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Leveraging Artificial Intelligence (AI) and Machine Learning (ML) in Women's Access to Healthcare in Rural India

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Abstract- Women's healthcare necessitates comprehensive approaches to address unique and ubiquitous health related issues of women, which include nutritional, reproductive, mental, and chronic diseases. On the other hand, rural healthcare must overcome tangible and intangible barriers, including geographic isolation, inadequate physical and digital infrastructure, sociocultural resistance, a shortage of healthcare professionals, and policy paralysis. Artificial Intelligence and Machine Learning have revolutionized the healthcare paradigm through developments such as deep learning enabled medical imaging and diagnostics, predictive analytics, drug discovery, real time monitoring of disease surveillance, precision and personalised medicines, robotic surgery, robotic neurorehabilitation, etc. However, the benefits of these breakthroughs are mostly being received by the advanced societies; the greater rural masses still expect miracles of the trickle down effect. The healthcare issues and challenges pertaining to women are peculiar and need special focus from researchers, particularly in low resource settings like rural India. Nevertheless, the researchers have long started exploring Artificial Intelligence and Machine Learning based solutions for problems related to women's healthcare and rural healthcare. In this article, focusing on the challenges and approaches, we review the state of the art of Artificial Intelligence and Machine Learning in women's healthcare that carries significant potential for implementation in the rural healthcare system in India.

Keywords – artificial intelligence, machine learning, clinical AI, women's healthcare, rural healthcare, maternal healthcare.

I. INTRODUCTION

The integration of Artificial Intelligence (AI) and Machine Learning (ML) with the healthcare system of India aligns with global initiatives that aim to strengthen health infrastructure and to achieve health related Sustainable Development Goals (SDGs). Different domains of digital health, including eHealth, telemedicine, mobile health (mHealth), big data analytics, and the Internet of Things (IoT), have emerged as transformative tools for universal health coverage (UHC), improving health outcomes, and health equity. Digital health has the ability to bridge the gaps in healthcare, and it reduces digital inequities. It also promotes knowledge exchange for better service delivery, which is aligned with the Sustainable Development Goals. In India, different initiatives such as the National Digital Health Mission (NDHM), the National Health Mission (NHM), and the Integrated Disease Surveillance Program (IDSP) collectively work utilising AI/ML for better public health outcomes. An integrated approach helps to deliver accessible and personalised health services. It also enhances community participation through various health programs.

Due to systemic disparities and uneven service distribution, access to quality healthcare remains a major challenge in rural areas of many developing countries like India [1,2,3]. Barriers like geographical isolation, inadequate infrastructure, financial dependency, and gender discrimination further exacerbate the existing problems [4,5]. Other important aspects of public health concern are maternal and child health issues, which necessitate innovative designs and ideas [6,7]. AI/ML can bring major transformation in healthcare, bridging the healthcare gaps in rural India [1,8].

In resource limited societies, AI/ML-driven approaches such as deep learning, predictive analytics, and intelligent triage systems can significantly enhance healthcare delivery [3,9,10]. It not only improves diagnostic accuracy and monitoring or surveillance of diseases but also supports the clinicians in clinical decision making [3,9,10]. These tools are being applied in maternal and perinatal care, and such tools can predict early risk and help in screening programs, particularly in rural healthcare where there is a shortage of health workers [5,10,11]. Infrastructural deficit, interrupted electricity, poor digital connectivity, and higher cost of implementation are some limitations faced while planning for large scale implementation of AI/ML [1]. Other challenges related to algorithmic bias, privacy, data quality concerns, and the difficulty in AI decision making further complicate this issue [12,13,14]. Moreover, gender bias is also extended to the digital world, and it restricts access to technology, digital literacy, and independent involvement in healthcare among women in rural areas of India [4,15].

A comprehensive understanding of the diverse applications of AI and ML in women's healthcare within the social context of rural India is essential to address these issues. The following are the objectives of our study.

- Understanding the scope and current status of AI/ML-based healthcare applications
- Examining the effectiveness and outcomes of various such applications
- Assessing implementation challenges and barriers
- Outlining the ethical, infrastructural, and policy needs for equitable and sustainable integration

II. STATE OF WOMEN'S HEALTHCARE IN RURAL INDIA, ISSUES AND CHALLENGES

Prominent challenges facing women's healthcare in rural India include access inequities, lack of women's bargaining power, and other socioeconomic determinants. Factors affecting the healthcare scenario in rural India also include inadequate availability of essential medical facilities, shortage of healthcare professionals, and poor infrastructure, such as healthcare delivery networks [1,8]. Women living in rural areas fall in the high risk group because of poor reproductive and maternal health facilities, inadequate support, lack of awareness and communication gaps. Such factors contribute to raised morbidity and mortality rates, along with perpetually high IMR and MMR in rural areas. To understand the burden of postpartum morbidity, a community oriented study was conducted in Aligarh which highlighted that backache was experienced by 82% of women, whereas lower abdominal pain was experienced by 92% of women following childbirth [16].

