous, longitudinal research linking mentorship exposure to objective outcomes such as workforce retention, service quality, and patient-level indicators, rather than relying largely on satisfaction and short-term knowledge gains as is currently the case. Expanding digital and hybrid mentoring models, with attention to connectivity constraints in rural areas, can help extend reach to underserved cadres such as ASHAs and CHOs. Incorporating dedicated mentorship modules into undergraduate and postgraduate medical curricula, and into in-service training for community health workers, would help institutionalize mentorship as a core professional competency rather than an optional add-on. Finally, policy-level integration of mentorship indicators into existing monitoring systems under the National Health Mission could support sustained investment and accountability over time.

Discussion

This review emphasizes mentorship as a valuable strategy for enhancing healthcare systems, facilitating skill transfer, confidence building, leadership development, and workforce retention across educational institutions, hospitals, and community health programs. Unlike one-time training, mentorship provides continuous, adaptive learning that meets evolving service needs. In countries like India, where challenges such as shortage of trained personnel and rural-urban disparities persist, mentorship is particularly crucial for frontline workers like Accredited Social Health Activists (ASHAs) and Community Health Officers (CHOs), helping bridge the gap between training and field implementation through practical guidance and emotional support.

Examples from India, such as the ASHA facilitator model and Project ECHO, illustrate that mentorship can be effective through peer support, digital platforms, and structured systems. However, current evidence mainly highlights short-term benefits, with limited data on long-term outcomes like retention and patient health. It is also important to distinguish mentorship from supervision; while supervision focuses on compliance, mentorship emphasizes growth and professional development. Unfortunately, mentorship in India often lacks formal systems and relies on motivated individuals or short-term initiatives. Integrating mentorship into health workforce policies and medical education could lead to significant long-term benefits for the health system.

Conclusion

Mentorship is a practical, scalable, and underused strategy for improving healthcare workforce performance and service quality. It has relevance across the continuum of care—from students and trainees to frontline workers, clinicians, and managers. Indian experiences demonstrate promising models, particularly when mentorship is embedded within existing public health programs. Institutional commitment, structured design, and robust evaluation are essential for sustainability.

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Review Article

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The SAKSHAM Model: A Rights-Based, Standardized Community-Based Rehabilitation Framework for Rural India

Pratik Ingle[1], Nandini Soni[2], Shyam D. Ganvir[3], Suvarna S. Ganvir[4]

[1]Master of Physiotherapy (MPTh) Student, Department of Community Physiotherapy, [2]Master of Physiotherapy (MPTh) Student, Department of Community Physiotherapy, [3]Principal and Professor, [4]Head, Department of Neurophysiotherapy and Professor, DVVPF's College of Physiotherapy, Ahilyanagar, Maharashtra, India.

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Abstract

Background: Community-Based Rehabilitation (CBR) has evolved from a primary health care strategy under the Declaration of Alma-Ata into a comprehensive rights-based development approach endorsed within the WHO biopsychosocial framework of the International Classification of Functioning, Disability and Health (ICF). India is home to 27.9 million persons with disabilities (PWDs), 76% of whom reside in rural areas where disability is compounded by poverty, agricultural livelihood dependence, gender inequality, caste-based discrimination and a critical shortage of specialist rehabilitation personnel (approximately 30,000 physiotherapists for 1.4 billion people). This paper describes the SAKSHAM Model, a standardized CBR framework designed to operationalize WHO CBR guidelines within India's existing government health, education, livelihood and social-welfare infrastructure.

Methods: A narrative synthesis of WHO CBR guidance, the ICF framework, national legislation (Rights of Persons with Disabilities Act 2016, RTE Act 2009), and operational guidelines of major Indian government schemes (National Health Mission, Samagra Shiksha, Deendayal Disabled Rehabilitation Scheme, MGNREGA and Ayushman Arogya Mandirs) was undertaken to design a five-component convergence model, a task-shifted community health workforce structure, and a life-course battery of 22 validated assessment instruments for standardized implementation and monitoring.

Results: The SAKSHAM Model integrates Health, Education, Livelihood, Social Inclusion and Empowerment components delivered through a three-tier task-shifted workforce of 2.84 lakh ASHAs, 0.12 million ANMs and dedicated Community Rehabilitation Workers, supervised by district physiotherapists and anchored at 1,73,881 Ayushman Arogya Mandirs. A three-tiered output-outcome-impact indicator system, standardized life-course screening tools (WHODAS 2.0, Modified Ashworth Scale, Functional Independence Measure, WHOQOL-BREF, and allied instruments), and convergent financing across five national schemes provide a replicable, low-cost (approximately Rs. 12-20 crore per million rural population annually) implementation pathway.

Corresponding Author: Nandini Soni, Master of Physiotherapy (MPTh) Student, Department of Community Physiotherapy, DVVPF's College of Physiotherapy, Ahilyanagar, Maharashtra, India.

E-mail: nandini02soni04@gmail.com

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Conclusions: The SAKSHAM Model offers public health practitioners, district administrators and policymakers a constitutionally grounded, standardized conceptual framework that repositions disability from an individual medical problem to a multi-sectoral social-determinants issue, addressable through convergent use of existing government infrastructure rather than parallel service creation. As the model has not yet been field-tested, its feasibility, acceptability, cost, workforce requirements and effectiveness should be evaluated through pilot implementation before wider state or national scale-up is recommended.

Keywords: Community-Based Rehabilitation; Disability; Rural Health; Task-shifting; India; ICF Framework; Public Health Policy

Introduction

Community-Based Rehabilitation (CBR) emerged globally following the Declaration of Alma-Ata (1978) as a primary health care strategy to extend rehabilitation access to low- and middle-income countries using local resources [1]. Over four decades, CBR has evolved from a predominantly medical service-delivery model toward a comprehensive rights-based development approach, repositioned in 2003-2004 by the World Health Organization (WHO), International Labour Organization (ILO) and United Nations Educational, Scientific and Cultural Organization (UNESCO) as a community-development strategy for rehabilitation, equalization of opportunities, poverty reduction and social inclusion of people with disabilities [2,3].

India is home to an estimated 27.9 million persons with disabilities, of whom 76% reside in rural areas, where disability is shaped by poverty, agricultural livelihood dependence (60% rural employment in agriculture), gender inequality, caste-based discrimination, educational barriers, healthcare-access deficits and infrastructural inaccessibility [4]. With only approximately 30,000 physiotherapists serving 1.4 billion people, specialist rehabilitation capacity remains critically constrained in rural India [4]. India's disability policy has transformed through constitutional commitments (Articles 14-17, 21 and 41) [6], ratification of the UN Convention on the Rights of Persons with Disabilities (CRPD) in 2007 [7], and the Rights of Persons with Disabilities (RPwD) Act 2016, effective June 2017, which expanded recognized disabilities from 7 to 21 categories and shifted policy from a medical-charity model toward a comprehensive social-rights framework [5].

Despite this evolving policy architecture, implementation of disability-inclusive rehabilitation in rural India remains fragmented across ministries and schemes, with limited standardization of screening tools, workforce training curricula or outcome indicators. Existing CBR programs in India have historically varied widely in scope and quality, ranging from NGO-led pilot projects to state-specific initiatives, with little cross-program comparability of outcomes. This fragmentation limits the ability of policymakers to identify which components of CBR delivery are most effective, to pool data across districts and states, or to make the case for sustained budgetary commitment based on demonstrated impact.

This paper describes the SAKSHAM Model, a standardized CBR implementation framework that operationalizes WHO CBR guidelines and the ICF biopsychosocial framework within India's existing government infrastructure through convergence of the National Health Mission, Samagra Shiksha, the Deendayal Disabled Rehabilitation Scheme (DDRS), MGNREGA and the national network of 1,73,881 Ayushman Arogya Mandirs [10,13,18,25,29,34]. The objective of this review is to present the conceptual foundation, five-component service matrix, standardized measurement framework, government-scheme integration, task-shifted workforce design, and implementation strategy of the model as a reference for public health professionals, community medicine practitioners and district-level administrators engaged in rural disability rehabilitation. By consolidating conceptual grounding, service design, measurement and financing into a single, internally consistent framework, this review addresses the current absence of a standardized, comparable CBR model for rural India and contributes to the literature a structured reference that can inform convergent program design, cross-district comparison, and future field evaluation of disability rehabilitation delivery.

EVIDENCE ACQUISITION

The SAKSHAM Model was developed through structured review and synthesis of: (i) WHO/ILO/UNESCO CBR guidance documents and the ICF framework [2,3,10]; (ii) Indian constitutional provisions and national disability legislation, including the RPwD Act 2016 and RTE Act 2009 [5,6,9]; (iii) operational guidelines of major convergent government schemes spanning health, education, livelihood, rural employment and social welfare [13,18,25,29,30,34,36,37]; and (iv) peer-reviewed literature on validated functional, developmental and disability-screening instruments applicable across the life course, from preconception through the elderly years [10,20,26,41,42]. Evidence from task-shifted community rehabilitation programs in India and Thailand informed the workforce-deployment design [43,44]. The synthesis followed a PICO (Population, Intervention, Comparison, Outcome)-informed structuring recommended for public-health program design—in this review, the rural Indian PWD population as the Population, government-scheme-convergent CBR delivery as the Intervention, existing fragmented/non-standardized CBR delivery as the implicit Comparison, and functional, participation and policy-level change as the Outcomes, and outcome measurement was aligned with a three-tiered output-outcome-impact indicator system consistent with WHO CBR monitoring guidance [3]. The stages of this synthesis process, from source identification through model formulation, are summarized in Table 1.

Table 1. Evidence acquisition and synthesis process

Synthesis Stage	Sources / Activity	Output
1. Source identification	WHO/ILO/UNESCO CBR guidance and ICF framework; Indian constitutional and legislative texts; national scheme operational guidelines; peer-reviewed literature on screening instruments; India/Thailand task-shifting evidence	Pool of conceptual, legal, policy and measurement source documents
2. PICO-informed structuring	Population (rural PWDs), Intervention (convergent CBR delivery), Comparison (existing fragmented delivery), Outcome (functional, participation and policy indicators) applied to each source	Structured evidence set aligned to program-design questions
3. Thematic mapping	Mapping of evidence to five candidate service domains (health, education, livelihood, social inclusion, empowerment) and to government scheme mandates	Five-component service matrix with scheme linkages
4. Workforce and measurement synthesis	Review of task-shifting evidence and validated life-course screening instruments	Three-tier workforce design; 22-instrument measurement battery
5. Model consolidation	Integration of components, workforce, measurement and financing into a single implementation framework	SAKSHAM Model

Results

Conceptual Foundation

The model operationalizes the International Classification of Functioning, Disability and Health (ICF), endorsed by 191 WHO member states in 2001, which frames disability as emerging from interactions between body functions, activities, participation, environmental factors and personal circumstances rather than individual pathology alone [8,10]. This biopsychosocial orientation shapes assessment, planning and outcome measurement throughout the model, moving beyond impairment reduction toward participation, community inclusion and autonomy. Concretely, each ICF domain is mapped to specific intervention components: body-function and structure impairments are addressed through the Health component's clinical and rehabilitation services; activity limitations are addressed through therapy, assistive devices and the Education component's skill-building; participation restrictions are addressed through the Social Inclusion and Livelihood components; and environmental and personal factors are addressed through the Empowerment component's rights-based and autonomy-supporting activities. The life-course instrument battery is likewise selected to capture body-function, activity and participation indicators separately, so that ICF operationalization is reflected in measurable assessment items rather than remaining a conceptual reference alone.

To reduce conceptual overlap among the five components, each is defined by a distinct primary functional domain: the Health component addresses body-function/impairment-level needs (clinical, rehabilitative and assistive-device services); the Education component addresses skill- and knowledge-acquisition needs across the life course; the Livelihood component addresses income-generation and economic-participation needs; the Social Inclusion component addresses community-participation and relational needs, including stigma reduction; and the Empowerment component addresses rights-exercise, agency and decision-making needs that cut across, but are conceptually distinct from, the other four. Activities are assigned to a single primary component based on which need they principally serve, even where a given activity (e.g., peer support) has secondary relevance to more than one domain.

The Five-Component Service Matrix

Health Component

The goal of the health component is equitable access to health promotion, disease prevention, medical care, rehabilitation and assistive devices integrated within primary health care. Promotion and prevention activities include health education on disability prevention and occupational safety in agriculture, integration with National Health Mission screening programs for hypertension, diabetes and cancer, and disability-inclusive antenatal care [11,13]. Primary-level screening is anchored in ASHA-led village case-finding, Rashtriya Bal Swasthya Karyakram school-level developmental and sensory screening, newborn hearing and visual screening with referral to district confirmation centers, and mental health screening integrated into Ayushman Arogya Mandir wellness services [13,15,16,17].

Ayushman Arogya Mandirs function as first-contact points providing triage, assessment, medication management and coordination, supported by a three-tier task-shifting referral protocol-ASHA community assessment, followed by ANM follow-up, PHC physician review and CHC/district specialist referral-supplemented by telehealth linkage to urban specialists [13,14,15,18]. Rehabilitation services are structured across three levels: community-level home-based rehabilitation delivered by trained community rehabilitation workers under physiotherapist supervision; facility-based primary rehabilitation delivered by ANMs at Ayushman Arogya Mandirs/PHCs; and specialist rehabilitation at CHCs and district hospitals for complex cases, including spasticity management using the Modified Ashworth Scale, prosthetics fitting and speech therapy [19,20]. Assistive devices and environmental modifications are provided through decentralized assessment and district-level procurement, local fabrication capacity built among village carpenters and blacksmiths, home modifications funded through MGNREGA community labor, and subsidy support through the Assistance to Disabled Persons for Aids and Appliances (ADIP) scheme [21,22,23,24]. Financing draws on National Health Mission budgets at zero

out-of-pocket cost, state health budget allocations of 2-3% for rehabilitation staffing, PM-JAY coverage of Rs. 5 lakh annually for BPL families, and DDRS grants channeled through registered NGOs [12,27,28].

Education Component

The education component aims to ensure inclusive, quality education and lifelong skill development from early childhood through adulthood. Early childhood development (0-6 years) is supported through developmental screening integrated with Integrated Child Development Services (ICDS) Anganwadis, parent coaching by trained Anganwadi workers, and inclusive preschool programming with curriculum adaptation [28,29]. Inclusive primary and secondary education is supported by ASHA-coordinated school-enrollment monitoring, mandatory 40-hour inclusive-pedagogy training for teachers, classroom assistants for children with significant support needs, accessible infrastructure (ramps, accessible toilets, braille materials, sign-language interpreters), and itinerant specialist teacher support for visual, hearing and intellectual disabilities [9,29,30].

Vocational education and adult livelihood skilling combine center-based training through District Industrial Training Institutes, community-based training through self-help groups, and on-the-job apprenticeships in sustainable agriculture, agro-processing, tailoring, carpentry, digital literacy and entrepreneurship, with placement supported through District Employment Exchange linkage and self-employment pathways through the National Rural Livelihoods Mission [31,32,33]. Non-formal and lifelong learning components provide community-based literacy programs and life-skills education in financial literacy, health literacy and disability rights [9]. The Samagra Shiksha Scheme, a centrally sponsored integrated school-education program covering pre-school to Grade XII, provided an outlay of Rs. 1,023.50 crore for the education of 21,00,918 children with special needs in 2018-19, functioning as the primary financing vehicle for this component [30].

Livelihood Component

This component targets economic independence through dignified employment, self-employment and community livelihood opportunities to break the disability-poverty cycle. Employment access is pursued through labor-market assessment, District Employment Exchange job-matching, employer sensitization workshops, monitoring of the 4% government job reservation for persons with disabilities, workplace accessibility support and retention follow-up addressing workplace discrimination [32,33,34]. Self-employment and entrepreneurship pathways include opportunity identification, structured business-planning support, microfinance linkage through National Rural Livelihoods Mission self-help groups, technology and equipment subsidies, and ongoing mentoring [33,34].

Cooperative and social-enterprise models-disability self-help groups, collective bargaining structures and disability-focused social enterprises-provide additional pathways for collective economic activity [34]. Given that 60% of rural employment in India is agriculture-based, the model places particular emphasis on agricultural livelihoods: advocacy for land access, training in sustainable and water-efficient farming, agricultural input subsidies, livestock and poultry startup support, value-addition training in agro-processing, and market-access linkage [4,35]. Social protection is reinforced through the Indira Gandhi National Disability Pension Scheme, PM-JAY health insurance, government savings schemes, crop-insurance mitigation through Pradhan Mantri Fasal Bima Yojana, and enrollment in conditional cash-transfer welfare schemes [26,35,36].

Social Inclusion Component

The social inclusion component seeks full participation in community life while addressing stigma and discrimination. Activities include mapping of participation opportunities, access support for religious, cultural and cooperative community activities, structural and attitudinal barrier removal, disability-focused peer-support groups, inclusive community recreation and adaptive sports, and respite and peer support for family caregivers [37]. Stigma reduction is pursued through village-level community awareness campaigns, engagement of religious leaders, school-based sensitization curricula, local media and community-theater advocacy, and leadership development among community disability champions [37,38].

Social services and support systems include community-based psychosocial counseling, family care-technique training, child-protection safeguarding for children with disabilities, gender-responsive services addressing menstrual hygiene and reproductive health for women and girls, and support for co-occurring substance-use disorders [19]. Civil-society strengthening includes capacity building for PWD-led organizations, collective advocacy, community forums for PWD voice in problem identification, and formal decision-making representation through reserved seats in panchayat, school-management and health committees [37,39]. Implementation is anchored in Village Health and Sanitation Committees, panchayat committees, school-management committees and community-based self-help groups, with PWD representation embedded in each governance structure [37,39,40].

Empowerment Component

The empowerment component enables persons with disabilities to exercise agency, claim rights, make autonomous decisions and lead community change. Rights education and awareness cover constitutional rights, the CRPD and the RPwD Act 2016, delivered through accessible formats (audio, braille, simple language, sign language) alongside advocacy-skills training in self-advocacy, public speaking, negotiation and policy engagement [5,7,39]. Self-advocacy and leadership development are pursued through peer-leadership training programs, mentorship by experienced PWD leaders, PWD-led forums and committees, and targeted engagement of youth and women with disabilities [39,40].

Participation in development planning is enabled through inclusive village-planning processes, participatory monitoring and evaluation, and grievance-redressal mechanisms demonstrating that community feedback translates into action [39,41]. Autonomous decision-making support includes supported decision-making systems for persons with cognitive disabilities, promotion of guardianship alternatives such as representative payee and power-of-attorney arrangements, informed-choice counseling for education, employment, marriage, healthcare and financial decisions, and financial-literacy guidance to prevent exploitation [39,40]. Community accountability mechanisms include accessible grievance systems, community oversight of service quality and rights compliance, and PWD-led advocacy campaigns for policy change and infrastructure accessibility [39,40].

Summary of Evidence, Proposed Intervention and Responsible Actors

Table 2. Summary of existing evidence, proposed intervention, responsible actors, implementation level and evidence strength by component

Component	Existing Evidence	Proposed Intervention	Responsible Actor	Implementation Level	Evidence Strength
Health	WHO CBR/ ICF guidance; NHM screening evidence; task-shifting studies (India/ Thailand)	ASHA/ANM/ CRW-delivered screening, home-based and facility rehabilitation, assistive devices	ASHA, ANM, CRW, PHC physician, district physiotherapist	Village, Ayushman Arogya Mandir/ PHC, CHC/ district	Moderate (drawn from established WHO/NHM programs; not field-tested as an integrated package)
Education	Samagra Shiksha and ICDS program data; inclusive-education literature	Developmental screening, inclusive-pedagogy teacher training, itinerant specialist support	Anganwadi worker, classroom teacher, itinerant special educator	Anganwadi, school, block	Moderate (established schemes; convergence with CBR not previously evaluated)

Cont....

Livelihood	NRLM and MGNREGA program evidence; disability-employment literature	Job-matching, self-employment support, agricultural livelihood assistance	District Employment Exchange, NRLM SHGs, block livelihood staff	Block, district	Low-to-moderate (scheme evidence exists; disability-specific uptake data limited)
Social Inclusion	Community-based stigma-reduction literature; panchayat governance guidelines	Awareness campaigns, peer support, governance representation	Village Health and Sanitation Committee, panchayat, community groups	Village, panchayat	Low (largely qualitative/ observational evidence)
Empowerment	CRPD/RPwD rights literature; self-advocacy program evidence	Rights education, self-advocacy training, participatory planning	PWD-led forums, National Institute of Social Defence trainers	Village, block, district	Low-to-moderate (evidence mainly from advocacy-program evaluations, not CBR-integrated trials)

Theory of Change

The model's expected causal pathway can be summarized as a logic model linking inputs, activities, outputs, outcomes and impact (Table 3). Convergent government financing and a trained task-shifted workforce (inputs) deliver standardized screening, rehabilitation, education, livelihood and empowerment activities (activities), producing measurable service coverage (outputs), which are expected to translate into functional, participation and quality-of-life improvements (outcomes) and, over a longer horizon, into reduced disability-associated poverty, stigma and policy change (impact). This logic model is intended as a testable framework: field evaluation should assess whether each linkage holds as hypothesized, rather than assuming progression from outputs to impact.

Table 3. Theory of change / program logic model

Inputs	Activities	Outputs	Outcomes	Impact
Convergent NHM, Samagra Shiksha, DDRS, MGNREGA, NRLM, PM-JAY financing	Task-shifted training of ASHAs/ ANMs/CRWs	Number trained; number of PWDs identified	Improved functional status (FIM, MAS)	Reduced disability-associated poverty
Ayushman Arogya Mandir infrastructure and referral network	Life-course screening and referral	Screening coverage; referral completion rate	Improved participation and quality of life (WHODAS 2.0, WHOQOL-BREF)	Reduced stigma and discrimination

Cont....

Trained community workforce (ASHA/ ANM/CRW) and supervising physiotherapists	Home- and facility-based rehabilitation, assistive-device provision	Devices provided; rehabilitation sessions delivered	Increased school enrollment and workforce participation	Policy uptake at state/national level
Education, livelihood and social-welfare scheme convergence	Inclusive education, vocational training, livelihood linkage, social-inclusion and empowerment activities	School enrollment; livelihood placements; PWD representation in governance bodies	Enhanced autonomy and rights-exercise	Sustained multi-sectoral convergence institutionalized

Standardization and Measurement Framework

The model applies a three-tiered indicator system: output indicators (e.g., number of PWDs identified, screening coverage, school enrollment), outcome indicators (functional and quality-of-life change measured with instruments such as the Functional Independence Measure, Modified Ashworth Scale, WHODAS 2.0 and WHOQOL-BREF) and impact indicators (poverty reduction, stigma reduction and policy change) [20,26,41,42]. A life-course battery of 22 validated instruments is applied from the preconception phase (e.g., HbA1c testing, FIGO preconception checklist) through pregnancy (Edinburgh Postnatal Depression Scale, blood-pressure monitoring), infancy and childhood (Ages & Stages Questionnaires-3, Denver II), adulthood (WHODAS 2.0, Timed Up and Go test) and older age (Falls Efficacy Scale-International, Mini-Cog, Geriatric Depression Scale), enabling standardized, repeatable, evidence-based screening across all Community-Based Rehabilitation contact points [20,27].

Integration with Government Systems

The model achieves financial and administrative sustainability through convergence rather than parallel infrastructure creation. Key schemes include the National Health Mission (rehabilitation embedded in primary care at no out-of-pocket cost) [13], the DDRS (90-100% central grant support for NGO-led service delivery) [30], the Samagra Shiksha Scheme (an outlay of Rs. 1,023.50 crore for 21,00,918 children with special needs in 2018-19) [34], MGNREGA (100 days of guaranteed rural wage employment, inclusive of PWDs, for accessibility infrastructure) [25], and the Ayushman Arogya Mandir network, comprising 1,73,881 operational facilities delivering comprehensive primary care by July 2024 [18]. Governance is structured across national, state, district, block and community levels, with District Management Committees chaired by the District Collector coordinating health, education, social welfare and rural development functions [5,30].

Task-Shifted Community Workforce

Given the severe scarcity of rehabilitation specialists, the model deploys a three-tier task-shifted workforce. ASHAs (2.84 lakh female community health volunteers) complete a 40-hour curriculum on disability identification and referral, receiving performance-based incentives [13,15]. ANMs (0.12 million salaried professionals) complete an 80-hour module on functional assessment using WHODAS 2.0, basic therapeutic exercises and assistive-device orientation [15,27]. A dedicated cadre of Community Rehabilitation Workers, deployed at a ratio of one per 5,000 population and completing 120 hours of training in ICF-based assessment and home-based therapy, is supervised monthly by district physiotherapists [20]. This structure mirrors task-shifting evidence from India and Thailand demonstrating that trained community health workers can effectively deliver disability identification, home rehabilitation and health-system navigation [43,44].

Implementation Strategy and Financing

A five-step program cycle-situational assessment, planning, implementation, monitoring and evaluation, and adaptation-guides local rollout[3]. Estimated annual cost is Rs.12-20 crore per million rural population (approximately Rs. 100 per identified person with disability), financed through

convergent National Health Mission, state health budget, Samagra Shiksha, MGNREGA, NRLM, DDRS and PM-JAY allocations [13,25,29,30,34,37]. A phased three-stage scaling strategy is proposed: intensive implementation in 10-15 districts (Years 1-2), expansion to 30-40 districts (Years 3-4), and state-wide scaling with national policy uptake thereafter (Year 5 onward) [30]. Progression between stages is not intended to be time-triggered alone; advancement to the next stage should be contingent on pre-specified implementation criteria being met in the preceding stage, including: attainment of at least 70-80% of target screening and service-coverage indicators; documented workforce retention and competency on standardized training assessments; functioning of convergent financing and referral linkages without major disruption; and no unresolved major safety or grievance concerns identified through the monitoring and evaluation cycle. Districts not meeting these criteria within the planned timeframe would continue in the intensive-implementation stage with corrective adaptation rather than automatically advancing, so that scale-up decisions are evidence-triggered rather than predetermined by calendar year.

Discussion

The SAKSHAM Model's principal contribution is its convergence architecture: rather than proposing new vertical disability programs, it standardizes the use of existing, well-resourced government platforms-Ayushman Arogya Mandirs, ASHA/ANM cadres, Samagra Shiksha and MGNREGA-for disability-inclusive service delivery [13,18,25,34]. This approach is consistent with international evidence that task-shifted, community-embedded rehabilitation delivery is both feasible and effective in low-resource settings [43,44], and it directly addresses the specialist-to-population ratio constraint that limits facility-based rehabilitation scale-up in rural India [4].

The model's standardized life-course assessment battery addresses a recognized gap in Indian CBR practice, where disability screening has historically been ad hoc and non-comparable across programs. By anchoring assessment in globally validated, ICF-aligned instruments such as WHODAS 2.0 and the Functional Independence Measure, the framework enables data pooling, longitudinal outcome tracking and inter-district comparison [10,26,41]. Its emphasis on rights-based empowerment and social-participation outcomes, alongside functional outcomes, further aligns the model with the CRPD's shift away from a purely medical conceptualization of disability [7].

A further strength of the model lies in its financing design. Rather than requiring new budget lines, the model relies on convergent use of allocations already committed under the National Health Mission, Samagra Shiksha, MGNREGA, NRLM, DDRS and PM-JAY, an approach consistent with public-health financing literature emphasizing intersectoral convergence as a route to sustainability in resource-constrained settings [12,25,30,34,37]. The estimated annual cost of Rs. 12-20 crore per million rural population is modest relative to the scale of unmet need, and the phased three-stage scaling strategy allows early-phase evidence generation in a limited number of districts before wider rollout, reducing implementation risk [30].

The model's task-shifting design also carries workforce-development implications for public health training institutions. Standardized 40-, 80- and 120-hour curricula for ASHAs, ANMs and Community Rehabilitation Workers, respectively, create a replicable training architecture that can be embedded within existing in-service training systems rather than requiring new specialist cadres [13,14,15,19,20]. This is particularly relevant given that community medicine and social-work training programs in India currently provide limited formal curricular content on disability rehabilitation, and the model's structured competency framework offers a template that training institutions could adopt or adapt.

Limitations of the proposed framework include its dependence on the effective functioning of underlying government schemes, whose implementation quality varies substantially across Indian states and districts, and the absence, at this stage, of prospective field data demonstrating the model's real-world effectiveness, cost-effectiveness and acceptability. Because the framework is a conceptual synthesis rather than an empirically evaluated intervention, claims regarding functional and social outcomes should be interpreted as hypothesized benefits pending field validation rather than demonstrated effects. Sex- and gender-disaggregated outcome reporting, in line with SAGER

guidance, and context adaptation for tribal and semi-urban populations will be necessary as the model moves from conceptual design to field implementation and evaluation. Regional and local adaptation will need to extend beyond tribal and semi-urban settings to account for linguistic diversity in rights-education and screening materials, variation in the availability and functioning of Ayushman Arogya Mandirs and ASHA/ANM coverage across states, differing state-level disability-scheme provisions layered atop central schemes, and cultural variation in disability stigma, family decision-making structures and acceptability of home-based rehabilitation by community workers. In geographically dispersed or forested tribal areas in particular, the ratio of one Community Rehabilitation Worker per 5,000 population, and the referral pathway to CHC/ district specialists, may require local recalibration where travel distances and terrain limit the feasibility of the proposed supervision and referral frequency; state- and district-level adaptation protocols should therefore be developed alongside, rather than after, initial pilot implementation. Future work should prioritize pilot implementation with rigorous baseline-to-endline outcome measurement using the standardized instrument battery described above, alongside qualitative evaluation of acceptability among ASHAs, ANMs, Community Rehabilitation Workers and persons with disabilities themselves, whose lived experience should ultimately determine whether the model's rights-based aspirations translate into meaningful change in daily life.

Conclusion

The SAKSHAM Model presents a conceptually comprehensive, evidence-informed framework for operationalizing rights-based disability inclusion within India's existing government systems through five converging components-health, education, livelihood, social inclusion and empowerment [5,7,30]-delivered by a task-shifted community workforce and monitored through a standardized three-tiered indicator system [20,26,41,42]. Distinguished by its constitutional grounding, alignment with the ICF framework, and convergent use of the National Health Mission, Samagra Shiksha, DDRS, MGNREGA and the Ayushman Arogya Mandir network, the model offers public health professionals, community medicine practitioners, social workers and district-level policymakers a potentially scalable pathway, pending field validation, for extending rehabilitation to the estimated 19 million rural Indians with disabilities who remain underserved by services concentrated in urban tertiary centers [4,18]. Before wider state or national scale-up is recommended, the feasibility, acceptability, cost, workforce requirements and effectiveness of the model should be assessed through pilot implementation. Translating this conceptual model into successful implementation will require sustained district leadership, adequate community-worker staffing, authentic participation of persons with disabilities in program governance, and rigorous monitoring to generate the field evidence needed for state-wide and national scale-up.

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Review Article

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Correlation of Sonomammography and Histopathology/Cytology in the Detection of Breast Cancer: A Structured Narrative Review

Mayuri Ojah[1], Priyanka Bhattacharyya[2], Bhargav Das[3]

[1]PhD Scholar, Department of Radiology, The Assam Royal Global University, Guwahati, India. [2]Assistant Professor, The Assam Royal Global University, Guwahati, India. [3]Consultant Radiologist, Life Care diagnostics, Maligaon, Guwahati, Assam.

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Abstract

Background: Breast cancer is one of the most common causes of cancer-related morbidity and mortality among women worldwide. Early diagnosis is essential for enhancing survival and treatment outcomes. Sonomammography, which combines ultrasound and mammography, improves lesion detection and characterization, especially in women with dense breast tissue. However, histopathology and cytology remain the gold standards for definitive diagnosis.

Objective: This narrative review evaluates the diagnostic correlation and reliability of sonomammography compared to histopathology and cytology in breast cancer detection.

Methods: A structured narrative review was conducted using PubMed, Scopus, and Google Scholar databases. The search included studies from 2015 to 2025, focusing on the correlation between sonomammography and histopathology/cytology.

Results: Sonomammography demonstrates high sensitivity and moderate specificity, with good concordance with histopathological outcomes. This enhances diagnostic confidence and minimizes unnecessary invasive procedures. However, operator dependence and lesion variability can affect diagnostic accuracy.

Conclusion: Sonomammography is an effective tool for breast cancer screening and diagnosis, particularly when combined with histopathological assessment. This integrated approach improves early detection, diagnostic accuracy, and patient outcomes.

Keywords: Breast cancer, Sonomammography, Mammography, Ultrasonography, Histopathology, Cytology, Diagnostic accuracy, BI-RADS

Introduction

Global Burden of Breast Cancer

Breast cancer is the most common malignancy diagnosed in women worldwide and a leading cause of cancer-related deaths. Recent statistics indicate a steady rise in cancer incidence, with around 2.3 million new cases annually, representing a significant percentage of all female cancers.[1]

Corresponding Author: Mayuri Ojah, PhD Scholar, Department of Radiology, The Assam Royal Global University, Guwahati, India.

E-mail: mayuriojah39@gmail.com

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Mortality rates are particularly high in low- and middle-income countries due to late-stage diagnosis and limited screening facilities.[2]

Importance of Early Detection

Early detection of breast cancer significantly improves survival rates. Localized, early-stage disease has a five-year survival rate of over 90%.[3] Early diagnosis allows for less aggressive treatment and better quality of life.[7]

Definition of Key Terms:

Sonomammography: It is the integration of mammography and ultrasonography to improve lesion identification and differentiation.[5]

Histopathology: It is the microscopic examination of tissue obtained via biopsy, which is considered as the gold standard for definitive cancer diagnosis.[6]

Cytology (FNAC): Fine needle aspiration cytology is a less invasive technique for assessing cell morphology.[11]

Aim of the Review

This narrative review aims to evaluate the correlation between sonomammography findings and histopathology/cytology in breast cancer diagnosis, focusing on diagnostic accuracy, sensitivity, specificity, and concordance rates.

Materials & Methods

Methodology of Review

This study was conducted as a narrative review to synthesize and critically evaluate the literature on the relationship between sonomammography and histopathology/cytology in breast cancer detection. The narrative approach allows for a comprehensive interpretation of findings from diverse study designs.

Search Strategy

A systematic search was conducted using electronic databases: PubMed, Scopus, and Google Scholar. The search strategy included keywords and Boolean operators to retrieve relevant studies. Keywords included: "breast cancer" "sonomammography,", "mammography" "ultrasonography", "histopathology", "cytology", "diagnostic accuracy", "BI-RADS"

Inclusion and Exclusion Criteria

Inclusion Criteria: Studies published between 2015 and 2025, involving human subjects, and providing a direct comparison of sonomammography with histopathology or cytology were included.

Exclusion Criteria: Case reports, editorials, non-English studies, and studies with insufficient data were excluded from the study.

