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Global eHealth capacity: secondary analysis of WHO data on eHealth and implications for kidney care delivery in low-resource settings

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ABSTRACT

Objective To describe the use of electronic health (eHealth) in support of health coverage for kidney care across International Society of Nephrology (ISN) regions.

Design Secondary analysis of WHO survey on eHealth as well as use of data from the World Bank, and Internet World Stats on global eHealth services.

Setting A web-based survey on the use of eHealth in support of universal health coverage.

Participants 125 WHO member states provided response.

Primary outcome measures Availability of eHealth services (eg, electronic health records, telehealth, etc) and governance frameworks (policies) for kidney care across ISN regions.

Results The survey conducted by the WHO received responses from 125 (64.4%) member states, representing 4.4 billion people globally. The number of mobile cellular subscriptions was <100% of the population in Africa, South Asia, North America and North East Asia; the percentage of internet users increased from 2015 to 2020 in all regions. Western Europe had the highest percentage of internet users in all the periods: 2015 (82.0%), 2019 (90.7%) and 2020 (93.9%); Africa had the least: 9.8%, 21.8% and 31.4%, respectively. The North East Asia region had the highest availability of national electronic health record system (75%) and electronic learning access in medical schools (100%), with the lowest in Africa (27% and 39%, respectively). Policies concerning governance aspects of eHealth (eg, privacy, liability, data sharing) were more widely available in high-income countries (55%–93%) than in low-income countries (0%–47%), while access to mobile health for treatment adherence was more available in low-income countries (21%) than in high-income countries (7%).

Conclusion The penetration of eHealth services across ISN regions is suboptimal, particularly in low-income countries. Increasing utilisation of internet communication technologies provides an opportunity to improve access to kidney education and care globally, especially in low-income countries.

Strengths and limitations of this study

► This is the first study to assess the availability and use of electronic health (eHealth) services across International Society of Nephrology regions using global data on eHealth availability and use.

► Data were collected by the WHO through a web-based survey to evaluate the availability of eHealth across eight themes: eHealth foundations, mobile health, telehealth, electronic learning, electronic health records, legal frameworks for eHealth, social media and big data.

► Lack of policy and governance strategies relevant to eHealth (eg, privacy, liability, data sharing/ownership) as well as poor utilisation of eHealth for learning and health information systems remain the major hurdles to achieving universal health coverage, especially in low-income and lower-middle-income countries.

► The findings of this study can be used to improve workforce shortages for learning, training and delivery of kidney care, especially in low-resource settings.

► A limitation of this work may relate to the non-participation in the survey used for our study of a few countries with large populations in their regions.

INTRODUCTION

Approximately 97% of people worldwide live within reach of a mobile cellular signal.[1] The widespread availability of this service can be a platform for increased utilisation of registries, electronic health records (EHRs) and disease surveillance systems to empower monitoring and reporting of disease incidence and prevalence,[2] patient outcomes,[3] and quality and safety of delivered care,[3 4] as well as to allow comparison between and within health services.[5–7] Electronic health (eHealth) is the cost-effective and secure use of information

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and communications technologies (ICT) in support of health and health-related fields, including healthcare services, health surveillance, health literature, and health education, knowledge and research.[8] According to the WHO, 87% of member states have one or more national mobile health (mHealth) initiatives, 58% have an effective strategy for eHealth and 55% have legislation to protect electronic patient data.[8]

In the current era of the COVID-19 global pandemic, the potential for using eHealth to transform kidney disease management is increasingly recognised.[9 10] A cross-sectional survey conducted by the International Society of Nephrology (ISN) Global Kidney Health Atlas (GKHA) in 2017 reported low utilisation of health information systems in the care of patients with kidney failure, especially in low-income countries (LICs) and lower-middle-income countries (LMICs).[11] However, the survey was limited by a focus on registries.[11] Furthermore, a systematic review of 43 studies that included 6617 participants and evaluated the impact of an eHealth intervention in people with chronic kidney disease (CKD) did not find statistically significant improvements in the health domains assessed with eHealth in patients with CKD, although eHealth was suggested to be useful for dietary sodium intake and fluid management.[12] However, other studies have shown that some forms of eHealth (eg, tele-nephrology) are useful in improving access to kidney care in primary care settings,[13] for self-management of patients with CKD,[14] for nurse practitioner and nephrologist training and education,[15 16] and for safe, economical and efficient care delivery in rural and remote areas.[17] The aim of this study is to secondarily analyse available WHO data on eHealth across eight themes (eHealth foundations, mHealth, telehealth, electronic learning (eLearning), EHR, legal frameworks for eHealth, social media and big data) for universal health coverage[18] and appraise the implications of our findings for kidney care across ISN regions.

