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Emerging Trends of using Digital Tools including Artificial Intelligence in Health sector in Nepal: What Next?

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Abstract
The integration of AI and digital technology in Nepal's primary health care system has significantly enhanced diagnostic capabilities, enabling early diagnosis and treatment. The study highlights the use of AI, databases, telemedicine, and mobile apps for disease diagnosis and prevention. AI platforms, particularly those processing radiological images, are the most widely adopted tools. While these technologies have the potential to revolutionize healthcare by improving efficiency, accuracy, and patient outcomes, addressing the existing gaps in policies, regulations and ethical considerations is essential for maximizing their benefits. Further studies are recommended to generate the systematic evidences of adopting digital health solutions for enhancing Nepal's healthcare system.
Keywords: Artificial Intelligence, m-health, digital tool, health service, equity, telemedicine

Introduction
Artificial Intelligence is defined as the technology induced designed system that is capable of reproducing the behavior of humans in their reasoning process. Such systems are commonly referred as intelligence system. Such system needs a hardware and software components to acquire and apply knowledge in an "intelligent way" [1]. In resource-poor countries like Nepal, the use of AI and digital technology supports the primary health care service delivery in a number of ways such as cultivating diagnostic understanding thus help prompting for early diagnosis and treatment [2,3]. However, the use of AI and digital technology could not be able to keep pace due to limited government policies, regulations on ethical concerns on AI and lack of reliable sources of information that track the application and use of AI [4]. As the use of AI technologies is thriving

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globally, Nepal has been spotting a persistent obligation for its development and regulation. The Digital Nepal Framework, a government proposal for raising digital literacy and supporting the advancement of information and communications technology. Furthermore, Nepal Science, Technology and Innovation Policy (2019) has stated that the emerging and novel technologies like biological information, artificial intelligence, and robotics shall be utilized at optimum level and thus assist in the rapid development of industries, commerce and other sectors. Since Artificial intelligence (AI) is has been becoming a cutting edge in future global technological landscape, several stakeholders have emphasized the necessity for a new governmental policy on it and adopting towards the use of AI in developmental agenda [5].

Similarly, the AI tools helped in predicting disease outcomes such as COVID-19 mortality among diverse population by analyzing the disease pattern from clinical data [6]. Telemedicine and m-health interventions were implemented for the management of chronic disease monitoring and provision of health care support without visiting the clinicians in remote healthcare settings like rural Nepal [7,8]. The practice of using digital technology is gradually evolving as evidenced by a growing number of digital and AI intervention in various sectors including health, however, the evidence on the use of AI and digital technology in Nepal for disease diagnosis, prognosis and treatment in Nepal has poorly documented. Recently, AI system are increasingly used for interpreting radiographic images including chest x-rays for tuberculosis detection and other pulmonary diseases and using AI based diagnostic model for Malaria detection [9,10].

Thus, considering the context, this article aims to explore the emerging practices of using digital tools and artificial intelligence in public health program relevant to Nepalese context elucidating the major digital interventions including its challenges and opportunities to pave the way for future perspectives in Nepal's health system.

Methodology

Study Design and Data Sources

This study employs a descriptive study based on narrative literature review of the secondary published and grey literatures from multiple sources followed by review and analysis.

Literature search strategy

The study included the articles published in research database as well as grey literatures. The relevant grey literatures published on internet have also been covered for literature review purpose. The grey literatures were used for setting up the study and visualizing the problem, while the articles published in academic databases were used for thematic review. The thematic review and analysis were based on the review of secondary researches published on the PubMed during 2018 to 2024. Based on the search strategy using string of key terms "Digital Tools OR Artificial Intelligence AND Health AND Nepal", total of 66 results hit and matching the selection criteria relevant to Nepal, 30 literatures selected and included in the review. The criteria was set as the literature should include the digital tools and/or AI in healthcare interventions for disease

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diagnosis, prognosis, treatment, prevention and health trainings. The literatures which used in the program surveillance and other programmatic components were excluded. The key results extracted from the qualified literatures extracted for the thematic analysis was presented in appendix 1 [6-35].

Thematic Analysis

The information was extracted from the literatures and sorted in the form of data extraction table using the Microsoft Excel. The literatures were analyzed to identify the themes for theme development such as **type of digital tools**, **data input type, healthcare interventions and the target disease** interventions. such as type of input data used, type of health care services and diseases of interventions. Followed by the thematic analysis on the use of digital tools and AI, the inference was generated for each thematic category using percentage statistics for comparison among the different thematic variables.