Data Extraction and Synthesis

Data extraction focused on key diagnostic performance indicators which are sensitivity, specificity, diagnostic accuracy and concordance rates. The synthesis was qualitative, aiming to provide a structured and clinically meaningful overview of the evidence.

Table 1: Summary of Methodology and Study Selection Criteria

Component	Details
Review Type	Structured Narrative review
Databases Used	PubMed, Scopus, Google Scholar
Search Strategy	Boolean combination: (*"Breast cancer" OR "breast neoplasm") AND ("sonomammography" OR "ultrasonography" OR "mammography") AND ("histopathology" OR "cytology" OR "biopsy"*)
Search Period	2015–2025
Study Population	Human subjects undergoing breast lesion evaluation
Study Types Included	Comparative diagnostic studies, observational studies, cross-sectional studies
Inclusion Criteria	Studies comparing imaging (USG/mammography) with histopathology/cytology; peer-reviewed

Cont...

Exclusion Criteria	Case reports, editorials, non-English studies, studies with insufficient data
Data Extraction Focus	Sensitivity, specificity, positive/negative predictive values, concordance rates
Analysis Method	Qualitative synthesis (structured narrative approach)
Quality/Bias Consideration	Verification bias, spectrum bias, operator dependence acknowledged; no formal QUADAS-2 scoring applied
Languagae Restriction	English only (language bias acknowledged as a limitation)

Explanation

The table presents a structured overview of the methodology adopted in this narrative review. A narrative review design was chosen to allow flexibility in synthesizing findings from diverse study designs, particularly those evaluating diagnostic correlations. Multiple databases, including PubMed, Scopus, and Google Scholar, were used to ensure comprehensive literature coverage and minimize selection bias.

The keyword strategy was designed to capture studies focusing on both imaging modalities and histopathological confirmation, thereby ensuring relevance to the review objective. A defined time frame of 2015–2025 was applied to include recent advancements and contemporary diagnostic practices.

Inclusion criteria emphasized studies with direct comparative analysis between sonomammography and histopathology or cytology, ensuring that only clinically relevant and methodologically sound studies were considered. Exclusion of case reports and non-English studies helped maintain consistency and reduce bias.

The data extraction focused on key diagnostic performance indicators such as sensitivity, specificity, diagnostic accuracy and concordance rates. Overall, this methodological framework ensured a structured, unbiased, and clinically meaningful synthesis of available evidence.

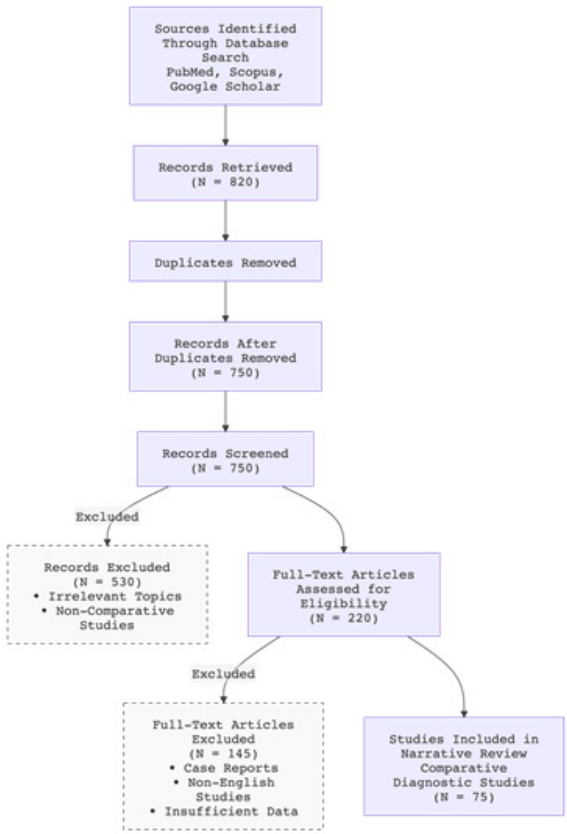

Figure 1. Study Selection Flowchart for the Narrative Review

Breast Imaging Techniques

Mammography

Mammography is a radiology modality for imaging that makes use of low dose of X-rays in order to visualize internal structures of the breast and identify abnormalities that include masses and micro calcification. It has continued to be the backbone of breast cancer screening initiatives because it has proved to detect early-stage cancerous growths before it can manifest itself clinically.[6,7] Breast Imaging Reporting and Data System (BI-RADS) offers a uniform system of reporting the findings (0 (incomplete) to 6 known malignancy) thus enhancing diagnostic quality and clinical judgment.[8] Mammography has a high rate of sensitivity, which is usually 75-90% of the time, however, in women with dense breast tissue, overlapping fibroglandular structures may mask lesions.[9]

Ultrasonography

Ultrasonography involves the use of sound waves of high frequencies to create real time images of the breast tissues. It is especially useful as a supplement to mammography, particularly in younger and dense-breasted women.[5] Ultrasound is vital in the process of distinguishing between cystic and solid lesions, biopsy procedures, and assessment of palpable abnormalities which are invisible under mammography. Its benefits are that it does not contain ionizing radiations, is portable, cost-effective, and can produce real time and dynamic images.[10] Nevertheless, it is operator-dependent, and might not be as specific as mammography, which results in possible false-positive results.

Sonomammography (Combined Approach)

Sonomammography can be described as the integration of mammography and ultrasonography to improve the diagnostic image. This is the combined use of both modalities, which is the best way to detect and describe lesions, especially for pregnant women with thick breast tissue.[12] The combination of the two methods enhances the sensitivity and decreases the rate of false-negatives. Secondly, sonomammography has an advatage because of its role in refining BI-RADS classification. Ultrasound findings can either elevate the suspicion for malignancy in initially indeterminate lesions or reassure the benign nature of lesions that appear suspicious on mammography alone.[12] As a result, clinicians can make more targeted biopsy decisions and implement management plans that align with the true risk profile of each lesion. All in all, this combined technique has a more comprehensive evaluation as it fills the gap between the imaging and pathological confirmation.

Histopathology and Cytology (Gold Standard)

Histopathology

The diagnostic modality that is absolutely definitive in the diagnosis of breast cancer is histopathology as it provides details of tissue architecture and cellular morphology. The most frequently used method is core needle biopsy that enables the collection of sufficient tissue samples but with minimum invasion.[13] Microscopic analysis facilitates determination of malignant cells including cellular atypia, mitotic activity, and patterns of invasion, etc. Moreover, histopathology is an important part of tumor grading and staging as well as assessment of histological subtype, lymphovascular invasion, and receptor status (ER, PR, HER2, etc), which is vital in prognostication and therapy decisions.[14]

Cytology (FNAC)

Fine Needle Aspirations Cytology (FNAC) is a less invasive method of diagnosis in which a fine needle collects cells and then cytological examination is conducted on them. It is commonly applied to provide an initial assessment of breast lesions because it is simple, cost-effective, and gives results in less time.[15] FNAC has a specific application in the differentiation of benign and malignant tissues in outpatient conditions. It is however limited compared to the histopathology, which includes the inability to investigate the structure of tissues, the risk of insufficient sampling, and less effectiveness in borderline or complex lesions.[16]

Importance as a Standard of Reference.

Histopathology and cytology are used as reference standards in verifying imaging findings in the diagnosis of breast cancer. They offer conclusive data that is needed to make clinical decisions, such

as surgical planning, chemotherapy, and targeted therapy.[15] Imaging modalities and pathology correlation increases the quality of diagnostic findings, the rate of false interpretation, and better handling of the patients. While imaging-based measurements are valuable, these complementary diagnostic approaches are gaining importance in establishing comprehensive breast cancer diagnosis

Correlation Between Sonomammography and Histopathology/Cytology

Diagnostic Accuracy

The properties of sonomammography which are used to identify the diagnostic accuracy includes sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). It has been shown that mammography and ultrasonography can be used together, which results in a high sensitivity level, usually being between 85-95, especially in the detection of early and small lesions.[5] Specificity is enhanced by imaging results being paired with histopathological validation, so it will minimize false-positive results.[17] Diagnostic performance metrics, including PPV and NPV, are influenced by lesion characteristics and patient factors, with NPV demonstrating particular value in screening applications.

Diagnostic performance metrics, including PPV and NPV, are influenced by lesion characteristics and patient factors, with NPV demonstrating particular value in screening applications.

Concordance Rates

Coherence between imaging and histopathology/cytology is one of the important factors of diagnostic integrity. When the BI-RADS is compared to correlate with the results of the histopathology, high agreement rates have been reported particularly when dealing with the class 4 and 5 lesions.[18]Inconsistencies between imaging appearance and true pathological status represent a significant diagnostic challenge, resulting in both overestimation of lesion severity in benign cases and underdiagnosis of malignancies, especially within fibroglandular breast tissue.[5]

BI-RADS Correlation

BI-RADS classification is crucial in the process of correlating the imaging results with pathological results. There are strong predictive validity of higher BI-RADS categories (4 and 5) with regard to malignancy whereas lower categories (2 and 3) are usually linked to benign conditions.[19] Ultrasound findings can be used to upgrade or downgrade the BI-RADS category, subsequently refining the biopsy recommendations and increasing the accuracy of diagnosis.[20]

Comparative Analysis

Parameter	Sonomammography	Histopathology/Cytology
Nature	Non-invasive	Invasive (requires biopsy)
Accuracy	High(screening);moderate specificity	Gold standard for definitive diagnosis
Cost	Moderate; cost effective	Higher; requires laboratory processing
Time	Immediate/ Real time	Delayed (depends on the method)
Clinical role	Detection & Characterisation	Confirmation and staging
Opeartor dependence	High	Low

Key Findings from Literature

Evidence suggests that sonomammography provides high sensitivity and improved lesion detection compared to single-modality imaging like mammography or ultrasonography alone.[5] Specificity is significantly enhanced when imaging is correlated with histopathological findings, ensuring accurate diagnosis and reducing unnecessary interventions.[21] FNAC serves as a useful preliminary diagnostic tool but lacks the comprehensive detail of histopathology, making the latter essential for definitive diagnosis and treatment planning.[17]

Advantages and Limitations

Advantages

Sonomammography has a lot of potential benefits in the early diagnosis of breast cancer especially when combined as an imaging modality. Combined

mammographic and ultrasonographic screening enables earlier lesion detection, facilitating timely interventions that significantly improve treatment outcomes and reduce breast cancer mortality rates.[1] Imaging techniques are non-invasive, and therefore applicable to regular screening and follow-up without exposing patients to invasive procedures.[5] Furthermore, sonomammography is fairly inexpensive relative to other advanced imaging technologies like MRI, and thus, it can be used extensively in developing nations where access to proper medical services is scarce.[21] The potential to use ultrasound as a supplement to mammography, particularly in dense breast tissue, again leads to the increase of the clinical application of ultrasound in improving lesion detection and characterization.[22]

Limitations

Although sonomammography has its benefits, there are various limitations of the diagnostic method that may compromise the level of accuracy. Ultrasonography is operator-specific and the quality of the findings can be inconsistent, depending on the ability and level of experience of the radiologist which can result in inconsistency in interpretation.[22] The imaging modalities are reported to contain false-positive results, where benign lesions can be interpreted as suspicious instead of the expected benign lesion, which leads to the unwarranted biopsies, and emotional harassment of the patient.[23] On the other hand, there may be false negatives, especially in heavy breast tissue, where the lesions may be concealed due to thick tissue.[5] FNAC in cytology is also susceptible to sampling errors and can produce insufficient and inconclusive findings, which is why it is less reliable than histopathology.[17] Thus, imaging is a valuable screening method but its results should be analyzed together with pathological examination so that correct diagnosis and proper clinical treatments could be taken into account.

Clinical Implications

Importance in Screening Programs

Sonomammography has been relevant in the modern breast cancer screening programs as it helps to boost early detection and diagnostic yield. Mammography and ultrasonography combination enhance the chances of detecting lesions that cannot be detected using a single modality, especially among women with dense tissue.[5] Such a combination aids in the screening programs that are population-based because it enhances sensitivity and enables the intervention to take place in time, which is why it helps with the reduction in mortality rates.[1] Standardized reporting methods like BI-RADS also contribute to making of clinical decisions and uniformity of screening results.[8]

Role in Rural Setting

Sonomammography provides a viable and convenient option of diagnosis in rural and resource-challenged environments. Ultrasonography has an advantage over other advanced imaging modalities because it is portable and low-cost, and can be implemented in primary healthcare facilities to provide prompt screening of symptomatic patients with no access to other advanced imaging technologies.[10] By using both basic mammography and ultrasound, the level of diagnostic coverage in underserved groups may be greatly enhanced, eliminating the gap in cancer diagnosis and treatment.[19]

Eliminating the Unnecessary Biopsies.

Correlating imaging results with histopathology or cytology can be used in reducing the unnecessary invasive procedures. Correct BI-RADS classification with sonomammographic evidence will enable clinicians to differentiate between benign and suspicious lesions, preventing the unnecessary biopsy of low-risk cases.[19] This does not only minimize patient anxiety and risks associated with the procedure but also maximizes the use of healthcare resources.

Instructing Therapeutic Choices.

When combined with histopathological confirmation, sonomammography constitutes a comprehensive diagnostic approach that directly informs and guides treatment planning. Imaging data can be used to identify the size, location, and extent of a lesion, whereas histopathology identifies the type, grade, and receptor of a tumor, and this combined information base enables evidence-based selection of surgery, chemotherapy, or targeted agent therapy tailored to individual tumor biology.[13] This is a combined method that guarantees proper staging and enhances the clinical results.

Future Directions

AI Integration in Imaging

Artificial intelligence (AI) is quickly changing the face of breast imaging to increase detection accuracy and ensure more uniform interpretations. Algorithms of machine learning and deep learning will help identify the lesion, risk stratification, and BI-RADS classification automatically, which will increase the efficiency and consistency of the diagnosis.[20] Large-scale screening analysis also can be analyzed with AI-driven tools, which is especially useful in demanding environments with a shortage of radiology expertise.[21]

Contrast-Enhanced Ultrasound and Elastography.

Elastography and contrast-enhanced ultrasound (CEUS) are recent techniques of high-level ultrasound that are emerging as useful complement to breast imaging. Elastography measures the rigidity of the tissues and it is used to distinguish between malignant and benign lesions according to their mechanical characteristics.[23] Likewise, CEUS can be used to improve the visualization of tumor vascularity and perfusion patterns with a further functional information that helps to characterize the lesions better.[24] The innovations help in making things more specific and helps to avoid biopsies which may be unnecessary.

Digital Pathology

Digital pathology is changing the way histopathological assessment is conducted by providing a high-resolution slide scan, remote diagnostics, and integration with the AI-based analysis. This strategy makes it easier to diagnose, enhance reproducibility, and collaborate more effectively between pathologists.[24] Digital pathology coupled with imaging data assists in more and better correlation studies and in the overall diagnostic processes.

Individualized Screening Procedures

It is likely that in the future, screening of breast cancer will change to individualized screening depending on the individual risk factors such as hereditary predisposition, breast density, and lifestyle. Individualized screening regimens combining sonomammography with high-level imaging and molecular diagnostics can be optimal in terms of early identification and reduction of inaccurate diagnosis.[25] The objectives of using such strategies are to enhance patient outcomes by matching screening intensity with a risk individual profile.

Conclusion

Sonomammography has become a very effective and feasible modality for screening and initial diagnosis of breast cancer, particularly because it combines the advantages of both mammography and ultrasonography. This combined imaging method improves the ability to detect lesions, especially in women with dense breast tissue, and demonstrates increased sensitivity in detecting suspicious abnormalities. As a non-invasive and relatively accessible modality, it is essential in mass screening and initial clinical assessment programs.

Although these benefits are recognized, histopathology remains the gold standard for definitive diagnosis of breast cancer. Microscopic examination of tissue obtained through biopsy provides information about tumor type, grade, and receptor status, all of which are necessary for proper diagnosis and treatment planning. Fine needle aspiration cytology (FNAC) is a useful supplementary tool for rapid assessment, but they are not as definitive as histopathology.

Several studies suggests that the correlation between sonomammography and histopathology or cytology is clinically significant and increases diagnostic accuracy. This integrated approach reduces the likelihood of both false-positive and false-negative results, enhances clinical confidence, and supports ethical decision-making regarding biopsy and treatment planning. By combining imaging findings with pathological confirmation, clinicians can achieve a more comprehensive assessment of breast lesions.

In summary, sonomammography and histopathological assessment can be used in conjunction to achieve early detection, effective clinical management, and improved patient outcomes. This integrated diagnostic approach not only will enable

timely intervention but also will enhanceprognosis and survival rates for breast cancer patients.

Declaration by Authors

Ethical Approval: Obtaining informed consent was not applicable here since it is a narrative review.

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Conflict of Interest: The authors declare no conflict of interest.

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Original Article

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A Subclinical Decrease in Hand Grip Strength in Type 2 Diabetes Mellitus and Its Effects on ADL's

Ajithkumar Anbazhagan[1], P. Senthil Selvam[2], B.Nandhini[3], Diana Priya .P[4], Vishnu.V[5]

[1]Assistant Professor, [2]Professor and HOD, [3]Assistant Professor, [4]Assistant Professor, [5]Post- Graduate Student, School of Physiotherapy- Vels Institute of Science, Technology & Advanced Studies.

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Abstract

Background: Type 2 Diabetes Mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia due to insulin resistance and/or impaired insulin secretion. Skeletal muscle function is significantly affected in individuals with diabetes due to altered glucose metabolism, increased intramuscular fat deposition, and reduced protein synthesis. Hand grip strength is a simple and reliable indicator of overall muscle strength and functional status. Subclinical reduction in hand grip strength may occur even before noticeable disability, potentially affecting performance in Activities of Daily Living (ADL). This study aims to evaluate the subclinical decrease in hand grip strength in individuals with Type 2 Diabetes and its impact on ADL.

Methods: This observational study included 100 participants, comprising 50 individuals diagnosed with Type 2 Diabetes Mellitus and 50 age-matched healthy controls. Participants aged above 60 years were recruited. Hand grip strength was assessed using a Hand-Held Dynamometer (HHD). Functional performance in Activities of Daily Living was evaluated using standardized ADL scales RAND SF-36 Questionnaire Statistical analysis was performed using an independent-samples t-test to compare groups and a Pearson correlation coefficient to assess the relationship between hand grip strength and ADL performance.

Conclusion: Type 2 Diabetes Mellitus is associated with a subclinical decrease in hand grip strength, which may not be immediately evident but can gradually impact functional independence. Early identification and intervention targeting muscle strength may help in preventing decline in Activities of Daily Living and improving quality of life. ated using standardized ADL scales RAND SF-36 Questionnaire Statistical analysis was performed using an independent sample t-test to compare groups and a Pearson correlation coefficient to assess the relationship between hand grip strength and ADL performance.

Results: The results showed a statistically significant reduction in hand grip strength among individuals with Type 2 Diabetes compared to healthy controls ($p < 0.05$). A significant negative correlation was observed between hand grip strength and ADL performance, indicating that decreased grip strength is associated with reduced functional ability. However, some ADL components showed minimal or non-significant differences.

Key Words: Diabetes mellitus, Hand Grip strength, hand-held dynamometer.

Corresponding Author: Ajithkumar Anbazhagan, Assistant Professor, School of Physiotherapy- Vels Institute of Science, Technology & Advanced Studies.

E-mail: dr.ajithkumarava@gmail.com

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Introduction

Diabetes is one of the most common chronic metabolic conditions characterised by inadequate insulin production and impaired insulin action, or both. Additionally, insulin acts as an anabolic hormone, influencing the metabolism of carbs, lipids, and proteins[1].

Many studies have shown numerous complications of DM, such as diabetic retinopathy, chronic renal disease, reduced muscular strength, and other long-term consequences that affect an individual's quality of life.[1]

Diabetes can lead to a decrease in hand grip strength, limiting independence. Limited upper extremity mobility leads to inactivity, resulting in muscle mass loss and reduced muscle strength[2]. Musculoskeletal symptoms, such as muscular weakness, greatly impact the quality of life for those with diabetes mellitus in later stages. Muscle weakness is a subclinical feature, which means that symptoms are not severe enough to be a visible clinical sign. Therefore, it's underestimated, and inadequate attention was placed on the assessment of muscular strength in clinical practice.

Chronic hyperglycaemia induces a catabolic state marked by increased muscle protein breakdown, systemic inflammation, and skeletal muscle atrophy, which collectively diminish muscle quality and functional capacity [3]. Insulin resistance and the accumulation of advanced glycation end products further disrupt muscle protein synthesis while promoting atrophy, leading to reduced muscle mass and strength [4]

Evaluation of muscle strength as a subclinical factor in ambulatory, well-functioning older individuals in healthy individuals with diabetes, as compared to normal subjects of the same age and Body Mass Index (BMI), is not supported by any research. Diabetes patients do not show significant changes in their quality of life since hand grip muscle strength loss is still subtle and unnoticeable. However, in later stages, this may result in severe muscle weakness and decreased dexterity.

We chose to determine the relationship between hand grip muscle strength and functional performance and quality of life since there is still data that suggests a decline in hand grip muscle strength has been linked to functional limitations and quality of life, which was evident in individuals with diabetes. Diabetes and age-matched healthy adults will be assessed for HBA1C and the 36-item Short Form Survey (SF-36) questionnaire for quality of life (QOL).

The primary aim of this study is to ascertain the potential existence of a clinical scenario in which subclinical muscle power is reduced without impacting functional performance and quality of life in diabetic individuals, as compared to age-matched healthy individuals, and to investigate the correlation between diabetes mellitus and hand grip strength, as well as its impact on quality of life.

Materials and Methods

This is an observational study that includes 100 males and females, in which 50 have Type II diabetes mellitus, and 50 are age-matched healthy individuals without any difficulty in activities of daily living, who are recruited into the study. Convenient sampling was used. Inclusion criteria: male and female individuals with type II DM of known duration, HbA1c levels > 6.5 and aged between 55 and 65 years. Individuals should be cooperative and able to understand the instructions given by the therapist. The diabetic individuals are compared with healthy individuals without any known comorbidities. They should have good functional hand movements, like brushing their teeth, combing and dressing themselves without any discomfort. Individuals with orthopaedic or neurological impairments, which can limit the outcome of the study, were excluded.

Details of the study were explained to those who met the inclusion criteria, and informed consent was obtained from the willing participants. Consent was obtained from the caregivers if the individuals were unable to sign the written consent.

Procedure:

Basic Demographic data, like age, gender, and Hand Dominance, were obtained from both groups before.

Subclinical indicators, such as glycaemic measures, will be meticulously evaluated through fasting plasma glucose and HbA1c levels to ascertain

the degree of metabolic dysregulation. Hence, HbA1c levels have been documented for both diabetic and non-Diabetic individuals.

Maximal isometric strength was measured by using a Hand-Held Dynamometer (Jammer). Muscle strength testing was performed in a sitting position, with the forearm supported on a table for finger flexors and extensors. Before the testing, participants were given 2 to 3 chances of a test trial so that they could understand the method. All measurements were taken for both hands for both diabetic and age-matched healthy individuals.

Results

The data were analyzed using SPSS software version 20.0, used for the independent t-test and Pearson correlation coefficients. 50 Healthy individuals (male, female) and 50 type 2 diabetic individuals (male, female) were assessed. Age and BMI were matched between diabetic and healthy individuals.

Table 1: Demographic Data

Variables	Healthy Individuals	Type 2 Diabetic Miletus
Age Mean(SD)	61.8(5.05)	62.6(5.46)
Gender (Male /Female)	29/21	30/20
Hand Dominance (Right/Left)	46/4	45/5

Table 2: Comparison of Hand Grip Strength Between Healthy Individuals and Individuals with TYPE 2 DIABETES Using Hand-Held Dynamometer

IndependentSamples t-test for HHD Levels						
Variable		**N**	**Mean**	**SD**	**t**	**P-value**
Hand Held Dynamometer	HEALTHY INDIVIDUAL	50	31.94	6.21	4.80	0.000
	TYPE 2 DIABETES	50	25.48	7.21		

An independent samples t-test was performed to compare hand grip strength measured using Hand Held Dynamometer (HHD) between healthy individuals and individuals with type 2 diabetes. The results revealed a statistically significant difference between the two groups ($t = 4.80$, $p = 0.000 < 0.05$). Since the p-value is less than 0.05, the null hypothesis was rejected, indicating that handgrip strength differed significantly between healthy individuals and those with type 2 diabetes. Comparison of the mean values showed that the healthy individual group had a higher mean handgrip strength (31.94 ± 6.21) than the type 2 diabetesgroup (25.48 ± 7.21). As higher handgrip strength indicates better muscular strength, it can be concluded that **Healthy Individuals** demonstrated **significantly better Hand Grip Strength** than individuals with **type 2 diabetes**

Table 3: Comparison of HbA1C Levels Between Healthy Individuals and Individuals with type 2 diabetes.

Independent Samples t-test for HbA1C Levels						
Variable		**N**	**Mean**	**SD**	**t**	**P-value**
HbA1C Levels	HEALTHY INDIVIDUAL	50	5.28	0.15	-27.15	0.000
	TYPE 2 DIABETES	50	7.81	0.64		

An independent-samples t-test was conducted to compare HbA1C levels between healthy individuals and those with Type 2 diabetes. The analysis showed a statistically significant difference between the two groups ($t = -27.15$, $p = 0.000 < 0.05$). Since the p-value is less than 0.05, the null hypothesis was rejected, indicating that HbA1C levels differed significantly between the groups. On comparing the mean values, the healthy individual group had a substantially lower mean HbA1C level (5.28 ± 0.15) than the type 2 diabetes group (7.81 ± 0.64). As lower HbA1C levels indicate **better Glycemic control**, it can be concluded that **Healthy Individuals** had **significantly better Glycemic status** than individuals with **type 2 diabetes**

Table 4: Correlation between SF-36, HbA1C, and Hand-Held Dynamometer scores among Healthy Individuals &type 2 diabetes Group.

Correlations			Rand SF-36 questionnaire	HbA1C Levels	Hand Held Dynamometer
Group					
HEALTHY INDIVIDUAL	Rand SF-36 questionnaire	Pearson Correlation	1	.115	.061
		P-value	-	.425	.676
		N	50	50	50
	HbA1C Levels	Pearson Correlation	.115	1	-.131
		P-value	.425	-	.365
		N	50	50	50
	Hand Held Dynamometer	Pearson Correlation	.061	-.131	1
		P-value	.676	.365	-
		N	50	50	50
Type 2 Diabetes Mellitus	Rand SF-36 questionnaire	Pearson Correlation	1	-.009	-.108
		P-value	-	.952	.454
		N	50	50	50
	HbA1C Levels	Pearson Correlation	-.009	1	-.104
		P-value	.952	-	.474
		N	50	50	50
	Hand Held Dynamometer	Pearson Correlation	-.108	-.104	1
		P-value	.454	.474	-
		N	50	50	50

In Healthy Individuals:

RAND SF-36 vs HbA1C Levels

The correlation between RAND SF-36 questionnaire scores and HbA1C levels was r = 0.115, indicating a very weak positive linear relationship. However, this correlation was not statistically significant (p = 0.425 > 0.05), suggesting that there was no significant association between quality of life and HbA1C levels among healthy individuals.

RAND SF-36 vs Hand Held Dynamometer

The correlation between RAND SF-36 questionnaire scores and Hand-Held Dynamometer values was r = 0.061, indicating a very weak positive linear relationship. This correlation was not statistically significant (p = 0.676 > 0.05), indicating that there was no significant association between quality of life and hand grip strength among healthy individuals.

HbA1C Levels vs Hand Held Dynamometer

The correlation between HbA1C levels and Hand-Held Dynamometer values was r = -0.131, indicating a very weak negative linear relationship. However, this correlation was not statistically significant (p = 0.365 > 0.05), suggesting that there was no significant association between Glycemic status and hand grip strength among healthy individuals.

In Type 2 Diabetes Mellitus Individuals:

RAND SF-36 vs HbA1C Levels

The correlation between RAND SF-36 questionnaire scores and HbA1C levels was r = -0.009, indicating a negligible negative linear relationship. This correlation was not statistically significant (p = 0.952 > 0.05), suggesting that there was no significant association between quality of life and HbA1C levels among individuals with type 2 diabetes.

RAND SF-36 vs Hand Held Dynamometer

The correlation between RAND SF-36 questionnaire scores and Hand-Held Dynamometer values was r = -0.108, indicating a very weak negative linear relationship. However, this correlation was not statistically significant (p = 0.454 > 0.05), indicating that there was no significant association between

quality of life and hand grip strength among individuals with type 2 diabetes.

HbA1C Levels vs Hand Held Dynamometer

The correlation between HbA1C levels and Hand-Held Dynamometer values was r = -0.104, indicating a very weak negative linear relationship. This correlation was not statistically significant ($p = 0.474 > 0.05$), suggesting that there was no significant association between glycemic status and hand grip strength among individuals with type 2 diabetes.

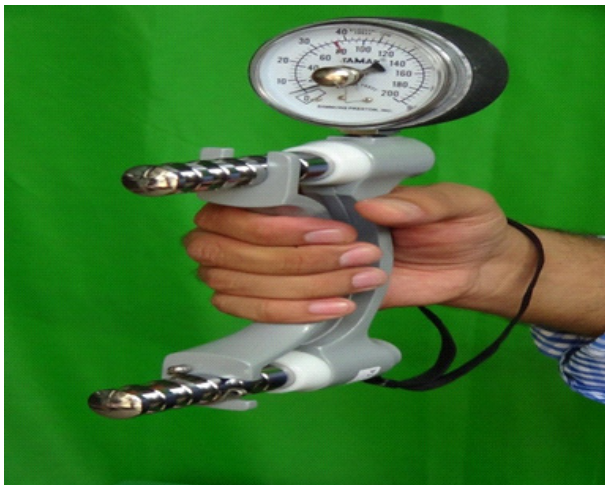

Figure 1: Hand-Held Dynamometer (Jammer)

Figure 2: Diabetic Individual with Hand Held Dynamometer

Figure 3: Age-Matched Healthy Individual with Hand-Held Dynamometer

Discussions

Individuals with diabetes mellitus had a significant reduction in hand grip strength when compared to their normal matched controls, which is supported by previous studies, as adults with type 2 diabetes had reduced hand grip strength compared to healthy individuals, and muscle quality was consistently reduced regardless of gender or muscle group. This clarifies that people with type 2 diabetes are more likely to experience functional difficulties and impairments [5].

Although diabetes was associated with a reduction in handgrip strength, this was subclinical and did not affect daily activities or quality-of-life scores. Evidence shows handgrip strength is reduced in people with type 2 diabetes, with or without polyneuropathy and is associated with impaired hand joint mobility and may lead to difficulty in performing their activities of daily living[2]. In contrast, our current study revealed that diabetic individuals did not exhibit any change in QOL measures, although there were no changes in physical or emotional limitation variables.

Handgrip strength was evaluated using the Hand-Held Dynamometer, which showed a similar decline in diabetic individuals. This measure reveals an apparent decline in dexterity and functional strength, even though they did not exhibit any variation in the activities of daily living. Even if diabetics can carry out their everyday activities, these alterations are still significant and could eventually result in chronic disability.

This study further found that hand grip strength was significantly reduced among individuals with diabetes. According to an earlier study, observed associations between subclinical diabetes and reduced handgrip strength will be contextualised against established research on sarcopenia and diabetic myopathy, addressing discrepancies or reinforcing existing paradigms in the understanding of musculoskeletal decline in diabetic populations.[6]

This will involve an in-depth exploration of how subtle, often asymptomatic, physiological changes preceding a formal diabetes diagnosis can manifest as measurable reductions in handgrip strength, thereby serving as a potential early indicator for targeted interventions. Such early detection, leveraging the accessibility of handgrip strength measurement [7], could facilitate the implementation of preventative strategies to mitigate the progression of diabetes-related functional decline. Furthermore, early identification of individuals at risk for diminished grip strength due to subclinical diabetic markers could inform tailored exercise regimens, nutrition plans, and other lifestyle modifications aimed at preserving muscle function and enhancing overall quality of life. The observed correlation between elevated HbA1c levels and reduced grip strength further underscores the utility of handgrip strength as a non-invasive indicator for monitoring glycemic control and potential muscle deterioration in type 2 diabetes[8]

These findings are consistent with prior research highlighting the utility of handgrip strength as an important tool for diagnosing sarcopenia and chronic diseases in older adults.[6]This connection suggests that handgrip strength measurements could serve as a valuable, easily implementable screening tool for early detection and management of sarcopenia in diabetic populations, which is particularly relevant given the increased prevalence of sarcopenia in individuals with diabetes.[9]

The integration of handgrip strength assessments into routine clinical practice for diabetes management could therefore offer a cost-effective and efficient method for identifying individuals at higher risk for functional decline and disability, prompting earlier intervention.[10] This proactive strategy could lead to improved patient outcomes by addressing not only the metabolic aspects of diabetes but also the often-overlooked musculoskeletal complications that significantly impact daily living and overall well-being.[11,12]

Conclusion

Type 2 diabetes mellitus is associated with a reduction in hand grip muscle strength, particularly in the dominant upper limb, which remains subtle and unidentified; as the disease progresses, the muscle weakness may become progressive and lead to decreased dexterity function and various musculoskeletal complications. The decline in hand grip muscle strength resulted in a longer decrease with the hand-held dynamometer in diabetic individuals, but it did not show any changes in ambulation and quality of life. It becomes very mandatory to evaluate hand grip muscle strength at the early stage of diabetes to prevent musculoskeletal complications at the later stages.

Limitations: Reduced sample size in diabetic individuals

Future Studies: To include a large number of the DM population with varied durations

To develop a hand grip exercise protocol to prevent any further decline in dexterity functionin individuals with diabetic mellitus.

Conflict of Interest: No conflict of interest was associated with this study.

Funding: No funding

Ethical Approval: Ethical committee approved as per institutional norms. **SOPT/VISTASSEC/067/2026**

Consent: Consent form obtained from all the participants.

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Original Article

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Knowledge, Attitude and Practice of ORS and Zinc Supplementation in Management of Diarrhoea among Mothers of Under-five Children: A Cross-Sectional Study

Annastasia A Sangma[1], H Sanayaima Devi[2], L Markordor[3]

[1]Senior Resident, Department of Community Medicine, Shillong Medical College, Northeastern Hill University, India, [2]Professor & HOD, Department of Community Medicine, RIMS, Manipur University, India, [3]Assistant Professor, Department of Community Medicine, Shillong Medical College, Northeastern Hill University, India.

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Abstract

Introduction: Oral rehydration solutions (ORS) and zinc supplementation are pivotal interventions in the management of acute diarrhoea, hence having adequate knowledge, proper attitude and safe practice are critical in this juncture. This study will help in identifying gaps on this topic.