METHODS

This study is a secondary analysis of data from the WHO third global survey on eHealth.[18] The study, which was designed using a survey method, is summarised as follows. The cross-sectional survey was developed and conducted by the WHO through the Global Observatory for eHealth (GOe), with input and consultation from experts in eHealth. The survey assessed eight themes in eHealth, namely (1) eHealth foundations, (2) mHealth, (3) telehealth, (4) eLearning, (5) EHR, (6) legal frameworks for eHealth, (7) social media and (8) big data. Concise definitions of these themes are provided:

► *eHealth*[19]: the cost-effective and secure use of ICT in support of health and health-related fields, including healthcare services, health surveillance, health literature, and health education, knowledge and research.

► *mHealth*[18]: the use of mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants and wireless devices, for medical and public health practice, including free telephone hotlines for emergencies provided by trained personnel, and prerecorded messages (toll-free emergency telephone services), reminder messages provided by health services to patients aimed at achieving medication adherence, reminder messages to patients to make or attend an appointment, etc.

► *Telehealth*[18]: the delivery of healthcare services through ICT for the exchange of information in real time (synchronously; eg, by telephone or video link) or by store-and-forward methods (asynchronously; eg, by email) for the diagnosis and treatment of diseases and injuries, for research and evaluation, and for the continuing education of health professionals where patients and care providers are separated by distance.

► *eLearning*[20]: the use of ICT for education.

► *EHR*[18]: real-time, patient-centred records that provide immediate and secure information to authorised users and typically contain a patient's medical history, diagnoses and treatment, medications, allergies, immunisations, as well as radiology images and laboratory results.

► *Legal framework for eHealth*[18]: the legislative process addressing transfer and use of information between healthcare workers and patients that is relevant to issues of privacy and confidentiality of patient data, access rights and sharing rights for data, addressing data quality and integrity as a basis for clinical and patient decision-making, and rules governing the adaptation of professional liability to accommodate care provided remotely or virtually.

► *Social media*[18]: interactive platforms for individuals, communities and organisations to share and discuss content, debate issues and promote new ideas, for example, Facebook, Twitter or YouTube.

► *Big data*[18]: extremely large data sets that encompass a range of data including clinical data from EHR, phenotype, genomic information and data on other determinants of health, such as environment and lifestyle.

The survey was developed in English and translated to seven languages (Arabic, Chinese, English, French, Russian, Spanish and Portuguese) to improve country responses and accuracy of responses. A web-based tool (LimeSurvey; https://www.limesurvey.org/en/) was used for online form creation, data collection and management. WHO regional offices staff assisted in coordinating the survey process and liaising with the GOe Secretariat in Geneva. National-level survey coordinators, together with relevant ministries and academic and research institutions, identified between 5 and 10 national expert informant groups in eHealth to participate in the survey. The group consisted of eHealth specialists, professionals in telehealth, EHRs and mHealth, and statisticians responsible for national health data. Expert informants met for 1 day to reach consensus on a single national-level response. Hence, each participating country submitted a

single national survey with input from its group of expert informants. The survey was conducted between 1 April and 30 June 2015. Data on ICT indices (a composite index of fixed-telephone subscriptions, mobile cellular telephone subscriptions, international internet bandwidth per internet user, households with a computer and households with internet access; scored as low as 0 to as high as 100 and presented in unit scores) were obtained from the World Bank,[21] while more recent (2019 and 2020) data on internet usage were obtained from Internet World Stats (https://www.internetworldstats.com/).

Data handling and processing
The results of the survey were reported according to the Checklist for Reporting Results of Internet E-Surveys statement[22] (online supplemental appendix). After receiving the completed questionnaires, all non-English responses were translated to English and survey responses were checked for consistency. Data were then analysed by thematic sections using computed percentages for each 'yes' response to obtain the overall results for all responding countries and regions. We regrouped country responses using the 10 ISN regional classification: Africa, East and Central Europe, Latin America, Middle East, Newly Independent States (NIS) and Russia, North America and Caribbean, North and East Asia, Oceania and South East Asia (OSEA), South Asia, and Western Europe (https://www.theisn.org/about-isn/governance/regional-boards/). Country responses were also grouped according to World Bank income groups. Data on mobile cellular subscriptions and internet users in each region were provided as the median percentage of the total population of the participating regions. No statistical comparisons were used for describing the data which were presented in percentages.

Patient and public involvement
Patients or the public were not involved in the design, or conduct, or reporting or dissemination plans of our research.