Socioeconomic and regional disparities limit accessibility, availability and affordability (AAA) for maintenance of menstrual hygiene in rural India, as only 42% of adolescent females follow hygienic menstrual practices in rural India [17]. Jeopardising maternal and fetal health, anaemia affects more than half of pregnant women in rural India [19]. Prevalence of hysterectomy is higher in rural areas (3.4%) than in urban areas (2.7%), and this reflects the inappropriate medical practices for reproductive health management in rural India [20]. Mental health issues remain an underrecognized public health concern among women living in rural areas. Due to poor socioeconomic status, gender disparity, and other sociocultural norms, depression, anxiety, postpartum depression, and postpartum psychosis are prevalent among married women [21].

eSanjeevani is India's national telemedicine platform aimed at addressing inequities in healthcare. This large scale digital health initiative aims to bridge healthcare gaps in rural India. A substantial proportion of its users comprises the women living in rural India, and as such, this model proves to be effective [18]. In resource constrained healthcare settings like that in rural India, AI/ML integration into maternal and perinatal healthcare can transform the scenario. In order to strengthen healthcare for rural women, tasks such as early risk stratification, antenatal monitoring, and predictive analytics in preterm birth prevention are already enabled with AI/ML-based applications [11,24,25]. However, large scale integration of AI/ML in health applications still remains limited by persistent infrastructural challenges. Furthermore, lack of decision making power and financial dependence, compounded with lower digital literacy and lack of technological knowledge among rural women, remain major challenges in this direction, restricting them from effectively utilising digital health resources [4,18].

III. METHODOLOGY

This review followed the methodological framework prescribed by Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) guidelines. We searched various digital databases, including Google Scholar, PubMed, Scopus, ScienceDirect, Semantic Scholar, and IEEE Xplore, to find the studies that match our needs. Our search included articles published between 2015 and 2025, and we used keywords such as "artificial intelligence," "machine learning," "women's health," "maternal health," and "rural health" using a combination of Boolean operators, viz., "AND" and "OR". Only those studies that are concerned with AI/ML applications in women's or maternal healthcare in India or similar low resource contexts were included. We excluded non empirical works, non-English studies, duplicate records, and abstracts without full text. From an initial 231 records, 43 relevant studies were selected after screening titles, abstracts, and full texts.

IV. USE OF AI/ML IN WOMEN'S HEALTHCARE IN RURAL INDIA

The integration of AI and ML carries the potential for transformation of the healthcare scenario, addressing the challenges related to women's health in rural India, where there are infrastructural insufficiencies, manpower shortages, and hostile socioeconomic conditions limiting access to quality health services [1,3,6]. Advanced AI/ML technologies are being used to expand diagnostic capabilities and accuracy, to augment the local healthcare workforce, and to personalise

patient care and treatment, based on digital platforms and applications specially designed for low resource settings [1,6].
AI/ML in Maternal and Perinatal Healthcare:

Application of AI and ML holds a critical role in rural settings in maternal and child health, as there are high rates of mortality and morbidity in these two areas. Active use of AI and ML algorithms for early risk prediction and remote monitoring enhances accessibility to care and its efficiency [23,24,25].

- **Risk Prediction and Diagnostics:** AI/ML techniques play a vital role in analysing data to predict maternal health risks during pregnancy, including the mode of childbirth. Performance of AI models in predicting maternal mortality and serious obstetric complications like gestational diabetes, preeclampsia is impressive [26,27,28,29], thereby yielding better outcomes in maternal and neonatal health. [30] used ML to create a prediction model for preterm birth in rural India.
- **Real Time Monitoring:** AI/ML-powered systems are emerging as an enabler of real time pregnancy monitoring and remote consultations, which significantly improve early detection of complications of pregnancy [11,25,31]. Such monitoring and risk prediction systems can also ensure the wellbeing of the fetus [32,33].
- **Screening and Specialized Care:** Specialised screenings, such as those for cervical cancer, can be improved with the help of AI/ML-powered systems [11,39]. AI-guided citizen centric predictive models are being developed to support pregnant women in India by identifying antenatal care (ANC) utilisation gaps and predicting outcomes of high risk pregnancy, such as the mode of delivery or related complications [7]. AI/ML is also being used to identify non communicable diseases (NCD) in peri and post menopausal women[34]. In the MadhuNetr project conducted in Rajasthan, AI is used for early detection of diabetic retinopathy in rural centres [35].