Aim: 1) To assess the knowledge, attitude and practice of ORS and zinc supplementation in management of diarrhoea among mothers of under five children

2) To determine the association between knowledge and attitude of ORS and zinc supplementation and selected variables

Methods: Study was conducted among 285 mothers of under-five children in the urban field practice area of a Tertiary Care Hospital, Imphal from 1st September 2022 to 30th June 2024. Participants were interviewed face to face using a pre-tested questionnaire. Data was analysed in IBM SPSS Version 2. Descriptive statistics like mean with standard deviation, frequency and percentages were used. Chi-square analysis was done to check for association. Logistic regression was performed for multivariable analysis. A p-value of less than 0.05 was considered statistically significant.

Results: About 85% of the participants had inadequate knowledge about ORS and zinc supplementation in management of diarrhoea. There was significant association between older age group (p=0.004), higher education level (p=0.019) and adequate knowledge.

Conclusion: Eight out of ten respondents had inadequate knowledge about the usage of ORS and zinc in the management of diarrhoea hence, awareness is required regarding this topic.

Key words: ORS; Zinc; Under-five mothers.

Corresponding Author: Annastasia A Sangma, Senior Resident, Community Medicine Department, Shillong Medical College, Shillong, Meghalaya.

E-mail: annastasiasangma15@gmail.com

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Introduction

Diarrhoea is currently the second leading cause of death in children under five years old.[1,2] Globally, dehydration is one of the biggest causes of mortality and morbidity in newborns and young children.[3] Oral Rehydration Solution (ORS) was first used in 1969 and later approved, recommended, and distributed globally by UNICEF and WHO for treating clinical dehydration. WHO and UNICEF now recommend countries use the new reduced osmolarity ORS (245 mOsm/l), which is more effective than the older 311 mOsm/l solution. This new formula reduces supplemental IV therapy in children by 33%, stool output by 20%, and vomiting by 30%.[4] Since January 2004, the new ORS formulation is the only one procured by the UNICEF. India was the first country in the world to launch this ORS formulation since June 2004.[5] The recommended dosage is 20 mg of zinc/day (10 mg of zinc/day for those below 6 months of age) for 14 days.[6] Combining zinc with low osmolarity ORS can shorten diarrhoea episodes for up to three months. However, a UNICEF survey in India found that under 1% of prescriptions included zinc under the National Rural Health Mission. [7]Just one-fifth of children with diarrhoea receive zinc tablets, and there is limited documentation on their treatment adherence in India.[8] Only 38 % of children suffering from diarrhoea are treated with ORS and fewer than 5% are treated with zinc.[10] ORS and zinc coverage is insufficient in all regions, and efforts are needed to ensure all children receive both treatments for diarrhoea.[9] Assessing baseline knowledge, attitudes, and practices about zinc and ORS, particularly among mothers and caretakers, is needed for effective education strategies. Few studies have evaluated awareness in Manipur. This study was conducted to assess the knowledge, attitude and practice of ORS and zinc supplementation in management of diarrhoea among mothers of under five children as well as to determine the association between knowledge and attitude of ORS and zinc supplementation with selected variables.

Materials and methods

A cross-sectional study was conducted from 1st September 2022 to 30th June 2024 in the urban field practice area of Tertiary Care hospital, Imphal and covered all the Leikais under it, namely Sinam Leikai A, Sinam Leikai B, Neikanlong village, Guigalong village, Grace colony, Tarung village, Ramgailong village and Meitei Langol. From the family folder of the Department of Community Medicine, 812 households were identified with a population of 5430.

STUDY POPULATION: Mothers/caregivers of at least one child under the age of five years who provided consent to participate in the study and have been residing in the urban field practice area, Tertiary care hospital, Imphal, Manipur for at least 6 months. Mothers/caregivers who were not available for interview after two visits were excluded.

SAMPLE SIZE: From the study conducted by Behura SC et al[10] in two blocks of Rayagada, Odisha, India, the prevalence of mothers who had good knowledge towards diarrhoea management was 63.6%.Sample size was calculated using the formula $\frac{4PQ}{L^2}$ where, P = 63.6% (P = Prevalence of good knowledge in management of diarrhoea); Q = 100 – P; L = 7(L= Absolute allowable error) Sample size of 188 was calculated. Adding a 10% non-response rate, a sample size of 207 was estimated. From the family folder record of the Department, a total of 285 under-five mothers was identified. As 285 was a small population of mothers, all the under-five mothers from all the Leikai were included in the study.

Study Tool

A structured, questionnaire developed by the reasearchers was pre-tested and used for data collection using interview schedule. The questionnaire consisted of socio-demographic profile of the study subjects, knowledge, attitude and practices regarding ORS and Zinc in management of diarrhoea.

Knowledge Score: The total number of questions along with the subsets are 22. For each correct answer a score of one and for each incorrect answer a score of zero was assigned. Minimum obtainable score was zero and maximum obtainable score was 22.

Attitude Score: There were nine questions to assess the attitude of the participants by using a five-point Likert Scale. Each question was given a scale of one to five against their opinion (strongly disagree/ disagree/ neutral/ agree/ strongly agree). The highest score and lowest score attainable by a participant were forty-five and nine respectively.

A. Practice Questions: There was a total of 17 questions along with the subsets.

Data Collection: Informed written consent was obtained from the participants. Face-to-face interviews were conducted using a pre-tested structured questionnaire, ensuring privacy.

Operational definitions

B. Knowledge level was classified as being adequate or inadequate according to the scores obtained by them.

a. Adequate knowledge—more than 75 % of obtainable score

b. Inadequate knowledge—less than or equal to 75% of obtainable score

B. Attitude of the participants was classified as three groups according to their obtainable scores.

a. Unfavourable attitude---- score of 9-20

b. Neutral--- score of 21-32

c. Favourable attitude---- score of 33-45

For the purposes of analysis, neutral and unfavourable attitude were clubbed together as

Unfavourable attitude.

Data analysis: Data was checked for completeness and consistency and entered in IBM SPSS Version 26 software. Quantitative data was presented in mean with standard deviation, median and 95% confidence interval. Qualitative data was expressed infrequency and percentages. Chi-square analysis was performed to check for association between knowledge, attitude, practice and selected variables. Variables of p-value less than 0.2 in univariate analysis was put in logistic regression model to find the association between outcome variables and categorical variables. A p-value of less than 0.05 was considered statistically significant.

Ethical issues: Ethical approval was granted by the RIMS Research Ethics Board. Informed consent was obtained and confidentiality maintained. All data collected were used solely for the study and not shared outside the research team.

Results

Total number of mothers approached was 285 of which 283 responded making the response rate 99%. Mean age of the participants was 31.57 years ± 5.3 years and median age was 32 years. Minimum and maximum age of the participants was 20 and 45 years respectively.

Table 1: Table showing the socio-demographic characteristics of the participants (N=283)

Characteristic		n (%)
Marital status	Married	(92)
	Unmarried	(5)
	Divorced	(2)
	Widow	(1)
No. of children	One child	(36)
	2-5 children	(59)
	>5 children	(5)
Religion	Christian	(49)
	Hindu	(28)
	Others (Islam & Sanamahism)	(23)
Education level	No formal education	(1.4)
	Primary school	(2.5)
	Middle school	(7.4)
	High school	(35.3)
	Graduates or higher	(53.4)
Father's education level	No formal education	0(0)
	Primary school	(0.7)
	Middle school	(3.9)
	High school	(21.6)
	Graduates or higher	(73.9)
Occupation	Students	(39.9)
	Government employees	(23)
	Private employees	(15.5)
	Self employed	(19.8)
	Unemployed	(1.8)
Father's occupation	Students	(3.2)
	Government employees	(48.1)
	Private employees	(21.2)
	Self employed	(21.9)
	Unemployed	(5.7)
Type of family	Nuclear	(54)
	Joint	(46)
Socio-economic status (modified BG Prasad Scale)	Upper class	(79.5)
	Upper middle class	(11.7)
	Middle class	(3.2)
	Lower middle class	(3.9)
	Lower class	(1.8)

Ninety-two percent of the participants were currently married, 59% were multiparous, 49% were Christian, 53.4% were graduates or higher, 73.9% of the husbands were graduates or higher, 48.1% of the husbands worked for the government, 54% of participants belonged to nuclear families and 79.5% belonged to upper class according to Modified BG Prasad classification (2023).[15]

Majority of the respondents had inadequate knowledge 240(85%) while only 43(15%) had adequate knowledge. Majority of the participants (63%) had favourable attitude.

Table 2: History of diarrhoea in under-five child (N=283)

Practice questions		n (%)
Episodes of diarrhoea in the past one year	1-3	197(81.4)
	>3	17(5.8)
	Don't remember	31(12.8)
Management of diarrhoea	With ORS	218(90.1)
	Others*	24(9.9)
Type of water used for the preparation of ORS	Boiled water	160(66)
	Filtered water	80(33)
	Tap water	2(1)
Amount of water used to prepare ORS	1liter	172(71)
	Others**	(48.1)
Duration of storage of prepared ORS for	24 hours	107(44.2)
	Others***	(46)
Continuation of breastfeeding when your child was on ORS	Yes	222(92)
	No	20(8)
Preparation of home available fluids at home if ORS was not available	Yes	105(43)
	No	137(57)
Usage of zinc supplementation in management of diarrhoea	Yes	135(56)
	No	107(44)

*Include juice, local medicine, rice water, soup and water with salt & sugar

**Include 1 glass,1/2 a liter & 2 liters

***Include 2hrs, 4hrs, 12hrs, 24hrs, 48hrs & don't know

Out of the 56 respondents who has used zinc supplementation, 37% gave the correct dose, 15% gave the correct dosage and 5% gave zinc for a complete 14 days duration.

Table No 3: Logistic regression between variables of interest and knowledge on usage of ORS and Zinc in the management of diarrhoea (N=283)

Variables	Univariate analysis cOR (95% CI)	p value	Logistic regression aOR (95% CI)	p value
Age (in years)				
>32	1		1	
≤ 32	0.363(0.184-0.716)	0.003	0.352(0.172-0.719)	0.004
Education level of self				
Graduate and above	1		1	
Up to high school	0.252(0.116-0.548)	<0.001	0.308(0.115-0.825)	0.019
Education level of husband				
Graduate and above	1		1	
Up to high school	0.326(0.123-0.863)	0.024	0.887(0.284-2.777)	0.837
Occupation level of self				
Employed	1		1	
Unemployed	0.370(0.175-0.785)	0.010	0.839(0.340-2.069)	0.703

The participants aged 32 years or less were 65% less likely to have adequate knowledge compared to those participants aged above 32 years and it is statistically significant (AOR: 0.352, CI:0.172-0.719, p=0.004). The participants who had an education level only up to high school were 70% less likely to have adequate knowledge as compared to those participants who were graduate and above and it is statistically significant (AOR:0.308, CI:0.115-0.825, p=0.019).

Table No 4: Logistic regression between variables of interest and attitude on use of ORS and Zinc in the management of diarrhoea (N=283)

Variables	Univariate analysis cOR (95% CI)	p value	Logistic regression aOR (95% CI)	p value
Age (in years)				
>32	1		1	
≤ 32	0.710 (0.434-1.161)	0.172	0.709(0.383-1.311)	0.273
Marital status				
Currently married	1		1	
Currently single	0.322(0.129-0.805)	0.015	0.275(0.096-0.778)	0.015
Parity				
Multiparous	1		1	
Primiparous	0.723(0.443-1.18)	0.196	0.823(0.432-1.565)	0.553
Number of children				
≤2	1		1	
>2	1.89(1.07-3.31)	0.027	2.463(1.204-5.037)	0.014
Religion				
Christian	1		1	
Hindu	0.488(0.275-0.868)	0.015	0.529(0.271-1.030)	0.061
Others	0.644(0.348-1.189)	0.159	0.855(0.418-1.747)	0.668
Education level of self				
Graduate and above	1		1	
Up to high school	0.200(0.118-0.339)	<0.001	0.183(0.093-0.359)	<0.001
Education level of husband				
Graduate and above	1		1	
Up to high school	0.396(0.230-0.682)	<0.001	1.168(0.568-2.398)	0.673
Socio economic status				
Middle class and above	1		1	
Lower middle and lower class	0.423(0.153-1.17)	0.098	0.823(0.255- 1.746)	0.932

The currently single participants were 73% less likely to have favourable attitude about usage of ORS and zinc supplementation in management of diarrhoea as compared to those who were currently married, and it is statistically significant (AOR: 0.275, CI: 0.096-0.778, p=0.015). Mothers who had more than two children were 2.46 times more likely to have favourable attitude about usage of ORS and zinc supplementation in management of diarrhoea as compared to mothers who had only one or two children and it is statistically significant (AOR: 2.463, CI: 1.204-5.037, p=0.014). The participants who had education level of only up to high school were 82% less likely to have favourable attitude about usage of ORS and zinc supplementation in management of diarrhoea as compared to those who had education level up to graduate and above and it is statistically significant (AOR: 0.183, CI: 0.093-0.359, p<0.001)

Discussion

Studies show considerable differences in knowledge about ORS and zinc for treating diarrhoea. Rani VP et al[25] reported 73.3% while W.S. Sumathi et al[38] about 59% good knowledge of ORS use. Contrastingly, the prevalence of adequate knowledge about the usage of ORS and zinc in management of diarrhoea in this study was only 15%.The variation may result from our study assessing knowledge of both zinc and ORS, whereas other studies focused solely on ORS. Geographical location as well as access to healthcare services could also be a factor for the wide variation in findings.

There was significant association between age and knowledge about use of ORS and Zinc in management of diarrhoea (p=0.003). This could be because with age, people accumulate life experiences, that might have required the use of zinc supplements or ORS and contributed to a deeper understanding and familiarity with these treatments. Also, mother's occupation was significantly associated with knowledge (p= 0.008), which was comparable to the findings of Yimenu DK et al[41], where occupational status was significantly associated with knowledge. Also, in our study, those who had an educational level only up to high school had 70% less chance of having an adequate knowledge as compared to those who had an educational level of graduate and above (AOR 0.308, CI: 0.115- 0.825, p=0.019), this was similar to the findings of Okafor IF et al[40] where good knowledge was predicted by a higher mother education level (AOR 3.19, CI: 1.36-7.47). This may be because formal education often includes basic health topics such as nutrition, hygiene, and ORS for diarrhoeal dehydration, and it enhances critical thinking, enabling individuals to better understand and evaluate health information.

In our study, many of the participants (63%) had favourable attitude, while 36% had neutral attitude and only 1% had unfavourable attitude. In comparison, a study conducted by Gazi E et al[23] had a higher proportion of mothers (76.5%) with favorable attitude.

There was significant association between education of self and attitude (p=0.000) as well as education level of husband with attitude(p=0.001) in present study. This finding was like the findings of Gazi E et al[23]wheremother's attitude was significantly related to education status of mother, education status of husband and occupation of husband. There is a significant association between religion and favourable attitude about the use of ORS and zinc in the management of diarrhoea in our study (0.042). In our study, participants were significantly more likely to have favourable attitude about the use of ORS and zinc in the management of diarrhoea if they had more than two children as compared to those participants who had only one or two children (AOR 2.463; CI: 1.204-5.037; P=0.014). This may be because parents with more children are likely to have encountered diarrheal illnesses more frequently and repeated exposure can lead to greater familiarity with ORS as a treatment. Those who are currently single are less likely to have favourable attitude than those who are currently married (AOR 0.275; CI: 0.096-0.778; P=0.015). Married couples often share decisions about their children's health, promoting informed use of ORS, while spousal support reinforces consistent use during diarrhoeal episodes. Those with an education level only up to high school were 82% less likely to have favourable attitude than those who were graduate and above (AOR 0.183; CI: 0.093-0.359; P <0.001) this was similar to the findings of Muthulakshmi M et al[27], where caregivers with higher education (college, university level) were 4.148 times more likely to have a good attitude about ORS and zinc utilization, respectively than those who had no formal education (COR = 4.148(1.065,16.154)). Graduates may be more likely to critically evaluate health information and distinguish between credible sources and misinformation.

In this study, proportion of mothers who used boiled water for the preparation of ORS was 66% which is higher than the findings of Yimenu DK et al[41] where only 33.3% of the respondents used previously boiled and cooled water to prepare ORS solution. Also in our study, 71% of the mothers correctly used one litre of water for the preparation of one sachet of ORS but it was lower than the findings of Yimenu DK et al[41] where about 94.1% of caregivers prepared ORS correctly by adding one ORS sachet to 1000 ml of water while. In a study conducted by Okafor IF et al[40] the participants who used sugar and salt solution were 27.7% whereas in our study only 8% used sugar

and salt solution in management of diarrhoea. While homemade sugar and salt solutions can be used if ORS is not available, the danger is that with incorrect ratios of salt and sugar, it can be ineffective or even harmful.

In our study 95% of the respondents did not give zinc to their child correctly for a duration of 14 days, this is extremely high in comparison to a study by Okafor IF et al[40], about 32.4% of them did not complete the 10-14 days course of zinc. This could be due to incorrect prescription by healthcare providers as was found in a study conducted by Omuemu VO et al[18] where nearly half of the participants (48.7%) prescribed zinc for the correct duration of 14 days. Even when information is available, financial constraints may limit access to zinc supplements or healthcare services that provide guidance on its role in reducing diarrhoeal morbidity and mortality.

Participants who had favourable attitude were found to have more adequate knowledge of use of ORS and zinc supplementation in management of diarrhoea and it was statistically significant (p=0.000). This could be because individuals who understand the role of ORS and zinc in preventing and treating dehydration and diarrhea are more likely to have a positive attitude towards using these supplements.

The study achieved a 99% response rate by surveying all mothers of under-five children in Leikai, offering a thorough view of local knowledge, attitudes, and practices. Data collected revealed major gaps in awareness and use of ORS and zinc, highlighting areas for public health improvement.

Limitations: Participants' self-reported practices could not be verified and hence there is a chance of social desirability bias as well as recall bias as it was a cross-sectional study.

Conclusion

Eight out of ten respondents lacked adequate knowledge about using ORS and zinc for diarrhoea management Over half used zinc for diarrhoea management. Among those who hadn't, most were afraid to use zinc, some didn't know how, and very few said doctors hadn't prescribed it.Knowledge of ORS and zinc use for diarrhoea was significantly linked to age and education level, while attitude was significantly associated with marital status, number of children, and education level. There was also a significant association between Knowledge and Attitude toward ORS and zinc supplementation in diarrhoea management.

Recommendations: Caregivers should be educated on proper ORS preparation, zinc completion, and the free availability of ORS and zinc in government facilities to improve diarrhoea management and child health outcomes.

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Original Article

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Academic Self-Efficacy Domains among University Students in South Gujarat, India: A Cross-Sectional Study

Harris D Ballah[1], Deepak Vishwakarma[2], Swathika S[3]

[1]MPH Scholar, P P Savani University, [2] Associate Professor P P Savani University, [3]Assistant Professor P P Savani University.

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Abstract

Background: Academic self-efficacy plays a crucial role in students' academic performance, motivation, and learning behaviours. However, evidence on its multidimensional assessment among university students in India remains limited. This study assessed academic self-efficacy domains among university students in South Gujarat, India, evaluated the internal consistency reliability of the College Academic Self-Efficacy Scale (CASES), and examined the relationships among its domains.

Methods: A cross-sectional analytical study was conducted among 499 undergraduate and postgraduate students selected using stratified random sampling from a private university in South Gujarat, India. Data were collected using a structured online questionnaire incorporating the 33-item College Academic Self-Efficacy Scale (CASES). Descriptive statistics were used to summarize participant characteristics and domain scores. Internal consistency was assessed using Cronbach's alpha, and Pearson's correlation analysis examined relationships among academic self-efficacy domains.

Results: Leadership and Extracurricular Confidence demonstrated the highest mean score (2.78 ± 0.56), followed by Communication and Resource Confidence (2.74 ± 0.50), Classroom Learning Behaviors (2.69 ± 0.45), and Academic Content Mastery (2.63 ± 0.47). The CASES demonstrated excellent internal consistency (Cronbach's α = 0.93). Significant positive correlations were observed among all academic self-efficacy domains ($p < 0.001$), with the strongest association between Academic Content Mastery and Communication and Resource Confidence ($r = 0.81$).

Conclusion: The CASES is a reliable instrument for assessing multidimensional academic self-efficacy among university students. Regular assessment of academic self-efficacy may assist higher education institutions in developing targeted interventions to strengthen students' academic confidence and engagement.

Keywords: Academic self-efficacy; College Academic Self-Efficacy Scale; CASES; university students; higher education; cross-sectional study.

Corresponding Author: Deepak Vishwakarma, HOD, Department of Public Health, University IQAC Co-coordinator, P. P. Savani University Surat.

E-mail: deepak.vishwakarma@ppsu.ac.in

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Introduction

Academic self-efficacy (ASE) has been identified as one of the strongest predictors of academic achievement. Enhancing student's self-efficacy may contribute to improved learning outcomes and higher academic attainment (1). Self-efficacy is defined as an individual's confidence in their ability to accomplish a particular task or achieve a specific goal. In an academic context, students with high academic self-efficacy tend to exhibit greater motivation, persistence and confidence in their learning abilities, which can contribute to improved academic performance. Self-efficacy varies across individuals and is influenced by factors such as gender, age and the specific domain (2,3).

Academic self-efficacy is acknowledged as a multifaceted construct that includes participation in leadership and extracurricular activities, communication and use of academic resources, mastery of academic information, and confidence in classroom learning. The **College Academic Self-Efficacy Scale (CASES)**, developed by **Owen and Froman**, is one of the most widely used instruments for assessing these dimensions among university students and has demonstrated satisfactory psychometric properties across diverse educational settings (4).

Academic self-efficacy acts as an indicator of student's psychological well-being, reflecting their confidence in managing academic challenges. Academic engagement is another important factor that has been closely linked to student's academic performance and achievement in higher education (5).

Academic self-efficacy and academic engagement have been identified as key factors influencing academic achievement among higher education students. Previous studies has consistently demonstrated a positive association between academic self-efficacy and academic performance (5,6). Higher academic self-efficacy has also been linked to reduced academic stress, decreased fear of failure, and improved psychological well-being, according to recent research (7).

Materials and Methods

Study Design and Setting: A cross-sectional analytical study was conducted among university students enrolled at a private university in South Gujarat, India, from January to April 2025.

Study Population and Sampling: The study population comprised undergraduate and postgraduate students aged 18 years and above. The required sample size was calculated using the OpenEpi sample size calculator, assuming a total student population of 8,000, a 95% confidence level, a 5% margin of error, 50% anticipated prevalence, and a design effect of 1. The minimum required sample size was 499 participants. A stratified random sampling technique was employed to ensure representation across academic programmes and years of study. Students who provided informed consent and completed the questionnaire were included in the study.

Study Instrument: Data were collected using a structured, self-administered online questionnaire consisting of two sections. The first section captured participants' socio-demographic characteristics, including age, gender, nationality, academic level, and year of study. The second section comprised the **College Academic Self-Efficacy Scale (CASES)** developed by **Owen and Froman**, a validated instrument that measures students' perceived academic self-efficacy across four domains: Classroom Learning Behaviors, Academic Content Mastery, Communication and Resource Confidence, and Leadership and Extracurricular Confidence. The instrument contains 33 items rated on a five-point Likert scale ranging from **1 (Very Little Confidence) to 5 (Quite a Lot of Confidence)**, with higher scores indicating greater perceived academic self-efficacy.

Data Collection: The questionnaire was administered electronically using Google Forms after obtaining permission from the university authorities. The survey link was shared through official institutional communication platforms. Participation was voluntary, and electronic informed consent was obtained before completion of the questionnaire. To ensure confidentiality, no personally identifiable information was collected.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using **IBM SPSS Statistics version 25.0**. Descriptive statistics, including frequencies, percentages, means, and

standard deviations, were used to summarize participants' socio-demographic characteristics and academic self-efficacy domain scores. The internal consistency reliability of the CASES and its individual domains was assessed using **Cronbach's alpha coefficient**. Pearson's correlation analysis was performed to examine the relationships among the four academic self-efficacy domains. A two-tailed *p*-value of **<0.05** was considered statistically significant.

Ethical Considerations: The study involved an anonymous online survey with minimal risk to participants. As the study did not involve any clinical intervention or collection of sensitive personal information, formal institutional ethics committee approval was not obtained. However, permission to conduct the study was obtained from the concerned university authorities. Electronic informed consent was obtained from all participants before participation, and anonymity, confidentiality, and voluntary participation were ensured throughout the study.

Result

A total of **499 university students** participated in the study. The findings are presented under four sections: participants' sociodemographic characteristics, academic self-efficacy domain scores, internal consistency reliability of the College Academic Self-Efficacy Scale (CASES), and the relationships among academic self-efficacy domains.

Results

Table 1. Sociodemographic Characteristics of the Study Participants (N = 499)

Variable	Category	n (%)
Gender	Female	353 (70.7)
	Male	146 (29.3)
Age Group (years)	18–21	366 (73.3)
	22–25	119 (23.9)
	26–29	7 (1.4)
	≥30	7 (1.4)
Nationality	Indian	469 (94.0)
	International	30 (6.0)
Academic Level	Undergraduate	479 (96.0)
	Postgraduate	20 (4.0)
Year of Study	First Year	256 (51.3)
	Second Year	100 (20.0)
	Third Year	93 (18.6)
	Fourth Year	50 (10.0)

Table 1 presents the sociodemographic characteristics of the study participants. A total of **499 university students** participated in the study. The majority were **female (70.7%)**, aged **18–21 years (73.3%)**, and **Indian nationals (94.0%)**. Most participants were **undergraduate students (96.0%)**, while only **4.0%** were postgraduate students. More than half of the respondents were **first-year students (51.3%)**, followed by second-year (20.0%), third-year (18.6%), and fourth-year students (10.0%).

Table 2. Academic Self-Efficacy Domain Scores Among University Students (N = 499)

Academic Self-Efficacy Domain	Mean ± SD	Mean (%)
Classroom Learning Behaviors	2.69 ± 0.45	53.8
Academic Content Mastery	2.63 ± 0.47	52.6
Communication and Resource Confidence	2.74 ± 0.50	54.8
Leadership and Extracurricular Confidence	2.78 ± 0.56	55.6

Table 2 presents the mean scores of the four academic self-efficacy domains assessed using the College Academic Self-Efficacy Scale (CASES). Among the domains, **Leadership and Extracurricular Confidence** recorded the highest mean score (**2.78 ± 0.56; 55.6%**), followed by **Communication and Resource Confidence** (**2.74 ± 0.50; 54.8%**), **Classroom Learning Behaviors** (**2.69 ± 0.45; 53.8%**), and **Academic Content Mastery** (**2.63 ± 0.47; 52.6%**). Overall, the mean scores were comparable across all domains, indicating similar levels of perceived academic self-efficacy among the study participants.

Table 3. Internal Consistency Reliability of the College Academic Self-Efficacy Scale (CASES) and Its Domains Among University Students (N = 499)

Academic Self-Efficacy Domain	Number of Items	Cronbach's α	Interpretation
Classroom Learning Behaviors	10	0.86	Good
Academic Content Mastery	10	0.9	Excellent
Communication and Resource Confidence	11	0.91	Excellent
Leadership and Extracurricular Confidence	2	0.7	Acceptable
Overall CASES	33	0.93	Excellent

Table 3 presents the internal consistency reliability of the College Academic Self-Efficacy Scale (CASES) and its domains. The overall instrument demonstrated **excellent internal consistency (Cronbach's α = 0.93)**. Among the individual domains, **Communication and Resource Confidence** showed the highest reliability (α = 0.91), followed by **Academic Content Mastery** (α = 0.90) and **Classroom Learning Behaviors** (α = 0.86), indicating excellent to good internal consistency. **Leadership and Extracurricular Confidence** demonstrated acceptable internal consistency (α = 0.70). Overall, the findings support the reliability of the CASES for assessing academic self-efficacy domains among university students.

Table 4. Pearson's Correlation Matrix Among Academic Self-Efficacy Domains (N = 499)

Academic Self-Efficacy Domain	1	2	3	4
1. Classroom Learning Behaviors	1			
2. Academic Content Mastery	0.79*	1		
3. Communication and Resource Confidence	0.75*	0.81*	1	
4. Leadership and Extracurricular Confidence	0.55*	0.61*	0.73*	1
*p < 0.001 (Pearson's correlation coefficient).				

Table 4 presents the Pearson's correlation coefficients among the four academic self-efficacy domains. Statistically significant positive correlations were observed between all domains ($p < 0.001$). The strongest positive correlation was found between **Academic Content Mastery** and **Communication and Resource Confidence** ($r = 0.81$), followed by **Classroom Learning Behaviors** and **Academic Content Mastery** ($r = 0.79$). **Classroom Learning Behaviors** also demonstrated a strong positive correlation with **Communication and Resource Confidence** ($r = 0.75$). **Leadership and Extracurricular Confidence** showed moderate to strong positive correlations with the remaining domains, with correlation coefficients ranging from **0.55 to 0.73**. These findings indicate that higher confidence in one academic self-efficacy domain was associated with higher confidence across the other domains assessed in the study.

Discussion

The present study assessed academic self-efficacy among university students using the College Academic Self-Efficacy Scale(CASES).

Among the four domains, Leadership and Extracurricular confidence demonstrated the highest mean score, whereas academic content mastery was the lowest. Although the differences were modest, they indicate the students perceived varying levels of confidence across various academic activities. Similar results were indicated in a study which found that academic self-efficacy is influenced by multiple factors, including student's behaviours, values and experiences both within and beyond the classroom (8). Likewise, a study conducted by Hayat et al. reported that academic self-efficacy varies across learning contexts and is positively associated with student's learning behaviours and metacognitive strategies, suggesting that confidence differs according to the academic tasks being performed (9).

A study conducted in Yemen by Al-Qadriet al. demonstrated that academic self-efficacy significantly predicted student's academic commitment and engagement, indicating that confidence across different academic domains contributes collectively to overall learning outcomes. Although the present study did not assess academic performance or engagement, the strong positive correlations observed among the CASES domains suggest that academic self-efficacy functions as an integrated construct rather as independent dimensions (10).

The present study results are also consistent with a study conducted by Komarraju and Nadler who suggested that academic self-efficacy represents a multidimensional construct in which different aspects of confidence interact to influence student's learning behaviours, persistence and academic adjustment (11).

Significant positive correlations were observed among all four academic self-efficacy domains, with the strongest relationship identified between Academic Content Mastery and Communication and Resource Confidence. This finding suggests that students who were confident in understanding academic content were also more likely to feel confident in communicating academic ideas and effectively utilizing available learning resources. These results were similar to another study among university students that academic self-efficacy was positively associated with meta cognitive learning strategies, classroom participation and academic engagement (9).

Strengths of the Study

This study used the validated **College Academic Self-Efficacy Scale (CASES)** to comprehensively assess multidimensional academic self-efficacy among university students. The instrument demonstrated excellent internal consistency, and the use of stratified random sampling enhanced the representativeness of the study population.

Limitations of the Study

The cross-sectional design limits causal inference, and the findings may not be generalizable beyond the study setting, as the research was conducted at a single private university. In addition, the use of a self-administered questionnaire may have introduced self-report bias.

Conclusion

The present study demonstrated comparable levels of academic self-efficacy across four domains among university students and confirmed the excellent internal consistency reliability of the College Academic Self-Efficacy Scale (CASES). Significant positive correlations among the domains indicate that students' confidence across different academic activities is closely interrelated. These findings support the use of CASES as a reliable instrument for assessing multidimensional academic self-efficacy in Indian higher education settings. Regular assessment of academic self-efficacy may help higher education institutions identify students requiring additional academic support and develop targeted interventions to enhance students' academic confidence and engagement.

Ethical Considerations: The study involves only minimal risk to participants. Permission to conduct the study was obtained from the concerned university authorities before data collection. Electronic informed consent was obtained from all participants, and participation was voluntary. The confidentiality and anonymity of all participants were maintained throughout the study.

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Original Article

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Epidemiological Determinants of Dengue Infection in Dhaka: A Cross-Sectional Study

Kabir Hossain[1], Md. Rasel Hossain[2], Indi Islam[3] Abu Hurira[4]

[1]Department of Statistics, Noakhali Science and Technology University, Noakhali, Bangladesh, [2]Department of Statistics, Noakhali Science and Technology University, Noakhali, Bangladesh, [3]Department of Law, Islamic University, Kushtia, Bangladesh, [4]Department of Management Information Systems, Lamar University, Beaumont, Texas, USA.

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Abstract

Background: In Dhaka, Bangladesh, dengue outbreaks are influenced by demographic, geographic, and housing factors, which presents valuable insights for improving preventive measures and reducing public health hazards.

Objectives: The main objective of this study was to identify the prevalence of dengue infection in Dhaka and the factors that contribute to it.

Study designs: This study used secondary data from a publicly available Kaggle dataset and included 1,000 respondents.

Methods: To examine relationships between dengue positivity and contributing factors, chi-square tests were conducted using SPSS version 26.

Results: The study found that 53.3% of participants had dengue, with 52.7% of cases occurring in females and 47.3% in males. The age group <21 years old had the highest percentage of dengue cases (22.3%), followed by those aged 41 to 50 (18.7%) and those aged 31 to 40 (17.4%), while the age group over 60 years old had the lowest percentage (7.4%). Geographically, the most significant percentage was recorded in Western Dhaka (27.1%), followed by Southern Dhaka (22.1%) and Northern Dhaka (10.7%). Regarding area type, the percentage of undeveloped areas was marginally higher (51.8%) than that of developed areas (48.2%). Among the respondents, 35.5% lived in buildings, 31.7% in tin-shed homes, and 32.9% in other types of houses.

Conclusions: The results focused on interventions to strengthen dengue prevention and control efforts by offering practical insights into high-risk populations and geographic areas.

Keywords: Dengue, outbreak, demographic, geographic, Dhaka, Bangladesh

Corresponding Author: Md. Rasel Hossain, Department of Statistics, Noakhali Science and Technology University, Noakhali, Bangladesh.

E-mail: rasel.stat@nstu.edu.bd

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Introduction

Dengue fever (DF) is an infectious illness caused by the dengue virus, which is primarily transmitted to humans through the bite of infected *Aedes* mosquitos, particularly *Aedes aegypti* and *Aedes albopictus*. *Aedes* mosquitoes can transmit one of the four types of dengue virus (DENV), including DENV-1, DENV-2, DENV-3, or DENV-4, by feeding on the blood of an infected person. The virus is then injected into the bloodstream of a healthy person by the mosquito, which spreads the infection [(1),(2),(3)]. The virus can produce a variety of symptoms, ranging from a mild fever and rash to more severe cases that can result in potentially fatal dengue hemorrhagic fever (DHF), dengue shock syndrome (DSS), undifferentiated fever and classical dengue fever [(3),(4)]. Notably, peri-cholecystic fluid, persistent vomiting, abdominal pain, mucosal bleeding, and tender right hypochondrium were all substantially responsible for a higher risk of DHF [(5)]. The World Health Organization reports that the number of dengue cases has increased dramatically worldwide, rising from 505,430 in 2000 to 5.2 million in 2019 [(6)]. In 2023, South America reported the highest number of dengue cases with 3,924,992 cases and 1,946 deaths, while South and Southeast Asia recorded 1,622,405 cases and 3,637 deaths [(7)]. High infection rates were also reported in Asia from Bangladesh (321,000 cases), Malaysia (111,400 cases), Thailand (150,000 cases), and Viet Nam (369,000 cases) [(6)]. The capital of Bangladesh, Dhaka, is one of the most densely populated cities in the world, which raises the possibility of a widespread dengue outbreak [(8)].There was an alarming rise in dengue cases in Dhaka city between 2019 and 2023, with 101,354 cases recorded in 2019 and a five-fold increase to 321,179 in 2023. Even though Dhaka's case fatality rate dropped from 51% in 2019 to 34% in 2023, the rate's steady increase to 0.5% is still concerning[(9)].