RESULTS
Participating country indices
A response to the survey was received from 125 WHO member states out of 194 member states that were surveyed, representing a response rate of 64.4% and a total population of 4.39 billion people. The list of participating countries based on ISN regional groups is presented in online supplemental table S1, and a summary of the demographic, economic and health metrics for each region is shown in table 1. Overall, the median ICT development index for the participating countries was 4.8 (95% CI 2.9 to 6.9). Four regions, Africa (2.3), South Asia (2.3), OSEA (4.0) and Latin America (4.4), had lower indices compared with the median value, while Western Europe had the highest (7.9). Subscriptions to mobile cellular networks were highest in the Latin America region

(124.6%, 95% CI 89.9 to 142.7) and lowest in South Asia (71.3%, 95% CI 63.7 to 120.6), while the percentage of the population that used the internet was highest in Western Europe (82.0%, 95% CI 70.0 to 93.0) and lowest in Africa (9.8%, 95% CI 3.0 to 18.1) (figure 1). However, internet users increased across all regions in 2019 and 2020, including Africa (21.8% and 31.4%, respectively) and South Asia (34% and 46%, respectively) (figure 1).

National eHealth policies, funding and capacity building
A national policy for eHealth was available in all participating countries in North America (100%) and North East Asia (100%) and was lowest in participating countries from Africa (42%) and from East and Central European countries (47%) (online supplemental figure S1). Availability of policies governing health information systems in countries across regions also varied across regions. Overall, participating countries reported multiple sources of funding for eHealth, including public (77%), donor (non-public) (63%), private (commercial) (40%) and public–private partnerships (42%), and LICs and LMICs relied more on donor funding for eHealth services (online supplemental figure S2). Overall, preservice and inservice training in eHealth were available in 74% and 77%, respectively. Preservice training was lowest in Africa (55%) and highest in the NIS and Russia region (100%) and North America (100%). Inservice training was lowest in Africa (58%) and highest in North and East Asia (100%) (online supplemental figure S3).

Mobile health
Data on access to mHealth across three of the six domains reported (toll-free emergency, appointment reminders and treatment adherence) are provided in online supplemental table S2. International toll-free emergency access to mHealth was available in only two regions, OSEA (10%) and Western Europe (11%), and was unavailable in all regions for appointment reminders. National toll-free emergency access to mHealth services was variably available in all regions. Access to national mHealth services for treatment adherence was mostly available in LICs (21%) and was lowest in high-income countries (HICs) (7%).

Telehealth
Teledermatology, telepathology, teleradiology and telepsychiatry were reported, but telenephrology programmes were not reported. Nonetheless, services to remote patient monitoring were mostly available in HICs (40%) and at the local/peripheral healthcare system level, with the programme fully established only in 26% of countries (table 2).

Electronic learning
The availability of eLearning for health sciences students (preservice) and health professionals (inservice) in medicine (medical school), nursing and midwifery, and pharmacy is reported in online supplemental figure S4. Use of eLearning in medical school was highest in North East Asia (100%) and lowest in South Asia (40%) and

Table 1 Features of participating countries ranked according to ISN regions and World Bank groups

	Total population of participating countries (million)*	GNI per capita (PPP International $)*	Physician density (per 10 000 population)	Nurse and midwife density (per 10 000 population)	Hospital bed density (per 10 000 population)	Life expectancy at birth (years)	Total health expenditure (% GDP)	ICT development index†
Overall (n=125)	4389.9	18 220 (18 722)	1.63 (0.31–3.24)	2.53 (0.74–6.11)	28 (13–49)	74 (66–78)	6.7 (5.4–8.9)	4.8 (2.9–6.9)
ISN region								
Africa (n=33)	600.7	4873 (6190)	0.11 (0.06–0.29)	0.68 (0.42–0.91)	13 (5–20)	60 (57–64)	5.7 (4.4–7.1)	2.3 (1.6–3.7)
Eastern and Central Europe (n=17)	197.2	18 943 (6815)	2.39 (2.02–3.38)	5.50 (4.16–6.27)	54 (39–66)	75 (74–77)	7.2 (5.9–8.0)	6.4 (5.8–6.9)
Latin America and the Caribbean (n=14)	330.6	12 952 (5452)	1.48 (1.11–2.10)	1.04 (0.62–1.51)	14 (10–21)	77 (74–78)	7.3 (6.4–8.8)	4.4 (3.6–6.0)
Middle East (n=8)	152.3	38 863 (40 229)	1.95 (0.91–2.88)	2.72 (1.87–5.38)	18 (14–18)	76 (74–78)	5.1 (3.0–7.0)	5.9 (4.7–6.8)
NIS and Russia (n=11)	278.4	11 351 (7072)	3.47 (2.53–3.93)	7.11 (5.02–9.04)	52 (40–87)	69 (69–72)	6.1 (4.5–6.8)	5.3 (5.2–6.4)
North America (n=4)	359.4	32 815 (19 823)	1.63 (0.79–2.26)	6.42 (2.33–9.55)	28 (23–31)	77 (73–81)	8.4 (5.7–14.0)	6.6 (4.9–7.9)
North and East Asia (n=4)	1548.2	19 430 (15 835)	2.57 (1.90–3.06)	3.87 (2.64–7.80)	95 (50–135)	73 (69–80)	6.0 (5.6–10.3)	4.8 (4.5–8.3)
Oceania and South East Asia (n=10)	276.2	20 210 (24 142)	1.17 (0.18–1.95)	3.50 (1.11–6.00)	23 (14–31)	74 (67–82)	5.3 (4.0–9.4)	4.0 (2.8–7.9)
South Asia (n=5)	370.4	5366 (3238)	0.36 (0.27–0.83)	0.57 (0.50–0.98)	6 (4–18)	68 (66–71)	3.7 (3.6–8.1)	2.3 (2.2–3.1)
Western Europe (n=19)	276.6	40 262 (11 395)	3.49 (3.15–4.10)	8.80 (4.96–15.20)	46 (33–56)	81 (81–82)	9.4 (8.9–10.6)	7.9 (7.5–8.5)
World Bank group								
Low income (n=19)	353.6	1390 (429)	0.07 (0.04–0.12)	0.53 (0.26–0.77)	10 (4–17)	59 (56–62)	6.2 (4.8–8.1)	1.6 (1.3–1.9)
Lower-middle income (n=30)	899.9	4816 (2102)	0.38 (0.17–1.60)	0.90 (0.62–3.71)	14 (7–31)	69 (64–72)	5.8 (4.2–6.9)	3.1 (2.4–4.0)
Upper-middle income (n=34)	2200.5	14 547 (4236)	1.49 (1.15–2.56)	3.28 (1.41–5.41)	27 (17–54)	74 (72–76)	6.3 (5.4–7.2)	4.7 (4.4–5.9)
High income (n=42)	936.0	38 213 (19 296)	3.27 (2.43–3.78)	6.27 (4.46–10.86)	38 (32–56)	81 (77–82)	8.9 (6.7–9.7)	7.5 (6.8–8.1)

