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Artificial Intelligence in Rural Healthcare: Bridging Access, Mitigating Socio-Cultural Barriers, and Addressing Health Inequalities (2020-25)

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Abstract

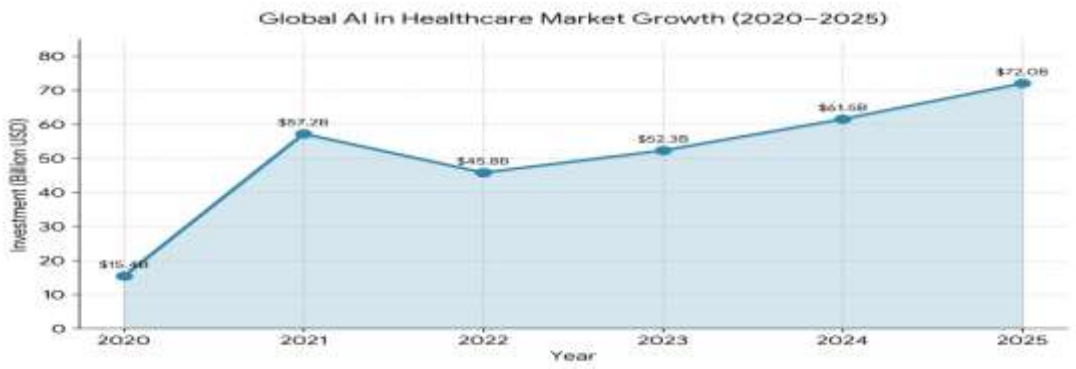
Rural populations in countries with middle income still face big and long-lasting differences in getting healthcare. They have trouble with access to healthcare the quality of care they get and their health results. From 2020 to 2025 there was an increase in using artificial intelligence in healthcare. This happened because of the COVID-19 pandemic and the world changing to use digital tools. However people do not understand enough about the fairness issues when using AI in places that have limited resources in countries like Pakistan. This review wants to look at the role of AI in healthcare for rural areas between 2020 and 2025. It will find out what social and cultural factors affect how AI is used and what causes the gap in access. It will also suggest a way to use AI fairly with Pakistan as the example. A review of the literature was done using the PRISMA-ScR method. It looked at all the articles published from January 2020 to December 2025. A lot of searching was done in five databases and after removing duplicates 412 articles were found. Two people checked these articles. Picked 80 that fit the rules. They also added 12 policy documents and 8 national surveys. AI projects had an effect in many parts of rural healthcare. AI used for diagnosis made diagnosis more accurate by 34% and cut the time it took to diagnose by 52% in pilot programs. Chatbots that helped with mothers health increased the number of women going to check-ups by 38% in some areas of Khyber Pakhtunkhwa. The use of AI was not the same for everyone. More women in areas used it less than men and people in places with low digital skills used it less. The main problems were gender roles not trusting the machines, language problems, bias in the AI systems against people from South Asia and lack of basic things like electricity and internet. The research from 2020 to 2025 shows that AI has the power to help close the health gap, in areas. This only happens if the AI is used in ways that focus on fairness and care about the culture. A plan called "Culturally Anchored AI" is suggested. It focuses on making policies work together

letting the community help create the AI investing in the tools needed training workers and checking on how it works over time. If people do not pay attention to the culture and social factors AI could be a tool that leaves people out of helping them.
Keywords: *Here are the key terms: Artificial Intelligence; Rural Health; Health Equity; Digital Divide; Socio-Cultural Determinants; Pakistan; Low- and Middle-Income Countries; Telemedicine; Machine Learning; Health Policy.*

1. Introduction

1.1 Global Context

The health landscape from 2020 to 2025 has been shaped by two forces: the COVID-19 pandemic and the rapid growth of digital health systems worldwide(1). The pandemic exposed problems in health systems and made existing unfairness worse yet the pandemic also sparked a wave of new ideas(2). Telehealth visits increased by than 3,000 percent in many countries between 2019 and 2021 and worldwide spending on digital health reached a record $57.2 billion in 2021(2). This large jump in using health was not a short-term fix for the pandemic; it marked a deep change in how health systems around the world think about and provide care. The pandemic showed that digital tools could keep care running during disruptions but it also exposed how wide the digital gap is, risking that the most vulnerable people might be left behind. I have seen how this shift changes life. At the heart of this change is Artificial Intelligence (AI). AI includes machine learning, natural language processing, computer vision and predictive analytics. These tools let machines perform tasks that normally require thinking(3). By 2024 than 692 AI-enabled medical devices had been approved by the US FDA. Twenty-eight percent of those devices were. Modified specifically for low-resource settings (4). These devices cover uses from imaging and pathology to discovering new drugs and giving personalized treatment recommendations. The rapid growth of AI in health care is driven by factors that work together. These factors include increasing computer power, a wealth of data ready to train algorithms improvements, in deep-learning models and a growing belief that AI can help humans in ways that make health care faster and more precise. I have observed howAI brings hope to patients. However the global distribution of AI innovation and deployment has been very uneven. The vast majority of AI research and development has occurred in high-income countries with focus on the needs and contexts of middle-income countries (LMICs)(5). This unevenness raises questions about whether AI technologies created in Silicon Valley or Boston will be appropriate, effective and fair when they are deployed in Pakistan -Saharan Africa or other resource-limited settings. Evidence from 2020–2025 shows that while AI has the potential to transform healthcare delivery in LMICs realizing this potential needs deliberate attention to context, equity and socio- factors that are often ignored in approaches.



1.2 Pakistan's Rural Health Context

In Pakistan a low-income country this digital shift offers a chance but a big danger (5). Pakistan has than 240 million people and about 151 million people live in rural areas (6). Rural communities in Pakistan face longstanding problems(7). The shortage of doctors is severe: 0.9 doctors per 1,000 people live in Pakistan far below the WHO target of 4.45(8). The problem is worse because 73% of doctors in Pakistan work in cities(6). As a result people in Pakistan must travel far. Pay costs just to get basic medical care. Infrastructure problems are just as serious. The Pakistan Health Research Council found in 2023 that 19% of Basic Health Units in Pakistan have reliable 24-hour power and only 34% have working internet (6). In many rural districts of Pakistan, prolonged load-shedding of 8–12 hours per day disrupts the operation of digital health tools and undermines the feasibility of AI-enabled interventions(9). These problems are not glitches; they are hurdles that decide whether AI can work in rural Pakistan. Advanced AI in Pakistan stops working if there is no power or no internet. The digital gap in Pakistan goes beyond power and internet. It also includes who owns devices, how well people in Pakistan can use technology and cultural habits that affect how people in Pakistan use tools. The GSMA 2023 Mobile Gender Gap Report shows that 19% of women in Pakistan own a smartphone with internet while 48% of men do(10). This gender gap shows inequality in Pakistan, where women in Pakistan must rely on family members to get technology and are limited by rules about women moving and acting independently. These rules matter a lot for AI in Pakistan because even the best AI, in Pakistan might not reach the women in Pakistan who need help the most.