A.Remote Diagnostics and Clinical Decision Support:
Shortage of skilled medical professionals and specialists in rural India can be mitigated to some extent with the help of AI/ML [6,8]. AI/ML-powered diagnostic and decision support systems enable better care at the point of need.

- **Enhanced Diagnostic Accuracy:** AI/ML algorithms can analyse large medical datasets, including X-rays, MRIs, and CT scans and offer faster and more accurate diagnoses for various diseases [3,9]. In rural settings, such tools can increase diagnostic accuracy with quality [3].
- **Clinical Decision and Support Systems (CDSS):** Clinical Decision and Support Systems powered by AI/ML provides guidance and assistance on real real time basis to rural health practitioners, nurses and paramedical staff. It helps in decision making for diagnosis and treatment [3] and plays an important role in sustaining quality healthcare.

B. Telemedicine and Mobile Health (mHealth):
AI/ML, integrated to telemedicine and mobile health (mHealth), is another determinant of essential services. It can address the issue of geographical isolation which impacts healthcare delivery to women of remote villages of India [3]. Telemedicine platforms can also help women residing in remote villages to access advice from specialists. Due to such advancements, it has been seen that healthcare reach is significantly increased in remote areas, in some areas by up to 300% [35].

- **Offline First Solutions:** Internet connectivity is poor in rural India, which is a major challenge. Offline first designs are incorporated in AI/ML models [5]. These frameworks support AI-driven triage and securely cache medical records on edge devices, minimising dependence on continuous internet access [5, 12].
- **Chatbots and Virtual Assistants:** AI-enabled chatbots and virtual health assistants are based on Natural Language Processing (NLP) for standardised patient interactions, providing timely health information that helps in managing chronic diseases [36]. AI/ML tools can offer personalised health education, assistance in local languages and timely follow up, thereby enhancing patient engagement and adherence. Chatbots like "Poshan Didi" have shown feasibility for providing individual nutrition counselling to mothers in rural India and offer a private channel for discussion [37].
- **Mental Health Support:** AI-enabled chatbots and NLP tracking of maternal mood from smartphone apps can support mental health, potentially predicting the risk of postpartum depression [38].
- **Role of software:** WHONET (Windows based software from the WHO Collaborating Centre for Surveillance of Antimicrobial Resistance) is a free informatics tool designed to help microbiology laboratories collect, manage, analyse and share antimicrobial susceptibility test data in a standardised way [39]. WHONET 2025, which supports 45 languages and includes new features, is a modernised and expanded version of WHONET 5.6 [40]. Although initial versions are rule based, once integrated with advanced AI/ML, such surveillance systems have the potential for ameliorating the scenario of antimicrobial resistance, particularly of rural women who are often the victims of malpractices related to antibiotics. WHONET data can be uploaded to a dedicated repository by all the hospitals and laboratories to gain a true picture of antimicrobial resistance in the country [41], and the data repository thus created may be used for training novel ML-based models.

C. Challenges in Rural Women's Healthcare:

In spite of immense promise and potential, the effective and equitable deployment of AI/ML-based healthcare settings of rural India, with special focus on women's health, faces several major challenges related to infrastructure, data, and social equity.

- **Digital and Infrastructural Divide:** There is a lack of robust technological infrastructure, essential for deployment of AI/ML-based solutions in rural India, which includes high performance computing, reliable network connectivity, and consistent power supply [1,3,12]. Furthermore, women in rural India exhibit lower rates of digital literacy, lack of access to mobile phones, and less autonomy in making decisions regarding technology use compared to men [4,15].
- **Data Bias and Quality:** The effectiveness of AI/ML models is compromised by biased and poor quality data. Most of the existing AI/ML models are trained on datasets from urban areas of high income countries, which leads to geographical and demographic biases and limits their accuracy and generalizability in diverse rural Indian populations [5,24]. Developing and validating a model requires high quality and diverse datasets modified for rural demographics to ensure equitable outcomes [5].
- **Ethical Concerns:** Ethical concerns are crucial, and data privacy and data security of the patients must be ensured [42]. Lack of transparency and explainability is more often found in "black box" AI/ML algorithms, which can lead to doubt and poor adherence from both patients and healthcare providers [43]. In rural settings, poor and vulnerable populations may be exploited by using their medical records to train proprietary AI/ML algorithms without their consent or legal accountability for errors [14].
- **Sociocultural Barriers:** AI/ML-powered tools should be designed as user friendly and capable of overcoming cultural and language barriers. Social factors, such as patriarchal beliefs and financial dependence on male family members, limit the access and effective utilisation of new digital resources to women [4]. Robust policy frameworks, education and training of healthcare workers, and community friendly designs of AI/ML tools are required to deal with these problems [6].
- Priority should be given to developing lightweight, offline compatible designs. Techniques should be adopted to maintain patient privacy [5,11]. All these approaches should ensure accurate and timely diagnosis, and equitable healthcare services to underserved populations.