Numerous factors that impact both human populations and mosquito vectors impact the incidence and severity of dengue outbreaks. Higher monthly average temperatures, humidity, precipitation, and air pressure are likely to increase the number of dengue fever cases, while longer sunshine duration seems to lower the risk [(13),(14)]. An elevated risk of dengue fever (DF) and a markedly elevated risk of dying from the illness were associated with to diabetes mellitus (DM) [(15)]. Compared to peri-urban areas, dengue risk was higher in central urban areas, likely due to higher population density and environmental conditions that favor mosquito breeding [(16),(17)]. Furthermore, during the outbreak, IgM and IgG antibody levels that are elevated in infected patients are indicative of recent infections and the body's immune reaction to dengue [(12)].

Although the prevalence of dengue is rising in Bangladesh, limited study has been done to fully understand the factors that contribute to dengue outbreaks, especially in a city like Dhaka. Earlier research has mainly focused on descriptive statistics, environmental factors like urbanization and population growth, and climatic variables like temperature, humidity, and rainfall [(9),(13),(18),(19)]. This study addresses the research gap by exploring the demographic, geographic and housing factors associated with dengue outbreaks in Dhaka, aiming to provide a more comprehensive understanding of the disease's transmission dynamics. The results of this study will help Dhaka and other urban areas fight dengue by enhancing public health initiatives, allocating resources more effectively, and implementing more potent preventive measures.

Methods and Materials

Study area and data collection

The aim of this study was to determine the prevalence of dengue infection and examine the factors associated with it in Dhaka, Bangladesh's.

The present study did not involve primary data collection by the investigators. The investigators did not conduct hospital visits, patient interviews, or community surveys; rather, the analysis was performed using the data available in the publicly accessible dataset. Therefore, the sampling, participant recruitment, and original data-collection procedures were those of the source dataset and were not conducted or controlled by the authors of the present study [(21)].

Dhaka is the capital city of Bangladesh, which is situated at 23° 48′ 15″ N latitude and 90° 24′ 55″ E longitude. The population of Dhaka is 23,234 per square kilometer, making it the ninth largest and

seventh most densely populated city in the world. Its total area is approximately 300 square kilometers (20). Northern, Southern, Eastern, Western, and Central Dhaka are the five main geographic zones that make up the city of Dhaka, which serves as Bangladesh's administrative, cultural, and economic center. Dhaka is a perfect place to study the factors that contribute to dengue infection because these zones cover a wide range of neighborhoods that represent various socioeconomic and environmental circumstances. The Northern Dhaka area comprises places like Pallabi, Kafrul, Mirpur, and Biman Bandar. Demra, Gendaria, Jatrabari, Kadamtali, Kamrangirchar, Keraniganj, Shyampur, and Sutrapur are some of the neighborhoods that make up southern Dhaka. The areas of Badda, Banasree, Khilgaon, Khilkhet, Rampura, and Sabujbagh make up Eastern Dhaka. Places like Adabor, Bosila, Dhanmondi, Hazaribagh, Kalabagan, Lalbagh, Mohammadpur, New Market, Shahbagh, Sher-e-Bangla, and Tejgaon are all part of the Western Dhaka zone.Finally, Central Dhaka includes places such as Bangshal, Cantonment, Chawkbazar, Gulshan, Motijheel, Paltan, and Ramna. This zoning system offers an extensive structure for examining patterns of dengue infection in various Dhaka regions (**Figure 1**).

Data were gathered through hospital visits, patient interviews, and community surveys, with a focus on area-specific factors like crowdedness, sanitation, and waterlogging in affected neighborhoods.

Dependent variable

The dependent variable in the study was "Dengue status" (Positive/Negative), and that was determined by the rapid diagnostic test (RDT) conducted during hospital visits. The diagnosis was made using commercially available dengue test kits and the NS1 antigen and IgM/IgG antibody tests. The Panbio Dengue Early Rapid Test and the SD BIOLINE Dengue Duo, which are both frequently utilized in clinical settings in Bangladesh, were the most often utilized kits. By identifying the NS1 antigen and/or dengue-specific antibodies (IgM and IgG) in the patient's blood sample, these kits aid in the confirmation of dengue infection. In order to guarantee consistency and dependability, all test results were interpreted in accordance with the manufacturer's instructions.

Independent variables

A total of 5 independent variables were included and employed as factors in this study. The study used four different types of explanatory variables: demographic, geographic, housing and clinical. Demographic variable includes gender (male, female) and age (<21, 21-30, 31-40, 41-50, 51-60, >60). Geographic variable encompasses area of residence (Northern Dhaka, Southern Dhaka, Eastern Dhaka, Western Dhaka, Central Dhaka). The housing characteristics are included type of area (developed or undeveloped) and the type of house (building, tin-shed, or other).

Figure 1. Map highlighting the study locations across Dhaka city, Bangladesh

Study population

A total of 1,000 respondents from different areas of Dhaka provided the data used in this study during the 2022-23 dengue survey. The dataset contains data on demographics, geographic location, housing conditions, and dengue status. The study sample is composed of 52.4% females and 47.6% males. The prevalence of dengue infection is 53.3%, while 46.7% of people tested negative for dengue.

Table 1. Frequency Distribution of Dengue Diagnostic Test Results

Variables	Category	Frequency (n)	Percentage (%)
NS1status	Positive	519	51.9
	Negative	481	48.1
IgM status	Positive	475	47.5
	Negative	525	52.5

Statistical analysis

The statistical analyses and cross-sectional study design were conducted using the standard epidemiological research principles, and the SAMPL guidelines were followed for statistical reporting. The primary outcome variable was the status of dengue infection (positive or negative) as determined by rapid diagnostic assays. Demographic (age, gender), geographic (area of domicile), and housing (house type, developed or undeveloped area) were all considered independent variables. Chi-square (χ^2) tests were employed to investigate categorical data associations, a non-parametric method appropriate for evaluating categorical variables' independence. The test statistic χ^2 quantifies the discrepancy between the expected and observed frequencies. The probability of observing data as extreme as P-values represents those collected under the null hypothesis of no association. All tests were two-sided, with a predetermined significance level of $\alpha = 0.05$. Cramér's V was employed to calculate effect sizes and quantify the strength of association between variables, with values interpreted as small (≥0.10), medium (≥0.30), and large (≥0.50) when applicable. Primary analyses were pre-specified to assess the relationships between demographic, geographic, and dengue status. Housing type were analyzed as exploratory subgroups. The significance level for identifying significant associations was set at $p < 0.05$. IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA), was employed to conduct all statistical analyses.

Results

Table 2 presents the demographic, geographic, housing and clinical characteristics of the participants, as well as their dengue status.The study sample is made up of 47.6% males and 52.4% females, ensuring a balanced representation for investigating gender differences in dengue vulnerability. The largest age group of participants is <21 (23.5%), followed by those between 41 and 50 (18.7%), 31 and 40 (18.2%), 21 and 30 (16.5%), and 51 and 60 (15.1%). The significant burden of dengue in the study population was highlighted by the high prevalence of dengue, with 53.3% of participants testing positive and 46.7% negative (**Figure 2**). These results shed light on the demographic, and geographic factors that contribute to the high prevalence of dengue and provide guidance for focused interventions.

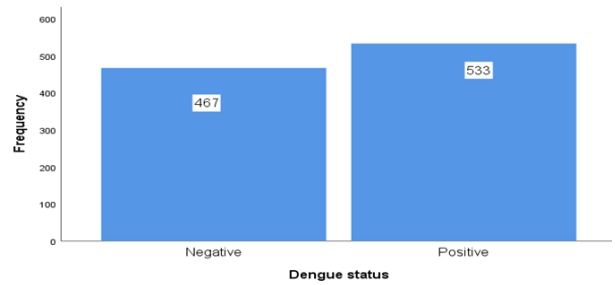

Figure 2. Frequency distribution of Dengue status in Dhaka, 2022-23

Table 2. Demographic, geographic, and housing characteristics of participants and their dengue status in Dhaka, 2022-23

Variables	Category	Frequency (n)	Percentage (%)
Gender	Male	476	47.6
	Female	524	52.4
Age	<21	235	23.5
	21-30	165	16.5
	31-40	182	18.2
	41-50	187	18.7
	51-60	151	15.1
	>60	80	8
Area	Northern Dhaka	113	11.3
	Southern Dhaka	241	24.1

Cont...

	Eastern Dhaka	166	16.6
	Western Dhaka	288	28.8
	Central Dhaka	192	19.2
Area type	Developed	501	50.1
	Undeveloped	499	49.9
House type	Building	354	35.4
	Tin-shed	317	31.7
	Other	329	32.9
Dengue cases	Positive	533	53.3
	Negative	467	46.7

From **Table 2,** it implies that the age group >60 years old (8.0%) is the smallest. In terms of geographic distribution, many participants are found in Western Dhaka (28.8%), followed by Southern Dhaka (24.1%), Central Dhaka (19.2%), Eastern Dhaka (16.6%), and Northern Dhaka (11.3%).There is a nearly equal distribution of area types, with 49.9% living in undeveloped areas and 50.1% in developed areas. Moreover, 35.4% of participant live in buildings, 31.7% in tin-shed houses, and 32.9% in other structures, indicating a diversity of housing types that summarizes in **Table 2**. A significant prevalence of recent infections was indicated by the clinical finding that 51.9% of participants tested positive for the NS1 antigen, and 47.5% tested positive for IgM, which reflects immune responses to recent or active infections.

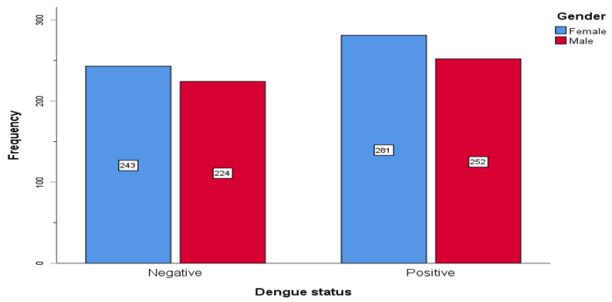

Figure 3. Frequency distribution of Dengue status by gender in Dhaka, 2022-23

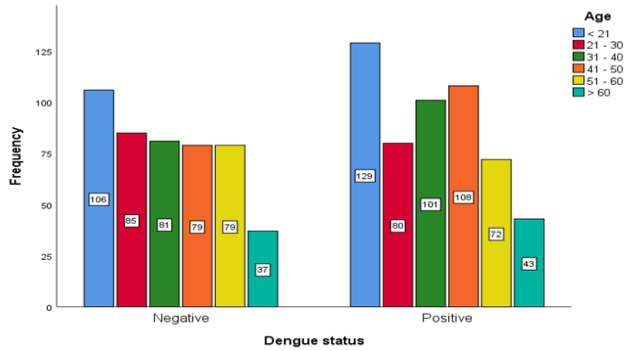

Figure 4. Frequency distribution of Dengue status by age in Dhaka, 2022-23

The relationship between dengue status and different demographic, geographic, and housing factors is presented in **Table 3**. The association between gender and dengue status is not statistically significant (χ^2 =0.047, P=0.828), males make up a slightly lower proportion of dengue-positive cases (47.3%) than females (52.7%) (**Figure 3**).

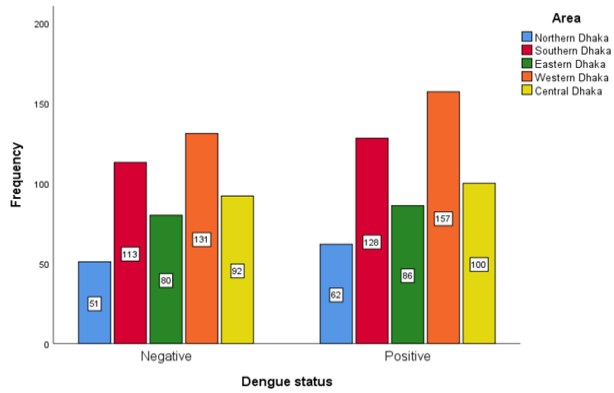

Figure 5. Frequency distribution of Dengue status by area in Dhaka, 2022-23

The prevalence of dengue is highest among those under 21 years old (24.2%), followed by those between the ages of 41 and 50 (20.3%) and those between the ages of 31 and 40 (18.9%) (**Figure 4**). When compared to other age groups, there is no significant difference in the risk of dengue despite these variations (χ^2 =5.540, P=0.354). There are no statistically significant regional differences were found (χ^2 =0.548, P= 0.969), although Western Dhaka has the highest percentage of people with dengue (29.5%), followed by Southern Dhaka (24.0%) and Central Dhaka (18.8%) (**Figure 5**).

Table 3. Relationship between dengue status and demographic, geographical, and housing factors in Dhaka, 2022-23

Variable	Category	Dengue status		Chi-square	P value
		Positive; n (%)	Negative; n (%)		
Gender	Male	252 (52.9)	224 (47.1)	0.047	0.828
	Female	281 (53.6)	243 (46.4)		
Age	<21	129 (54.9)	106 (45.1)	5.54	0.354
	21-30	80 (48.5)	85(51.5)		
	31-40	101 (55.5)	81 (44.5)		
	41-50	108 (57.8)	79 (42.2)		
	51-60	72 (47.7)	79 (52.3)		
	>60	43 (53.8)	37 (46.3)		
Area	Northern Dhaka	62 (54.9)	51 (45.1)	0.548	0.969
	Southern Dhaka	128 (53.1)	113 (46.9)		
	Eastern Dhaka	86 (51.8)	80 (48.2)		
	Western Dhaka	157 (54.5)	131 (45.5)		
	Central Dhaka	100 (52.1)	92 (47.9)		
Area type	Developed	257 (51.3)	244 (48.7)	1.618	0.203
	Undeveloped	276 (55.3)	223 (44.7)		
House type	Building	191 (54.0)	163 (46.0)	0.761	0.683
	Tin-shed	173 (54.6)	144 (45.4)		
	Other	169 (51.4)	160 (48.6)		

In comparison to developed areas (48.2%), dengue positivity is slightly higher in undeveloped areas (51.8%) (χ^2 =1.618, P=0.203). Although there is no significant difference, participants who live in buildings have a higher chance of having dengue (35.8%) than those who live in tin-shed houses (32.5%) and other types of housing (31.7%) (χ^2=0.761, P=0.683).

Discussion

Dengue fever poses a serious threat to public health in cities, especially in places with high population densities like Dhaka, Bangladesh. To better understand the epidemiological features of the disease, this study sought to determine the prevalence of dengue infection and examine its relationship to demographic, and geographic and housing factors.

According to the study, the prevalence of dengue cases was 53.3%. A study found that the number of dengue cases in Bangladesh increased significantly between 2019 and 2023, reaching a total of 513,344 cases. In 2023, the prevalence in Dhaka city was 34% [(9)]. A systematic review and meta-analysis found that between January 2000 and March 2024, there were 565,438 dengue cases and 2,587 fatalities, with 60% of cases during the outbreaks in 2019 and 2023 occurring in areas that had not previously been endemic [(22)]. The present analysis found variations in dengue positivity across the five Dhaka zones; however, the association between geographic region and dengue status was not statistically significant (P = 0.969). Therefore, the higher observed proportions in some zones should be regarded as descriptive findings rather than evidence that dengue risk differs significantly across geographic regions. Although environmental conditions such as urban planning, water management, sanitation, and vector-control practices may be relevant to dengue transmission, the present study does not provide statistical evidence to establish such relationships.

Northern Dhaka had the highest percentage of dengue-positive respondents (54.9%) out of the five Dhaka zones, closely followed by Western Dhaka (54.5%) and Southern Dhaka (53.1%). This geographic variation suggests that disease distribution may be influenced by localized factors like urban planning,

water management, sanitation, and the effectiveness of vector control. Prior research has also demonstrated that poor waste management, waterlogging, and unplanned urbanization all play a major role in dengue outbreaks in Dhaka.

The analysis also showed no statistically significant difference in dengue positivity by sex (P = 0.828). Although females had a slightly higher proportion of dengue-positive cases than males, this difference was small and statistically non-significant. Therefore, the findings do not support a conclusion that either sex had a higher risk of dengue infection in this study population.

Similarly, dengue positivity varied across age groups, with the highest proportion observed among participants aged <21 years in the Results analysis. However, the association between age and dengue status was not statistically significant (P = 0.354). Thus, the observed differences among age groups should be interpreted only as descriptive patterns and should not be considered evidence of age-related differences in dengue risk. Adults between the ages of 16 and 60 were more likely to contract dengue fever (DF) because they were more likely to travel and exposed to mosquitoes, with men being more affected than women [(10),(11),(12)].

Housing type also showed some variation in dengue positivity, but the association was not statistically significant (P = 0.683). Likewise, the slightly higher dengue positivity observed among participants living in undeveloped areas was not statistically significant (P = 0.203). Consequently, these findings should be considered descriptive rather than evidence that housing type or area development status affects dengue risk. A prior study reported residing in buildings or tin sheds seems to be linked to a lower risk of contracting dengue because of the better quality of structure and more controlled environment these housing options provide, which can limit exposure to dengue virus vectors and decrease mosquito breeding sites [(11)]. Furthermore, the prevalence was higher in undeveloped areas (55.3%) compared to developed zones (51.3%), highlighting the importance of environmental factors in dengue transmission.

This study uses an extensive data set of 1,000 respondents from a publicly accessible Kaggle dataset to provide a thorough analysis of the factors influencing dengue outbreaks in Dhaka. Chi-square tests provided insightful information about the geographic, demographic and housing factors related to dengue positivity. The emphasis on descriptive statistics draws attention to important trends and patterns that can guide focused preventative and control measures. This study has several limitations. First, it is based on a publicly available secondary dataset obtained from Kaggle, and the investigators had no control over the original sampling, participant selection, or data-collection procedures. Therefore, potential selection bias cannot be ruled out, and the findings may not be fully representative of the broader population of Dhaka. Second, the cross-sectional design limits the ability to establish temporal or causal relationships between the examined characteristics and dengue infection. Third, the dataset did not contain several potentially important determinants of dengue transmission, including climatic factors (e.g., temperature and rainfall), entomological indicators (e.g., mosquito density and breeding-site characteristics), behavioural factors (e.g., mosquito-control practices and outdoor exposure), and detailed socioeconomic characteristics. The absence of these variables may have limited the ability to comprehensively assess factors associated with dengue positivity. Fourth, the analysis was based primarily on bivariate associations and did not include multivariable adjustment for potential confounding factors. Consequently, the observed associations should be interpreted cautiously. Finally, the dataset lacked sufficient seasonal and temporal information to examine changes in dengue occurrence over time. Future studies using primary, longitudinal, and more comprehensive datasets incorporating climatic, entomological, behavioural, and socioeconomic variables, together with multivariable statistical modelling, are recommended to provide a more complete understanding of dengue transmission in Dhaka.

Conclusion

This study emphasizes the important demographic, geographic, and housing factors affecting dengue outbreaks in Dhaka. The results highlight the significance of focusing on high-risk groups and regions for efficient dengue prevention

and control measures. However, more studies that consider temporal trends, climate variables, and entomological investigations are needed to improve prevention strategies and provide a deeper understanding of the dynamics of disease transmission.

Acknowledgments: We are very much grateful to the Kaggle dataset Program for their data.

Availability of data: The datasets used and analyzed during the current study are available from the corresponding author

https://www.kaggle.com/datasets/kawsarahmad/dengue-dataset-bangladesh

Ethical Approval and Informed Consent: This study followed the ethical principles of the Declaration of Helsinki and relevant international guidelines. The analysis used a publicly available, anonymized secondary dataset on dengue disease obtained from Kaggle for research and educational purposes. The original data collection complied with ethical standards, including informed consent and confidentiality safeguards. As this study involved only secondary analysis of publicly accessible anonymized data and no direct participant contact, additional institutional ethical approval was not required. Dataset access and use were conducted in accordance with Kaggle's data usage policies.

Consent to participate: All respondents give their consent before collecting the data and this consent was confirmed by the enumerators. This data is secondary data and consent was received during the survey questionnaire that follows the ethical rules during data collection.

Consent to Publications: All respondents give their consent for publication of the survey results. Moreover, all authors read the manuscript and give consent to publish this article in this study.

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Conflict of Interest Statement: The authors declared that they have no conflict of interest regarding this paper.

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Original Article

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Estimation of Cardiovascular Disease Risk using Framingham Risk Score among Urban Adults: A Cross Sectional Study

Manish Kumar S[1], Nisha M[2], Kalpana A.P[3]

[1]PG resident, KMCH College of Physiotherapy, Coimbatore, The Tamil Nadu Dr. M.G.R Medical University, [2]PG resident, KMCH College of Physiotherapy, Coimbatore, The Tamil Nadu Dr. M.G.R Medical University. [3]Professor, KMCH College of Physiotherapy, Coimbatore, The Tamil Nadu Dr. M.G.R Medical University.

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Abstract

Background: The American Heart Association recommends predicting risk of Cardiovascular Disease Events; they rely on clinical and biochemical parameters. Framingham risk score is used to estimate 10-year cardiovascular risk. This study aimed to estimate cardiovascular disease risk using the Framingham score and its association with treadmill test.

Methods: A cross-sectional study was conducted among 120 adults attending the Master Health Check-up Department at KMCH, Coimbatore, India. Adults were categorized into low (<10%), intermediate (10-20%), and high (>20%) risk. Treadmill test parameters, including metabolic equivalents (METS), maximum heart rate achieved, and duration, were recorded for analysis. Data was analyzed using IBM SPSS Statistics version 32. Descriptive statistics, Spearman's rank correlation coefficient, and Kruskal-Wallis tests were performed.

Results: Among 120 adults, 91 (75.8%) were low, 26(21.7%) as intermediate, and 3 (2.5%) as high risk. Framingham Risk score demonstrated negative correlations with METS achieved (ρ = -0.635, p<0.001), maximum heart rate (ρ = -0.567, p<0.001), and treadmill test duration (ρ = -0.670, p<0.001). Significant differences across treadmill test parameters were observed across Framingham risk categories (p<0.001).

Conclusion: Higher Framingham risk scores were associated with poorer tread mill performance. Combining cardiovascular risk assessment with treadmill exercise testing may facilitate identification of cardiovascular risk.

Keywords: Cardiovascular disease risk, Functional capacity, Framingham Risk Score, Treadmill test.

Introduction

Cardiovascular diseases are among the most prevalent non-communicable diseases and remain a major cause of morbidity and mortality worldwide. In 2019, approximately 17.9 million deaths were attributed to cardiovascular conditions each year.[1] Several modifiable risk factors known to increase the risk of cardiovascular disease, including

Corresponding Author: Manish Kumar S, PG resident, KMCH College of Physiotherapy, Coimbatore, The Tamil Nadu Dr. M.G.R Medical University.

E-mail: smanishsv@gmail.com

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hyperglycemia, hyperlipidemia, sedentary lifestyle, unhealthy diet, smoking, and obesity.[2]

In India, non-communicable diseases accounted approximately 63% of total deaths in 2016, as reported by the World Health Organization. Cardiovascular diseases alone contributed to around 27% of these deaths. Despite being widely recognized as a significant public health concern in India, access to adequate cardiovascular care remains limited. It is reflected by the low rates of detection, insufficient treatment, and adherence to evidence-based clinical guidelines among the population.[3]

Urbanization, aging, and increasing digitization have significantly contributed to a decline in the per capita physical activity level. As a result, physical inactivity has emerged as one of the leading global risk factors for mortality and is currently ranked as the fourth leading cause of death worldwide.[4] Evidence supports the use of various methods to estimate and classify cardiovascular risk for the prevention and management of cardiovascular diseases. These risk prediction models are essential for targeting preventive interventions and optimizing therapeutic outcomes.[5]

Among the different risk assessment tools available, the Framingham risk score is one of the most commonly used methods in clinical practice for evaluating cardiovascular risk. This scoring system estimates the 10 year risk of future cardiovascular events based on the clinical and laboratory variables.[6, 7, 8] Exercise treadmill testing (ETT) is non-invasive and commonly performed procedure in clinical practice and provides valuable diagnostic and prognostic information.[9]Exercise capacity is one of the important prognostic indicators assessed during exercise treadmill testing. Exercise capacity has consistently been identified as an important predictor of mortality across studies involving healthy women's in epidemiological studies, asymptomatic populations with cardiac risk factors, and populations with existing cardiovascular disease, underscoring its prognostic significance.[10, 11]

While several studies have evaluated cardiovascular risk using the Framingham Risk Score, limited evidence is available regarding its relationship with objective treadmill test parameters among apparently healthy adults undergoing routine health screening.[12, 13] Furthermore, data exploring the association between Framingham Risk Score and exercise capacity in the Indian population remains limited. Understanding this relationship may provide functional implications for cardiovascular risk and help identify individuals who may benefit from early preventive intervention. Therefore, the present cross-sectional study aimed to estimate the cardiovascular disease risk using the Framingham Risk Score and to examine its association with treadmill parameters among adults.

Materials and Methods

Study design, setting, and duration

This crosssectional study was conducted in the Kovai Medical Center and Hospital (KMCH) in the department of master health check-up, Coimbatore, India, from February 2026 to May2026. The center provides master health check-up services through specialized doctors, nurses, dieticians, and radiologists.

During the check-up, the individuals are screened for height, weight, body mass index, smoking habits, comorbidities such as hypertension, blood glucose, lipid profile, treadmill Test,and other important screenings, which are provided under the health check-up and documented in the individual'srecords, and a copy is given to the patient.

Sample size and sampling technique

The sample size was estimated using formula $n = Z^2p(1-p)/d^2$, where Z= 1.96 (corresponding to a 96% confidence interval), p= expected prevalence of dyslipidemia, taken as 44.8% based on a previous study on physical activity and cardiovascular risk factors[14], and d= absolute precision (margin of error), set at 9%. This yielded a minimum sample size was estimated to be 118 participants. To ensure adequate representation and compensate for any incomplete data, a total of 120 participants were included in the study.

The study was conducted among adults attending the Master Health Check-up Department at KMCH Hospital. Approximately 20-30 individuals undergo master health check-up services daily. During the

study period, nearly 250 individuals attended the department of routine health screening. However, only participants who fulfilled the predefined inclusion and exclusion criteria and had complete data required for calculating the Framingham Risk Score and assessing the treadmill test assessment were included in the study. Convenience sampling was used for participant recruitment, whereby eligible individuals meeting the inclusion criteria were enrolled.

Study participants

Individuals eligible for inclusion were required to meet the following criteria:adults aged 30 to 65 years, both genders, willing to participate, and provide informed consent. Individuals were excluded; known history of diagnosed cardiovascular disease (myocardial infarction, heart failure, and coronary artery disease), any recent surgery, malnutrition, recent weight loss due to an unknown cause, recently engaged in weight lifting activities, any severe neurological and musculoskeletal disorders, severe respiratory disease, pregnant women.

Ethical consideration

Ethical approval was obtained from the Institutional Scientific Research Committee of KMCH College of Physiotherapy (ref no: KMCHCOPT/ISRC/04/2026). Eligible participants were informed about the purpose of the study. Written informed consent was obtained in either Tamil or English prior to participation. Participants were assured that their decision to participate or decline in the study.

Study procedure

The data was collected using a structured screening form. Demographic data, including age, gender, smoking, and diabetes mellitus, was obtained through participant interview. Blood pressure was measured using a sphygmomanometer. Lipid profiles required for Framingham Risk Score calculation, including total cholesterol and high-density lipoprotein cholesterol levels, were obtained from participants' Master Health Check-up laboratory reports. Information regarding diabetic status was collected from medical records. The Framingham Risk score calculation was determined using individual information including: age, gender, systolic blood pressure, hypertension, diabetes status, smoking, total blood cholesterol, and high-density lipoprotein (HDL) levels. The Framingham Risk Score was calculated using the General Cardiovascular Disease (10-year) Risk Prediction Model developed from the Framingham Heart Study [15].The collected variables were entered into the Framingham risk score online calculator. The calculated score, adults were categorized into three: low-risk (<10%), intermediate-risk (10-20%), and high-risk (>20%) according to established Framingham Risk Score guidelines[16]. As part of a routine Master Health Check-up, participants underwent a symptom-limited treadmill exercise test under the supervision of a cardiologist using the standard Bruce protocol as part of the routine Master Health Check-up [17]. The test was terminated according to standard clinical indications, including achievement of target heart rate, fatigue, electrocardiographic (ECG) changes, shortness of breath, angina, abnormal blood pressure response [18].The cardiologists interpreting the treadmill test was not informed of the participant's calculated Framingham Risk Score was calculated separately by the investigator after collection of required clinical and laboratory variables. Treadmill reports were reviewed, and parameters including exercise duration (minutes), maximum heart rate achieved, and metabolic equivalents (METS) were recorded. These parameters were used to assess exercise capacity and cardiovascular performance. The STROBE flow chart of participants' recruitment is presented in Figure 1.

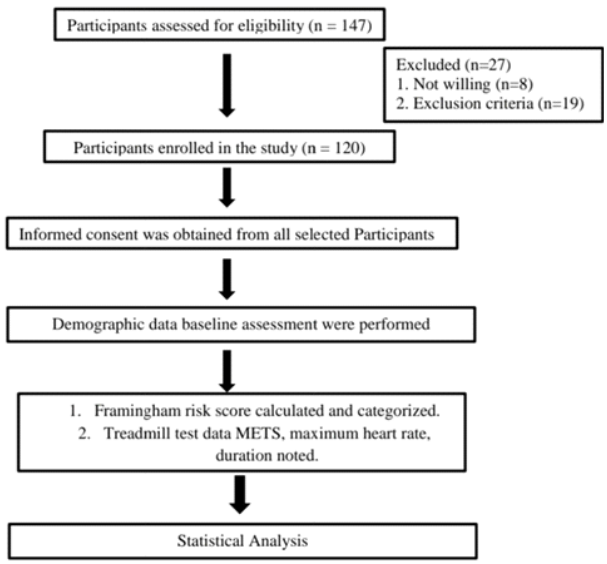

Figure 1: participant recruitment flowchart.

Statistical analysis

Data were analyzed using IBM SPSS Statistics Software version 32.0 (IBM Corp., Armonk, NY, USA). Demographic and clinical data of study participants were calculated using descriptive statistics. Categorical variables, including gender, smoking status, body mass index, diabetes, and Framingham risk categories, were presented as frequencies and percentages. Continuous variables, including age, height, and weight, presented as mean. The normality of continuous variables such as Framingham risk score, METS achieved, maximum heart rate achieved, and treadmill test duration was not normally distributed ($p<0.05$), which was assessed using the Shapiro-Wilk test. Spearman's rank correlation coefficient (ρ) was used to assess the relationship between Framingham risk score and treadmill test parameters. A chi-square test was performed between the BMI category and the Framingham risk category. The Kruskal-Wallis test was used to compare treadmill test parameters across the Framingham Risk Score. Simple linear regression analysis was performed to determine whether the Framingham Risk Score significantly predicted METS achieved, maximum heart rate achieved, and treadmill test duration. A p-value <0.05 was considered statistically significant.

Results

Participant characteristics

A total of 120 adults were included in the study. The mean age of the participant was 49.08±10.24 years. The mean height was 164.80±8.74, and the weight was 73.15±14.5. The study participants' consists of 73 (60.8%) males and 47 (39.2%) females are shown in Figure 2. Based on BMI classification, 2 participants (1.7%) were underweight, 41 (34.2%) had a normal weight, 70 (58.3%) were overweight, and 7 (5.8%) were obese. Among the participants, 31 (25.8%) were smokers, while 89 (74.2%) were non-smokers. Diabetes mellitus was present in 78 participants (65%), where 42 (35%) were non-diabetic. The demographic and clinical characteristics of the study participants are presented in Table 1.

Framingham Risk Categories

Based on the Framingham Risk Score, 91 participants (75.8%) were classified as low-risk, 26 (21.7%) as intermediate-risk and 3 (2.5%) as high risk for future cardiovascular events. The distribution of participants according to Framingham Cardiovascular risk categories is presented in Figure 2.

Correlation Analysis

Spearman's rank correlation analysis demonstrated significant negative correlations between Framingham Risk Score and all treadmill test parameters, as presented in Table 2. The Framingham risk score showed a moderate negative correlation with METS achieved in a treadmill testing (ρ = -0.635, $p<0.001$), indicating that the adults with higher cardiovascular risk had lower exercise performance. A moderate negative correlation was observed between Framingham Risk Score and maximal heart rate achieved in treadmill testing (ρ = -0.567, $p<0.001$). Framingham Risk Score demonstrated a negative correlation with treadmill test duration (ρ = -0.670, $p<0.001$), represents that adults shorter durations of treadmill testing with higher cardiovascular risk.

Comparison across Framingham Risk Categories

Kruskal-Wallis test analysis demonstrated statistically significant differences in treadmill test parameters across Framingham risk categories is presented in Table 3. For METS achieved in treadmill testing, significant differences were observed among the low, intermediate-, and high-risk groups ($H=21.379$, $p<0.001$). The mean rank of METS progressively decreased from the low-risk category (68.53) to the intermediate-risk category (36.58) and the higher-risk category (24.17), indicating reduced exercise capacity with increased cardiovascular risk. Similarly, maximum heart rate achieved differed significantly across Framingham risk categories ($H=16.644$, $p<0.001$). Adults in the low-risk category demonstrated the highest mean rank (67.67), followed by the intermediate-risk (39.75) and high-risk category (22.83), suggesting reduced maximal heart rate with greater cardiovascular risk. Treadmill test duration also showed a significant difference between Framingham risk categories ($H=22.076$, $p<0.001$). The low-risk category exhibited the highest mean rank, 37.23 and 16.17, respectively. These findings suggest that adults with higher the Framingham risk scores were able to do for shorter durations in during treadmill testing. The percentages of Framingham risk score are presented in Figure 3.

BMI Categories and Framingham Risk Distribution

Among overweight participants (n=70), 54 (77.1%) were classified as low-risk, 15 (21.4%) as intermediate risk, and 1 (1.4%) as high risk. Among the obese participants(n=7), 6 (85.7%) were categorized as low risk and 1 (14.3%) as intermediate risk. Although overweight participants represents the largest proportion of the study population, the distribution of BMI categories did not statistically significant in Framingham risk groups in chi-square test ($x^2 = 2.715$, p= 0.844).