*Data expressed as mean (SD); all other data represent median and IQR.
†Data from the World Bank (2015).
GDP, gross domestic product; GNI, gross national income; ICT, information and communications technology; ISN, International Society of Nephrology; NIS, Newly Independent States; PPP, purchasing power parity.
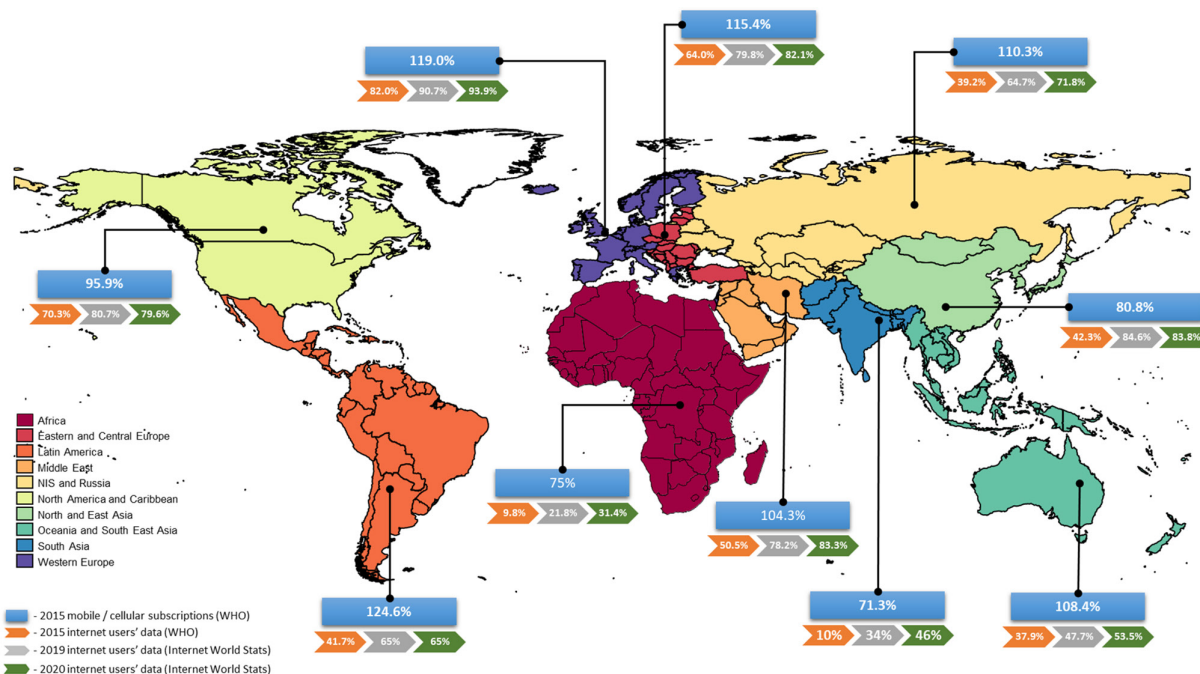
Figure 1 Proportion of mobile cellular users and internet access across International Society of Nephrology regions. NIS, Newly Independent States.

