

journal homepage: www.ijmijournal.com

Kenya's Health Workforce Information System: A model of impact on strategic human resources policy, planning and management[☆]

Keith P. Waters^{a,*}, Alexandra Zuber^a, Rankesh M. Willy^b, Rose N. Kiriinya^c, Agnes N. Waudu^c, Tom Oluoch^d, Francis M. Kimani^b, Patricia L. Riley^a

^a Division of Global HIV/AIDS, Center for Global Health, Centers for Disease Control and Prevention, 1600 Clifton Road, MS-E41, Atlanta, GA 30333, USA

^b Ministry of Medical Services, Government of Kenya, Nairobi, Kenya

^c Kenya Health Work Force Project, Nairobi, Kenya

^d Centers for Disease Control & Prevention, Nairobi, Kenya

ARTICLE INFO

Article history:

Received 11 October 2012

Received in revised form

18 May 2013

Accepted 1 June 2013

Keywords:

Nursing informatics

Medical informatics

Human resources information system (HRIS)

Human resources for health (HRH)

Workforce surveillance

Global health

ABSTRACT

Objective: Countries worldwide are challenged by health worker shortages, skill mix imbalances, and maldistribution. Human resources information systems (HRIS) are used to monitor and address these health workforce issues, but global understanding of such systems is minimal and baseline information regarding their scope and capability is practically non-existent. The Kenya Health Workforce Information System (KHWIS) has been identified as a promising example of a functioning HRIS. The objective of this paper is to document the impact of KHWIS data on human resources policy, planning and management.

Methods: Sources for this study included semi-structured interviews with senior officials at Kenya's Ministry of Medical Services (MOMS), Ministry of Public Health and Sanitation (MOPHS), the Department of Nursing within MOMS, the Nursing Council of Kenya, Kenya Medical Practitioners and Dentists Board, Kenya's Clinical Officers Council, and Kenya Medical Laboratory Technicians and Technologists Board. Additionally, quantitative data were extracted from KHWIS databases to supplement the interviews. Health sector policy documents were retrieved from MOMS and MOPHS websites, and reviewed to assess whether they documented any changes to policy and practice as having been impacted by KHWIS data.

Results: Interviews with Kenyan government and regulatory officials cited health workforce data provided by KHWIS influenced policy, regulation, and management. Policy changes include extension of Kenya's age of mandatory civil service retirement from 55 to 60 years. Data retrieved from KHWIS document increased relicensing of professional nurses, midwives, medical practitioners and dentists, and interviewees reported this improved compliance raised professional regulatory body revenues. The review of Government records revealed few references to KHWIS; however, documentation specifically cited the KHWIS as having improved the availability of human resources for health information regarding workforce planning, management, and development.

[☆] The findings and conclusions in this report are those of the authors and do not necessarily reflect the views of the U.S. Centers for Disease Control and Prevention and the Kenyan Government.

* Corresponding author. Tel.: +1 404 956 2024.

E-mail address: kpwaters@cdc.gov (K.P. Waters).

1386-5056/\$ – see front matter. Published by Elsevier Ireland Ltd

<http://dx.doi.org/10.1016/j.ijmedinf.2013.06.004>

Conclusion: KHWIS data have impacted a range of improvements in health worker regulation, human resources management, and workforce policy and planning at Kenya's ministries of health.

Published by Elsevier Ireland Ltd

1. Introduction

Countries worldwide are challenged by health worker shortages, skill mix imbalances, and their geographic and sectoral maldistribution. Among the most economically afflicted countries, these shortages are worsened by inadequate investment, out-migration, and HIV/AIDS [1], which increases the demand for services and renders health workers themselves vulnerable to death and disease [2]. The World Health Organization (WHO) has identified 57 countries where the health workforce shortages are at crisis levels [3]. These crisis countries are characterized by insufficient human resources to achieve standard care benchmarks, such as 80% coverage for both measles immunizations and skilled attendants at birth. As adequate numbers of healthcare providers can impact the health outcomes targeted in the United Nations Millennium Development Goals (MDGs) [4,5], there is concern whether human resources crisis countries, such as Kenya, can meet the health-related MDGs by the specified timeframe of 2015 [3,6].