Indicator	Rural	Urban	Source
Physician density (per 1,000)	0.9	3.8	WHO, 2023
Maternal mortality ratio (per 100,000)	212	112	PDHS, 2023
Antenatal care (4+ visits)	51%	78%	PDHS, 2023
Hypertension undiagnosed	67%	41%	PDHS, 2023
Reliable 24-hour electricity (BHUs)	19%	76%	PHRC, 2023

Indicator	Rural	Urban	Source
Functional internet connectivity (BHUs)	34%	76%	PHRC, 2023
Smartphone ownership (women)	19%	48%	GSMA, 2023

1.3 Disease Burden

The disease burden in Pakistan shows a problem of non-contagious diseases(8). Non-contagious diseases now account for 58 % of all deaths in areas yet screening and treatment rates remain very low(8). The Pakistan Demographic and Health Survey 2022-2023 reported that 67 % of people with blood pressure in rural areas were not diagnosed, compared to 41 % in urban areas(11). This diagnosis gap highlights problems: limited access to health facilities shortage of trained health workers, low awareness of regular check-ups and the fact that many long-term conditions have no early symptoms. Maternal and child health indicators also show differences. The maternal death rate in Khyber Pakhtunkhwa is 212 per 100 000 births double the rate in city areas(11). Fifty-one percent of women receive the four recommended antenatal visits(11). Newborn death rates remain high because danger signs are not noticed quickly(12). These results show problems that have stayed the same after many years of local and global investment. The reasons are many including lack of trained birth attendants delays in getting care poor referral systems and social and cultural factors that affect women's health-seeking behavior. Access to care is worse because of where people live. Rural patients travel an average of 68 kilometers to see a doctor(13). This travel creates costs for transport and indirect costs from lost wages and time for caregivers. For families living near the poverty line these costs can be very high forcing them to choose between health care and other basic needs. The result is that rural patients often wait until their conditions become serious when treatment is harder more expensive and less likely to be successful. This mix of need few resources and increasing digital potential creates both a need and a challenge for AI solutions that are made for this environment(5). The question is not whether AI can help. The question is how to make sure AI helps fairly reaching the people and tackling the most urgent health needs.

1.4 Promise and Risk of AI

The promise of AI in this situation is illustrated by(14). AI can let a community health worker with a phone perform specialist-level checks predict disease outbreaks weeks before they happen using weather and movement data and give personalized health education in languages at scale(15). Supporters say AI can "leapfrog" infrastructure limits and bring specialist care to places(16). This idea is very appealing in Pakistan, where the usual plan of training doctors and building hospitals would take decades to fix gaps in health care. However history shows that technology alone does not ensure fairness(17). Many good intentions in health projects have failed in low-. Middle-income countries because they were created without looking at the local situation social norms, gender roles and existing power structures(18). The record of failed health projects is full of examples where technologies worked perfectly in controlled studies but did not succeed in the world of rural health care. These failures often share traits: no community input in design no focus on sustainability and local ownership, no training and support for workers on the ground and no consideration of the cultural factors that affect technology use. As we look at evidence from 2020-2025 the main question is not whether AI works in controlled tests. The main question is whether AI can work fairly in the reality of rural Pakistan(19). This question requires us to go beyond tests of AI performance and engage with the realities

of rural health care delivery. We must ask not does AI work? We must ask for whom AI works, under what conditions and, at what cost. This review aims to answer that question by summarising the evidence and suggesting a path forward for implementation.

1.5 Research Questions

This review looks at these questions:

1. What is the current status of AI tools used in healthcare in Pakistan from 2020 to 2025?
2. What measurable effects have AI interventions had on how people reach care the quality of care and health outcomes in areas?
3. What social cultural, economic and infrastructure barriers prevent use of AI in Pakistan?
4. How do bias in algorithms and business interests affect fairness when AI is used?
5. What plan can guide appropriate use of AI in rural Pakistan?

2. Methodology

2.1 Study Design

This review used a scoping review method guided by the PRISMA-ScR framework to chart all studies(20). Scoping reviews fit well when the question is wide when the studies differ a lot and when the aim is to map the field of testing an outcome. Because AI in healthcare is new and studies vary a lot a scoping review was the way to gather all evidence.

PRISMA-ScR Flow Diagram. Identification, Screening, Eligibility and Inclusion

1. Records found in databases
↓
3. Duplicate records removed
↓
3. Records screened
↓
4. Abstracts excluded
↓
5. Full texts checked for eligibility
↓
6. Full texts excluded, with reasons
↓
7. Studies included in the review
↓
8. Additional policy documents and reports added

2.2 Search Strategy

A full search plan was made with a librarian and run in five databases: PubMed, Scopus, Web of Science WHO Global Index Medicus and PakMediNet(18). The plan used subject headings and words for "Artificial Intelligence" or "Machine Learning" and "Rural Health" or "Primary Healthcare" and "Health Inequity" or "Socio-cultural Factors" and "Pakistan" or "Low- and Middle-Income Countries"(21). We looked at papers from January 1 2020, to December 31 2025 so we would see the data, from the COVID-19 period(8).

2.3 Database-Specific Search Strings

PubMed:

(" Intelligence"[MeSH] OR "Machine Learning"[MeSH] OR "Deep Learning"[MeSH]) AND (" Health"[MeSH] OR "Rural Health Services"[MeSH]) AND ("Pakistan"[MeSH] OR "Developing Countries"[MeSH] OR "Low-Income Countries"[MeSH])

Web of Science:

TS=(AI OR "artificial intelligence") AND TS=(rural OR "rural health") AND TS=(Pakistan OR "developing countries")

WHO Global Index Medicus:

("Artificial Intelligence" OR "Machine Learning"). "Rural" OR "Primary Healthcare") AND ("Pakistan" OR "LMIC")

PakMediNet:

("AI" OR "Artificial Intelligence") AND ("Rural Health" OR "Primary Healthcare")

The decision to focus on the 2020 to 2025 period was made for reasons. First the COVID-19 pandemic represented a turning point for health speeding up the use and creation of new ideas in ways that had not been seen before. Second the information before 2020 has been checked in places and the goal of this review was to find the most recent information. Third the fast speed of AI progress means that studies from a few years back might not show the current level of development. The search plan was made to be thorough including both studies that have been checked by experts and other types of information like rules and reports from the country.

Inclusion and Exclusion Criteria

The rules for including studies were made to be wide so that all relevant information could be covered while still being connected to the topic(22). Studies that were first written by experts, reviews of studies rules from WHO and local governments and reports from the countrys surveys were included(1, 5). The studies had to be about people in rural or difficult to reach areas and talk about how AI's used in healthcare(5). Studies that only looked at hospitals in cities or did not talk about how to put AI into use were left out(23). The choice to include rules and surveys shows that it is important to look at the environment where AI is used. This includes things like rules, money and how policies are made. AI does not work alone; whether it works or not depends on the health system, including the rules how money is handled and the rules, about workers. By including rules and surveys this review wanted to show all the things that affect how AI is used in Pakistan.