Africa (39%). North East Asia also had the highest use of eLearning services for preservice training of nurses and midwives (75%) and pharmacists (100%). Use of eLearning for pharmacists training was unavailable in South Asia (online supplemental figure S4).

EHR systems
National EHR systems were mostly available in North East Asia (75%), while countries in Africa had the least availability of EHR systems (27%) (figure 2A). Overall, secondary healthcare facilities were more likely to have EHR systems (42%) than primary healthcare (41%) or tertiary healthcare facilities (39%) (online supplemental figure S5). Secondary and tertiary facilities in NIS and Russia had the highest availability of EHR systems (73% and 64%, respectively), while all tiers of healthcare facilities in Africa had the lowest (online supplemental figure S5). The availability of laboratory information systems, pathology information systems, picture archiving and communication system, and pharmacy information systems by income group is shown in figure 2B–E, with most regions reporting low availability of these systems for healthcare. Human resource availability for health information systems was similar across income groups but was highest in the OSEA region (80%) (online supplemental figure S6).

Legal frameworks for eHealth
Aspects of the legal framework governing use of eHealth were not readily available across countries and regions (online supplemental figure S7). For instance, countries from the South Asia region did not have frameworks governing liability or reimbursement for eHealth, patient safety and quality of care based on data quality, protection

of the privacy of individuals, sharing of digital data between health professionals, and sharing of personal health data between research entities (online supplemental figure S7).

Social media
National policy on use of social media by government organisations was lacking and ranged from as low as 9% in the NIS and Russia region to 50% in the North East Asia region. However, specific policy on the use of social media in the health domain was unavailable in six regions (Eastern and Central Europe, Latin America, Middle East, NIS and Russia, North America, and South Asia). When used, social media were mostly used for making emergency announcements, general health announcements and for health promotion campaigns (online supplemental figure S8).

Big data
Information on policy or strategies that govern use of big data in the health sector and private companies was sparsely reported. North East Asia had the highest proportion of policies in the health sector (75%), while Africa had the least (6%). No data were obtained for North America (online supplemental figure S9).

DISCUSSION
The United Nations Sustainable Development Goals emphasise the great potential of the spread of ICT and global interconnectedness to accelerate human progress, and to bridge the digital divide to develop knowledge in societies.[23] The ISN-GKHA has identified large and varied gaps in resources and workforce required for adequate

Table 2 Remote patient monitoring

	Health system level*, n (%)						Programme type†, n (%)			
	International	Regional	National	Intermediate	Local or peripheral level	No response	Informal	Pilot	Established	No response
Overall (n=125)	4 (3)	4 (3)	19 (15)	21 (17)	28 (22)	65 (52)	12 (10)	38 (30)	15 (12)	67 (54)
ISN region										
Africa (n=33)	2 (6)	0 (0)	3 (9)	2 (6)	4 (12)	25 (76)	2 (6)	5 (15)	1 (3)	25 (76)
Eastern and Central Europe (n=17)	1 (6)	1 (6)	3 (18)	2 (12)	5 (29)	6 (35)	2 (12)	9 (53)	0 (0)	6 (35)
Latin America and the Caribbean (n=14)	0 (0)	0 (0)	1 (7)	1 (7)	4 (29)	9 (64)	1 (7)	4 (29)	1 (7)	9 (64)
Middle East (n=8)	0 (0)	0 (0)	0 (0)	2 (25)	1 (13)	5 (63)	1 (13)	1 (13)	1 (13)	5 (63)
NIS and Russia (n=11)	0 (0)	1 (9)	2 (18)	3 (27)	2 (18)	5 (45)	3 (27)	3 (27)	1 (9)	5 (45)
North America (n=4)	0 (0)	0 (0)	0 (0)	2 (50)	1 (25)	2 (50)	0 (0)	1 (25)	1 (25)	3 (75)
North and East Asia (n=4)	0 (0)	0 (0)	2 (50)	0 (0)	1 (25)	1 (25)	0 (0)	1 (25)	1 (25)	2 (50)
Oceania and South East Asia (n=10)	0 (0)	0 (0)	0 (0)	0 (0)	3 (30)	7 (70)	0 (0)	3 (30)	0 (0)	7 (70)
South Asia (n=5)	1 (20)	0 (0)	1 (20)	1 (20)	0 (0)	2 (40)	0 (0)	2 (40)	1 (20)	2 (40)
Western Europe (n=19)	0 (0)	2 (11)	7 (37)	8 (42)	7 (37)	3 (16)	3 (16)	9 (47)	8 (42)	3 (16)
World Bank group										
Low income (n=19)	0 (0)	0 (0)	3 (16)	1 (5)	2 (11)	13 (68)	1 (5)	3 (16)	1 (5)	14 (74)
Lower-middle income (n=30)	2 (7)	1 (3)	3 (10)	3 (10)	3 (10)	21 (70)	3 (10)	6 (20)	1 (3)	21 (70)
Upper-middle income (n=34)	0 (0)	0 (0)	3 (9)	4 (12)	6 (18)	22 (65)	2 (6)	9 (26)	2 (6)	22 (65)
High income (n=42)	2 (5)	3 (7)	10 (24)	13 (31)	17 (40)	9 (21)	6 (14)	20 (48)	11 (26)	10 (24)