Linear regression

Simple linear regression analysis demonstrated that the Framingham Risk Score was a significant predictor of treadmill test parameters. Higher Framingham risk scores were significantly associated with lower functional capacity, as reflected by reduced METS achieved (β = -0.553, R^2 = 0.306, p< 0.0001), shorter treadmill test duration (β = -0.584, R^2 = 0.341, p< 0.0001), and lower maximum heart rate achieved (β = -0.496, R^2 = 0.246, p< 0.0001) as presented in Table 4. These findings indicate that increasing cardiovascular risk associated with poor treadmill exercise performance.

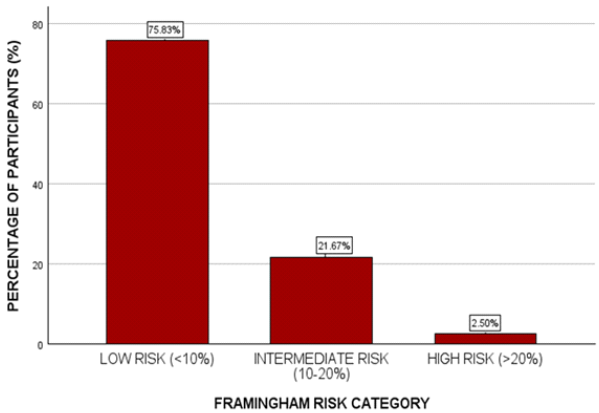

Figure 2: Distribution of participants into cardiovascular risk categories as per Framingham risk score.

Table 1: Demographic and clinical characteristics of participants (n=120)

SI.NO	Variables	Category	N (%)/Mean±SD
1.	Age (years)	-	49.08±10.24
2.	Height (cm)	-	164.80±8.74
3.	Weight (kg)	-	73.15±14.5
4.	Gender	Male	73 (60.8%)
		Female	47 (39.2%)
5.	Body mass index (kg/m^2)	Underweight	2 (1.7%)
		Normal	41 (34.2%)
		Overweight	70 (58.3%)
		Obese	7 (5.8%)
6.	Smoking	Smoker	31 (25.8%)
		Non-smoker	89 (74.2%)
7.	Diabetes	Diabetic	78 (65%)
		Non-diabetic	42 (35%)

SD-standard deviation

Table 2: Correlation between Framingham Cardiovascular Risk Score and Treadmill Test Parameters.

SI.NO	Variables	**Spearman's rho (*ρ*)**	p-value
1.	Framingham Score versus TMT METS Achieved	-0.635	<0.001
2.	Framingham Score versus TMT Maximum Heart Rate	-0.567	<0.001
3.	Framingham Score versus TMT Duration	-0.670	<0.001

TMT-Treadmill test, MET-metabolic equivalent of task

Table 3: Comparison of Treadmill Test Parameters across Framingham Risk Categories.

SI.NO	Variables (TMT)	Low risk (n=91) Mean Rank	Intermediate risk (n=26) Mean Rank	High risk (n=3) Mean Rank	Kruskal-Wallis H	p-value
1.	METS Achieved	68.53	36.58	24.17	21.379	<0.001
2.	Maximum Heart Rate	67.67	39.75	22.83	16.644	<0.001
3.	Duration	68.61	37.23	16.17	22.076	<0.001

METS- Metabolic equivalent of task

Table 4: Simple linear regression analysis showing the association between Framingham Risk Score and treadmill test parameters (n=120)

Dependent Variable	Predictor	β	95 % Confidence travel for β	Adj.R^2	R^2	t	F	p-value
METS	Framingham score	-0.553	-0.202 to -0.115	.300	0.306	-7.25	52.495	<0.001
Maximal Heart Rate	Framingham score	-0.496	-2.458 to -1.273	.240	0.246	-6.24	38.872	<0.001
Duration	Framingham score	-0.584	-0.190 to -0.114	.336	0.341	-7.85	61.594	<0.001

METS-Metabolic equivalent

Discussion

Cardiovascular diseases remain to be a leading contributor to morbidity and mortality in worldwide and significant public health concern, particularly in low- and middle-income countries. Estimation from the Global Burden of Diseases study suggests that cardiovascular diseases are one of the primary causes of mortality and disability in 2020[19]. Identifying individuals at increased cardiovascular risk at an early stage is essential for prevention and risk reduction. Risk prediction models such as the Framingham risk score are most commonly used to estimate an individual's of 10-year cardiovascular disease risk.

The present cross-sectional study evaluated the association between cardiovascular disease risk estimated using the Framingham risk score and exercise performance assessed through treadmill testing among adults attending a Master Health Check-up Department. The findings demonstrated significant negative correlations between Framingham risk score and treadmill test parameters, including METS achieved, maximum heart rate achieved, and treadmill test duration. Comparison of treadmill test parameters across the Framingham risk categories showed that participants classified as low risk achieved better exercise performance than those in the intermediate-and high-risk categories. Previous studies have demonstrated an association between cardiovascular risk and exercise capacity[20-21], evidence from the Indian population, particularly among asymptomatic adults attending routine Master-Health Check-up program, remains limited. The present study adds to the existing literature by evaluating the association between the Framingham Risk Score and objective treadmill test parameters in an Indian urban population. These findings provide population-specific evidence supporting the importance of cardiovascular risk assessment in asymptomatic healthy adults before the onset of clinically established cardiovascular disease.

The majority of the participants were categorized as low-risk (75.8%), while 21.7% and 2.5% belonged to intermediate-and high-risk categories. This distribution may be attributed to the inclusion of individuals undergoing master health screening rather than the patient's established cardiovascular disease. A significant negative correlation was observed between Framingham Risk score and treadmill parameters, such as METS achieved (ρ = -0.635, p<0.001), maximal heart rate (ρ = -0.567, p<0.001), and duration (ρ = -0.670, p<0.001), indicating that individuals with higher estimated cardiovascular disease risk tend to demonstrate lower exercise

capacity. Exercise capacity measured in METS is an important indicator of cardiorespiratory fitness and health. Therefore, the inverse relationship observed in the present study suggests that individuals with a greater burden of cardiovascular risk factors may contribute to a reduction in exercise capacity. The observed reduction in exercise capacity among individuals with higher Framingham Risk Scores may be effects of multiple cardiovascular risk factors. Hypertension, diabetes mellitus, smoking, and advancing age contribute to endothelial dysfunction, arterial stiffness, impaired myocardial perfusion [22-23]. BMI alone was not significantly associated with Framingham risk category, suggesting that cardiovascular risk assessment should consider multiple risk factors including age, diabetes mellitus, smoking status, hypertension, lipid profile, and physical activity, rather than body weight alone.

While age, sex, and family history are non-modifiable risk factors of cardiovascular disease risk, many other contributing factors can be altered through lifestyle and medical intervention. Individuals with modifiable risk factors should undergo regular check-ups and risk evaluation. It is practical to estimate CVD risk in asymptomatic individuals, using the resulting data to promote knowledge, awareness, and as motivation for adopting healthy lifestyles for therapeutic change. Individuals attending routine master health screening may exhibit reduced exercise capacity even when they do not have established cardiovascular disease[24]. Integrating cardiovascular risk assessment with objective measures of exercise performance may therefore enhance preventive cardiovascular care and facilitate lifestyle intervention. The combined use of the Framingham Risk Score and treadmill testing may provide greater clinical value than assessment alone. While the Framingham Risk Score estimates an individual's long-term cardiovascular risk based on established clinical and biochemical risk factors, treadmill testing shows an objective assessment of functional capacity and cardiovascular response to physical stress. Integrating these assessments may improve early identification of individuals at increased cardiovascular risk who may remain asymptomatic, thereby implementing preventive interventions, individualized exercise prescription, and lifestyle modification. This combined approach may be useful in routine health screening program.

Evidence has also highlighted the association between cardiovascular risk estimation and treadmill physiological parameters.[25, 26, 27]Subjects aged ≥50 years had a significantly higher risk of cardiovascular disease within 10 years.[28]

The strengths of the present study include the use of a validated cardiovascular risk prediction tool, objective assessment of functional capacity through standardized treadmill testing, and evaluation of the association between cardiovascular risk estimation and functional capacity in an Indian urban population attending routine health screening. These findings provide clinically relevant information that may support early identification of cardiovascular disease risk and preventive health strategies.

Recommendations

Future studies should adopt longitudinal or prospective multicenter study design involving larger and more diverse populations, particularly with greater representation high-risk individuals, are recommended to validate these findings. Future studies should incorporate multivariable regression analyses to adjust for potential confounding variables and evaluate the independent contribution of cardiovascular risk to exercise performance. Periodic exercise capacity assessment using treadmill testing may help identify individuals with reduced functional capacity.

Limitations

The present study has several limitations that should be considered while interpreting the findings. First, because of the cross-sectional study the observed relationships represent association and cannot establish causality relationship between Framingham Risk Score and treadmill test performance. Second, participants were recruited using convenience sampling from a single Master Health Check-up center, which may have introduced selection bias and limits the generalizability of the findings to the broader population. Third, only three participants were classified as high cardiovascular risk, limiting the stability of comparisons involving this subgroup. Fourth, information regarding medication use (including antihypertensive),

habitual physical activity was not collected. These factors may have influenced both the Framingham Risk Score and treadmill exercise performance and should be considered in future studies. Finally, the study population consisted of adults attending routine health screening, who may differ from the general community.

Conclusion

The present study demonstrated a significant association between estimated cardiovascular diseases risk and treadmill test parameters among adults attending a routine Master Health Check-up. Individuals with higher Framingham Risk Scores showed lower exercise capacity, reflected by reduced metabolic equivalents, lower maximum heart rate achieved, and shorter treadmill duration. These findings suggest that combining Framingham Risk Score assessment with treadmill test may provide complementary information for identifying individuals at increased cardiovascular risk and reduced functional capacity in preventive health screening.

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Declaration of conflicts of interest statement: The authors declare that there are no conflicts of interest.

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Original Article

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Development and Validation of a Food Frequency Questionnaire to Assess Energy, Macronutrient and Micronutrient Intake of Adolescents Residing in Mumbai City

Mishra Sonu[1], Mandalika Subhadra[2]

[1]PhD Scholar, [2]Former Professor, Department of Foods, Nutrition and Dietetics, College of Home Science, Nirmala Niketan, Affiliated to University of Mumbai, Mumbai, Maharashtra, India.

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Abstract

Background: Assessment of dietary intake of adolescents is challenging due to irregular eating habits, social desirability bias, peer influence, and difficulty in estimating portion sizes. Validated dietary assessment tools for Indian adolescents are limited. We aimed to develop and validate a Semi-Quantitative Food Frequency Questionnaire (SQFFQ) to assess dietary energy and selected nutrient intake among adolescents in Mumbai city.

Methods: The study was conducted in two phases. In Phase I, a 279-item SQFFQ was developed using literature review and a rapid online dietary survey. After content and face validity assessment, the questionnaire was refined to 104 food items across nine food groups. In Phase II, the tool was validated against 24-hour dietary recall method among 358 adolescents aged 10–19 years selected through random sampling. Nutrient intakes were analysed using DietCal software. Validity was assessed using advanced statistics. Reproducibility was tested in a subsample (n=44) using the test-retest method.

Results: The SQFFQ showed significantly higher mean nutrient intakes than recalls ($p<0.001$), but demonstrated strong correlations for crude and energy-adjusted nutrients ($r=0.721–0.961$, $p<0.001$). The cross-classification analysis showed that between 90.6% and 99.9% of foods were categorized into the same or adjacent quartiles, whereas gross misclassification remained below 10%. The Bland–Altman analysis indicated acceptable agreement between the methods. The reproducibility analysis showed high correlations ($r=0.779–1.000$), with good Intraclass Correlation Coefficient and Cronbach's alpha values.

Conclusion: The developed SQFFQ was found to be a valid, reliable, practical, and cost-effective tool for assessing dietary intake of adolescents in Mumbai.

Key words: Adolescents, Semi-quantitative Food Frequency Questionnaire, Validation, 24-hour dietary recall, dietary assessment, Mumbai

Corresponding Author: Mishra Sonu, PhD Scholar, Department of Foods, Nutrition and Dietetics, College of Home Science, Nirmala Niketan, Affiliated to University of Mumbai, Mumbai, Maharashtra, India.

E-mail:

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Introduction

Adolescence is a transitional stage of growth and development from childhood to adulthood, and spans from 10–19 years as per the World Health Organization. This phase is characterised by rapid physical, cognitive, emotional, and social changes, making adequate nutrition essential. However, poor nutrition during adolescence may result in stunting, wasting, delayed puberty, and a higher risk of future health problems.

Adolescents gain greater autonomy over food choices, often leading to increased consumption of energy-dense processed foods, irregular meal patterns, and more frequent eating outside the home [(1)]. Since several dietary behaviours linked to adult disease begin during childhood and adolescence, timely assessment during this stage is important for early corrective action [(2)]. However, dietary assessment of adolescents is challenging due to their irregular eating habits, social desirability bias, peer influence, forgetfulness, and difficulty in estimating portion sizes.

Among the various methods, the 24-hour dietary recall and Food Frequency Questionnaire (FFQ) are the most common. In addition, a semiquantitative FFQ (SQFFQ) records both frequency of consumption and portion sizes of foods, allowing the estimation of habitual energy and nutrient intake with relatively low respondent burden. SQFFQs are effective for evaluating dietary patterns, energy, and macronutrient intake, with reliability enhanced through the use of standard portion guides and food images making it useful for large-scale epidemiological studies [(3,4)].

Although several Indian and international studies have demonstrated the validity and reproducibility of FFQs in adults, evidence on tools specifically designed for Indian adolescents are limited. Hence, the present study aimed to develop a gender and socio-economically appropriate SQFFQ to assess the dietary practices, energy, macronutrient and selected micronutrient intake of adolescents, and validate the same using multiple 24-hour recall method.

Materials and Methods

The study's research proposal has been approved by the Institutional Ethical Committee (IEC) of Dr. BMN College of Home Science. Informed consent was obtained from the participants' parents, as the participants were minors. All the data collected were kept confidential. The study was a cross-sectional study and was conducted in 2 phases in Mumbai city. The present study was conducted from 2022 to 2025 at College of Home Science, Nirmala Niketan; University of Mumbai.

Phase I: Development of a Semiquantitative Food Frequency Questionnaire (SQFFQ): Information obtained through literature review and a rapid online assessment survey of common food consumption patterns among adolescents was used to construct the SQFFQ including a 279 item food list.

The developed SQFFQ had 4 sections; section-1 contains questions on sociodemographic details of the participants (name, gender, age, contact details), section-2 contains a list of 279 food items divided into seven food groups, i.e., cereals and millets (28), pulses (14), vegetables (24), fruits (25), milk and products and non veg (13), nuts and oilseeds and fats (7), miscellaneous (bakery items, savoury items, sweets, beverages and other) (58), section-3 contains eight predefined frequency categories (never or less than once per month, once a month, 2 -3 times a month, once a week, 2 -3 times a week, 4 -5 times per week, once a day; 2 or more times per day); and section-4 contains a booklet with images of reference portion sizes of foods.

Content validity of the SQFFQ was assessedfor its relevance and comprehensiveness by 10 experts from the Nutrition field with an experience of >10 years. Face validity was assessed by tenadolescents (10-19 years) who were randomly selected to test the tool to confirm the appropriateness of the questionnaire for the target population.

Based on the results of content and face validity, the preliminary list of 279 foods in the SQFFQ was consolidated into a final set of 104 items which were systematically categorized into nine principal food groups: cereals (18), pulses (5), vegetables (14), fruits (5), milk and milk products (6), non-vegetarian foods (5), nuts and oilseeds (5), fats and oils (3), and miscellaneous items (43).

Phase-II: Validation of SQFFQ against the 24 hour recall method.

A sample of 358 adolescents (13-18 years) were selected using a random sampling technique from various academic institutions in Mumbai. Data on their dietary intake was collected using SQFFQ and 24-hour recall method applied on two different days (one holiday and one weekday).Dietary energy, macronutrient and selected micronutrient (vitamin A, beta carotene, vitamin D, calcium, iron) intake of the participants was calculated from the data collected using Dietcal software.

Nutrient intake obtained from the newly developed SQFFQ and 24-hour recall method were compared and statistically analysed to determine the validity of the SQFFQ. Paired sample T test was used to measure the difference in the dietary energy and nutrient intake, agreement between the two methods was assessed by the Bland–Altman analysis, and categorical agreement was assessed using quartile classification of each nutrient from both methods. In addition, a test-retest analysis was performed on a subsample (n = 44) to assess the reproducibility of SQFFQ with the tool administered twice at 4 weeks intervals.

Correlation of nutrient intake calculated from the first and second administrations of SQFFQ was calculated using Pearson's correlation coefficient. The degree of agreement between repeated administrations was calculated using the Intraclass Correlation Coefficient (ICC) and Internal consistency of the SQFFQ administrations was assessed using Cronbach's alpha.

Results and Discussion

Content validity analysis performed by nutrition experts suggested some modifications like- removal of certain food items not commonly consumed by the adolescents, inclusion of certain local delicacies and slight rearrangement of the food items to enhance the logical flow of the questions. The face validity results from adolescents confirmed that the SQFFQ was understandable, culturally relevant, and feasible to administer among adolescents in Mumbai. However, one adolescent recommended combining food items of a similar nature and removing certain junk foods to reduce the questionnaire length and save time which was taken into consideration and many junk foods of similar ingredients were clubbed as one category (eg: sandwich- cheese sandwich/ toast sandwich/ vegetable sandwich; chaat- sevpuri/bhelpuri/ pani puri).

A Semi Quantitative Food Frequency Questionnaire (SQFFQ) was thus developed incorporating the feedback from nutrition experts and adolescents as part of content and face validity.

The study sample (n = 358) comprised a nearly equal proportion of adolescent boys and girls. A majority of participants belonged to nuclear families (73.7%) and majority of the parents were educated(58.7%). Most mothers were homemakers (86.3%), while fathers were predominantly engaged in salaried employment or business occupations (Table 1).

Table 1: Socio-demographic characteristics of the participants (N=358)

Demographics	n (%)
Age group	
13-15 years	180 (50.3)
16-18 years	178 (49.7)
Gender	
Boys	178 (49.7)
Girls	180 (50.3)
Type of family	
Joint	94 (26.3)
Nuclear	264 (73.7)
Occupation of the father	
Salaried employment	224 (62.6)
Business	131 (36.6)
Not working	3 (0.8)
Education of the father	
≤10 std.	174 (48.6)
≤12 std.	75 (20.9)
Graduate	91 (25.4)
Post graduate	18 (5)
Occupation of the mother	
Housewife	309 (86.3)
Teacher	18 (5.0)
Salaried employment	27 (7.5)
Business	4 (1.1)
Education of the mother	
≤10 std.	210 (58.7)
≤12 std.	56 (15.6)
Graduate	80 (22.3)
Post graduate	12 (3.4)

The dietary nutrient intake data obtained using the SQFFQ and 24- hour recall method are presented in Table-2. Paired sample t- test indicated significant differences between the methods for all macronutrients with the SQFFQ showing a higher mean percentage intake of energy, macronutrient and selected micronutrients compared with the 24-hour dietary recalls (p<0.001). Bogea et al. [5] observed greater percentage differences between FFQ and 24-hour recall estimates than the current study. In their study, carbohydrate intake showed a 37.8% difference, protein 2.2% difference, fat 12.3% difference, and fiber 256.3% difference, indicating substantial overestimation of all nutrients by the FFQ. Similarly, Silva et al. [6] also documented overestimation of energy and nutrient intakes by semi quantitative FFQ compared to multiple-pass 24-hour recalls, with percentage differences of 21.4%, 27.4%, 24.2%, 25.1% 54.6% for protein, fats, carbohydrates, energy, and total fiber respectively.

Table 2: Dietary energy and nutrient intake of the adolescents and Percentage difference of data between SQFFQ and 24-hr dietary recall methods (N=358)

Macronutrients	SQFFQ	2-day average recall	Percentage difference (%)	P value
Energy (Kcal/d)	1343.0 ±245.0	1229.0 ±243.0	8.5±6.3	0.001
Carbohydrates (g/d)	214.5 ±57.9	195.2 ±57.6	9.1±9.3	0.001
Protein (g/d)	35.4 ±6.1	32.7 ±6.1	7.6±6.3	0.001
Fats (g/d)	38.1 ±7.9	35.2 ±8.1	7.8±6.3	0.001
Total fiber (g/d)	18.3 ±5.5	15.7 ±5.2	14.4±12.9	0.001
Retinol (µg)	212.8 ±45.6	189.4 ±46.6	11.1±9.9	0.001
Beta-carotene (µg)	1229.5 ±177.5	1131.9 ±148.9	8.8 ±9.9	0.001
Vitamin C (mg)	33.4 ±8.3	29.2 ±8.1	12.8±11.2	0.001
Vitamin B9 (µg)	137.8 ±36.1	122.2 ±33.9	10.8±11.8	0.001
Calcium (mg)	544.1 ±143.0	499.9 ±130.4	7.8±6.3	0.001
Iron (mg)	6.2 ±2.2	5.5 ±2.0	11.5±11.5	0.001
Zinc (mg)	4.4 ±1.5	3.8 ±1.4	13.3±10.3	0.001

Data presented asmean ±SD.

Further, the agreement between the SQFFQ and 24-hour dietary recall method was assessed using a combination of advanced statistical techniques - correlation analysis, Bland Altman analysis and cross-classification analysis.

Correlation analysis was carried out on crude as well as energy adjusted data. Crude values assess absolute nutrient intake, whereas energy-adjusted values control for total calorie intake and better reflect the SQFFQ's ability to rank individuals by dietary quality. A strong correlation was observed in the data obtained using SQFFQ and 24-hr dietary recall methods (p<0.001) (Table-3)

Table 3: Correlationof energy and macronutrient intake estimated by SQFFQ and 24-hr dietary recalls (N=358)

Nutrients	Crude values		Energy adjusted values	
	R value	P value	R value	P value
Energy (Kcal/d)	0.939	0.001	-	-
Carbohydrates (g/d)	0.941	0.001	0.961	0.001
Protein (g/d)	0.927	0.001	0.899	0.001
Fats (g/d)	0.959	0.001	0.961	0.001
Total fiber (g/d)	0.880	0.001	0.883	0.001

Cont....

Retinol	0.893	0.001	0.894	0.001
Beta-carotene	0.802	0.001	0.803	0.001
Vitamin C	0.890	0.001	0.889	0.001
Vitamin B9	0.906	0.001	0.907	0.001
Calcium	0.958	0.001	0.951	0.001
Iron	0.929	0.001	0.927	0.001
Zinc	0.936	0.001	0.936	0.001

Cross-classification analysis was interpreted based on the proportion of participants classified into the same and opposite quartiles. Classification of >50% of participants into the same quartile was considered indicative of good agreement, whereas gross misclassification was defined as < 10% of participants being classified into the opposite quartile. The cross classification demonstrated 64.8–79.0% exact agreement, indicating good same-quartile agreement.

Accordingly, the percentage of participants in the same and adjacent quartiles for macronutrients ranged from 96.7% (fats) to 99.2% (energy) and for micronutrients ranged from 99.9% (calcium) to 97.9% (zinc), with gross misclassification occurring in <10% (0.1% to 9.4%) of the participants (Table 4). Ajabnoor et al, reported comparable findings; >50% of participants were classified into the same quartile for energy, protein, and total fat, with good weighted kappa agreement for energy (0.83) and protein (0.72), and acceptable agreement for carbohydrates and fat [7]. Similarly, a validation study conducted among Ethiopian adults reported satisfactory cross-classification results, with most participants classified into the same or adjacent intake categories and minimal gross misclassification[8]. These findings support the utility of FFQs for ranking individuals according to habitual dietary intake. These findings also support that the developed SQFFQ is effective in ranking adolescents according to habitual nutrient intake, which is a key requirement for epidemiological dietary assessment.

Table 4.: Cross-classification of energy and macronutrients based on SQFFQ & 24-hr dietary recalls (N=358)

Macronutrients and micronutrients	Cross classification between SQFFQ & average values obtained by 24-hr dietary recall			Cohen's Kappa	P value
	% CC	%CCI	%GM		
Energy (Kcal/d)	72.0	99.2	0.8	0.628	0.001
Carbohydrates (g/d)	74.4	99.3	0.7	0.657	0.001
Protein (g/d)	79.3	98.9	1.1	0.724	0.001
Fats (g/d)	74.1	96.7	3.3	0.654	0.001
Total fiber (g/d)	58.9	96.0	4.0	0.453	0.001
Retinol	69.1	96.9	3.1	0.588	0.001
Beta-carotene	60.6	94.9	5.1	0.475	0.001
Vitamin C	57.9	94.1	5.9	0.438	0.001
Vitamin B9	70.9	99.1	0.9	0.613	0.001
Calcium	75.6	99.9	0.1	0.676	0.001
Iron	77.0	98.6	1.4	0.695	0.001
Zinc	75.9	97.9	2.1	0.680	0.001

% **CC (Correct Classification)** = percentage of participants with SQFFQ and 2DR intakes that are correctly classified in the same quartiles.

% **CCI (Correct Classification Including Adjacent Quartiles)** = percentage of participants with SQFFQ and 2DR intakes that are classified in the same and adjacent quartiles.

% **GM (Gross Misclassification)** = percentage of participants with SQFFQ and 2DR intakes that are grossly misclassified in the extreme quartiles.

Bland-Altman analysis (Figures 1- 5) revealed that the mean differences for energy, macronutrient and fiber intake estimated by SQFFQ and 24 hour recall methods remained similar between the 95% limits of agreement. This indicates that even though SQFFQ overestimated nutrient intake (table -4), it was still in concordance with the intake estimated by the 24-hr dietary recall method.

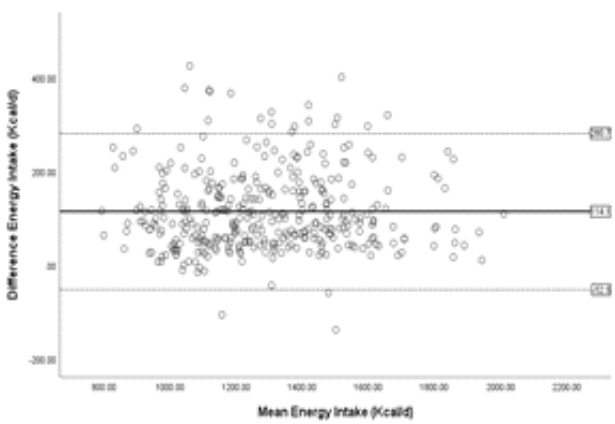

Figure 1 Bland-Altman plot showing difference between mean of energy intake estimated by FFQ and 24-hr dietary recall

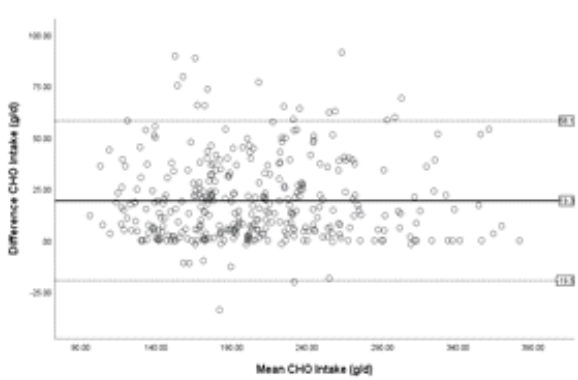

Figure 2: Bland-Altman plot showing difference between mean of carbohydrate intake estimated by FFQ and 24-hr dietary recall

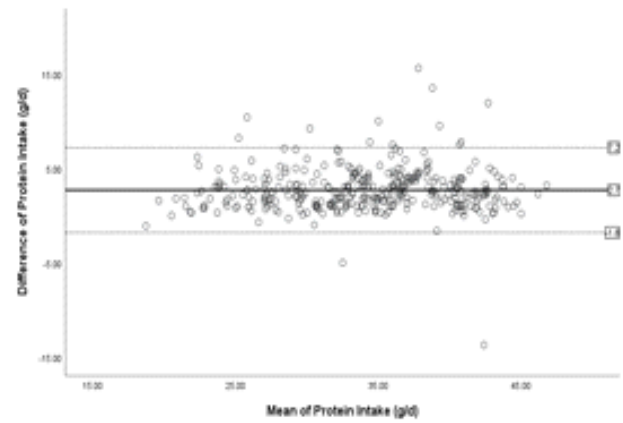

Figure 3: Bland-Altman plot showing difference between mean of protein intake estimated by FFQ and 24-hr dietary recall

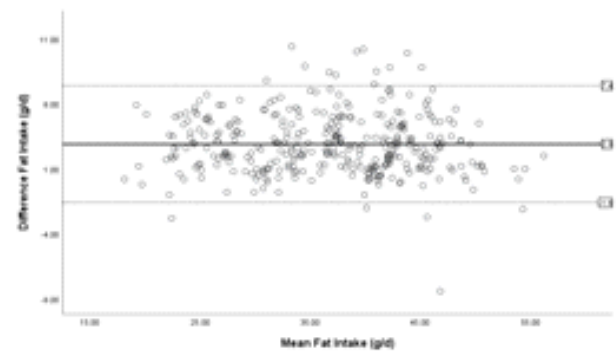

Figure 4: Bland-Altman plot showing difference between mean of fat intake estimated by FFQ and 24-hr dietary recall

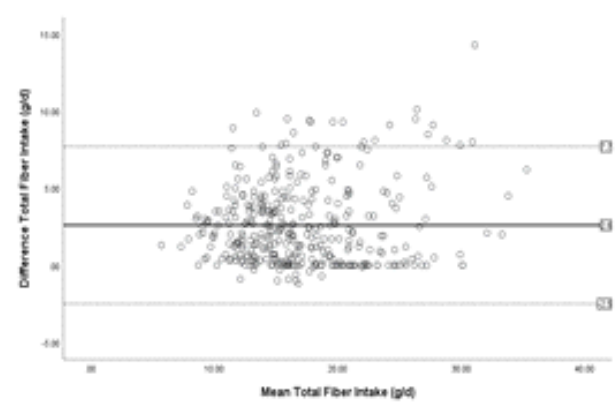

Figure 5: Bland-Altman plot showing difference between mean of total fiber intake estimated by FFQ and 24-hr dietary recall

Similar results were obtained for micronutrients as well.

Reproducibility and Reliability of the SQFFQ

Reproducibility and reliability are essential in newly developed questionnaires to ensure the

credibility, accuracy, and stability of the data collection instrument. These psychometric properties ensure that the results remain consistent over time and across different observers, and are not influenced by random error, measurement noise, or ambiguity. Without establishing these qualities, questionnaires may yield misleading or difficult-to-interpret findings.

A test-retest analysis conducted in a subsample (n = 44) to assess the reproducibility of the newly developed SQFFQ indicated that the mean nutrient intake was comparable across the two administrations (Table 5). Significant positive correlations were observed for nutrients indicating high consistency between both administrations, reflecting reproducibility of the SQFFQ over time. Similar findings were reported in a study from Fujian, China, where repeated administration of an FFQ demonstrated moderate-to-high ICC values (0.57–0.97) and significant correlations for nutrient intakes, supporting the reliability of FFQs for repeated dietary assessment [9].

Table 5: Results of test -retest analysis of SQFFQ (N=44)

Nutrients	Mean nutrients intake		Mean difference between SQFFQ administrations	Percentage difference between SQFFQ administrations	Pearson's Correlation	P value
	SQFFQ first administration	SQFFQ second administration				
Energy (kcal/d)	1560.0±251.0	1542.0±235.0	18.5±45.0	1.1±2.5	0.985	0.001
Carbohydrate (g/d)	233.4±49.5	232.4±44.0	1.1±12.2	-0.3±6.2	0.974	0.001
Proteins (g/d)	39.8±5.7	38.1±5.2	1.7±2.9	3.8±6.6	0.864	0.001
Fats (g/d)	39.8±5.7	38.8±5.1	1.0±2.4	2.1±6.6	0.903	0.001
Total fiber (g/d)	21.2±5.2	21.1±4.8	0.1±1.6	-0.5±8.9	0.955	0.001
Retinol (µg)	212.7±46.7	209.7±43.8	3.0±9.5	1.1±3.6	0.980	0.001
Beta-carotene (µg)	1220.5±173.8	1232.2±172.6	-11.7±63.4	-1.1±5.5	0.933	0.001
Vitamin C (mg)	34.5±5.9	35.4±6.2	-0.8±3.1	-2.7±9.8	0.870	0.001
Vitamin B9 (µg)	153.8±29.8	153.9±28.4	-0.1±6.1	-0.3±4.5	0.979	0.001
Calcium (mg)	600.4±145.3	613.8±143.0	-13.4±41.3	-2.7±8.1	0.959	0.001
Iron (mg)	8.2±2.1	8.4±2.0	-0.2±1.3	-5.0±26.3	0.807	0.001
Zinc (mg)	5.5±1.3	5.4±1.2	0.1±0.6	1.7±7.4	0.892	0.001

Data analysed using Pearson's correlation

Reliability of the SQFFQ

The reliability of the SQFFQ was assessed using Cronbach's alpha and ICC. Cronbach's alpha showed good agreement between repeated SQFFQs which was further confirmed by the ICC, showing good absolute agreement between repeated SQFFQs (Table 6). The ICC values obtained in the present study were comparable to those reported in several FFQ validation studies. In a Saudi Arabian adult population, ICC values ranged from 0.60 to 0.91 for nutrients assessed by their FFQ, indicating good reproducibility[10]. Similarly, ICC values ranged from 0.52 to 0.82 for nutrient intakes in a reproducibility study of a self-administered FFQ among Japanese adults[11]. The higher ICC values observed in the present study (0.805–0.983) suggest excellent temporal stability of the SQFFQ.

Table 6: Results of reliability analysis (N=44)

Nutrient	Cronbach's alpha	ICC	(95% CI)		P value
			Lower bound	Upper bound	
Energy (kcal/d)	0.991	0.983	0.969	0.991	0.001
Carbohydrate (g/d)	0.983	0.966	0.939	0.982	0.001
Proteins (g/d)	0.924	0.859	0.756	0.920	0.001
Fat (g/d)	0.964	0.898	0.820	0.943	0.001
Total fiber (g/d)	0.975	0.952	0.913	0.973	0.001
Retinol (µg)	0.989	0.978	0.960	0.988	0.001
Beta-carotene (µg)	0.965	0.933	0.880	0.963	0.001
Vitamin C (mg)	0.930	0.869	0.773	0.926	0.001
Vitamin B9 (µg)	0.999	0.978	0.960	0.988	0.001
Calcium (mg)	0.979	0.959	0.926	0.977	0.001
Iron (mg)	0.892	0.805	0.669	0.889	0.001
Zinc (mg)	0.941	0.888	0.805	0.938	0.001

Data analysed using Cronbach's Alpha and ICC

Thus the SQFFQ developed in the present study showed good agreement with the 24-hour recall method. In addition, the tool demonstrated satisfactory reproducibility thus supporting its application as a practical, reliable and cost-effective dietary assessment tool.