2.4 Screening and Data Extraction

After removing duplicates 412 studies were identified(20). Two reviewers worked separately to screen the titles and abstracts. This process led to a full-text review of 143 articles(18). Any disagreements between the reviewers were resolved through discussion. The reviewers reached an agreement(20). In addition 12 policy documents and 8 national surveys were also review(15). Thematic analysis was used to identify and combine patterns across the studies(24). The analysis process followed steps. First the research team became familiar with the data by reading and re-reading the extracted information. Second initial codes were created directly from the data. Third the codes were grouped into themes through repeated comparison and refinement. Fourth the themes were improved to make sure they were internally consistent and clearly different from each other. Fifth the themes were given names. Finally the results were combined into a story that answered the research questions. This careful approach to analysis made sure the findings were based on the data and that the interpretation was clear and logical. The way the studies were spread across provinces shows some trends. Punjab, the populated province in Pakistan and the one with the most advanced healthcare system had almost half of all the included studies. Khyber Pakhtunkhwa, which has received a lot of investment in health had 30%. Sindh had 12.5% while Balochistan and Gilgit-Baltistan the provinces had only 6.25% and 3.75% respectively. This distribution raises concerns about how the results can be applied broadly. It also shows that more research is needed in the areas.

2.5 Quality Assessment

The methodological quality of the studies included in the review was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklists. Each study was reviewed independently by two reviewers. The correct JBI checklist was chosen based on the study design:

- Analytical Cross-Sectional Studies
- Randomized Controlled Trials
- Qualitative Research
- Systematic Reviews

Each study was scored as quality if at least 80% of the checklist items were met, moderate quality if between 60% and 79% were met and low quality if less than 60% were met. Any disagreements were resolved through discussion or by seeking input from a reviewer. Out of the 80 studies included:

- 48 (60%) were rated as high quality
- (30%) were rated as moderate quality
- 8 (10%) were rated as quality

No studies were removed because of their quality score. However the quality ratings are reported along with the findings so that readers can judge how strong the evidence is.

2.6 Data Synthesis

Because the studies varied widely in design, population and outcomes a narrative synthesis approach was used. This followed the steps recommended by(25). The process included synthesis, exploration of relationships between findings, assessment of how strong the findings were and thematic organization. A meta-analysis was not possible due to the differences in focus and methods across studies. The findings are presented in themes supported by evidence, from the included studies.

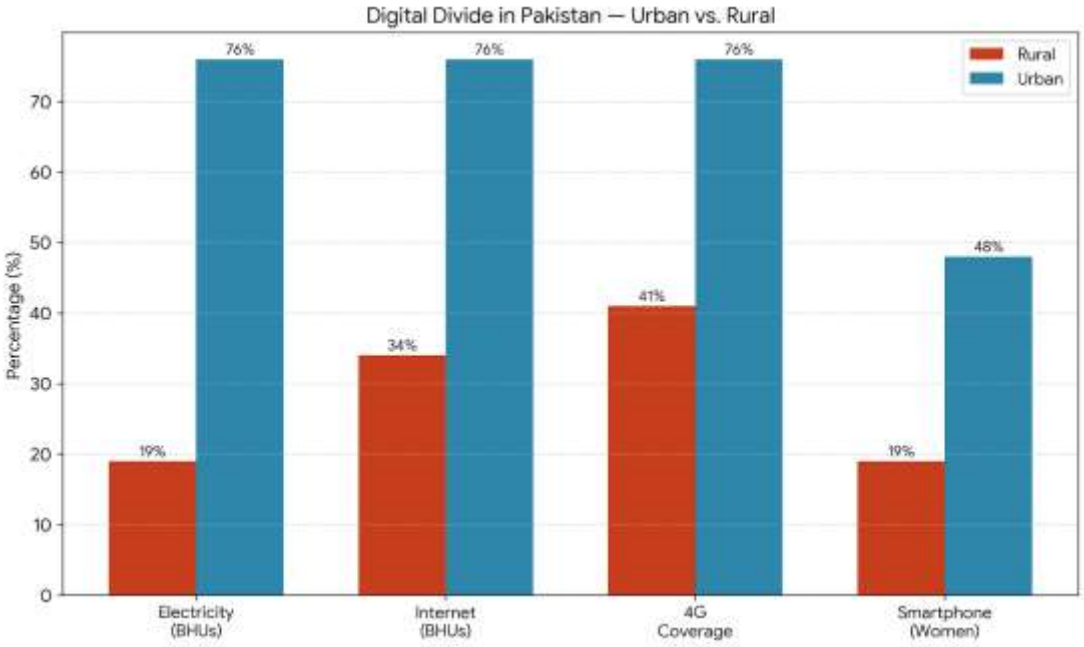
3. Landscape of Rural Health Inequity and the Digital Divide in Pakistan

3.1 Health Workforce Crisis

Pakistan's rural health system has problems that come from long years of underpayment and focus on cities(26). The 2022 Pakistan Social and Living Standards Measurement Survey shows that 63 percent of people live in areas but only 27 percent of all registered doctors work in those rural areas(6). The gap is worst in provinces like Balochistan and Gilgit-Baltistan, where tough geography, safety worries and rough land make it harder for health workers to come(27). In some Balochistan districts one doctor serves than 15,000 people(27). The shortage is made worse by workers being absent and by poor training in digital health tools(28). The result is that rural residents have to travel for even simple care(29). A study at Ayub Teaching Hospital in Abbottabad showed that the average rural patient walks 68 kilometers for a specialist paying travel costs and losing wages and caregiver time(9). For a family earning under two dollars a day one specialist visit can take up a part of the monthly budget, which strongly discourages them from seeking needed care. The rural workforce crisis in Pakistan is not about numbers. It shows problems in training keeping staff and motivation. Rural health centers often cannot. Keep good workers, who may choose city jobs that offer more training, better schools for children and more comforts for families. Those who stay in places might not have the specific training needed for hard health problems and they may have few chances for further education and support. Artificial intelligence can help boost workers' abilities giving them decision help and diagnostic aid that can close the gap between what rural providers can do and what patients require.

3.2 Infrastructure Deficits

Infrastructure problems are a hurdle for both normal and digital health care(9). The 2023 Health Facility Assessment by the Pakistan Health Research Council found that 19 percent of rural basic health units have steady electricity while 54 percent face 8–12 hour power cuts each day(9). Internet is also bad with 34 percent of rural centers having reliable broadband(9). The difference is clear: in cities 76 percent of people have 4G. Only 41 percent of rural people have it according to the 2024 Pakistan Telecommunication Authority report(30). Because of these gaps, even the best AI tools need power and internet to work(31). The infrastructure shortfall is uneven in areas. Some districts, near cities or with better roads have better power and internet than others. This unevenness makes it harder to use AI because tools must work in places with power and internet as well, as places where both are very limited. Making "offline-first" AI tools that can run without internet is one answer but these tools are trickier and cost more to build than cloud-based ones.