*International level: health entities in other countries in the world; regional level: health entities in countries in the same geographical region; national level: health institutes; intermediate level, covering district or provincial facilities: public, private for-profit and private not-for-profit (eg, religious) hospitals and health centres; local or peripheral level: health posts and health centres providing basic level of care.
†Informal: use of ICT for health purposes in the absence of formal processes and policies; pilot: testing and evaluating a programme; established: an ongoing programme that has been conducted for a minimum of 2 years and is planned to continue.
ICT, information and communications technology; ISN, International Society of Nephrology; NIS, Newly Independent States.
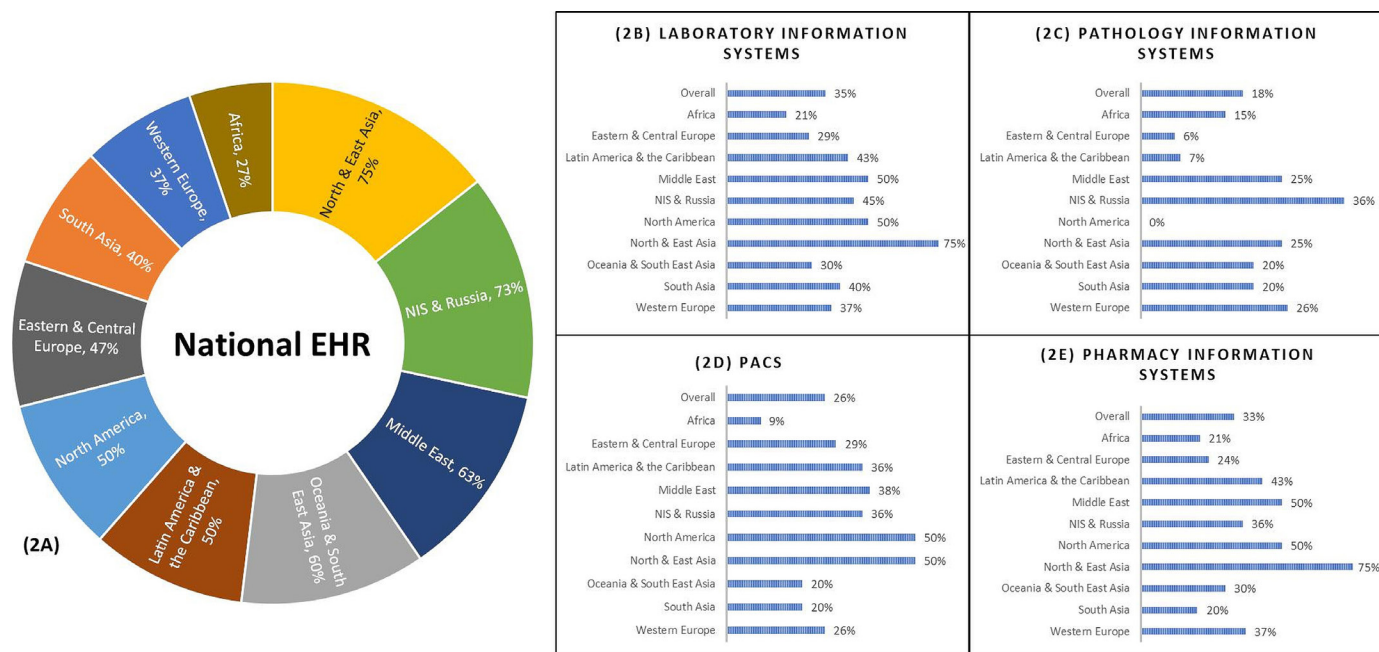
Figure 2 (A) Availability of national EHR system. (B–E) Availability of other electronic health record systems (laboratory information systems, pathology information systems, PACS and pharmacy information systems). EHR, electronic health records; NIS, Newly Independent States; PACS, picture archiving and communication system.

provision of kidney care across several countries, particularly in LICs and LMICs in all ISN regions. eHealth services may be a potential vehicle to harness local resources for improvement in kidney care. This study, which mainly analysed WHO eHealth survey data using ISN regional groups, found low ICT development indices mostly in LICs and LMICs, low availability of national EHR and proportion of national eHealth policies in LICs and LMICs, increased utilisation of mHealth services in low-income settings, lack of use of eLearning across regions, and absence of legal frameworks governing use of eHealth in several ISN regions. These findings underscore the need for concerted action if eHealth is to achieve its potential in reducing inequities in kidney care across regions and countries.