Conclusion

The study findings demonstrated that the SQFFQ was a valid and reliable instrument for assessing energy, macronutrient and micronutrient intakes of adolescents. The tool also holds a significant potential to be used in epidemiological studies and public health interventions targeting urban Indian adolescents. The study had a few limitations, such as the reference method used in the present study—two-day 24-hour dietary recall—may not fully capture intra-individual variability in dietary intake. Inclusion of three-day or seven-day recalls could have provided a more comprehensive representation of habitual intake. Biomarker-based validation was not undertaken, which could have provided independent confirmation of nutrient intake estimates and lastly the SQFFQ was validated within a specific geographic and socio- demographic setting; therefore, validation in rural populations and diverse socio-economic groups is necessary to enhance generalizability. For future research, the tool may also be employed in school health programs for early identification of dietary risk behaviours and for monitoring intervention outcomes, particularly in light of the observed dietary pattern characterised by high intake of carbohydrate-rich foods and HFSS foods with comparatively lower consumption of nutrient-dense protective foods. Considering advancements in technology-assisted dietary assessment, adapting the SQFFQ into a digital or app-based format may reduce respondent burden, improve portion size estimation, and enhance data accuracy.

In a rapidly urbanizing setting, adolescents seem to have a traditional dietary pattern coexisting with westernised food habits. For such a population, culturally adapted and validated SQFFQs are essential to assess the emerging food choices and dietary intakes. To address this need, the present study investigators thus developed and validated the SQFFQ for adolescents residing in Mumbai city.

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Ethical Clearance/Statement of Ethics*:* The research proposal has been approved by the Institutional Ethical Committee (IEC) of Dr. BMN College of Home Science. The proposal has been registered on the Clinical Trials Registry – India (CTRI). The registration number is: CTRI/2021/07/034563.

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Original Article

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Study of Distribution of Blood Groups in the Kadugolla Community of Chitradurga District, Karnataka, India

Muruli YN[1], Nagarathna N[2], Shubha DS[3], Sreenivasa G[4]

[1]Research Scholar, [2]Research Scholar, Human Genetics laboratory, DOS in Zoology, Davangere, University, Davangere, [3]Professor, Molecular Biology Laboratory & Dept. of Microbiology, Basaveshwara Medical college and Hospital, Chitradurga, Karnataka, [4]DOS in Zoology, Davangere, University, Davangere.

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Abstract

Background: Community-based blood grouping is helpful for establishing demographic and genetic profiles. The information obtained helps in blood banking activities within a particular region and helps to identify the hereditary diseases among patients.

Objective: This study is aimed at finding out the frequency of various blood types among people in the Kadugolla tribal community in Chitradurga district, Karnataka, India.

Material and methods: A total of 240 individuals who voluntarily agreed to take part in the study have been included in this study.

Results: This study documented that, O blood group is the most common (42.5%), and A is second most common (36.6%) blood type in the study cohort. Blood group B is found in 16.2% of individuals, while the least frequent blood group in the study is AB present in 4.5%. In the Rh system, the Rh-positive allele is more prevalent with the frequency of is 95% (allelic frequency 0.78) and the frequency of Rh negative is 5% (allelic frequency0.22).

Conclusion: Community-based blood grouping analysis provides valuable insights into the demographic distribution and inheritance patterns of blood groups within a population. Such data can help identify individuals and communities at potential risk of hemolytic diseases and support early preventive and diagnostic strategies.

Key words: Blood typing, Kadugolla tribal community, Chitradurga.

Introduction

Blood grouping is determined based on the surface antigens in the red blood cells. This determines compatibility of blood transfusion and avoids any type of reaction such as hemolysis.[(1)] Studies of populations blood groups show variation across

Corresponding Author: Sreenivasa. G, Assistant Professor, DOS in Zoology, (Human Genetics Research Laboratory), Davangere University, Davangere.

E-mail: sreenivasa.g47@davangereuniverity.ac.in, ORCID No. 0009-0009-7481-8693

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the world with respect to ABO and Rh factors, thus helping in organizing blood banks and recruiting rare donors.[2] The blood type is genetically determined by the ABO gene located at the ninth chromosome. The three main alleles are A, B, and O. The allele A codes for a glycosyltransferase enzyme responsible for adding N-acetylgalactosamine onto the H antigen expressed on all normal erythrocytes, while the allele B codes for another glycosyltransferase enzyme responsible for adding D galactose onto the same H antigen. [3, 4] The O allele contains a deletion that prevents production of a functional enzyme, resulting in an inactive glycosyltransferase and leaving the H antigen unmodified. [3, 5] A and B are codominant, therefore, people having the AB genotype will show both A and B antigens in their red blood cells. Rh status depends on the RHD gene located on chromosome 1p36.11, determines the Rh positive or negative. This gene has 10 exons and is very close to the RHCE gene. The presence of functioning D antigen makes Rh+, while absence makes Rh- (homozygous deletion). This is inherited independently of ABO, resulting in eight different genotypes.[6] The genetic diversity in humans is very well correlated with the geographical proximity, people living closer together will tend to have more similar alleles despite belonging to different ethnic groups.[11] Thus distribution of blood groups often shows a geographical gradient. Small-sized, endogamous, and isolated tribal populations may develop unique blood group distributions. [7, 8] The Kaadugolla community is residing in the southern part of India and predominantly found in Chitradurga, Tumkur and Hassan district of Karnataka. The name 'Kaadugolla' means 'forest shepherds' because of the community's historical association with livestock herding in the forests. Based on the above literature background, the current study aimed to document the frequency of blood types associated with the Kadugolla tribal community in Chitradurga district, Karnataka, India.

Material and Methods

Study design: This cross-sectional study was carried out in the hamlets of Kadugolla community of Chitradurga district of Karnataka, India.

Sampling Size: This study was carried out between 2023 to 2025, 240 consenting participants from the Kadugolla community were recruited through random selection rather than family-wise recruitment to minimize familial clustering and potential selection bias, and ABO and Rh blood groups were determined using the agglutination method.

Ethical Consideration: The Institutional Ethical clearance was obtained from the Basaveshwara Medical College and Hospital, Chitradurga, Karnataka, (ref: BMC&H/IEC/2022-23/55) India. Written informed consent was taken (in local language-Kannada) from the study participants.

Exclusion criteria: Individuals who decline to participation or refused to provide consent were excluded from the study.

Statistical analysis: The obtained data was entered into MS Excel spreadsheet. The ABO phenotype frequencies were calculated as the proportion of individuals with A, B, AB, and O phenotypes, where (N=A+B+AB+O), the corresponding (I^A), (I^B), and (i) allele frequencies were subsequently estimated from the observed ABO phenotype frequencies using the standard ABO allele-frequency estimation method, and the calculations were performed using IBM SPSS Statistics version 20 package.

Result

The blood samples from 240 people are analyzed with respect to the ABO and Rh blood grouping. Table-1 shows the distribution of ABO Blood groups in the study population. In this study, the most frequent blood group is O, which is found in 102 individuals with a frequency of 42.5%. Blood group A is the second most common, with 88 individuals with a frequency of 36.6%. Blood group B is observed in 39 individuals with a frequency of 16.2%. Blood group AB is the least frequent phenotype, observed in 11 individuals, with a frequency of 4.5%. The estimated ABO allele frequencies were highest for the *i*(O) allele (0.43), followed by the I^A allele (0.39) and the I^B allele (0.19), indicating that the O allele was the most prevalent allele in the study population. Chi-square analysis revealed a significant difference between the observed ABO phenotype frequencies (O=102, A=88, B = 39, and AB=11) and equal expected frequency of 60 individuals for each phenotype ($\chi 2$ =89.83, df =3, P<0.001).

Table 1: Distribution of ABO Blood Groups among Study participants

Blood group	N0. of Samples (N=240)	Frequency	Expected	Allelic frequency	χ 2 value	df	P value
O	102	42.5	60	0.43	89.83	3	0.01*
A	88	36.6	60	0.39			
B	39	16.2	60	0.19			
AB	11	4.5	60				

**P* is significant at 0.05

Table-2 and Figure-1, illustrate the ABO-Rh blood type distribution in the study population. Among 102 individuals, O blood group individuals shows 92.1% (94/102) of Rh-positive and 7.8% (8/102) Rh-negative; for blood group A, 97.7% (86/88) were Rh-positive and 2.2% (2/88) Rh-negative. Similarly, for blood group B 94.8% (37/39) are Rh-positive and 5.1% (2/39) Rh-negative, while all AB individuals (11/11) were Rh-positive (100%).

Table 2: Distribution of ABO Blood Groups and Rh-factor in the Study population.

Blood group	Rh +VE	%	Rh -VE	%	Total
O	94	92.1	8	7.8	102
A	86	97.7	2	2.2	88
B	37	94.8	2	5.1	39
AB	11	100	0	0	11
Total	228		12		240

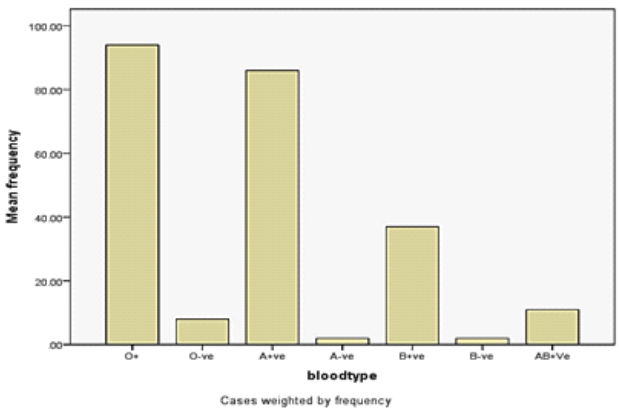

Figure 1: Frequency distribution of different blood group in the study population.

Table-3 depicts the distribution of the allelic frequency of Rhesus (Rh) blood group in the study cohort. Among 240 individual assessed for Rh blood type, the highest number of the individuals were Rh positive, corresponding to a phenotypic frequency of 95%. In contrast, 12 individuals were Rh negative, with a frequency of 5%. Based on these phenotype data, the estimated allelic frequencies were 0.78 for the Rh-positive allele (D) and 0.22 for the Rh-negative allele (d), indicating a clear predominance of the D allele in this study population. This pattern suggests that Rh positivity is highly prevalent in the study group, with Rh negativity occurring at a relatively low frequency.

Table 3: Frequency distribution of Rh (Rhesus) blood group in the study population.

Blood type	N (240)	frequency	Allelic frequency
Rh +ve	228	95%	0.78
Rh -ve	12	05%	0.22

Discussion

Regional and tribal blood type studies in India hold greater significance due to pronounced genetic diversity, endogamy, and isolation, which create micro-variations. [7] India's geography, migration history, and environment drive shifts like higher B blood group in central/northern regions (36%) vs. O in south (39%). [9] Previous studies have showed that blood group "O" is the most prevalent ABO phenotype in Karnataka regions, ranging from 36-40%. Across multiple geographical regions of Karnataka, the "O" phenotype was reported at 39.82% in Bangalore, approximately 36.7% in Davangere, and around 39.17% in Shivamogga (Shimoga).[10, 11, 12]Another study on Hakki-Pikki tribal childrens, reported that the O-positive blood group was the most common, with a frequency of 52.63%, followed by B-positive (43.42%) and A-positive (2.63%) blood groups.[13] However, in the present study, blood group A was the second most common, followed by B and AB, respectively. [9, 14] Similar result was reported in the

Gangadikara Vokkaligas of Mysore, Karnataka, India, where the O group recorded the highest frequency, followed by A and B.[15] In this study cohort 42.5% of O blood group frequency exceeds the local benchmarks by 2-4%. But from southern India's overall O incidence is 38.95%, so the present study result remains elevated locally but fits high-end variability.[10] The prevalence of Rhesus positive blood group in most of the part of India varies from 94-98% and 2-6% with Rh negative.[16] The present study results on Rh blood grouping consistent with the previous studies. The frequency of the A, B, O and AB blood grouping may varies across the geographical regions and different ethnic races influenced by familial marriage practices and population history. This study provides a basic background to understand community based analysis on genetic structure and ABO blood grouping inheritance pattern.

Conclusion

This study documents the distribution of ABO and Rh blood groups in the Kadugolla community of Chitradurga district, with O positive being the most frequently observed blood group, followed by A > B >AB. The Rh positive was the most prevalent (95%) blood types observed in the study cohort. Future research is recommended with large sample size that will help in identifying the people who are at risk of hemolytic diseases.

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Original Article

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Socioeconomic Inequity in NCD Healthcare Utilization in India: Evidence from NFHS-4 and NFHS-5

Paramanand Rajwar[1], Shukkoor T[2], Pravin Jadhav[3]

[1]PhD Research Scholar, [2]Assistant Professor, [3]Associate Professor, Department of Humanities and Social Sciences, Institute of Infrastructure Technology Research and Management (IITRAM), Ahmedabad, Gujarat, India.

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Abstract

Background: Non-communicable diseases now account for close to two-thirds of all deaths in India, yet at the national level we still know very little about whether socioeconomic inequity in NCD healthcare utilisation has shifted since the 2018 launch of Ayushman Bharat Pradhan Mantri Jan Arogya Yojana (PMJAY).

Methods: Pooling adult data from the fourth (NFHS-4, 2015–16) and fifth (NFHS-5, 2019–21) rounds of the National Family Health Survey, we examined four utilisation outcomes — hypertension treatment, diabetes treatment, any NCD care-seeking, and NCD hospitalisation — using Erreygers-corrected concentration indices (CIs), horizontal inequity (HI), and Wagstaff decomposition.

Results: Each of the four outcomes was significantly pro-rich in both rounds. For hypertension treatment, the concentration index fell from +0.128 to +0.094 (a 27% reduction); for diabetes treatment, from +0.143 to +0.116; and for any NCD care-seeking, from +0.098 to +0.077. Inequity in NCD hospitalisation barely moved (+0.061 to +0.058). Horizontal inequity remained significantly pro-rich in both rounds. Wealth contributed most to the overall inequity (38–45%), followed by education (19–24%), while insurance contributed only 9–14% even as coverage nearly doubled. The lowest treatment rates were observed among Scheduled-Caste and Scheduled-Tribe women in the poorest wealth quintile.

Conclusions: Between 2015–16 and 2019–21, socioeconomic inequity in NCD healthcare utilisation in India narrowed somewhat but remained substantial and decidedly pro-rich. That hospitalisation inequity did not budge — and that insurance contributed so modestly to overall inequity — suggests financial protection geared to inpatient care is, on its own, not enough. Extending coverage to outpatient NCD medicines and strengthening primary-care supply should rank high on the policy agenda.

Keywords: Non-communicable diseases; Healthcare utilisation; Health equity; Ayushman Bharat; India

Corresponding Author: Paramanand Rajwar, PhD Research Scholar, Department of Humanities and Social Sciences, Institute of Infrastructure Technology Research and Management (IITRAM), Ahmedabad, Gujarat, India.

E-mail: Paramanand.Rajwar.24pS@iitram.ac.in

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Background

India is in the middle of a sustained epidemiological transition. Non-communicable diseases (NCDs) have overtaken the older cluster of communicable, maternal, neonatal, and nutritional conditions to become the country's leading causes of illness and death. Roughly 66% of all deaths nationally are now attributable to NCDs, with cardiovascular disease alone responsible for 28.1% of mortality[1,2,3]. An estimated 101 million adults live with diabetes[4] and hypertension affects 21.3% of women and 24.0% of men aged 15 years and older[5]. The care cascade is weak across the board: one nationally representative study reported just 7.9% of adults with controlled hypertension[6] a finding that subsequent NFHS-5 analyses have reinforced, particularly for rural and low-income households[7,8]. The economic toll is equally consequential — NCDs account for a rising share of out-of-pocket (OOP) household expenditure and contribute substantially to health-related impoverishment[9,10].

The policy response has not been negligible. India launched the National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) in 2010 to strengthen primary-care NCD screening and management[11]. In 2018, Ayushman Bharat introduced a dual architecture: Ayushman Arogya Mandirs (Health and Wellness Centres) for primary care and NCD screening, and PMJAY, a publicly funded insurance scheme providing Rs. 5 lakh of family cover for secondary and tertiary hospitalisation to roughly 107 million eligible families[12,13]. Over the same period, OOP expenditure as a share of total health spending dropped from 62.6% (2014–15) to 39.4% (2021–22)[14]. Whether these financing reforms have translated into a reduction in socioeconomic inequity in NCD care, however, is far from settled.

The existing evidence base does not point cleanly in one direction. A systematic review of fourteen Indian insurance schemes documented consistent post-enrolment gains in service utilisation but only modest reductions in OOP outlays[15]. State-level evaluations of PMJAY have reported little movement on catastrophic expenditure, a possible drift towards costlier private hospitals[16,17], persistent gender and caste asymmetries in enrolment[18], and concerns about private-provider dominance[19]. Several specific gaps in this literature shape the present study. Concentration-index methods are well established in health economics[20,21,22,23], yet few studies have applied Wagstaff decomposition with the Erreygers correction to NCD utilisation using NFHS data — which is unusual among Indian datasets in combining biomarkers, utilisation measures, and household socioeconomic information in a single instrument (unlike the National Sample Survey or LASI). National-level pre/post-PMJAY comparisons are also scarce, with existing assessments tending to be state-specific or qualitative. Quantitative intersectional decomposition of NCD care-seeking has rarely been attempted for the Indian context. And because PMJAY and NPCDCS are multi-NCD programmes, pooled rather than single-disease analyses are arguably better suited to evaluating them.

This paper takes up that task. Drawing on pooled NFHS-4 and NFHS-5 data, the analysis (i) estimates need-adjusted, Erreygers-corrected concentration indices for four NCD utilisation outcomes; (ii) decomposes each index into contributions from wealth, education, gender, caste, place of residence, and insurance; (iii) uses Oaxaca–Blinder decomposition to identify drivers of change between rounds; and (iv) examines intersectional (caste × gender × wealth) patterns of disadvantage. The interpretive lens combines Andersen's[24] behavioural model of healthcare utilisation, the social determinants of health framework[25], and intersectionality theory[26,27]. It bears emphasising at the outset that this is a cross-sectional before–after analysis: it describes how inequity patterns evolved across two nationally representative surveys, but it does not claim causal attribution to any single programme.

Method

This is a cross-sectional secondary analysis of two rounds of the National Family Health Survey — NFHS-4 (2015–16) and NFHS-5 (2019–21) — conducted by IIPS under the DHS programme[5,28]. Both rounds used a stratified two-stage design with probability-proportional-to-size selection of primary sampling units, covering 601,509 and 636,699 households respectively. NFHS was chosen because

it is the only nationally representative Indian survey that combines measured NCD biomarkers, service-utilisation indicators, and household socioeconomic characteristics within a single instrument. Because NFHS-5 extended biomarker collection to all adults aged 15 and above, whereas NFHS-4 had been restricted to women aged 15–49 and men aged 15–54, the pooled sample was confined to these age ranges for comparability. After dropping observations with missing biomarker, wealth, or utilisation data, the final analytical sample comprised 1,637,762 adults (811,808 from NFHS-4; 825,954 from NFHS-5).

Four binary outcomes were constructed. Hypertension treatment was coded one for respondents identified as hypertensive who were currently taking antihypertensive medication. Diabetes treatment followed a parallel logic for respondents with elevated random blood glucose (>140 mg/dL) or self-reported diabetes — a screening-based definition consistent with NFHS, WHO STEPS, and DHS conventions[29,30]. Any NCD care-seeking combined hypertension and diabetes treatment with self-reported care for cancer, heart disease, or chronic respiratory conditions. NCD hospitalisation captured any NCD-related inpatient admission in the preceding year.

Explanatory variables were organised around Andersen's[24] behavioural model. Predisposing factors comprised sex, age, caste, religion, marital status, and household size; enabling factors included the wealth-index quintile, education, urban/rural residence, region, and health insurance. The wealth index was derived via principal-component analysis of household assets[31,32], monthly per capita consumption expenditure (MPCE) was used in sensitivity checks.

Socioeconomic inequity was quantified through the concentration index (CI)[21], with the Erreygers[20] correction applied to all binary outcomes. Horizontal inequity (HI) was calculated as the difference between the observed CI and the need-standardised CI obtained through indirect standardisation[33,34]. Each CI was further decomposed following Wagstaff et al.[23] to identify the contributions of individual determinants. Between-round changes in the CI were attributed to endowment and coefficient effects using Oaxaca–Blinder decomposition[35,36]. Intersectional patterns were examined across caste × gender × wealth strata[26].

All estimates incorporated individual sampling weights, with variance estimated by Taylor-series linearisation. Analyses were run in Stata 17.0 using the *conindex*[37] and *oaxaca*[38] commands, and cross-checked in R 4.3.1.

Results

The pooled analytical sample comprised 1,637,762 adults — 811,808 in NFHS-4 and 825,954 in NFHS-5. Mean age was 31.4 years, and women made up 87.4% of the sample, a composition that reflects NFHS's design emphasis on women of reproductive age. Between rounds, measured hypertension prevalence rose from 11.5% to 12.5%, measured diabetes from 6.2% to 7.9%, and the share of respondents with any insurance coverage from 28.7% to 41.0% (Table 1).

Table 1. Descriptive characteristics of the pooled analytical sample, NFHS-4 and NFHS-5.

Characteristic	NFHS-4 (2015–16) N = 811,808	NFHS-5 (2019–21) N = 825,954	Pooled N = 1,637,762
Age (years), mean (SD)	31.2 (9.6)	31.7 (9.8)	31.4 (9.7)
Sex, female (%)	87.1	87.7	87.4
Urban residence (%)	30.6	30.9	30.8
Caste category (%)			
Scheduled Caste	21.4	21.8	21.6
Scheduled Tribe	9.2	9.6	9.4
Other Backward Class	44.3	45.1	44.7
General / Others	25.1	23.5	24.3

Cont...

Wealth quintile (%)			
Poorest	19.6	19.3	19.4
Poorer	20.2	20.1	20.1
Middle	20.1	20.2	20.1
Richer	20.0	20.1	20.0
Richest	20.1	20.3	20.2
Education (%)			
No schooling	30.4	26.1	28.2
Primary	13.8	13.3	13.5
Secondary	43.1	46.4	44.8
Higher	12.7	14.2	13.5
Any insurance coverage (%)	28.7	41.0	34.9
Measured hypertension (%)	11.5	12.5	12.1
Measured diabetes (%)	6.2	7.9	7.1

Note. SD = standard deviation. All percentages are weighted using NFHS individual sampling weights. Caste shares differ from the Census 2011 distribution because of NFHS sample design (over-representation of women of reproductive age and certain state-level strata). Hypertension and diabetes prevalence are reported for the comparable age band (women 15–49, men 15–54) using JNC-7 thresholds. Source: authors' analysis of NFHS-4 and NFHS-5.

In both survey rounds, the concentration curves for all four utilisation outcomes lay below the line of equality, confirming that NCD healthcare utilisation was concentrated in wealthier households (Figure 1). Between NFHS-4 and NFHS-5, the curves for hypertension treatment, diabetes treatment, and any NCD care-seeking moved closer to the line of equality — indicating narrowing inequity — whereas the curve for NCD hospitalisation barely shifted.

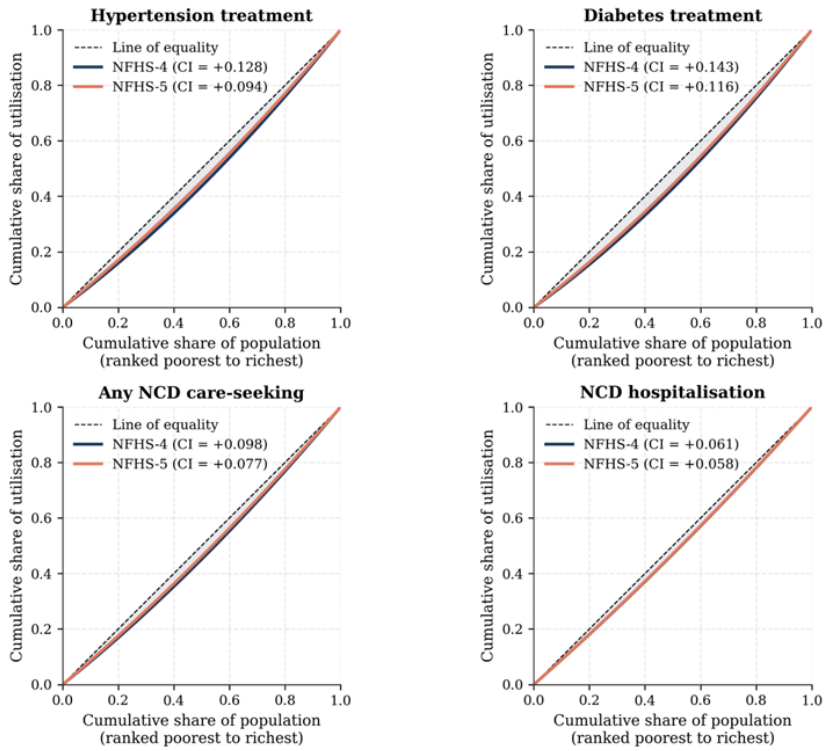

Figure 1. Concentration curves for the four NCD healthcare utilisation outcomes, NFHS-4 and NFHS-5. All curves lie below the line of equality, indicating pro-rich inequity.

Source: authors' analysis of NFHS-4 and NFHS-5.

Among respondents with measured hypertension, awareness rose from 45.4% to 52.1% between rounds, medication use from 14.6% to 19.8%, and control from 8.3% to 11.6%; the diabetes cascade showed smaller gains (Table 2). The cascade gains were strongly graded by wealth. Hypertension medication uptake, for instance, rose from 8.1% to 12.7% in the poorest quintile and from 23.7% to 29.4% in the richest. The relative gain was larger for the poorest (57%) than for the richest (24%), but the absolute gap between them persisted (Figure 2).

Table 2. NCD care cascade by wealth quintile, NFHS-4 and NFHS-5.

Cascade step	Poorest	Poorer	Middle	Richer	Richest
Hypertension — NFHS-4					
Aware (%)	33.2	38.7	44.5	51.9	58.6
On medication (%)	8.1	11.3	14.9	18.8	23.7
Controlled (%)	4.6	6.1	7.9	10.5	13.8
Hypertension — NFHS-5					
Aware (%)	39.7	45.2	51.9	59.1	64.4
On medication (%)	12.7	15.9	19.8	24.1	29.4
Controlled (%)	7.8	9.4	11.4	13.7	16.5
Diabetes — NFHS-4					
Aware (%)	28.4	34.1	39.6	46.3	53.2
On medication (%)	7.3	10.2	13.8	17.9	22.6
Diabetes — NFHS-5					
Aware (%)	33.6	39.3	45.1	51.8	58.2
On medication (%)	10.7	13.6	17.4	21.3	26.8

Note. Cascade metrics are conditional on measured NCD status: awareness = prior diagnosis; on medication = currently taking prescribed medication; controlled = measured blood pressure < 140/90 mmHg or random blood glucose ≤ 140 mg/dL. Source: authors' analysis of NFHS-4 and NFHS-5.

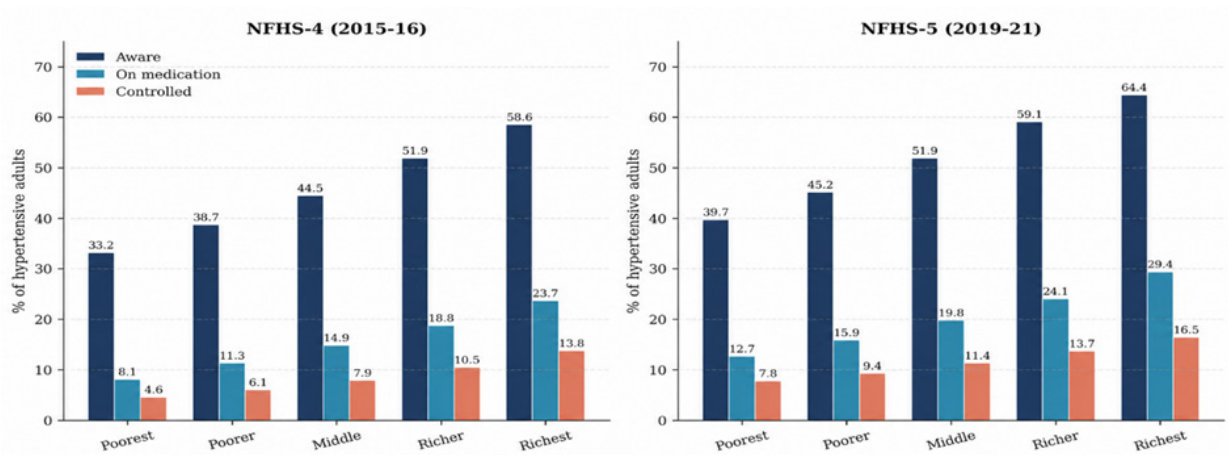

Figure 2. Hypertension care cascade (awareness, medication, control) by wealth quintile, NFHS-4 and NFHS-5. Source: authors' analysis of NFHS-4 and NFHS-5.

All four outcomes showed statistically significant pro-rich inequity in both rounds (Table 3; Figure 3). The Erreygers-corrected concentration index for hypertension treatment moved from +0.128 (95% CI +0.121 to +0.135) to +0.094 (+0.088 to +0.100), a 26.6% reduction. Diabetes treatment fell from +0.143 to +0.116, and any NCD care-seeking from +0.098 to +0.077; NCD hospitalisation was essentially flat (+0.061 to +0.058). After need-standardisation, horizontal inequity in hypertension treatment was +0.094 in NFHS-4 and +0.068 in NFHS-5 — significantly greater than zero in both rounds.

Table 3. Erreygers-corrected concentration indices and horizontal inequity for NCD healthcare utilisation outcomes, NFHS-4 and NFHS-5.

Utilisation outcome	Erreygers CI, NFHS-4 [95% CI]	Erreygers CI, NFHS-5 [95% CI]	HI, NFHS-4 [95% CI]	HI, NFHS-5 [95% CI]
Hypertension treatment	+0.128 [+0.121, +0.135]	+0.094 [+0.088, +0.100]	+0.094 [+0.087, +0.101]	+0.068 [+0.062, +0.074]
Diabetes treatment	+0.143 [+0.134, +0.152]	+0.116 [+0.108, +0.124]	+0.108 [+0.099, +0.117]	+0.087 [+0.079, +0.095]
Any NCD care-seeking	+0.098 [+0.093, +0.103]	+0.077 [+0.072, +0.082]	+0.072 [+0.067, +0.077]	+0.056 [+0.051, +0.061]
NCD hospitalisation	+0.061 [+0.055, +0.067]	+0.058 [+0.052, +0.064]	+0.045 [+0.039, +0.051]	+0.042 [+0.036, +0.048]

Note. CI = concentration index; HI = horizontal inequity. Positive values indicate pro-rich concentration. HI is the concentration index of actual utilisation minus that of need-expected utilisation. Raw and Wagstaff-normalised indices are reported in Supplementary Table S1. Source: authors' analysis of NFHS-4 and NFHS-5.

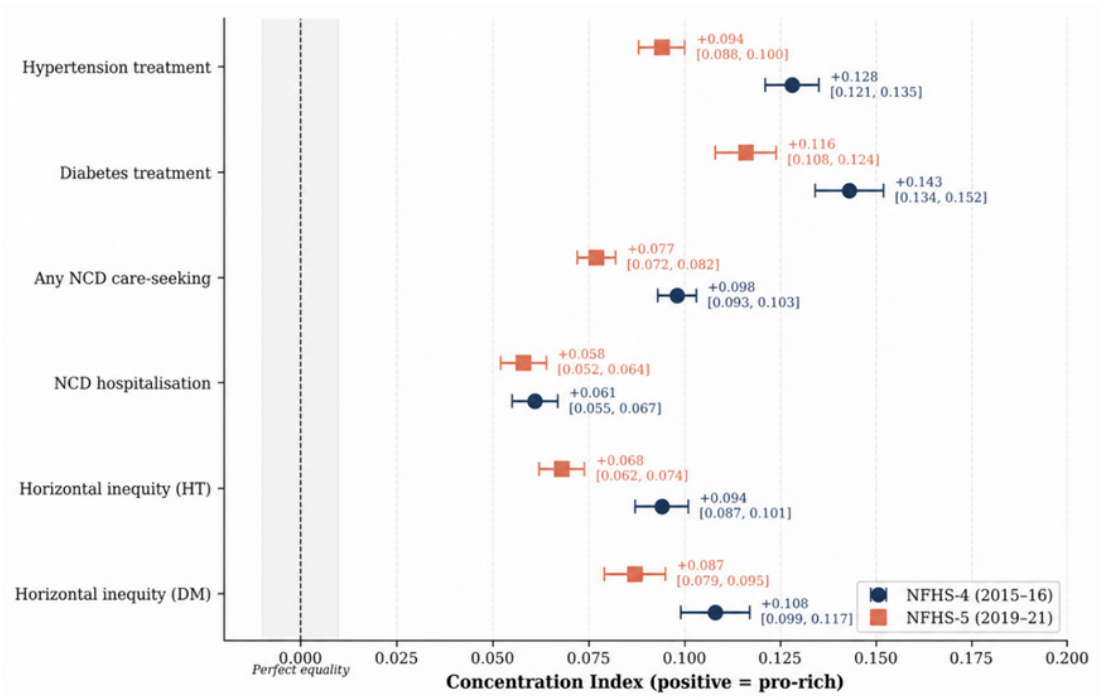

Figure 3. Erreygers-corrected concentration indices for NCD healthcare utilisation outcomes, with 95% confidence intervals, by survey round.

Source: authors' analysis of NFHS-4 and NFHS-5.

Wagstaff decomposition identified wealth as the single largest contributor to pro-rich inequity across every specification, accounting for 41.5–45.3% of the hypertension-treatment CI and 37.7–44.2% across the four outcomes (Table 4; Figure 4). Education came second, at 19.8–23.9%. Health insurance contributed 9.4–13.7% — meaningful, but well below wealth and education — and urban residence 8.2–11.6%. Caste accounted for 5.1–8.8%, mostly through Scheduled-Caste status. The unexplained residual stayed below 9.4% in every model, suggesting the linear decomposition captured most of the measured inequity.

Table 4. Wagstaff decomposition of the Erreygers-corrected concentration index: contributions of determinants to inequity in NCD healthcare utilisation.