Results and Discussion

The review found that digital tools such as AI, database, telemedicine and mobile apps have been used in health sector in Nepal. Artificial Intelligence platform was most widely used tool in healthcare services which accounted for more than three-fourth (77%) followed by other digital data (10%) and Mobile apps (3%). Similarly, based on the type of input data used for AI and digital platform, the radiological and other images were used mostly (50%) followed by the followed by program data/report (43%) and remaining 7% used video/audio recording as input data for processing (**Table 1)**.

Table 1

Type of Digital Tools vs input data for machine learning

Tools	Type of Input Data				
	Image	**Database Report**	**Video**	**Grand Total**	**%**
AI	14	9		23	77%
Database		3		3	10%
Mobile Apps		1		1	3%
Telemedicine	1		2	3	10%
Grand Total	**15**	**13**	**2**	**30**	100%
%	50%	43%	7%	100%	

Analyzing the use of AI and digital technology for the healthcare service, it has been most widely adopted for the purpose of disease diagnosis (63%) followed by disease prevention (23%), healthcare training (7%), prognosis and treatment 3% each.

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Table 2

Type of tools used vs health service category

Digital tool	Diagnosis	Disease Prevention	Health Training	Prognosis	Treatment	Grand Total	%
AI	18	3		1	1	23	**77%**
Database		3				3	**10%**
Mobile Apps			1			1	**3%**
Telemedicine	1	1	1			3	**10%**
Grand Total	19	7	2	1	1	30	**100%**
%	**63%**	**23%**	**7%**	**3%**	**3%**	**100%**	

Further among the category of disease those utilizing the digital tools, the various type of cancers and respiratory diseases including Tuberculosis, each of around one-fifth (17%); are mostly diagnosed and treated followed by utilized in preventive services including COVID-19 prevention and control (13%) and eye care (10%).

The use of AI in COVID-19 disease prediction was widely used during the pandemic context globally which helped to shape the preparedness and response strategies and monitoring the response [36]. Many of the studies conducted globally revealed that the cancer, eye problems and respiratory diseases are diagnosed and treated with the help of AI tools which is similar to the results revealed by this study [37-39]. The application of AI in eye care has become highly sought after. AI algorithms capable of identifying over 50 eye conditions from scans have advanced to such an extent that they surpass specialists' ability to interpret the images. As a result, more patients than necessary are being referred to eye specialists, potentially delaying treatment for those at risk of blindness [40].

There is weak policy framework to guide the use of AI interventions in healthcare though the Government of Nepal has prioritized AI and information technology. The affordability and accessibility of health service could be improved using digital technology in health sector [41]. Among the studies made, the digital tools were used for prognosis of the disease ailment followed by the human judgement to make the final clinical decisions. In Nepal, most of the studies also follow with the similar practices with the marginal benefits for effective resource mobilization such as saving the time of specialists, decision on early diagnosis and treatment, reducing the cost of healthcare cutting down the several follow up tests. Another aspect is that the review captured the cotemporary practices of using combined tools such as AI followed by clinical judgement.

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Although A majority of the studies present machine learning analytic applications have been adopted such as early screening and recognizing of the symptoms and diagnosis, few of the studies shown that the beneficial outcomes in healthcare practices combining the digital tools including AI and human interaction on clinical judgement and treatment decision making for the optimum outcomes [42].

Table 3

Tools vs Disease category

Tools	Cancer	Respiratory Disease	COVID-19	Eye	AMR	Brain disease	Dental disease	Eye disease	General Health	Malaria	Mental Health	Monkeypox	NCD	Surgery	Grand Total
AI	5	4	4	3		2	1			2		1	1		23
Digital Data					1				1				1		3
Mobile Apps														1	1
Telemedicine		1						1			1				3
Grand Total	5	5	4	3	1	2	1	1	1	2	1	1	2	1	30
	17%	17%	13%	10%	3%	7%	3%	3%	3%	7%	3%	3%	7%	3%	

Conclusion

The AI and digital technology have been increasingly used for disease diagnosis such as cancer and infectious diseases including recent COVID-19 pandemic which consequently quickened treatment decision making. Combining the digital technology with human interactions would be feasible strategy until the ethical and legal concerns for ensuring the clients privacy and autonomy have been addressed. As the practice of increasing use of AI or digital tools in Nepal has been