A major challenge in accessing kidney care in many countries is the lack of skilled workforce, specifically the absence of an adequate number of nephrologists.[24] The nephrologist density in HICs in North America and Western Europe is more than 90 times that in LICs in Africa, South Asia and Oceania regions (28.52 vs 0.31 per million population),[25] suggesting a clear disadvantage in care access for populations with low nephrologist densities.[26] In a global survey Lunney et al[27] identified geography and low nephrology workforce to be associated with lack of access to kidney care, especially in LICs. Low nephrology workforce, particularly in rural or remote areas, often means long travel distance to access care,[28] with potentially negative consequences, including increased cost of care, low quality of life,[29] lack of access to kidney replacement therapies (KRT; ie, dialysis and transplantation)[29–31] and increased likelihood of death.[32] In a large South African province with only two public

service nephrologists, a study that assessed the predictors of mortality in rural-dwelling patients receiving KRT at a district hospital found mortality to be higher in peritoneal dialysis (PD) patients (p<0.001) who travelled farther to reach the hospital than those treated with hemodialysis (HD).[30] These challenges are not limited to low-resource countries. One study from Australia estimated that use of telehealth services for evaluating post-transplant patients resulted in a net saving of 203 202 km in patient travel distance, 2771 hours in car travel time, about $A31 048 in petrol savings and 51 tonnes carbon dioxide equivalents of greenhouse gas emissions.[28] Due to the widespread availability of mobile cellular signals,[1] cellular and internet technologies have potential to improve access to nephrology care in remote and/or underserved settings. Access to care can also be improved in children with kidney diseases given the significant shortage of paediatric nephrologists[33] and mitigate high mortality identified in children with kidney failure in regions such as Africa.[34] The global COVID-19 pandemic demonstrates that use of eHealth technologies will likely increase over the coming years,[35 36] thereby highlighting the need to strengthen governance on how eHealth systems are used across ISN regions. Care of patients with CKD has been grossly affected during the pandemic, and it falls on the stakeholder community to develop sustainable solutions.

The prevalence of CKD risk factors, such as hypertension and diabetes mellitus, continues to increase globally. The rise is projected to be significant, especially in LICs and LMICs of South Asia, South East Asia and Africa.[37 38] For instance, globally, 79% of people with diabetes live in LICs or LMICs (mostly Oceania, South Asia and South East Asia regions) and projections of diabetes prevalence

by 2045 suggest an increase of 143% in Africa, 96% in the Middle East and 74% in South East Asia compared with 15% and 33% increase in Europe and North America, respectively.[37] Innovative models of care delivery are therefore needed to manage the growing disease burden. Given the wide coverage of mobile phone networks, mHealth holds promise as an important delivery tool for healthcare delivery in resource-constrained regions (figure 1). mHealth interventions are in use for diagnosis and management of various infectious diseases including malaria,[39] tuberculosis[40] and human immunodeficiency virus (HIV)[41] and for improving maternal and fetal health[42] in several developing countries. Although mHealth interventions are increasingly used for non-communicable diseases,[43–45] some studies highlight only a modest impact in non-communicable disease (NCD) control, likely due to limited number of studies and impact on process of care alone.[46 47] Our analysis showed that use of mHealth (appointment reminders and treatment adherence) and telehealth services (remote patient monitoring) was much higher in LICs and LMICs than in HICs (online supplemental table S2 and table 2). In a study conducted in a rural Indonesian population, multifaceted mobile technology-supported primary healthcare intervention was associated with greater use of preventive cardiovascular disease (CVD) medication and lower blood pressure (BP) levels among high-risk individuals.[48] These findings suggest that despite the relatively low current use, mHealth may be potentially useful for supporting case-finding for CKD,[49] CKD-specific education to improve awareness, integrated care delivery and efficient referral pathways, and perhaps allow quality control through real-time monitoring.[50]

To guide implementation, ethical issues including the type and quality of digital technology, doctor–patient relationship, data confidentiality and security, informed consent, and patients' and families' satisfaction with telemedicine services should be considered in framing legal governance for eHealth.[51] Increasing the use of such technologies will require demonstration of public benefits (eg, cost saving),[52] while ensuring that there is no discrimination or digital inequality (eg, not tailored to only those with a smartphone or for the disabled)[53] and to protect patient and data privacy.[54] As our study shows the legal frameworks that govern sharing of personal health data or digital data and protect the privacy of individual health-related data were either low or absent in many regions. There is a need to address such legislation in all regions (online supplemental figure S7).