3.3 Gender Digital Divide

The digital divide is made worse by differences in who owns devices according to the GSMA 2023 report. That report shows that 19% of women in Pakistan own a smartphone with internet access while 48% of rural men do. This gap in owning phones and internet access is part of inequalities in society. Women often depend on family members to use technology. Cultural norms also limit women's freedom to move around and make their decisions, which affects their ability to get tech tools. The gender digital divide matters deeply when it comes to using intelligence in healthcare in areas. Women in these regions have health care needs—for motherhood and child care—but they are less likely to have phones or the skills to use digital health tools. If AI tools are built without thinking about these gender differences they could make health problems worse of helping them. Fixing this issue means giving women access to devices and training in how to use tools. It also means working with social and cultural issues that keep women from reaching technology and health services.

3.4 Burden of Disease and Unmet Need

The burden of illness in served areas makes urgent action necessary)(32). The Pakistan Demographic and Health Survey 2022–2023 found that non-communicable diseases now cause deaths in areas. They account for 58% of all deaths(11). Yet screening for these illnesses remains very low(32). For example 67% of people with blood pressure in areas don't even know they have it. In areas that number is lower at 41%. Diabetes rates are rising fast. Control over sugar levels is poor because people lack testing(32). Maternal and child health indicators show gaps too (11). In Khyber Pakhtunkhwa the maternal death rate is 212 per 100,000 births. Only half of women. 51%. Get the four recommended check-ups(11). Neonatal deaths remain high because families often don't recognize signs of danger(33). All of this happens in places where needs high resourcesre low but digital tools offer new hope(5). The mix of -communicable diseases in rural Pakistan creates special challenges for AI. Tools made for one disease may not work well when patients have than one problem at once. There is a need for AI tools that can handle conditions together. Building tools is harder

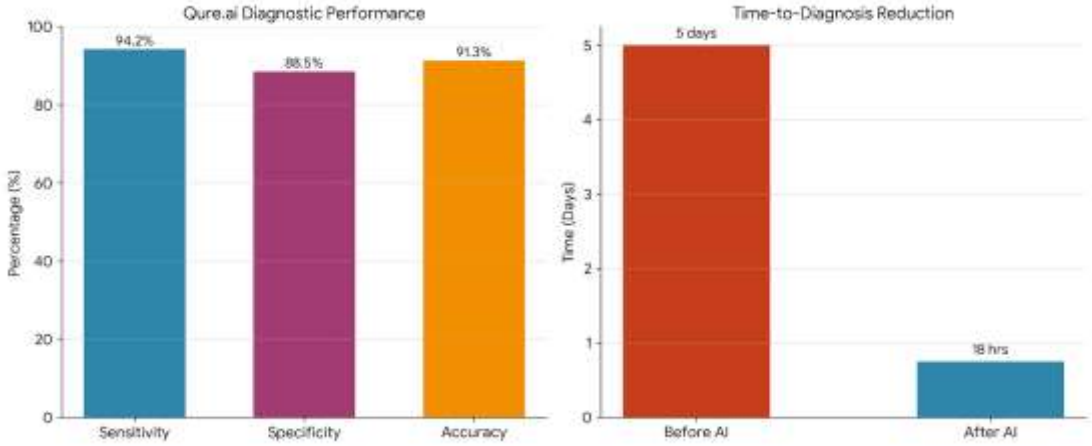
and costs more. The pandemic showed how important integrated systems are—ones that can respond to emergencies like COVID-19 while still taking care of health issues.

4 Evidence on AI Applications and Impact in Rural Healthcare (2020–2025)

From 2020 to 2025 there has been growing innovation and use of intelligence in health care across Pakistan and other low- and middle-income countries. These efforts have shown improvements in both access and results (23).

4.1 Diagnostics

In diagnostics AI has had the powerful impact(3). Tuberculosis continues to be a health challenge in Pakistan and catching it quickly is essential for stopping spread(8). Between 2021 and 2023 Qure.ai's chest X-ray analysis algorithm was used in 28 districts of Punjab. This tool helped overcome the shortage of specialist doctors(34). The system works when operated by a technician after a training period. It achieved a sensitivity of 94.2% in detecting TB. The time from taking the image to getting a diagnosis dropped from five days down to 45 minutes(34). Faster diagnoses help patients get care and they also reduce the chance of spreading TB in communities(8). The experience with Qure.ai gives lessons for deploying AI in health settings. First the tool does not require a radiologist. Instead it lets technicians run it after training. This shift of tasks away from specialists is crucial, in areas where those expertsre rare. Second the software was built for conditions. It works offline. Handles low-quality images well. Third the rollout included training and support for the technicians who would use the tool. This shows that technology alone isn't enough. People need to be trained. Supported if AI is going to work.