Determinant	HT NFHS-4 (absolute)	HT NFHS-4 (%)	HT NFHS-5 (absolute)	HT NFHS-5 (%)	Any NCD NFHS-5 (%)	Hosp. NFHS-5 (%)
Wealth quintile	+0.0580	45.3	+0.0390	41.5	37.7	44.2
Education	+0.0265	20.7	+0.0225	23.9	22.3	19.8
Health insurance	+0.0120	9.4	+0.0129	13.7	10.4	12.6
Urban residence	+0.0133	10.4	+0.0088	9.4	11.6	8.2
Caste	+0.0087	6.8	+0.0083	8.8	7.2	5.1
Sex (female)	−0.0011	−0.8	−0.0020	−2.1	−1.3	+0.6
Age	+0.0019	1.5	+0.0015	1.6	2.3	3.1
Religion	+0.0012	0.9	+0.0014	1.5	1.1	0.9
Marital status	+0.0010	0.8	+0.0009	1.0	0.8	0.7
Residual (unexplained)	+0.0065	5.1	+0.0007	0.7	7.9	4.8
Total CI	+0.1280	100.0	+0.0940	100.0	100.0	100.0

Note. HT = hypertension treatment; Hosp. = NCD hospitalisation. Absolute contributions are in concentration-index units; percentages show the share of the total CI. Negative values indicate that the determinant attenuates pro-rich inequity. Source: authors' analysis of NFHS-4 and NFHS-5.

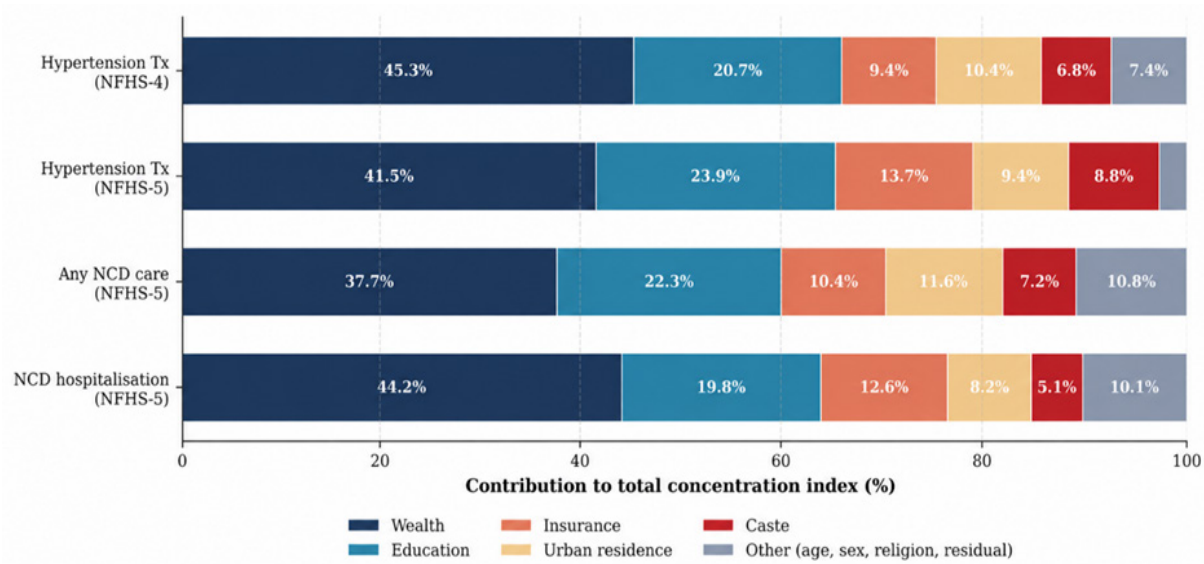

Figure 4. Wagstaff decomposition: percentage contribution of determinants to the Erreygers-corrected concentration index, by outcome.

Source: authors' analysis of NFHS-4 and NFHS-5.

The hypertension-treatment CI fell by 0.034 units between rounds. Oaxaca–Blinder decomposition attributed 42.8% of this decline to endowment effects — primarily shifts in the distribution of determinants, most notably expanded insurance coverage and education — 51.4% to coefficient effects reflecting weakened socioeconomic gradients, and the remaining 5.8% to their interaction (Figure 5).

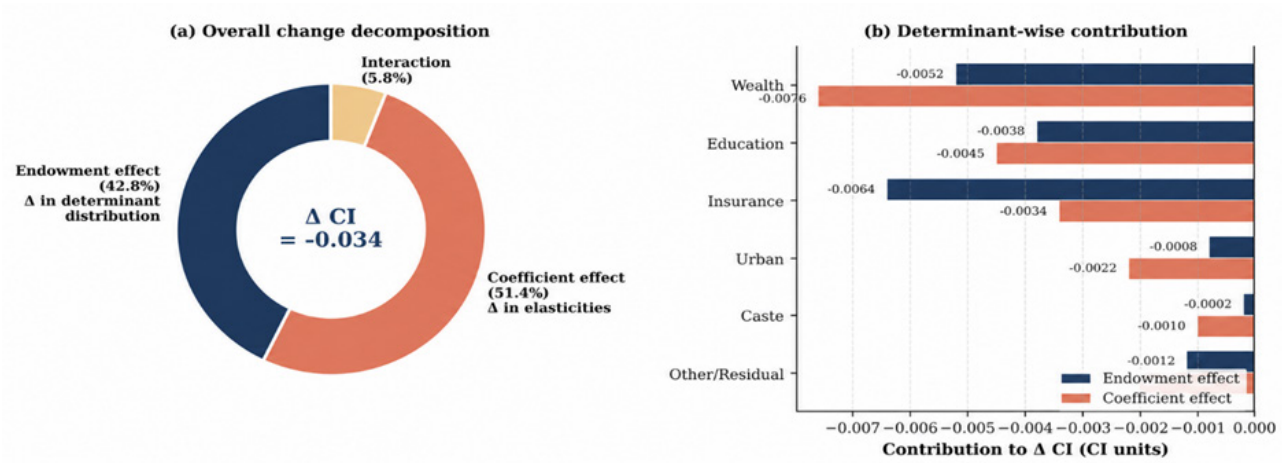

Figure 5. Oaxaca–Blinder decomposition of the between-round change in the hypertension-treatment concentration index.

Source: authors' analysis of NFHS-4 and NFHS-5.

In NFHS-5, hypertension treatment rates varied sharply across intersectional strata (Table 5; Figure 6). The lowest treatment rate was found among Scheduled-Caste women in the poorest wealth quintile (9.1%); the highest, among General-caste men in the richest quintile (32.6%) — a 3.6-fold gap. Scheduled-Tribe women in the poorest quintile had a treatment rate of 7.8%. Caste differentials narrowed somewhat at the top of the wealth distribution: the Scheduled-Caste / General-caste gap was 6.4 percentage points in the poorest quintile and 2.1 points in the richest. These intersectional patterns are descriptive only; formal three-way interaction tests were not performed because of sparse cells in some strata.

Table 5. Intersectional analysis: hypertension treatment rates (%) by caste, sex, and wealth quintile, NFHS-5.

Caste × Sex	Poorest	Poorer	Middle	Richer	Richest
Scheduled-Caste women	9.1	12.8	17.4	22.1	27.3
Scheduled-Caste men	11.4	14.6	18.9	23.4	28.6
Scheduled-Tribe women	7.8	10.9	15.1	19.8	24.7
Scheduled-Tribe men	10.2	13.1	16.8	21.2	25.9
OBC women	12.9	15.8	19.6	23.8	28.9
OBC men	13.7	16.9	20.8	25.1	30.1
General-caste women	14.8	17.6	21.9	26.4	31.7
General-caste men	15.5	18.4	22.7	27.2	32.6

Note. OBC = Other Backward Class. Values are weighted percentages of respondents with measured hypertension currently on antihypertensive medication. Source: authors' analysis of NFHS-5.

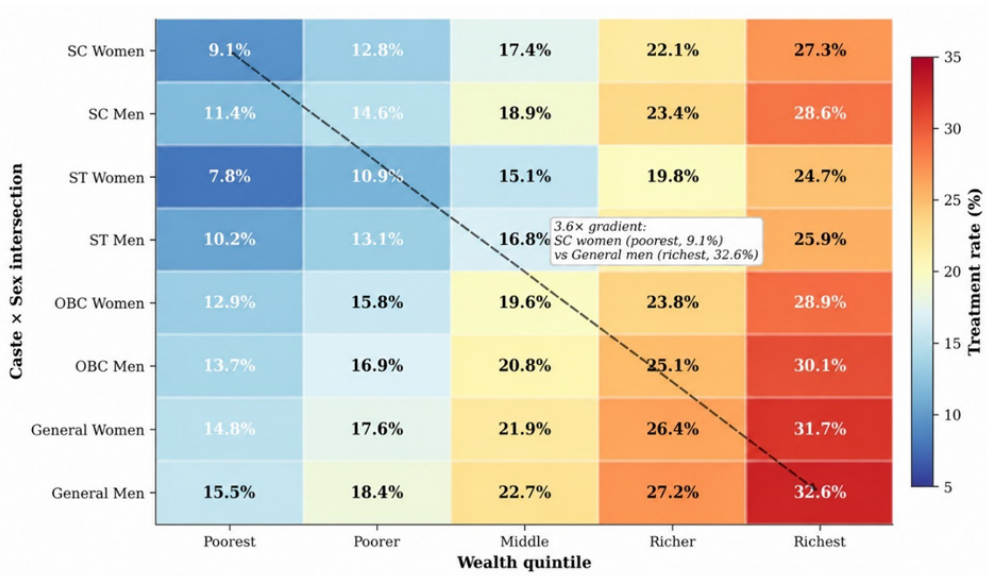

Figure 6. Intersectional heatmap of hypertension treatment rates by caste, sex, and wealth quintile, NFHS-5.

Source: authors' analysis of NFHS-5.

Discussion

Four findings emerge from this pooled NFHS-4/NFHS-5 analysis. Socioeconomic inequity in NCD healthcare utilisation did narrow between 2015–16 and 2019–21, but it remained substantial and pro-rich; the Erreygers-corrected CI for hypertension treatment dropped by 27% and yet stayed well above equity. Wealth was the dominant contributor (38–45%), followed by education (19–24%). Despite insurance coverage climbing from 28.7% to 41.0%, insurance contributed only 9–14% to measured inequity. And the narrowing observed for outpatient NCD treatment did not extend to inequity in hospitalisation, which remained essentially fixed.

The dominance of wealth in our decomposition aligns with prior National Sample Survey–based work on inequity in Indian healthcare utilisation[39,40] and with parallel analyses of cardiovascular care[41]. Our utilisation-based estimates point pro-rich, which sits in contrast to Mohanty and Dwivedi's[42] finding of strongly pro-poor catastrophic health expenditure (CI −0.22). The contrast is not a contradiction but a distinction: inequality in who receives care is not the same thing as inequality in who bears its cost. It also carries a policy caution — interventions that successfully raise utilisation may inadvertently widen expenditure inequity if outpatient costs remain uncovered[17,43].

The limited share of inequity attributable to insurance, even as coverage has expanded rapidly, deserves a closer look. PMJAY covers inpatient hospitalisation but not outpatient services, which is precisely where most NCD-related out-of-pocket spending occurs[44]. Enrolment also remains uneven across Scheduled-Caste, Scheduled-Tribe, and migrant populations[18]. Supply-side gaps compound the problem: Krishnan et al. [45] found that only 1.1% of rural public primary facilities stocked all the essential NCD medicines and equipment. Where service capacity is absent, insurance simply cannot translate into access[46]. Read together, the divergence between narrowing outpatient inequity and static hospitalisation inequity is more plausibly attributable to the expansion of primary care through NPCDCS and Ayushman Arogya Mandirs than to PMJAY's hospitalisation cover — although, given the descriptive design, this remains an interpretation rather than a measured programme impact.

The persistence of wealth and education effects, even as basic access barriers fall, accords with the fundamental-causes argument: people with more flexible resources convert improvements in availability into better care through information, navigation, and provider bargaining[47,48]. The persistence of caste differentials net of wealth points, in turn, to categorical

inequality of a kind that operates independently of economic position[49]. The intersectional findings — with the lowest treatment rates concentrated among Scheduled-Caste and Scheduled-Tribe women in the poorest quintile — illustrate how disadvantage along caste, gender, and wealth axes co-occurs in ways that a single-axis analysis would miss, and they reinforce the case for intersectional approaches in Indian health-equity research[26,50].

Three policy implications follow. Outpatient access to NCD medicines needs strengthening — through expansion of Jan Aushadhi outlets, state free-medicine schemes, and inclusion of chronic-disease drugs in benefit packages — because it is recurring medication costs, rather than hospitalisation, that drive NCD-related out-of-pocket expenditure. Demand-side financial protection must, in parallel, be matched by supply-side investment in primary-care facilities, equipment, medicines, and trained personnel; without that, insurance cannot deliver access. And NCD programme design should explicitly target intersectionally disadvantaged groups — particularly Scheduled-Caste and Scheduled-Tribe women in poorer households — rather than relying on single-axis categories.

Limitations

Several caveats temper our conclusions. The cross-sectional design supports temporal description but not causal inference, and the Oaxaca–Blinder decomposition cannot, on its own, isolate the effect of any single intervention. Utilisation outcomes rely on self-report, with the attendant risk of recall and social-desirability bias. The random capillary glucose measure is a screening rather than a diagnostic tool, and the asset-based wealth index does not capture liquidity or current consumption directly. The Wagstaff decomposition rests on a linearity assumption that may underweight genuine interactions. By design, the sample also excludes adults over 54 — the age band in which NCD burden is greatest — making our estimates conservative. NFHS-4 BP and glucose measurements for men were restricted to a state-module subsample, which reduces precision on the male side of the cascade. Finally, COVID-19 disruptions during NFHS-5 fieldwork may well have shaped reported utilisation patterns in ways we cannot fully unpack here.

Conclusions

Between 2015–16 and 2019–21, socioeconomic inequity in NCD healthcare utilisation in India narrowed modestly but remained substantial and pro-rich. The Erreygers-corrected concentration index for hypertension treatment fell by 27%, yet equal treatment for equal need was not achieved in either survey round. Wealth and education emerged as the dominant contributors to inequity; health insurance, despite a near-doubling of coverage, contributed only a small share — a reflection, in our reading, of PMJAY's focus on hospitalisation rather than on the outpatient medicines that anchor NCD management. Inequity in hospitalisation did not narrow at all, and treatment rates were lowest among Scheduled-Caste and Scheduled-Tribe women in the poorest households. Taken together, these patterns indicate that publicly funded hospitalisation insurance, by itself, cannot equalise NCD care-seeking. The priorities going forward are clear enough: extend financial protection to outpatient NCD medicines, invest in the supply side of primary care so that coverage actually becomes access, and design NCD programmes that explicitly reach intersectionally disadvantaged groups. Because adults aged 55 and above — among whom inequity is likely greatest — were excluded, the estimates here are conservative. Future work should turn to quasi-experimental designs exploiting the staggered rollout of PMJAY, draw on LASI to examine older adults, and revisit whether the narrowing observed in NFHS-5 holds up in NFHS-6.

Declarations

Ethics approval and consent to participate

This study is a secondary analysis of publicly available, de-identified microdata from the National Family Health Surveys (NFHS-4, 2015–16; NFHS-5, 2019–21), obtained from the Demographic and Health Surveys (DHS) programme. The original surveys were approved by the IIPS Institutional Review Board, with informed consent obtained from all participants. As the present study uses fully de-identified public-use microdata and involves no primary data collection, additional ethics review was not required under the institutional guidelines of IITRAM, Ahmedabad.

Competing interests: The authors declare that they have no competing financial or non-financial interests.

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Authors' contributions: P.R. conceptualised the study, conducted the literature review, performed the statistical analysis, and drafted the manuscript. S.T. contributed to the methodological design, supervised the analytical framework, and critically revised the manuscript. P.J. supervised the overall research, contributed to the theoretical framing and policy interpretation, and critically revised the manuscript. All authors have read and approved the manuscript.

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Original Article

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The Prevalence of Chronic Kidney Disease (CKD) and its Associated Factors: A Cross-Sectional Study among Civil Servants at the Secretariat Complex in Rivers State, Southern Nigeria

Pearl Ajie[1]., Kitoye Samuel[2]., Progress Victor[3], Peace Okpara[4]., Edith Reuben[4]., Felicia Okwakpam., [5]Nwokeleme Ogechi[6] Beverly Keguna[6], ErnestAchalu.[2]

[1]Department of Public Health Sciences, Faculty of Basic Medical Sciences, College of Medical Sciences, Rivers State University, Nkpolu Oroworukwo, Port Harcourt, Nigeria. [2]Department of Human Kinetics, Health and Safety Studies, Faculty of Applied and Natural Sciences, Ignatius Ajuru University of Education, Nigeria. [3]Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Medical Sciences, Rivers State University, Nkpolu Oroworukwo, Port Harcourt, Nigeria. [4]Department of Human Physiology, Faculty of Basic Medical Sciences, College of Medical Sciences, Rivers State University, Nkpolu Oroworukwo, Port Harcourt, Nigeria. [5]Department of Biochemistry, Faculty of Science, Rivers State University, Nkpolu Oroworukwo, Port Harcourt, Nigeria. [6]Department of Public Health Technology, Federal University of Technology, Owerri.

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Abstract

Background: Chronic kidney disease (CKD) is a global public health burden that causes significant morbidity and mortality and has been linked to end-stage renal disease (ESRD) with few to no treatment options. Early detection is particularly difficult in developing countriesdue to poor diagnostic protocols, as early symptoms are not unique to the condition. The goal ofthis study was to determine the prevalence of CKD and associated risk factors among civil servants in Rivers State.

Methods: The study employed a quantitative cross-sectional design with active screening for chronic kidney disease and associated factors. 300 participants were selected using a multistage sampling procedure, and data were collected using a self-administered questionnaire titled "Prevalence of chronic kidney disease and its associated factors," as well as measured and recorded clinical and biological variables such as height, weight, blood pressure, fasting blood sugar, serum creatinine, and urine protein levels. The estimated glomerular filtration rate (eGFR) was calculated using the CKD EPI 2021 equations, with chronic kidney disease (CKD) defined as an eGFR of less than 60 mL/min/1.73 m² and/or proteinuria (1+ or higher on a urine dipstick) from a single measurement. Body mass index (BMI) was calculated based on height and weight. Data were analyzed using SPSS

Corresponding Author: Pearl Chikasilamobu Ajie, Department of Public Health Sciences, Faculty of Basic Medical Sciences, College of Medical Sciences, Rivers State University, Nkpolu Oroworukwo, Port Harcourt, Nigeria.

E-mail: pearl.ajie@ust.edu.ng

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version 27. Descriptive statistics were summarized as means ± standard deviation for continuous variables and frequencies with percentages for categorical variables. Bivariate analysis was conducted using chi-square tests and independent samples t-tests. Variables with $p \leq 0.20$ at bivariate analysis and those of clinical relevance were entered into a multivariable binary logistic regression model. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported. Statistical significance was set at $p < 0.05$.The prevalence of CKD was 18.2%, with proteinuria at 9.8%, diabetes at 19.3%, high blood pressure at 34.5%, and overweight and obesity at 67.2%. In amultivariable logistic regression analysis, diabetes was independently associated with CKD, with affected participants being almost four times more likely to have CKD compared to those without diabetes (AOR = 3.86; 95% CI: 1.87–7.97; $p < 0.001$)after adjusting for age, sex, BMI, blood pressure, marital status, educational level, and family history of kidney disease. Marital status and educational level also showed significant associations with CKD *(AOR=p = 0.012 and p = 0.005, respectively)*. Blood pressure, BMI, age, sex, and family history of kidney disease were not independently associated with CKD after adjustment for cofounders.**Conclusion:** According to the study's findings, health education about CKD-associated factors and strategies for reducing them would be extremely beneficial to the study population.

Keywords: Chronic kidney disease, prevalence, CKD-associated factors, civil servants, Body mass index, Rivers State.

Key Messages Box

What is already known about this topic: Before this study, the prevalence of hypertension and diabetes had been reported among civil servants in Rivers State; however, there was no study on the prevalence of chronic kidney disease among this vulnerable group, hence the need for this study that involves active screening, as most cases of CKD in Nigeria were due to late presentation.

What this study adds: The result of this study implies that the prevalence of chronic kidney disease and its associated factors among civil servants in the state secretariat is very high which could be attributed to metabolic disorders due to their sedentary lifestyles and diet hence the need for health education and promotion intervention program on physical activity and the need to control modifiable risk factors of CKD.

How might these results change the focus of research or clinical practice?

The findings from this study callfor large studies with active screening in River State to improve the precision of previous data and the development of sustained community awareness campaigns on kidney health, as well as a proactive approach towards chronic kidney disease through routine screening by general physicians and nurses.

Introduction

Chronic kidney disease (CKD) is a significant public health concern that affects about 13.4% of the global population(1). CKD affects the global burden of morbidity and mortality, and this is mainly due to an increase in the prevalence of diabetes Mellitus, hypertension, obesity, and ageing (2,3). However, in some regions, other risk factors include infections, herbal remedies, and environmental toxins(3). The disease is more common in low and middle-income countries than high-income countries, with a prevalence of 15.8% and 17.7% in the general population of Africa and Sub-SaharanAfrica (SSA), respectively(4,5), with high-income countries spending a huge chunk of their healthcare budget on CKD and resulting in a shortened life span in low-income countries (6). It is associated with end-stage renal disease (ESRD), resulting in significant morbidity and mortality (7).Even though it is becoming more prevalent in Nigeria, there is no established national CKD register or national data on the prevalence of CKD, only a few reported community-based studies in some regions of Nigeria, and thus, no known national rate. Nonetheless, according to hospital-based data, CKD patients account for 6-12% t of hospital admissions in Nigeria (8, 9).There have been

few studies on chronic kidney disease (CKD) in the Niger Delta region of Nigeria, despite it being a major hub for oil and gas production, an economic centre, and a significant source of revenue for the country. The study location, Rivers State, is in the Niger Delta region of Nigeria and is home to seven different ethnic groups, each with its unique language and dialect. The state has experienced rapid development mainly due to industrialisation, particularly in the petroleum industry. Unfortunately, this has come at a cost to the natural environment, with air, water, and land pollution caused by chemicals released during exploration activities. These pollutants can have long-lasting effects on human health and have been linked to chronic diseases such as CKD (10, 11,12.).Furthermore, research has reported that civil servantsoften lead sedentary lifestyles with little physical activity, which can lead to complications such as obesity and hypertension (13). A previous study has reported sedentary lifestyles among Rivers State civil servants at the secretariat complex (14). However, no study has been conducted to the best of our knowledge regarding the prevalence of chronic kidney disease and its risk factors among the highly vulnerable group. The justification for the current study amongcivil servants in Rivers State, who work in the office environment with 75% of their work activity done sitting, is a major priority. This is critical because sedentary lifestyles have been linked to the development of high blood pressure, diabetes, and obesity, all of which are known risk factors for CKD and, consequently, ESRD.

The purpose of this study was to determine the prevalence of chronic kidney disease and the risk factors for it among civil servants working at the Rivers State Secretariat complex.

Materials and Methods

Study Setting and Population

This study was conducted in Rivers State, which is one of the thirty-six states of Nigeria and one of the nine states that make up the Niger Delta region. The headquarters of Rivers State is Port Harcourt city, which is one of the most populous cities in Nigeria. Rivers State has the Civil Service Commission, a statutorily constituted executive body authorised to oversee the development of the state's civil service system.The study was conductedat the Rivers State civil service clinic from December 2021 to February 2022among civil servants who work at the Rivers State Secretariat Complex, Moscow Road, Port Harcourt, Nigeria. Inclusion criteria for the study were Civil servants(age ≥ 18 years) working at the secretariat complex, who were not pregnant, agreed to participate in the study, andsigned an informed written consent. Exclusion criteria were visitors, corps members, pregnant women, those who were taking antibiotics, and those who did not sign an informed written consent.

Study Design

The research design was a cross-sectional descriptive study design that combined epidemiological and clinical methods to explore the prevalence of chronic kidney disease and its associated risk factors among Rivers State civil servants who work at the State Secretariat Complex. A total of 3,055 civil servants work at the Secretariat Complex as full-time staff.

Sample size determination

The sample size for this study was determined using Cochran's formula for single-proportion (prevalence) studies:

$$n = \frac{Z^2 \times p \times q}{d^2}$$

Where:

=minimumsamplesize

=standard normal deviate at 95% confidence level (1.96)

=estimated prevalence of chronic kidney disease = margin of error (0.05)

A prevalence of chronic kidney disease of 7.8% (0.078) from a previous study was used(15)

$$n = \frac{3.84 \times 0.0719}{0.0025}$$

n = 110

Since thepopulation of civil servants working in the Rivers State Secretariat Complexwas less than 10,000 (N = 3,055 civil servants), finite population correction was applied:

$$n_f = \frac{n}{1 + \frac{n-1}{N}}$$

$$n_f = \frac{110}{1 + \frac{109}{3055}} = 106$$

To account for a possible 10% non-response rate, the sample size was adjusted to 117 respondents.

Although the minimum required sample size was calculated to be 117, the sample size was intentionally increased to 300 civil servants. This increase was to improve the precision of prevalence estimates, enhance the representativeness of the study population, reduce sampling error, and allow for meaningful subgroup analyses. This will strengthen the reliability of the study and the generalizability of the study findings among civil servants working in the Rivers State Secretariat complex.The final sample size for this study was 300 civil servants.

Sampling technique

The participants for this study were chosen using a multistage sampling procedure.In stage one,the secretariat complex was divided into its five blocks(A, B, C, podium block, and point block) using random sampling. In the second stage, simple random sampling was used to select four ministries from each stratum, yielding a total of 20 ministries out of the 30 ministries housed in the Rivers State Secretariat Complex. In stage three, asystematic sampling technique was employed in selecting participants for the study. The sampling interval () was determined as follows:

$$k = \frac{N}{n} = \frac{3055}{300} = 10$$

A random starting point between 1 and 10 was selected from each ministry, after which every 10th civil servant on the sampling frame was recruited into the study until the required sample size of 15 participants was achieved for eachof the selected ministries based on informed consent approval and inclusion criteria, giving a total of 300 participants.

Participants and Public Involvement.

With the letter of approval by the Rivers State Research Ethics Committee, the Head of Service of the Civil Service Commission approved the study, and a memo authorising awareness creation was sent to the selected ministries. Awareness creation and mobilisation of participants was carried out a month before data collection in the various departments of the selected ministries. Participants were informed about the study, confidentiality of the study, the inclusion and exclusion criteria, the procedures that would be involved, the daily time frame for data collection, the duration of data collection, where interested participants were to come for data collection, and how the results of the outcome would be communicated to them. Participants were not involved in the design of the study; however, they were involved in the recruitment of other participants by relating information to their colleagues about the study and how to be a part of it. The dissemination of the results of participants was confidential and was managed by the civil service clinic, and based on the findings of this study, a proactive measure of CKD screening has been put in place.

Data Collection Procedure

Participants were first given the research instrument(questionnaire) for data collection titled "Prevalence of chronic kidney disease and its associated factors" questionnaire, which was used to collect information on sociodemographic characteristics, risk factor prevalence, and clinical and biological measurements. Participants' blood pressure (BP) was measured following World Health Organisation (WHO) standards by registered nurses in the health facility. This was done using an Accoson brand of mercury sphygmomanometer with a standard cuff (25cmx12cm) and Littman's stethoscope, which was used on the right arm with participants sitting comfortably on a chair, back rested, and legs uncrossed; all clothing covering the cuff location was rolled up to avoid a tourniquet effect above the cuff. The first Korotkoff sound determined the diastolic blood pressure (SBP), while the systolic blood pressure (SBP) was determined by the fifth Korotkoff sound (DBP). The average of two measurements was recorded. High blood pressure was defined as SBP greater than 140 mmHg and/ or DBP greater than 90 mmHg (16). In addition, registered nurses in the health facility measured participants' weight and height barefoot in the nurses' station using a ZT-120 health scale placed on a flat hard surface, a standard scale calibrated in kilograms (kg) for weight measurement, and a stadiometer for height measurement. Body mass index (BMI) was

calculated as weight (kg) divided by height (m2), and obesity was defined as BMI ≥ 30 kg/m^2 according to the WHO standards. After an overnight fast of at least 8 hours, all participants had 10 mL of venous blood taken. 5mls of blood was placed in a fluoride oxalate specimen container for a fasting blood sugar (FBS) test, which was estimated using a colorimetric method at the Rivers State Civil Servants Clinic laboratory, with results expressed in mmol/l. FBS > 5.6 mmol/l for colorimetric standard diabetes mellitus or previously diagnosed diabetes mellitus by a physician was considered hyperglycemia. The remaining 5mls of venous blood were placed in a Lithium heparin container for analysis of serum creatinine clearance in the same Clinic using a modified Jaffe's method and an RA-50 spectrophotometer (Bayer, Germany). The estimated glomerular filtration rate (eGFR) was calculated using the CKD-EPI 2021. According to the WHO and KDIGO guidelines, NBSA. Each participant was also given a universal bottle to make 10mls of a mid-stream spot urine for the detection of glycosuria and proteinuria using a COMBI 2 dipstick. Proteinuria and glycosuria were defined as the presence of at least 1+ of protein and 1+ of glucose on dipstick, respectively. No data was collected on the type of supplements participants were taking.

Ethical Clearance

The Rivers State Research Ethics Committee gave ethical approval for this study, and the research team included the researchers, doctors, nurses, laboratory technologists, and medical records officers who work in the health facility. The research protocol was explained to the participants, and they were assured of their confidentiality. The privacy of personal information was protected and kept confidential. Participants with abnormal findings were informed and referred to physicians for further investigation and appropriate management.

Data analysis: SPSS version 26 software was used to analyse the collected data. Only 296 participants had data that could be analysed.Descriptive statistics were summarized as means ± standard deviation for continuous variables and frequencies with percentages for categorical variables. Bivariate analysis was conducted using chi-square tests and independent samples t-tests. Variables with $p \leq 0.20$ at bivariate analysis and those of clinical relevance were entered into a multivariable binary logistic regression model. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported. Statistical significance was set at $p < 0.05$.

Results

Table 1: ***Socio-demographic Variables of Participants***

Demographic variables	**Cohort**	**F**	**%**
Age	18-25 years	18	6.1
	26-35 years	27	9.1
	36-49 years	127	42.9
	50 years and above	124	41.9
	Total	**296**	**100.0**
Gender	Male	94	31.8
	Female	202	68.2
Marital status	**Total**	**296**	**100.0**
	Single	68	23.0
	Married	198	66.9
	Divorced/Separated	12	4.1
	Widow/Widower	18	6.1
	Total	**296**	**100.0**
Educational status	Nonformal	5	1.7
	Primary	14	4.7
	Secondary	57	19.3
	Tertiary	220	74.3
	Total	**296**	**100**

Table 1 displayed a percentage analysis of the participants' sociodemographic characteristics. The findings revealed that: 6.1% of the participants were between the ages of 18 and 25, 9.1% were between the ages of 26 and 35, 42.9% were between the ages of 36 and 49, and 41.9% were between the ages of 50 and above; 31.8% (n=94) of them were males, while 68.2% (n=202) were females; 66.9% were married, 4.1% were divorced, and 6.1% had lost their spouse; 1.7% had no formal education.

Table 2: ***Clinical Characteristics of Participants***

Biochemical parameters	**Cohort**	**F**	**%**
BMI	Underweight Normal	2 95	0.7 32.1
	Overweight	120	40.5
	Obese	79	26.7
	Total	296	100
Blood Pressure	High	102	34.5
	Low	7	2.4
	Normal	187	63.2
	Total	296	100
Fasting glucose test	Diabetic	57	19.3
	Normal	239	80.7
	Total	296	100
Chronic Kidney Disease	Normal	242	81.8
	Stage 1	14	4.7
	Stage 2	12	4.0
	Stage 3	28	9.5
	Total	54	18.2
Proteinuria	Negative	267	90.2
	Positive	27	9.8
	Total	296	100.0
Glycosuria	Negative	283	95.6
	Positive	13	4.4
	Total	296	100.0

F-Frequency, %- Percentage

Table 2 summarises the biochemical parameters of the participants who were studied in percentages. The findings revealed that 32.1% of the population had a normal BMI, 0.7% were underweight, 40.5% were overweight, and 26.7% were obese. The average height was 164.24cm±11.419 and the average weight was 75.92kg±17.974kg.

Furthermore, 34.5% of the participants had high blood pressure, 19.3% were diabetic based on testing, 9.8% had proteinuria, 4.4% had glucosuria, and serum creatinine was used to estimate glomerular filtration rate using the Cockcroft Gault equation, which revealed that 14 (4.7%) of the participants were in CKD stage 1, 12 (4.0%) were in stage 2, and 28 (9.5%) were in stage 3 as shown (Figure 1).

Table 3: Prevalence of Perceived Associated factors of chronic kidney disease (CKD)

	CKD Associated Factors	No		Yes	
		F	%	F	%
1	Are you hypertensive?	220	74.3	76	25.7
2	Do you have a family history of HBP or hypertension?	189	63.9	107	36.1
3	Do you have diabetes mellitus?	253	85.5	43	14.5
4	Do you have a family member with diabetes mellitus?	229	77.4	67	22.6
5	Are you hypertensive and have diabetes mellitus?	265	89.5	31	10.5
6	Are you overweight or obese?	265	89.5	31	10.5
7	Do you have a genetic history of obesity?	273	92.2	23	7.8
8	Have any of your family members suffered from kidney disease?	266	89.9	30	10.1
9	Do you consume herbal remedies frequently?	249	84.1	47	15.9
10	Do you take painkillers like Ibuprofen whenever you have pain?	210	70.9	86	29.1
11	Do you smoke cigarettes and other tobacco products?	273	92.2	23	7.8
12	Do you drink alcohol?	210	70.9	86	29.1
	Aggregate	242	81.7	54	18.3

Table 3 summarizes the prevalence of perceived risk factors of CKD as, family history of hypertension 36.1%, regular consumption of painkillers like ibuprofen (29.1%), consumption of alcohol (29.1%), hypertension (25.7%), family history of diabetes mellitus (14.5%) while the least were smoking and genetic history of obesity (7.8%) respectively.

Table 4: Analysis of the Prevalence of CKD among Civil Servants in Rivers State based on Age, Gender, and Educational Status.

		CKD (eGFR calculated using CKD-EPI 2021)						
Demographic factors	**Cohorts**	**Stage 1**	**%**	**Stage 2**	**%**	**Stage 3**	**%**	**Total**
Age	18-25	1	1.85	0	0.00	0	0.00	1
	26-35	2	3.70	1	1.85	4	7.41	7
	36-49	4	7.41	3	5.56	6	11.11	13
	50 and above	7	12.96	8	14.81	18	33.33	33
	Total	14	25.93	12	22.22	28	51.85	54
Gender	Male	6	11.11	7	12.96	12	22.22	25
	Female	8	14.81	5	9.26	16	29.63	29
	Total	14	25.93	12	22.22	28	51.85	54
Educational status	Non-Formal	1	1.85	0	0.00	0	0.00	1
	Primary	2	3.7	1	1.85	1	1.85	4
	Secondary	5	9.26	4	7.41	10	18.52	19
	Tertiary	6	11.11	7	12.96	17	31.48	30
	Total	14	25.93	12	22.22	28	51.85	54

Table 4 reveals that 61.1% of those with CKD were 50 years and above, the percentage of CKD in males was 46.3%, and females 53.7%, while the prevalence of CKD based on educational status showed it was more prevalent in those participants with tertiary education, 31.48% (30).