Our study also identified EHR use to be low in LICs and LMICs, with poor utilisation of eLearning for preservice and inservice training in the health sectors (online supplemental figure S5). Barriers that impede adoption and/or implementation of EHR systems, such as cost (including setting up, maintenance and ongoing costs), technical concerns, technical support, resistance to changing work habits, loss of income and loss of productivity, will need to be identified in each setting and addressed. As Kruse

et al[55] have suggested, policy makers will need to consider incentives that reduce the implementation cost of EHR, possibly aimed more directly at organisations that are known to have lower adoption rates, such as small hospitals in rural areas. However, this may be possible in HICs, where such technologies are readily available, whereas in LICs and LMICs such incentives should be targeted towards secondary and tertiary care centres that serve a wider population. Measures that ensure successful adoption and implementation of EHR technology, including systems usability, interoperability and adaptability, need to be considered in terms of local context, individual end users and advancing technology.[56]

The potential and value of eLearning in addressing workforce shortages[20 57] and the educational needs of health professionals, especially in developing countries, are well recognised.[58] The ISN fellowship programme recently included hybrid (online plus hands-on) training as part of the strategy for improving training of nephrologists from low-resource settings.[24] This can improve training in glomerular diseases (histopathology), assessment of urine microscopic findings, as well as various aspects of interventional nephrology, including dialysis catheter insertion and care. A number of groups have used virtual platforms to upskill healthcare workers in the care of patients with COVID-19 in India and Africa.[59] Access to the basic information technology infrastructure (eg, computers and internet) remains a major hurdle to the implementation of technology-enhanced teaching in developing countries.[58] Any solution should be sensitive to local resources and be designed to operate at low cost (data, device). One study that assessed the awareness, attitudes, preferences and challenges to eLearning among medical and nursing students at Makerere University, Uganda identified low monthly income, quality of internet connectivity and lack of computer ownership among factors that significantly affected attitudes towards eLearning.[60] Perceived advantages of online learning by medical students in the UK included time and money saved from lack of travel and flexibility and ability to learn at one's own pace, whereas family distractions, internet connection and the timing of tutorials were identified as barriers.[61] The extent of integration of eLearning in health sciences (medicine, nursing and midwifery, and pharmacy) for both preservice and inservice training was low in most regions in our study (online supplemental figure S4). The impact of an improved integration of eLearning in health sciences will be widespread across all medical disciplines.

There were a few limitations to this study previously described in the WHO report.[18] These include the report being old (2015), given that there are no other reports superseding this with a global reach. However, our study has made up for this by the inclusion of newer data from elsewhere showing availability and use of telecommunications services as a proxy for use of eHealth that rely on such services. Also, WHO member states were limited to one response per country, that is, expert informants

were required to propose a consensus response for each question, which was difficult in cases where the situation varied widely within the country. Furthermore, although every effort was made to select the best national experts to complete the instrument, the knowledge capacity of each focus group to accurately answer the questions was not determined. Another limitation of this study is the focus on large hospitals and private health institutions as all eHealth capacities and strategies (eg, primary care level or general practitioner clinics) may not have been adequately captured, thus underestimating its use across countries. However, these data provide a broad scan of the availability of these services across participating countries and regions and are therefore useful for monitoring progress and for improving services. Finally, some countries with large populations (eg, France, Germany, Brazil, Egypt, Nigeria and India) did not participate in the 2015 survey. This is likely to have affected some of the results of this survey, for example, the proportion with access to the internet. Despite the limitations, this study is the first to present a comprehensive overview of the status and penetration of eHealth in ISN regions using data from the WHO global survey on eHealth. Our study has also been able to address identified gaps in availability of eHealth services and the implications of these for kidney care across ISN regions, particularly for LICs and LMICs.

CONCLUSION

There is wide variation in the availability and accessibility of eHealth services across ISN regions, with much reduced availability and access in LICs and LMICs. This is likely to have a significant negative impact for adequate kidney care provision in these regions, especially at a time when there are global restrictions in face-to-face contacts. Even though much infrastructure is required to set up such services, simple steps can be initiated towards broader use of eHealth services to aid care, including legislation and provision of national guidelines/requirements on use of these technologies. Infrastructure development to improve access to the internet will need to be improved across regions, especially in LICs. With rapidly evolving ICT technologies and as digitalisation of medical education and care continues to gather pace in the future of healthcare, further research on the impact of eHealth in care of patients with kidney diseases is critical. The development of and access to appropriate technologies which facilitate equitable and high-quality care are needed to ensure no one is left behind.

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