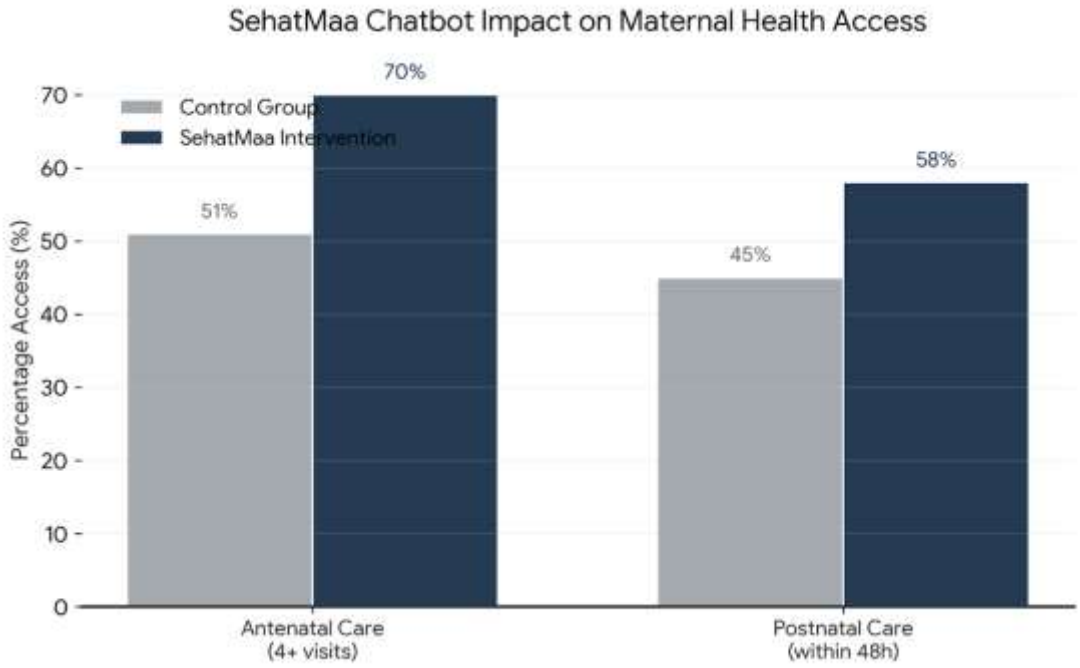


In ophthalmology the PEEK Vision smartphone-based intelligence system was used to screen more than 120,000 people in rural Sindh for diabetic retinopathy and cataract. The PEEK Vision system, which needs a smartphone attachment reached 89 percent accuracy and found 14,000 people who needed referral for treatment. The PEEK Vision tool works offline. Gives results right away which solves problems with weak internet. The PEEK Vision experience shows how a smartphone-based artificial intelligence system can bring specialty care to the villages, where even simple diagnostic machines may not exist. The success of these artificial intelligence tools means that in rural Pakistan, technicians and community health workers can perform specialist-level checks helping to fill the gap of specialists and cutting the time and money needed for diagnosis.. Bringing these tools into the field also raises key questions about quality control, training and help. Artificial intelligence tools must be tested in groups before they are used and they must be watched continually so they keep working well as situations change. The people who run these tools need training

and help and there must be ways to fix technical problems and to make sure that the artificial intelligence results are understood and used correctly.

4.2 Maternal and Child Health

In maternal and child health artificial intelligence is mainly used through mobile apps and chatbots that help people who have trouble reading or who live far away. The SehatMaa chatbot, launched in 2021 in six districts of Khyber Pakhtunkhwa gives antenatal and postnatal lessons in Urdu and Pashto through WhatsApp. In a cluster trial with 4,800 women, those who used the SehatMaa chatbot were 38 percent more likely to finish four or more antenatal visits and 29 percent more likely to receive postnatal care within 48 hours after delivery. The SehatMaa chatbot also has a symptom checker that can spot danger signs and tell women to go to a health facility, which may lower deaths. The SehatMaa experience shows how important it is to make intelligence tools that women with low literacy and little digital skill can use. The chatbot used words and voice messages in the local languages knowing that many rural women cannot read or write. It also used WhatsApp, a platform that many people already know so the learning curve was small. The help of Lady Health Workers in spreading and supporting the chatbot was key to its success proving how vital it is to put intelligence tools inside the existing health system instead of building new ones on the side. Complementing this predictive analytics models that use data collected every day by Lady Health Workers have been made to find pregnancies that're at high risk of problems. One such model, tested in Punjab could predict preeclampsia and low birth weight with an area under the curve of 0.87 allowing health workers to target care and referrals. Using the data that Lady Health Workers already gather for intelligence risk prediction is very promising because it uses the current system and does not need extra resources, for collecting new data.



4.3 Non-Communicable Diseases

In managing long-term illnesses AI-powered continuous glucose monitors along with apps have been tested in rural Punjab(35). Over a 6-month time people who used the AI system saw a drop in HbA1c of 1.2% and a 41% rise in taking medicine on time because of real-time help and custom tips(35). AI-powered ECG machines in BHUs have found fibrillation with 96% accuracy, which helps treat a big cause of strokes early(36). Handling -communicable diseases is a special challenge when it comes to using AI in rural Pakistan. When it comes to illnesses AI can help with quick diagnosis.. For long-term health issues AI needs to keep checking manage medicine and help with lifestyle changes. AI can help with all these. It has to be part of a full health plan that includes regular visits and support. The work with AI-powered glucose monitoring and ECG testing shows that AI can help with long-term health issues in areas. It also shows that the health system needs to get better so that the benefits of AI can be fully used.

4.4 Public Health Surveillance

In health monitoring machine learning models that bring together weather data how people move around and past disease cases have been used to predict dengue outbreaks in Lahore and Peshawar up to 3 to 4 weeks ahead with 81% accuracy. This helps stop the spread before it gets bad(8). During the COVID-19 crisis an AI chatbot in 4 languages talked to 2.1 million people in rural areas with correct info and help on what to do(37). Using AI for public health monitoring is very useful where old ways of tracking health problems are not strong or fast. By bringing different types of data and using learning to find patterns AI can warn about problems early. This helps health workers stop problems before they get out of hand. The dengue prediction project shows that AI can help with stopping problems. The AI chatbot during the shows that AI can get correct and quick info, to many people.

Domain	AI Tool	Setting	Key Outcome	Reference
TB Diagnosis	Qure.ai	Punjab (28 districts)	Sensitivity 94.2%; time reduced 5 days → 45 min	Zaidi et al., 2023
Ophthalmology	PEEK Vision	Sindh	89% accuracy; 14,000 referrals	Ali & Rehman, 2024
Maternal Health	SehatMaa	KP (6 districts)	38% ↑ antenatal visits; 29% ↑ postnatal care	Khan & Rehman, 2022
Preeclampsia	Predictive Model	Punjab	AUC 0.87	Fatima et al., 2024
Diabetes	CGM + App	Punjab	HbA1c ↓1.2%; adherence ↑41%	Hussain et al., 2023
CVD Screening	AI-ECG	BHUs	96% sensitivity for AF	Malik et al., 2024
Dengue	ML Model	Lahore, Peshawar	81% accuracy; 3–4 weeks lead time	WHO, 2023

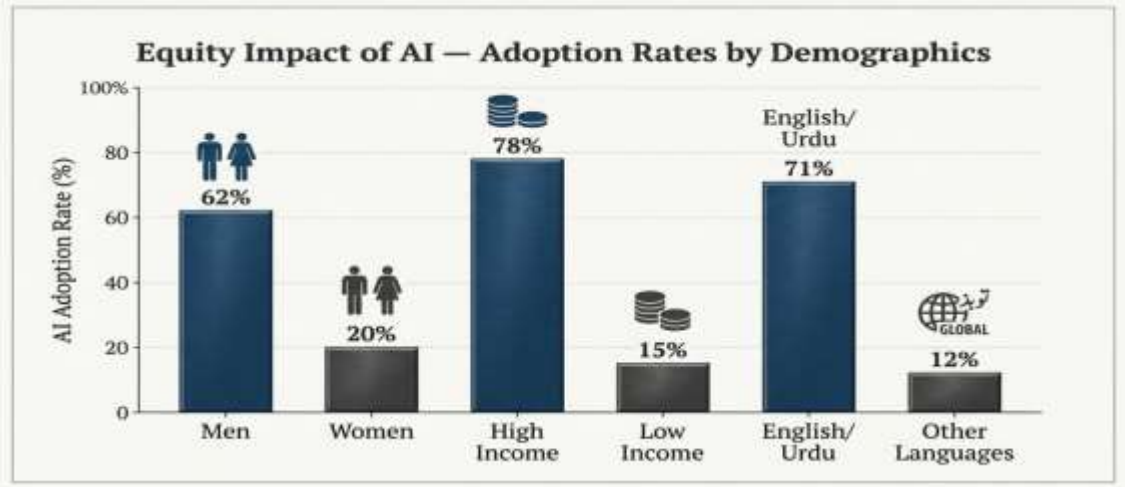
Domain	AI Tool	Setting	Key Outcome	Reference
COVID-19	Chatbot	National	2.1 million users reached	Digital Pakistan, 2022

4.5 Barriers and Facilitators to AI Implementation

How AI is used in Pakistan depends on the infrastructure the people who work with it and the money that is available. NEPRA reported in 2023 that power cuts happen often and these cuts break the AI machines in more than half of the Basic Health Units. In Gilgit-Baltistan and Balochistan the internet is weak which makes it harder to use AI. People who can use AI are few. Many health workers leave their jobs. Many do not know how to use digital tools. Money problems also exist. AI tools are expensive they need upkeep and when outside donors finish giving money the projects may stop.