Table 5: Independent Samples t-testComparison of Continuous Variables by CKD Status

Variable	CKD Absent Mean ± SD	CKD Present Mean ± SD	t(df)	p-value
BMI (kg/m²)	27.25 ± 4.78	28.33 ± 6.12	−1.41 (294)	0.159
Height (m)	1.66 ± 0.08	1.63 ± 0.08	1.72 (294)	0.087
Weight (kg)	74.83 ± 14.68	75.46 ± 16.31	−0.28 (294)	0.779

Table 5 presents the findings from independent-samples t-tests, which were performed to assess whether there were any significant differences in mean values of continuous variables (body mass index (BMI), height, and weight) between individuals with chronic kidney disease (CKD) and those without. The results indicate that there were no statistically significant differences in BMI, height, or weight when comparing participants with CKD to those without the condition.

Table 6: Bivariate analysis of factors associated with chronic kidney disease (CKD) (N = 296)

Variable	CKD Absent(%)	CKD Present (%)	(df)	χ^2	*p*-value
Gender			1	4.91	0.027
Male	70 (28.9)	24 (44.4)			
Female	172 (71.1)	30 (55.6)			
Age groups (Years)			3	10.51	0.015
18–25	17 (7.0)	1 (1.9)			
26–35	21 (8.7)	6 (11.1)			
36–49	112 (46.3)	15 (27.8)			
≥50	92 (38.0)	32 (59.3)			
Educational status			3	11.35	0.010
Non- formal	4 (1.7)	1 (1.9)			
Primary	11 (4.5)	3 (5.6)			
Secondary	38 (15.7)	19 (35.2)			
Tertiary	189 (78.1)	31 (57.4)			
Marital status			3	15.90	0.001
Single	64 (26.4)	4 (7.4)			
Married	159 (65.7)	39 (72.2)			
Divorced/Separated	9 (3.7)	3 (5.6)			
Widow/Widower	10 (4.1)	8 (14.8)			
Diabetes mellitus (measured)			1	23.13	<0.001
Yes	34 (14.0)	23 (42.6)			
No	208 (86.0)	31 (57.4)			
Proteinuria			1	109.92	< .001
Positive	3 (1.2)	26 (48.1)			
Negative	239 (98.8)	28 (51.9)			
Glucosuria			1	11.56	0.001
Positive	6 (2.5)	7 (13.0)			
Negative	236 (97.5)	47 (87.0)			
Use of painkillers (NSAIDs)			1	0.01	0.918
No	172 (7.1)	38 (70.4)			

Cont.....

Yesterday's	70 (28.9)	16 (29.6)			
Herbal remedies use			1	0.35	0.557
No	205 (84.7)	44 (81.5)			
Yes	37 (15.3)	10 (18.5)			
Family history of CKD			1	3.09	0.079
No	221 (91.3)	45 (83.3)			
Yes	21 (8.7)	9 (16.7)			
Alcohol use			1	0.19	0.664
No	173 (71.5)	37 (68.5)			
Yes	69 (28.5)	17 (31.5)			

Table 6 above presents the bivariate analysis of factors associated with chronic kidney disease (CKD) among the 296 study participants. Measured diabetes status and measured blood pressure categories were used, consistent with clinical assessments. Associations were tested using Pearson's chi-square test, with $p < .05$ considered significant. Bivariate analysis showed that proteinuria, diabetes mellitus, glucosuria, age group, and gender were significantly associated with chronic kidney disease (CKD). Proteinuria was markedly higher among participants with CKD (48.1%) compared to those without CKD (1.2%; $p < .001$). Similarly, diabetes mellitus was more prevalent among participants with CKD (42.6%) than among those without CKD (14.0%; $p < .001$). Glucosuria was also significantly associated with CKD (13.0% vs 2.5%; $p = .001$). Increasing age and male gender were significantly associated with CKD ($p = .015$ and $p = .027$, respectively). Family history of CKD, use of herbal remedies, use of painkillers, and alcohol consumption were not significantly associated with CKD in the bivariate analysis. Variables with theoretical and empirical relevance were entered into a multivariable binary logistic regression model. Statistical significance was set at $p < .05$.

Table 7: Binary Logistics Regression Analysis

Variable	AOR	95% CI	p value
Diabetes mellitus (Yes vs No)	3.86	1.87–7.97	< .001
Blood pressure (High vs Normal)	1.61	0.78–3.33	0.195
Blood pressure (Low vs Normal)	1.15	0.10–12.76	0.909
BMI category	0.99	0.64–1.53	0.952
Family history of CKD (Yes vs No)	0.52	0.21–1.33	0.172
Age	1.08	0.68–1.72	0.731
Gender (Male vs Female)	1.59	0.79–3.20	0.195
Single vs Married	0.07	0.01–0.35	0.001
Secondary vs Tertiary education	4.25	1.91–9.47	< .001

AOR = adjusted odds ratio; CI = confidence interval; CKD = chronic kidney disease.

Table 7 presents the multivariable binary logistic regression analysis. Diabetes mellitus remained an independent predictor of CKD, with participants with diabetes being nearly four times more likely to have CKD (AOR = 3.86; 95% CI: 1.87–7.97; $p < .001$). Marital status was also independently associated with CKD, with single participants having significantly lower odds of CKD than married participants (AOR = 0.07; 95% CI: 0.01–0.35; $p = .001$). Additionally, participants with secondary education had higher odds of CKD than those with tertiary education (AOR = 4.25; 95% CI: 1.91–9.47; $p < .001$). Other variables, including blood pressure, BMI category, age, gender, and family history of CKD, were not independently associated with CKD after adjustment.

Discussions

Prevalence of CKD

This study assessed the prevalence of chronic kidney disease (CKD) and its associated factors among civil servants in Rivers State, Nigeria, using the CKD-EPI 2021 equation. CKD was defined as an estimated glomerular filtration rate (eGFR) of 60–89 mL/min/1.73 m² with proteinuria or an eGFR <60 mL/min/1.73 m². The overall prevalence of CKD was 18.2%,with 14(4.73%) of the study population having CKD stage 1, 12(4.05%) having CKD stage 2, and 28(9.46%) having CKD stage 3, indicating a substantial burden of kidney disease within this occupational group**.** The prevalence of CKD observed in this study is higher than the 1.9% and 7.6% previously reported in Rivers State and Bayelsa State, respectively (15,17). The lower prevalence reported in the university-based study in Rivers State may be explained by the younger and more physically active nature of university populations, while the Bayelsa study was limited by a smaller sample size despite having a comparable civil servant population. These findings underscore the influence of population characteristics and occupational exposures on CKD prevalence estimates.

The prevalence of CKD in our study is also in contrast with the 7.6%, 12%, and 27% reported in Southeast, North Central, and Southwest Nigeria,respectively(18,19,20).These differences in prevalence may be due to variations in study participants and settings, the method or formula used in estimating glomerular filtration rate, and differences in sample size. The prevalence of CKD in our study is far higher compared with global and African figures in general (21-24), which reported 6%, 6.5%, 6.8%, and 14.2%, respectively. Also, far higher prevalences of 21.8% and 26% were reported in other studies,which were still in contrast to this study (25,26). These differences may be attributed to study settings and large sample sizes. Another reason for these differencescould be due to the use of different equations to estimate the glomerular filtration rate (GFR), as well as variations in study design and population. Some studies used the Modification of Diet in Renal Disease (MDRD) or Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equations, while others used the Cockcroft-Gault equation, which tends to overestimate CKD in the general population. Additionally, many studies only measured eGFR once, using a cross-sectional design. In conclusion, there is a high prevalence of CKD in Nigeria, which cuts across different regions of the country. Bivariate analysis in this study revealed increasing age was significantly associatedwith CKD, with participants aged 50 years and above exhibiting a higher prevalence of CKD(). This findings is consistent with several studies in Nigeria and globally, which have demonstrated a progressive increase in CKD prevalence with advancing age(21, 24, 25,27).Age-related decline in renal function has been attributed to cumulative nephron loss, vascular sclerosis and prolonged exposure to metabolic and hemodynamic stressors (1,3). However, CKD was detected in more females than males,however, it was not statistically significant and may be due to the higher percentage females which was more than twice the percentage of males in the sample population. Divergent reports from the present study revealedhigher CKD in males than females,which was statistically significant($p<0.001$) (28) and significantly associated with education (27,29). Furthermore, bivariate logistics regression analysis in the present study revealed Diabetes mellitus was an independent predictor of CKD, with participants with diabetes being nearly four times more likely to have CKD (AOR = 3.86; 95% CI: 1.87–7.97; $p < .001$). Marital status was also independently associated with CKD, with single participants having significantly lower odds of CKD than married participants (AOR = 0.07; 95% CI: 0.01–0.35; $p = .001$). Additionally, participants with secondary education had higher odds of CKD than those with tertiary education (AOR = 4.25; 95% CI: 1.91–9.47; $p < .001$). Other variables, including blood pressure, BMI category, age, gender, and family history of CKD, were not independently associated with CKD after adjustment for counfounders.A divergent report statedthat age, female gender, BMI, dyslipidaemia, diabetes and hypertension were the major risk factors significantly predicting CKD (20, 29).

Prevalence of Associated factors for CKD

Hypertension

In this study, clinically observed HBP was 34.5% of the sample, and a family history of HBP was

36.1%. The prevalence of hypertension in our study is in line with the range of the overall prevalence of hypertension in Nigeria reported by Ogah (30) as 8-46%. Hypertension is one of the major risk factors for CKD in Nigeria, Sub-Saharan Africa, and globally and is known to hasten the progression of CKD if uncontrolled (31-34). This high prevalence of hypertension may be attributed to the increasing urbanisation in Rivers State, and most civil servants depend on fast foods instead of nutritious home-cooked meals. It may also be associated with their inactivity in the work environment. Similar findings to the current study were reported in previous studies (18,29) as 36.9% and 30.4%, in Eastern and Western parts of Nigeria, respectively,and 36% and 38.6% (21,24) in other parts of the World.This contrasts with the 20.8%, 23.7%, and 13.8%reported in previous studiesin a university community in Port Harcourt,among the middle-aged population in North Central, and among civil servants in Sokoto, all in Nigeria.(16,19,35). Further contrasting reports were seen in other parts of the world (22,28), where 13.9% and 22.1% were reported. This difference in high blood pressure may be due to the study population andthe study's settings. Furthermore, self-reported hypertension was much lower than the clinically observed HBP (25.7% versus 34.5%). This agrees with other studies(19,24,36), which stated self-reported hypertension was much lower than the clinically observed HBP (8.6% versus 23.7%), (12.2% versus 38.6%), and (17.9% versus 19.4%), respectively.

Prevalence of Diabetes Mellitus

The prevalence of diabetes in the present study was 19.3%. This is in contrast with the prevalence of diabetes from some previous studies in the Niger Delta region of Nigeria (16,17), which reported 4.3% and 6.7%, respectively. It was also in contrast to reports in other parts of Nigeria (19, 25,36) conducted in North Central, Northern, and Southwest Nigeria, respectively. It was also in contrast to reports in other parts of the world (21,24,28,37), which reported 7.8%, 2.8%, 8.8%, and 4.3%, respectively, with most of the studies being large population studies.The reason for these differences may be population size, occupation of the respondents, or study settings.Furthermore, the prevalence of diabetes in this study was lowerthan that of some previous findings in Nigeria and globally (18,38,39), which reported 26%,24.8%, and 74.5% in a diverse population and diverse age group. The reason for these differences may be related to the population of the various studies, the study's setting, and the mean age of the participants.

Family history of HBP and Diabetes

In thisstudy, the Family history of HBP was 36.1% while the family history of diabetes was 22.6%. This finding correlates with previous studies (16) which reported 33.6% and 25.5% respectively for family history of HBP and diabetes in Southern Nigeria and 23.6% for family history of diabetes which is also in tandem with the present study however, the family history of HBP was 6.8% in their report (40) which was lower than the 36.1% in the current study. These similarities and differences may be due to the population size.

Prevalence of Overweight and Obesity

Overweight and obesitywere prevalent in 40.5% and 26.7%,respectively, giving a total of 67.2%. The increase in consumption of fast foods and sugar-dense carbonated drinks like colas and the sedentary lifestyle of the study population may be responsible for this extremely increased encumbrance of obesity seen among civil servants in Rivers State.A prevalence of 60.8% was reported in a previous study (24). However, some previous studies reported contrary findings, suchas 24%, 38.5%, and 40.5%(9,16, 32),respectively. This may be due to the disparity in the study's setting, that is, the occupation and level of physical activity of each study population.

Prevalence of herbal remedies and NSAID consumption

In this study, another prevalent risk factor of CKD was the use of herbal remedies/concoctions, which was found in 15.9% of the participants. In contrast, this percentage is lower than 64.9% and 43.5%reported in previous studies in Nigeria (29,35) and 27.9%, 57.8%, and 32.9% in other parts of the world (23,24,40).This may be related to variance in the study setting and population size. Frequent use of non-steroidal anti-inflammatory drugs (ibuprofen) has been observed to be a prevalent risk factor for CKD, which was found in 29.1% of the participants in our study. This is comparable to the 29.6% and 26.8%

reported in previous studies (24,35). It is in contrast with reports by Muiru et al. (48.4%)(23) and Ibitoba et al. (96.4%) (29) but lower than the report by Alobaidi et al. (20.7%) (41). This may be related to variance in the study setting, occupation of the study population, and population size.

Prevalence of proteinuria

Proteinuria was prevalent in 9.8% of the study population,which is an important marker of kidney disease that reflects glomerular injury to a greater degree. A similar finding was reported by Oviasu et al. (42), who reported the prevalence of Proteinuria to be 9.8%. This result was in contrast with the report published in some previous studies(16, 19, 22,40) which reported 12.4%, 13%, 16.7%,and 17.1% respectively.This may be related to the variance in the study setting, population size and the physical inactivity of the population of study, such as obesity/ overweight, which is known to directly induce glomerular hyperfusion and hyperfiltration, with resultant proteinuria(43).

Limitations of the study

Apart from funding as a primary limiting factor, Participants' reluctance to disclose and engage in this sensitive study posed a challenge. This problem was resolved by informing participants that they could withdraw from the study at any point if they felt uncomfortable. Another limitation of this study is its cross-sectional design, which does not allow for longitudinal follow-up to determine the persistence of chronic kidney disease in participants, as recommended by international guidelines for assessing CKD prevalence. Also, the scope of this study did not includethe duration of hypertension or diabetes, medication use, or adherence, which could be potential confounders, as the duration of comorbid conditions and treatment adherence may influence kidney function. Hence, the need for a longitudinal study among this vulnerable population.

Conclusion

The study was able to investigate the prevalence of chronic kidney disease and identify the associated factors of chronic kidney disease among civil servants in Rivers State. It was revealed that the prevalence of chronic kidney disease was 18.2% of the study participants, while identified associated factors of chronic kidney disease were diabetes mellitus, high blood pressure, overweight/obesity, family history of diabetes, and hypertension, and regular intake of herbal concoction and pain killers. The prevalence of chronic kidney disease was significantly different based on age but not based on gender or educational qualifications.

The study concluded that the prevalence of CKD and its associated factors is highly prevalent among civil servants working at the Rivers State Secretariat Complex despite possible methodological limitations and states the need for large studies with active screening in River State to improve the precision of previous data and the development of sustained community awareness campaigns on kidney health and preventive strategies by all stakeholders, including doctors, nurses, other healthcare providers and government. Health education and counselling on the importance of compliance with the treatment regimen (for hypertensive and diabetic individuals), exercise, diet, regular health check-ups, and the need to avoid other risk factors to prevent renal involvement and progression of CKD were recommended.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Ethical considerations: Ethical approval to carry out this research was obtained from the Rivers State Health Research Ethics Committee with the number RSHMB/RSHREC/11.21/VOL8/110. In addition, a letter of introduction was sent to the Head of Service, Rivers State Secretariat Complex, notifying him of the study. For all participants, written informed consent by signature or thumbprint was obtained.

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Authors Contribution: Dr Pearl Ajie conceived the idea for the study. The work was designed by Prof. Ernest Achalu, Dr Samuel Gentle, and Dr Pearl Ajie. All authors participated in data collection. The Manuscript was drafted by DrPearl Ajie and Dr Edith Reuben,while the statistical analysis was done byDr Pearl Ajie,Nwokeleme Ogechi and DrProgress Victor. All authors have read and agreed to the final version

of this manuscript and have equally contributed to its content and the management of the case.

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Conflict of Interest: The researchers declare no conflict of interest.

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Original Article

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Effectiveness of the GENIUS Undergraduate Research Training Program in Improving Research Literacy among Medical and Dental Students: A Pre–Post Assessment

Pooja Sharma[1], Adarsh Keshari[2], Punnya V. Angadi[3], Saumya Singh[4], Sanya Rao[5], Sucheta Banerjee Kurundkar[6]

[1]Founder & CEO, APAR Health, Clinical Research & Capacity Building, Gurugram, India, [2]Research Scientist – I, APAR Health, Clinical Research &; Capacity Building, Gurugram, India, [3]Professor & Deputy Director, Research and Development Cell, KLE Academy of Higher Education and Research (KAHER), Belagavi, Karnataka, India, [4]Research Coordinator, APAR Health, Clinical Research & Capacity Building, Gurugram, India, [5]BDS Student, KLE VK Institute of Dental Sciences, KLE Academy of Higher Education and Research (KAHER), Belagavi, Karnataka, India, [6]Professor & Director Research, Research and Development Cell, KLE Academy of Higher Education and Research (KAHER), Belagavi, Karnataka, India

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Abstract

Background: Research literacy is essential for healthcare professionals. It supports critical thinking and evidence-based practice. However, many undergraduate health sciences students have limited exposure to research methods and basic research concepts. This study aimed to assess the effectiveness of a structured health research training program in improving knowledge of basic health research concepts among undergraduate medical and dental students.

Materials and Methods: A structured questionnaire with 20 items was used to assess knowledge before and after the educational intervention. The analysis included 21 students who completed the intervention and met the study criteria. Data were analysed using descriptive statistics. Pre- and post-intervention scores were compared to evaluate changes in knowledge.

Results: The educational intervention led to a significant improvement in knowledge across all domains. Overall knowledge scores increased significantly from 46.10% and 90.40% ($p < 0.001$). This shows a marked enhancement in understanding of basic health research concepts. Participants also showed a positive attitude towards research, with 71.4% agreeing on the important role of research in medical education and future clinical practice.

Corresponding Author: Pooja Sharma, MD (Obstetrics and Gynaecology), Clinical Research & Capacity Building, APAR Health, Gurugram, Haryana, India.

E-mail: drpooja.apar@gmail.com

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Conclusion: The structured health research training program was effective in improving knowledge of basic health research concepts among undergraduate health sciences students. It also fostered a positive attitude towards research. Such programs can build research literacy, strengthen confidence, and encourage early involvement in research. This may help develop future healthcare professionals who can contribute to evidence-based healthcare.

Keywords: Health research, Early involvement, Undergraduate students, medical education, Research training

Background

Early involvement in research helps students develop critical thinking, analytical abilities, and problem-solving skills while also encouraging a scientific approach to clinical practice. These skills not only enhance their learning experience but, also contribute to improved decision-making and ultimately better health outcomes However, many students consider the lack of proper mentorship and guidance as one of the primary barrier to participating in research activities. Establishing well-structured undergraduate research programs is therefore essential. Undergraduate medical students have positive attitude towards the idea that 'research is essential for clinical care' and have shown interest in attending training in research methodology.[1] To promote a strong research culture, such programs should be regularly evaluated and supported to ensure a motivating and research-oriented environment for faculty[2] It is crucial to enhance the knowledge and competencies in order to succeed in this area by conducting research methodology classes, workshops, and creating a good research atmosphere.

Generating Engagement and Nurturing Innovative Undergraduate Students (GENIUS) programme is an educational intervention developed by the group of experienced experts in clinical research. It was established to improve the knowledge of UG students in the domain of Research Methodology.

The self-paced online modules of 10 hours covered the domains of health research and concepts of research methodology and were developed by clinical research experts, biostatisticians, public health researchers, clinicians, and pharmacologists, with more than 13 years of experience.. This study aimed to assess the impact of GENIUS programme on the knowledge scores of UG students. The study also sought to identify baseline knowledge gaps and assess students' perceptions on the role of research in healthcare education and practice.

Methodology

Study Design and study setting

This is a prospective questionnaire based observational study. The study was conducted among undergraduate medical and dental students at a medical teaching institute.

A total of 56 undergraduate (UG) students from medical and dental sciences backgrounds at a medical teaching institute were enrolled in the study. Of these, 21 students completed the educational intervention within the stipulated period and fulfilled the study inclusion criteria. Accordingly, all analyses were conducted on the final cohort of 21 participants only.

Educational Intervention

Development of GENIUS Modules

The GENIUS program was designed as a structured undergraduate research training initiative aimed at improving research literacy among health sciences students. It also aimed to increase participation in ICMR Short- Term Studentship (STS) and other such initiatives. An initial roundtable discussion between experts and young researchers was conducted to prepare a structured research training program.

The program included interactive online & offline sessions on research methodology, research question development, evidence-based medicine, research ethics, scientific writing, clinical research concepts, innovation frameworks, and basic biostatistics. Teaching methods included lectures, discussions, practical examples, and question-and-answer sessions.

The online training modules had a total course duration of 10 hours, whereas the offline sessions with the experts were conducted for 2 hours and 30 minutes.

Implementation

To assess the impact of the educational intervention, a pre–post survey design was used. A 20-item questionnaire including both open and close ended questions was prepared after adapting the data collection tool from similar studies.[3]

The content validity of the questionnaire was assessed by a team of subject experts from multidisciplinary fields, including clinical research, public health, medical writing, biostatistics, and clinical medicine.

Using the existing data collection tool from similar studies, the questions were revised to meet the subject- specific criteria of the present study under the guidance of the expert team.

Pilot testing was conducted on a group of 10 UG students. Minor corrections to the options provided for objective questions were made following pilot testing.

Online learning modules were subsequently shared with all respondents who completed the pre-assessment. Following completion of the online modules, an in-person interactive session was conducted. A post-assessment survey was then administered to evaluate changes in knowledge and perceptions. (Figure 1)

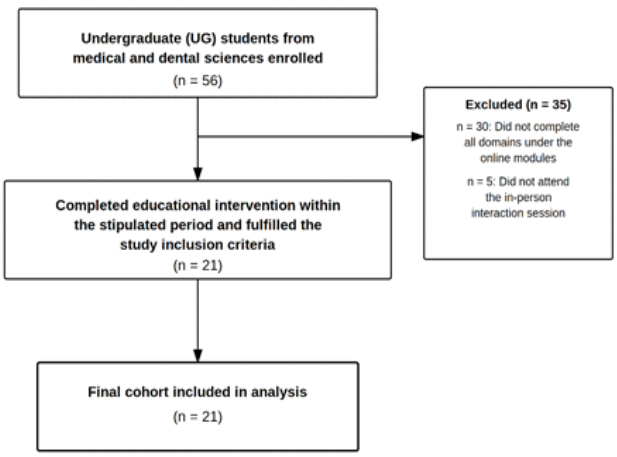

Figure 1: Representation of the participation enrolment

Statistical Analysis:

Data was analysed using descriptive statistics. Categorical variables were summarized as frequencies and percentages, while continuous variables were presented as means and standard deviations where appropriate. Pre- and post-assessment responses were compared to evaluate changes in knowledge following the educational intervention.

McNemar's test was applied to individual questionnaire items to evaluate changes in the proportion of correct responses between the pre- and post-assessments.

Ethical Considerations:

All responses were anonymized prior to analysis through removal of personal identifiers. The study protocol was reviewed by the Institutional Research and Ethics Committee of KLE VKIDS, Belagavi, which granted a waiver informed consent owing to the educational and minimal-risk nature of the study. (Approval No. EC/NEW/INST/2025/KA/0539; dated 05 April 2025).

Results

Initially, a group of 56 students were enrolled in the study, of whom 35 were excluded due to loss to follow-up and personal reasons. These students were unable to complete the online modules within the stipulated time period. In the final analysis, 21 students were included.

Among these groups, the majority were females (57.1%) and rest were males (42.9%).The mean age of the students was 19.4 years.

The majority of participants were enrolled in the MBBS programme (85.7%), while rest were pursuing BDS (14.3%). Approximately two-thirds of the participants were in the second year of study (76.2%), with the remainder in the first year (23.8%) (Table 1).

Table 1: Background of participants (n=21)

Age Group	
>20 years	7 (33.3%)
<20 years	14 (66.7%)
Gender	
Female	12 (57.1%)
Male	9 (42.9%)
Courses	
BDS	3 (14.3%)
MBBS	18 (85.7%)
Course year	
First Year	5 (23.8%)
Second Year	16 (76.2%)

Baseline Knowledge Assessment

In the study group, 46.10% of responses were correct in the pre-assessment. It was observed that participants were well aware of some common research concepts, such as, FINER criteria (85.7%). Also, substantial knowledge gaps were identified. The lowest knowledge scores were observed for IMRAD (19.0%), Technology Readiness Level (TRL) (19.0%), and the components of a research question (14.3%) (Table 2).

Table 2: Comparison of pre assessment and post assessment of correct responses

Question	Pre-test, n/N (%)	Post-test, n/N (%)	McNemar exact p-value
What is the purpose of health research?	9/21 (42.9%)	15/21 (71.4%)	0.07
What does "Type-2 error" refer to in research?	12/21 (57.1%)	18/21 (85.7%)	0.109
FINER stands for	18/21 (85.7%)	18/21 (85.7%)	1.000
What does TRL stand for in innovation?	4/21 (19.0%)	20/21 (95.2%)	<0.001
Which phase of a clinical trial is known as Post-Marketing Surveillance?	13/21 (61.9%)	20/21 (95.2%)	0.039
Which of the following are components of a research question?	3/21 (14.3%)	16/21 (76.2%)	<0.001
In Patient Centricity, what does POEM stand for?	12/21 (57.1%)	19/21 (90.5%)	0.065
What does PRO refer to?	7/21 (33.3%)	17/21 (81.0%)	0.013
In research publishing, what does the acronym IMRAD stand for?	4/21 (19.0%)	19/21 (90.5%)	<0.001
What is Mendeley?	13/21 (61.9%)	19/21 (90.5%)	0.031
Observational studies are also known as:	8/21 (38.1%)	15/21 (71.4%)	0.119
What is the main goal of informed consent in clinical research?	18/21 (85.7%)	20/21 (95.2%)	0.625
Which of the following is NOT a type of bias in research?	5/21 (23.8%)	18/21 (85.7%)	<0.001
PICOT in research refers to:	13/21 (61.9%)	18/21 (85.7%)	0.125
What is the main goal of Evidence-Based Medicine (EBM)?	14/21 (66.7%)	20/21 (95.2%)	0.031
Overall	46.10%	90.40%	

Post-Assessment Knowledge Improvement

Following the educational intervention, a marked improvement in knowledge was observed across all domains assessed. The overall proportion of correct responses increased from 46.2% to 90.5%.

There were significant changes observed in the seven domains such as, "TRL (Technology Readiness Level)", "Which of the following are components of a research question?", "What does PRO refer to-", "What is Mendeley?", "Which of the following is NOT a type of bias in research?", "What is the main goal of Evidence-Based Medicine (EBM)?". "In research publishing, what does the acronym IMRAD stand for?", with a p-value of less than 0.05.

Changes in responses to individual knowledge items were analyzed using McNemar's test. Several questions demonstrated improvements in correct responses from pre- to post-assessment, this overall improvements in correct responses indicates a positive educational impact of the intervention. (Table 2)

Attitude Towards Research

Participants expressed positive attitude regarding the role of research in medical education and future clinical practice (71.4%). . A large majority recognized its contribution to evidence-based decision-making (95.2%), while others highlighted its role in promoting learning beyond routine classroom teaching (57.1%).

Students further reported that engagement in research is an indication of increased curiosity (33.3%), innovation (28.5%), and critical thinking skills (23.8%). These findings suggest that the GENIUS training programme not only improved research knowledge but also fostered positive attitudes towards research participation, scientific inquiry, and evidence-based healthcare to some extent (Figure 2).

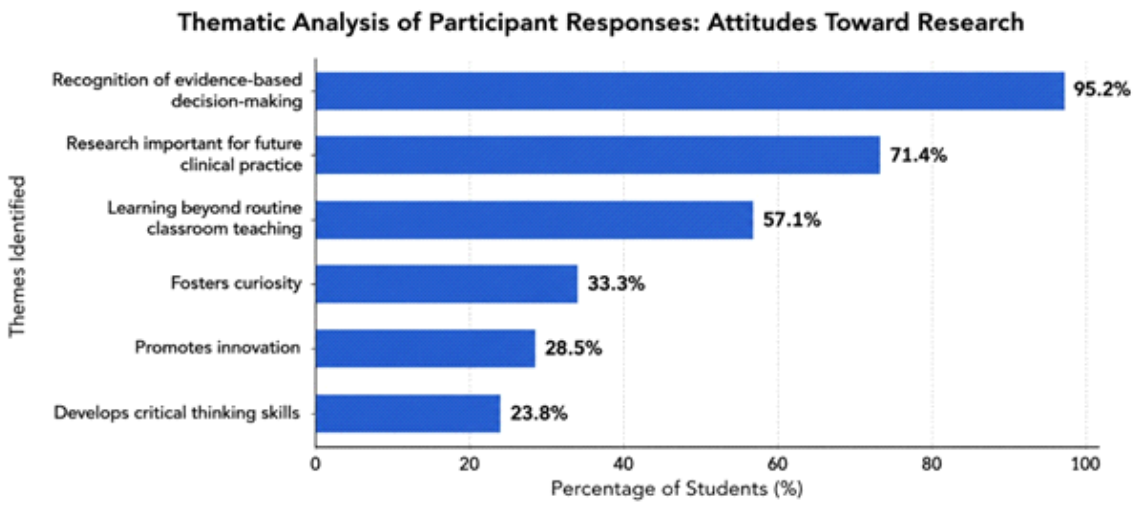

Figure 2: Students perceptions towards research

Discussion

The present study demonstrated a clear improvement in students' knowledge and understanding of health research following participation in the training programme, highlighting the effectiveness of structured, research-oriented educational interventions.

Blended learning demonstrated consistently greater effects on knowledge outcomes than traditional learning in health education. Further studies are needed to confirm these results and to explore the utility of different blended-learning design variants.[4]

The overall proportion of correct responses increased from 46.1% at baseline to 90.4% following the intervention, indicating a marked enhancement in research literacy. These findings suggest a positive impact of the structured educational intervention on students' knowledge.

Similar findings have been reported in previous studies, where research methodology training significantly improved students' awareness, confidence, and interest in research activities.[5,6] Studies conducted among medical students have also highlighted the importance of integrating research training into the medical curriculum. Students in the current study also showed a positive attitude towards integrating research training into the medical curriculum. This aligns with earlier studies reporting that undergraduate medical students perceive research as an important component of medical education that enhances evidence-based clinical practice and academic development.[4,7]

One of the most notable findings of the present study was the substantial improvement in concepts that demonstrated poor baseline understanding, including Technology Readiness Level (TRL), IMRAD, Patient-Reported Outcomes (PROs), and components of a research question. These findings suggest that several important research concepts are inadequately addressed during routine undergraduate teaching and may benefit from dedicated educational interventions.

The improvement observed in post-training responses may be attributed to the interactive nature

of the programme, which likely helped students better understand research concepts, study designs, data interpretation, and scientific thinking. The use of simplified explanations and real-world research examples may have facilitated better comprehension of complex concepts such as evidence-based medicine, clinical trial phases, research bias, and scientific writing frameworks. Previous educational intervention studies have similarly shown that workshops and mentored research activities improve students' analytical abilities, critical thinking, and engagement in scientific learning[8].

Participants in the present study also recognized the role of research in improving problem-solving skills, decision-making, and patient care. This observation is consistent with the principles of evidence-based medicine, where research literacy is considered essential for developing competent healthcare professionals capable of applying scientific evidence in clinical practice.[9] The positive perceptions observed in this study further suggest that structured research training may contribute not only to knowledge acquisition but also to the development of favorable attitudes toward future research participation.

Previous research has reported that awareness of research concepts among undergraduate medical students may be limited. Only two-thirds of the students knew about the concepts of research, sampling techniques, and descriptive statistics. The majority of the students had poor awareness regarding sample-size calculations and inferential statistics, and only one-third of them could correctly define informed consent.[3]

Structured undergraduate research training programmes can play an important role in strengthening research literacy among health sciences students. Early exposure to research concepts may help bridge existing knowledge gaps, foster critical thinking, and encourage future engagement in research and evidence-based healthcare practices.

The study has several strengths. It evaluated a structured research training intervention, assessed multiple domains of research literacy, and incorporated objective pre- and post-intervention assessments. Furthermore, the program addressed both traditional research methodology concepts and emerging domains such as innovation frameworks and patient-centered research. The relatively high attrition may have been associated with differences in student engagement or motivation, although these factors were not formally assessed in the present study.

Limitations & Future Recommendations:

The study was conducted at a single institution with a relatively small sample size. Only 21 of the 56 enrolled participants completed the post-intervention assessment, which may have introduced attrition bias and limited the precision of effect estimates. The assessment was limited to short-term knowledge gains, and long-term retention of knowledge was not evaluated. Future multicentre studies with larger sample sizes and longer follow-up periods are warranted to assess the sustained impact of undergraduate research training programmes.

The findings should primarily be interpreted as an improvement in knowledge scores following participation in the GENIUS programme. The observed change may also have been influenced by testing effects, questionnaire familiarity, attrition, and other factors occurring during the study period. The study assessed only the immediate effect on knowledge; therefore, further studies are required to evaluate longer-term effects.

The same questionnaire was administered immediately before and immediately after the intervention. Therefore, familiarity with the questionnaire and recall or testing effects may have contributed to some of the observed improvement in responses. Future studies should consider alternate but equivalent forms of assessment and longer follow-up intervals.

The findings of the current study must be implemented effectively.

Conclusion

The GENIUS undergraduate research training programme was associated with substantial improvements in knowledge of core health research concepts among undergraduate medical and dental students.

These findings indicate that structured research training programmes may serve as an impactful strategy for strengthening research abilities and promoting early engagement in research among health sciences students.

Conflict of interest statement by authors: None to declare

Financing: None to declare

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