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instrumental to shifting of the traditional way of healthcare delivery to the modern practices, the shift could be significant move to revolutionize the Nepal's healthcare system for equitable quality health care service provision particularly for underserved population. The regulatory and legal aspects of adopting AI in healthcare urgently need to address as the AI has been suffering a lot with limited practices due to gap in ethical aspects and legal ground and governing mechanism in Nepal. There is a larger scope to conduct further studies including the systematic scoping reviews exploring the use of digital interventions and AI technology on a large scale in improving the health system in Nepal.

In summary, the adoption of digital tools and AI in Nepal's healthcare sector holds significant potential to transform the system by improving efficiency, accuracy, and patient outcomes. However, it is crucial to address current shortcomings, such as the absence of policies and regulations, technological and knowledge resource gaps, and ethical considerations, to fully harness the benefits of these technologies for enhancing healthcare delivery in Nepal.

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Appendix 1: Extraction of results from the selected literatures

SN	Digital tools/AI type	Digital tools	Data used	Input Data	Disease/Intervention	Health Intervention	Targetted Disease or ailment
1	AI	AI	Retinal Images	Image	Retinopathy of prematurity	Diagnosis	Eye
2	Database	Digital Data	Program Report and data	data and Report	AMR	Disease Prevention	AMR
3	AI	AI	Radiological Image	Image	Intracranial Aneurysm	Diagnosis	Brain disease
4	AI	AI	Radiological Image	Image	TB	Diagnosis	Respiratory Disease
5	AI	AI	images	Image	oesophageal Carcinoma	Diagnosis	Cancer
6	AI	AI	Retinal Images	Image	Retinopathy of Prematurity	Diagnosis	Eye
7	AI	AI	Cephalogram Image	Image	Dental diagnosis	Diagnosis	Dental disease
8	AI	AI	Health Information	data and Report	COVID-19 prevention	Disease Prevention	COVID-19
9	AI	AI	images	Image	Epilepsy diagnosis	Diagnosis	Brain disease
10	AI	AI	Reports	data and Report	Cancer treatment	Treatment	Cancer
11	AI	AI	Health Information	data and Report	COVID-19 prevention	Disease Prevention	COVID-19
12	AI	AI	DHS data	data and Report	Hypertension	Prognosis	NCD
13	Digital sensing Technology	Telemedicine	video recording	video	Mental Health	Disease Prevention	Mental Health
14	AI	AI	Retinal Images	Image	Retinopathy of prematurity	Diagnosis	Eye

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15	AI	AI	Radiological Image	Image	TB	Diagnosis	Respiratory Disease
16	Mobile apps	Mobile Apps	Tele mentoring information exchange	data and Report	Laparoscopic cholecystectomy training	Health Training	Surgery
17	AI	AI	health information Datasets	data and Report	Monkeypox virus detection	Diagnosis	Monkeypox
18	Telemedicine	Telemedicine	Video and audio recording	video	resuscitation training of HCP	Health Training	Respiratory Disease
19	AI	AI	Image analysis	Image	Malaria diagnosis	Diagnosis	Malaria
20	Digital technology	Digital Data	health inforamtion	data and Report	community healthcare	Disease Prevention	General Health
21	Digital technology	Digital Data	health information	data and Report	NCD screening	Disease Prevention	NCD
22	AI	AI	Radiological Image	Image	TB Diagnosis	Diagnosis	Respiratory Disease
23	AI	AI	Radiological Image	Image	Respiratory Illnesses Diagnosis	Diagnosis	Respiratory Disease
24	AI	AI	Datasets	data and Report	COVID-19 mortality prediction	Disease Prevention	COVID-19
25	AI	AI	Datasets	data and Report	COVID-19 prevention	Diagnosis	COVID-19
26	Telemedicine	Telemedicine	images	Image	Eye disease	Diagnosis	Eye disease
27	AI	AI	Datasets	data and Report	Lung cancer	Diagnosis	Cancer
28	AI	AI	Image analysis	Image	Malaria diagnosis	Diagnosis	Malaria

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29	AI	AI	Image	Image	Breast Cancer	Diagnosis	Cancer
30	AI	AI	Datasets	data and Report	Colon Cancer	Diagnosis	Cancer