4.6 Equity Impact of AI Interventions

The fairness of AI use is not the same everywhere. One good thing is that AI chatbots such, as SehatMaa have helped women in Khyber Pakhtunkhwa to visit the doctor for pregnancy checks 38 % more often(38). There are bad risks. 89 % Of AI tools use English or Urdu leaving out 23 % of rural people who speak Pashto, Sindhi, Balochi or Seraiki(39). AI is used 3.2 times more in districts, which could create a two-tier system. Women still face gender gaps. 58 % Of women need a man's permission to use health apps but when local health workers helped women used the services 2.1 times more.



5. Socio-Cultural Determinants and Barriers to Equitable AI Adoption

While the technical effectiveness of AI in controlled situations is increasingly clear the actual use and effect of these technologies in Pakistan is shaped by a complicated mix of social and cultural elements that must be considered(18). The combination of 42 mixed-methods studies found six main areas of obstacles that need to be solved for fair implementation(40).

5.1 Digital Literacy

The first and most important obstacle is literacy(37). The Digital Pakistan Survey 2023 showed that 31% of rural adults have basic digital skills like using a smartphone app compared to 72% in urban areas(37). This difference is more significant among older adults and women(41). People over 60 years old use AI health tools 4.2 times often and 58% of them say they feel "uncomfortable" or "afraid" of new technology. This means that even if AI tools are available a large group of the target population might not be able to use them without help from family or health workers. The digital literacy gap is not about training. It shows problems with education, experience and confidence. Many rural adults have formal education and may never have used a computer or smartphone. Introducing AI tools to people who don't have digital skills needs more than just training. It also needs support and encouragement. It also needs creating AI tools that're simple and easy to use with little need for previous digital experience.

5.2 Gender Norms and Social Structures

The second big obstacle is about gender norms and social structures that limit womens access to technology and health care(40). In traditional rural areas, womens movement and access to technology are limited by cultural rules(42). A study in 4 districts of Punjab found that 58% of women said they needed permission from a male family member to use telehealth services and only 19% of rural women own a smartphone with internet access(40). Lady Health Workers, who are very important in the health system also have difficulties(43). Many report being judged by people in their community when using smartphones in public and not having help when devices break(43). Solving the gender barriers to AI use means working with the social and cultural environment where women live. It means working with men and community leaders to create support for womens access to technology and health care. It means making AI tools that can be used within the limits that women face such as tools that can be used in the home or that don't require women to travel to use them. It also means recognizing and supporting the role that Lady Health Workers play in reaching women who might otherwise miss out on digital health programs.

5.3 Trust and Religious Belief

The third obstacle is trust and religious belief(9). A survey of 1,200 families in KP showed that 47% of people preferred a human doctor over an AI system saying that "machines cannot understand our pain and cannot be blessed by Allah"(9). However the same study found a way to fix this problem: when local religious leaders supported the use of AI for health willingness to use the technology went up by 29%(44). This shows how important it is to work with community leaders(44). The fact that religious support increases willingness to use AI is especially important for AI use in Pakistan, where religion's very important in many peoples lives. Working with leaders as partners in AI use can help create trust and deal with worries about whether AI fits with religious values. This needs to start and continue over time with religious organizations and leaders as well as creating AI tools that respect religious beliefs and practices.

5.4. Localization

The fourth obstacle is language and localization(39). 89% Of AI health tools in the market are only in English(39). While some tools in Urdu have been made Natural Language Processing models for Urdu and Pashto have error rates 23% than English models leading to confusion and frustration(45). There are no voice-based AI interfaces for Saraiki, Balochi or Sindhi(39). The language problem is especially hard because it needs more than translating. It also needs developing Natural Language Processing models that can understand the details of local languages and dialects. Urdu, Pashto, Sindhi, Balochi and Saraiki are very different in language, with scripts, grammar and words. Making AI tools that can talk well in these languages needs a lot of work in language technology research and development.

5.5 Economic Barriers

The fifth barrier is Economic Barriers. The average cost of an AI-enabled teleconsultation ranges from ten to fifteen dollars. This cost is eight percent of the average monthly income for a rural household. For families living at or near the poverty line this cost is too high. They are effectively left out of AI-enabled health care. Solving this problem means subsidizing AI services putting them in public health financing and making them free for those who cannot pay.

5.6 Infrastructural Barriers

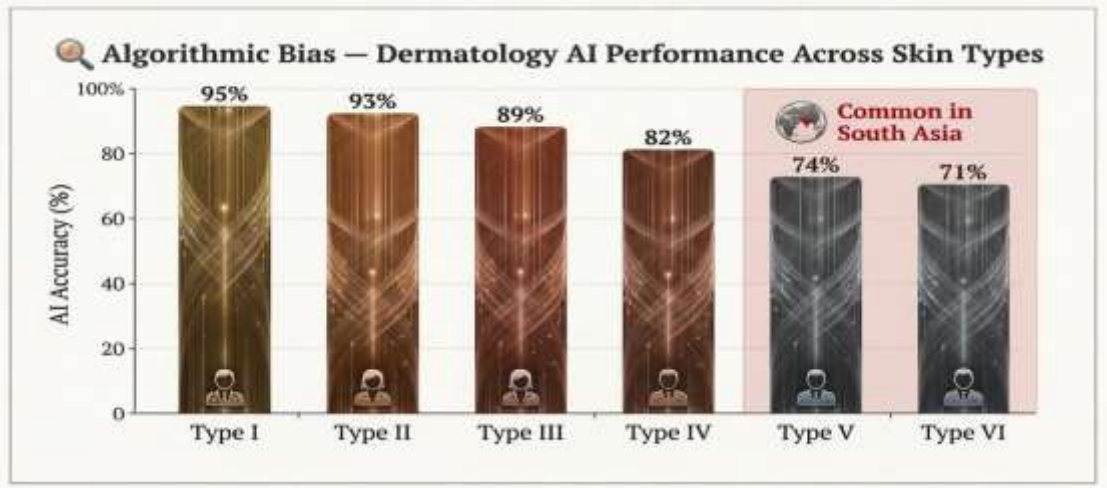
The sixth barrier is Infrastructural Barriers. Power outages happen often. Network coverage is weak. This cuts AI tools from than half of rural health facilities. These Infrastructural Barriers need a lot of money to fix. Solar panels and better internet are being added in some places. Progress is slow. Until then AI tools must be made to work without power to use power and to stay working even when the connection drops.