V. SUSTAINABILITY IMPACT

We reviewed various works and studies prescribing AI/ML-based advanced solutions that can be customised to cater local needs of the diverse Indian society. These solutions, if implemented adaptively by adopting proper policy measures, can bring about drastic changes in the rural healthcare scenario, thereby reinforcing India's commitment towards several SDGs, including SDG 3: Good Health and Wellbeing, SDG 5: Gender Equality, SDG 6: Clean Water and Sanitation, SDG 10: Reduced Inequalities, and SDG 11: Sustainable Cities and Communities.

VI. CONCLUSION & FUTURE WORK

Persistent challenges in women's healthcare in rural areas across India, concerning access, diagnostic limitations, and inefficient resource utilisation, represent major areas where AI and ML can bring transformative solutions [1,3,6]. Shortage of healthcare professionals and specialists in rural regions can be managed to some extent through AI/ML-enabled Clinical Decision Support Systems, which offer real time guidance in diagnostic and therapeutic decision making to clinicians, nurses and paramedics, thereby reducing the need of specialists [1,6,9]. Moreover, AI/ML-based tools hold significant promise in combating the problem of delay in diagnosis and high maternal mortality by facilitating early identification of complications such as preeclampsia, preterm birth, and severe maternal morbidity [11,23,38].

The integration of AI/ML into screening programs further makes the diagnosis of critical conditions like diabetic retinopathy cost effective and scalable, minimising the dependency on specialised diagnostic infrastructure and personnel at the point of care [3,9,13]. Additionally, AI-enabled chatbots and virtual assistants can help to overcome the barriers of low literacy and linguistic diversity by delivering personalised health education in local languages, guiding behavioural changes, engaging patients in self management of chronic diseases, nutritional practices, and improving mental health outcomes such as postpartum depression [9,11,25,36]. AI can be deployed to integrate automation in administrative workflows. It also helps to maintain strong patient adherence and better health outcomes [9,13]. Universal healthcare access can be achieved by this. Another important aspect is the narrowing of the gap between urban and rural healthcare [1,3].

The approach towards the advancement of AI/ML-based women's healthcare in rural India needs to be multidimensional and context sensitive. It must address infrastructural, ethical, and sociocultural barriers and ensure sustainability and inclusivity. In line with the vision of Industry 5.0, a critical component of this AI/ML revolution will be to develop user centric, context sensitive interfaces that will take care of multidimensional resource constraints. Digital Personal Data Protection Act, 2023, reinforces the need for privacy preservation. Future works can leverage federated learning using decentralised rural datasets, thereby ensuring privacy protection and minimising biases. Robust ethical and regulatory frameworks ensuring data protection, model transparency, and equitable deployment are also absolutely required to prevent and safeguard vulnerable groups. NITI Aayog mentions healthcare as a focus area for digital intervention, and its National Strategy for Artificial Intelligence #AIForAll focuses on leveraging AI for inclusive growth in sectors like healthcare. Digital literacy and AI capacity building for healthcare providers, including nurses, midwives, and paramedics, as well as patient education, are necessary for the successful implementation of novel techniques based on trust. For AI to evolve into an equitable and high impact instrument strengthening the rural healthcare system as well as bridging India's continuous rural healthcare divide, priorities must be given to affordable, adaptive, and interoperable technologies, as only such technologies align with local healthcare workflows [1,6,14].

Compliance, Ethics & Disclosure

- Human/animal studies: NA.
- Data, code & materials: NA.
- Plagiarism & AI: AI tool https://notebooklm.google.com/ was used for organizing the sources; AI enabled search engines were used for grammatical error correction.

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