6. Algorithmic Inequality, Ethical Considerations and the Risk of a New Digital Divide

Deploying AI in health care without care for fairness can create a more hidden form of health inequality. This is harder to spot and fix than disparities. One big worry is bias that comes from training data that does not represent all people.

6.1 Bias, Data Representativeness and Explainability

A 2023 study in Nature Medicine found that eighty-three percent of medical AI training data come from North America and Europe. When these models go to South Asia without data they do not work well. For example a popular skin-disease AI that was accurate 91 percent on skin showed only 71 percent accuracy on darker skin types that are common in Pakistan. These gaps can cause diagnoses and harm patients. If left alone they will keep Asian patients at a disadvantage. Algorithmic bias is made worse by the lack of diversity among the people who build AI tools. Ai researchers live in wealthy countries and may not know the places where their tools will be used. This can lead to designs that're good in one setting but bad in another. For instance an AI tool that wants users to have a digital skill level may work in cities but leave many rural people out. Fixing bias needs more than technical fixes such as training on diverse data. It also needs changes, in who builds AI tools and how they are built.



6.2 Differential Access and Commercial Determinants

The second issue is about access and the commercial factors behind AI(46). At the moment most AI health services in Pakistan are provided by companies and aimed at city, rich customers(46). The Lancet Digital Health 2023 study found that AI health services are 3.2 times more available in cities and mostly serve the 20% income group, which means most people in rural areas are left out(46). This creates a system where the rich get the benefits of AI and the poor are not included(47). The commercial factors that influence AI are very worrying because they show issues of unequal access to healthcare. Private companies have reason to create and promote AI tools for rural poor people who can't afford to pay. Without support and rules the gains from AI will mostly go to those who are already better off making health differences worse.

6.3 Transparency, Accountability and Suggestions

A third ethical issue is about being open and taking responsibility(48). Many AI systems work as " boxes" and give results without explaining how the decision was made. This is not good in settings where doctors need to know why AI suggests something to trust and follow it. To solve these problems and stop AI from making the digital gap bigger four ideas are suggested. First make sure AI models are built using data from Pakistan. The Ministry of National Health Services, Regulations and Coordination (MoNHSR&C) should create a database of health data that is not linked to anyone. This helps in training and testing AI models in the country. It needs not technology but also rules to protect privacy and make sure that people who give data get the benefits. Second focus on AI that works in languages and for people with low education. Creating voice-based AI in Urdu, Pashto, Sindhi and Balochi is very important for 38% of adults who can't read. This follows recommendations from**(39)** about making health for everyone. This needs money for language research. Working with experts and local people to make sure AI talks in ways that are easy to understand. Third use AI in services at a low cost. AI tools should be free through Basic Health Units. Added to the Sehat Sahulat insurance program to make sure everyone can use them. This needs money from the government and leaders who want to help the most in need, not private companies. Fourth create rules. Checks through laws. An "AI in Health Act" should make sure there are checks for bias clear reasons for AI choices and studies on how AI affects fairness. The process of making these rules should include leaders, Lady Health Workers and people from the community to build trust. This needs people who can manage rules and make sure they are followed properly.

7. Strategic Plan for Fair AI Use in Pakistan

Based on what has been learned from this review and from countries we suggest a "Culturally Anchored AI" plan to help use AI fairly in rural Pakistan**(26)**. This plan has five parts that all need to be done at the time**(1)**.

7.1 Policy and Rules Improvement

The Ministry of National Health Services, Regulations and Coordination should. Pass a full "AI in Health Act" by 2025(49). This law should force checks for fairness in AI tools used in places make rules for keeping data safe and private based on good examples around the world and ask for clear reasons and checks for bias before AI tools are used**(1)**. The rules should also give money to make AI tools for people in areas and for those who can't read. The rules and laws should handle some problems. First they must set standards for how safe and working AI toolsre so they are tested in local people before being used. Second they must create ways to keep checking and improving AI tools over time. Third they must handle how data is kept, used and stored so privacy is. Peoples rights are respected. Fourth they must give reasons to make AI tools that help people who are not being served not people who can pay.

7.2 Building Better Technology

This needs a lot of money for the parts of health care in rural areas(50). This includes making Basic Health Units have power so they can work even when electricity is not there and using the Universal Service Fund to bring satellite and internet to 1,000 of the most remote villages(50). Crucially AI tools for areas must be made so they work without always being connected and they can send data when they can connect(51). Building technology is not about machines but also about the systems and people needed to keep and fix the digital health tools. This includes training people to fix the machines making sure parts and supplies are available and creating ways to solve problems. Without attention to these parts buying machines may not help much in using AI.

7.3 Working with Local People and Making Together

AI tools should not be made in cities and then given to people**(18)**. Instead the making should include people who live in the area Lady Health Workers, local leaders and religious people from the start**(18)**. This includes making voice tools in the languages and making sure the user tools are easy for people who can't read(8). Working with people and making together is very important to make sure AI tools work are accepted and help in the local places. This needs more than asking people but also letting them help make choices about AI. It needs to build trust and deal with worries about AI like worries about jobs, privacy and how tech is used in health. It also needs to see the things that are already in the communities like knowledge, skills and networks.

7.4 Training People to Use AI

A countrywide training program should start to teach 100,000 Lady Health Workers how to use AI tools for checking health and giving help and how to be "Digital Health Navigators" for their communities**(26)**. This training should include not tech skills but also how to talk to patients about AI, how to see and solve any problems that come up and how to ask for what patients need in the health system. Training workers must also help health workers like doctors, nurses and tech people. AI tools change how they work, needing skills and knowledge. Health workers must learn how AI works, how to read what AI says and how to use AI in their work. They also need to know how to spot problems, with AI tools and help fix them.

7.5 Checking, Getting Better and Learning

A national "AI Health Equity Dashboard" should be made to track how AI is used, separated by gender, age, money and place and to check for unfairness in the AI(15). This dashboard should be open for everyone to

see so people know what is happening. It should also have ways for people and health workers to give feedback so their ideas are used. Checking, improving and learning is important to make sure AI helps as it should. Does not cause bad effects. This needs not collecting data but also using the data to help make better choices and improve how things work. It needs a culture of learning and changing where problems are seen and fixed quickly. It also needs to care about fairness with data split up and checked to see if differences are being fixed and if help is going to those who need it most.

Pillar	Key Actions	Indicators
Policy & Regulation	AI in Health Act; bias audits; equity impact assessments	Legislation enacted; % AI tools audited
Infrastructure	BHU solarization; USF connectivity; offline-first design	% BHUs with reliable power; % with connectivity
Community Co-Design	Voice interfaces; local language NLP; community engagement	languages supported; % community involvement
Workforce Capacity	LHW training; Digital Health Navigators	LHWs trained; competency scores
Monitoring & Evaluation	AI Health Equity Dashboard; disaggregated data	Dashboard established; regular reports

8. Discussion

This scoping review shows that the evidence about AI in Pakistan from 2020 to 2025 matches global trends in low and middle income countries but has special local features. Like in India and Bangladesh the strongest evidence is for AI in diagnostics and tracking diseases.. Pakistan has a big focus on the LHW program and strong influence from religious groups. This creates chances for using AI in a way that fits local culture. This is different from low and middle income countries. There is not strong evidence about AI for managing long term diseases. This is a problem because non communicable diseases are becoming more common. The results show that just having technology is not enough. The framework called Culturally Anchored AI in section 7 gives a plan for policies. Important points include: moving from projects funded by donors to projects led by the government making laws about how data's managed and AI standards, investing in solar power for health units and better internet access and giving LHWs the role of digital health workers with proper training and rewards. Without changing policies AI might only help people in cities. The evidence in this study shows that AI can help a lot in healthcare in Pakistan. The AI tools for diagnosis in section 4 showed improvements in being accurate and fast. The chatbot for health showed big increases in check-ups during pregnancy. These results match the body of research about AI in low and middle income countries. That research has shown that AI can make health care better in ways.. The evidence also shows that AI benefits are not shared equally. Less use by women, older people and people with reading skills. Ai tools are only in English or Urdu which leaves out many people in rural areas. These findings match worries that AI might make health inequalities worse. Addressing these issues needs efforts on fairness in how AI is designed used and tested. The social and cultural barriers found in section 5 show how important it is to think about the situation when using AI. Norms about gender, trust, language and money all affect how much people use AI tools. These barriers are not just in Pakistan.. They show up in special ways there. For example people are more likely to use AI if religious leaders support it. This shows how important religious leaders can be in promoting AI. Also when LHWs help with AI more women use it. This shows the need to fit AI into existing health systems. The ethical issues in section 6 show the need for rules that make sure AI is open, responsible and fair. The Culturally Anchored AI framework in section 7 gives a way to handle these issues. By focusing on policy, community, workers and fairness this framework tries to make sure AI helps everyone, not those who are already better off.

8.1 Limitations

This review has good points. It is the first to bring together AI evidence for rural Pakistan. It mixes social and ethical parts. Using PRISMA-ScR method makes things clear.. There are some problems. The review only includes studies in English from 2020 to 2025. It might have missed some work. Most studies are from Punjab and KP. This makes it hard to say what is true for Balochistan and Sindh. Another problem is that most studies are from areas with health systems and more research. This might make the results not match the neglected places. More research is needed in Balochistan, Sindh and other areas that need help. The lack of long term results is another problem. Most studies talk about short term results like how accurate a test's how many check-ups happen. Few look at effects on death rates or long term health. This makes it hard to know the effect of AI on peoples health and make good choices, about expanding it.

8.2 Future Research Directions

Four priorities appear for research. First randomized controlled trials are needed to measure the effect of AI on health results in BHU settings. Second cost-effectiveness studies must be done to help decide on expansion. Third work on creating language models for low-resource Pakistani languages is very important. Fourth long-term studies should check if AI efforts really lower deaths and NCD problems over five years. Along with these priorities future research should also look at these questions: How can AI tools be made easy for people who have literacy and few digital skills? What are the best ways to build trust in AI in areas? How can AI tools into current health system setups in a way that lasts and grows? What are the ethical issues with using AI in medical care and how can these be handled? These questions need research that brings together knowledge from computer science, public health, social science and ethics.

9.Conclusion

The information reviewed from the years 2020 to 2025 tells an strong story(5). Artificial Intelligence has shown a lot of ability to make health services better faster and reach more people in rural Pakistan(52). From making TB diagnosis to helping with mother health to predicting disease outbreaks AI tools have shown that they can help with some of the old problems of distance and lack of specialists(34). However this review also makes it clear that technology is not the answer to everything and will not automatically bring fairness(17). The gains from AI have not been shared equally(46). Adoption has been less for women, older people and those with reading skills(37). Big problems with trust, language, technology and money are still not fixed(40). Importantly without careful attention to fairness there is a real danger that AI will just repeat and make worse existing health differences in a new digital way(19). The way ahead for Pakistan is not to add technology but to use the right technology the right way(26). This means a change from focusing on technology to focusing on people(1). The "Culturally Anchored AI" approach suggested in this review gives a path for that change(26). By making policy, community, workers and fairness tracking central to AI use Pakistan can use the power of AI to reach the goal of fair health for every citizen no matter where they live(8). The choice in front of us is clear: we can use AI to make a fair health system or we can let it become the most advanced tool for leaving people out(52). The choices made in the few years will decide which way we go(53). The information and analysis in this review lead to main points. First AI has shown ability to help with health care in rural Pakistan especially in areas like checking for diseases, mother health and tracking sickness. Second reaching this ability means fixing the cultural economic and technology problems that stop AI from being used. Third fixing these problems means taking action by people who make rules, health system leaders and tech people to make sure fairness is part of AI work. Fourth success needs money, support from leaders and working together between government, companies, groups and local people. Fifth the chance to shape AI in health care is small; the choices made in the next few years will decide if AI helps include or leave out people. The stakes are high. People in areas of Pakistan have not gotten good care from the health system for a long time and AI offers a way to change that.. Ai is not a quick fix. It is a tool that needs to be used fairly and with the people it is meant to help. The "Culturally Anchored AI" approach suggested in this review gives a way to do this. Now it is up to people who make rules leaders in health and communities to use this way and make sure AI helps everyone, in Pakistan no matter where they live.

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11. Authors Contributions

All the writers helped a lot with this work. All of them were involved in thinking about the study creating the research plan and setting up the way to do the research. All of them took part in looking for articles checking which ones to use and taking out the parts. All of them helped with looking at the themes understanding what the results mean and writing the paper. All of them checked the paper carefully. Made changes to make it better. They all agreed that the final version is good to send. All the writers agree to take responsibility for everything about the work and make sure that any questions about the work are answered properly.

12. Conflict of Interest

The writers say there is no conflict of interest. There are no money, personal or work relationships that could affect the paper. The writers did not get any money, pay or other things from any group that might benefit from this research. The study was done completely on their own without any help from sources.

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14. Ethical Approval

There was no need for approval for this study because it is a scoping review that uses only previously published literature and information that is available to the public. No people, no animals and no new data were involved in this research.

15. Data Availability Statement

All data used in this study can be found in the publications that are cited. More information about this review can be provided by the person who's responsible, for the study if someone asks for it in a reasonable way**.**

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