While the demand for human resources for health (HRH) data and performance monitoring is a priority for the United States President's Emergency Plan for AIDS Relief (PEPFAR) and various global health initiatives [7–10], universal understanding of the human resources information systems (HRIS) used in monitoring HRH is minimal and baseline information regarding their scope and capability is practically non-existent [11]. In a global review of HRIS literature, Riley and co-authors (2012) found HRIS among HRH crisis countries are nascent and frequently lack information critical for addressing workforce policy and planning. The authors called for more descriptive research of HRIS globally, including the documentation of impact so as to advance the science and evidenced-based practice in this area. Responding to this call, and adding to an emerging body of peer-reviewed literature emanating from the Kenya Health Workforce Information System (KHWIS) [12–17], this paper provides a qualitative and quantitative review of KHWIS-generated information with regard to the Government of Kenya's health workforce policies and governance.

1.1. Overview of the Kenya Health Workforce Information System

The KHWIS was launched at the Nursing Council of Kenya (NCK) in 2002 with support from the U.S. Centers for Disease Control and Prevention (CDC), and has been the recipient of PEPFAR funding, through CDC, since 2005. With technical support provided by Emory University and CDC, KHWIS is owned and managed by the Government of Kenya (GOK) and its professional regulatory bodies of key health professions. The KHWIS comprises a series of databases, similar in design, developed and implemented by a local NGO, at the NCK, the Kenya Medical Practitioners and Dentists Board (KMPDB),

Kenya's Clinical Officers Council (COC), and the Kenya Medical Laboratory Technicians and Technologists Board (KMLTTB), and an additional database housed at the Department of Nursing (DON) within the Ministry of Medical Services (MOMS) tracking nursing deployment. Equipment and connectivity are supplied and maintained by a local IT company. Deployment data from the provinces were initially interlinked with deployment data at the MOMS via satellite Internet connection, the system later moved to fiber-optic connection. The Windows based system was developed using VB.Net 2002–2010, running on MS SQL Server 2000 databases, hosted on servers operating Windows Server 2003, and accessed within a Local Area Network (LAN) for each board.¹ Provincial coordinators have access to the system using a CITRIX connection.

Key features of the KHWIS are components for capturing data on pre-service education, training, registration and relicensing, in-service specialties and upgrades, continuing professional development (CPD), human resources management, nursing deployment, and the ability to link nursing regulation data with nursing deployment data. The aim is to facilitate deployment of the right health workers (qualifications, skills mix) in the right place (deployment location) at the right time (availability) [18]. In 2011, KHWIS received an Award for Excellence from the WHO for its impact on human resources planning, health management, and the provision of workforce information resulting in positive policy changes [19].

2. Methods

Semi-structured interviews were conducted with a total of nine senior Kenyan officials from the MOMS, the Ministry of Public Health and Sanitation (MOPHS), and the four health professional regulatory bodies: NCK, KMPDB, COC, and KMLTTB. The purposive sample included senior management officials responsible for high level human resources (HR) decisions and policy making, and individuals at operational level in database management. Interviewees were asked to describe the impact KHWIS data had had on policy decisions and practice at their respective organizations. Impacts identified by the interviewees were explored further during the interviews using more probing questions. Key domains of inquiry

¹ Development has begun toward an open-source web-based application, known as the regulatory HRIS (rHRIS), which is to be accessible to users at county and district levels, provide an interface to other boards' databases using web services and application programming interfaces (APIs), and integrate with other systems such as Kenya's Master Facility List (MFL), enhancing data security and accessibility, reducing maintenance costs and increasing sustainability and scalability. This manuscript retains the terminology KHWIS to describe all the databases, regulatory and deployment, that was in use at the time of interviews.

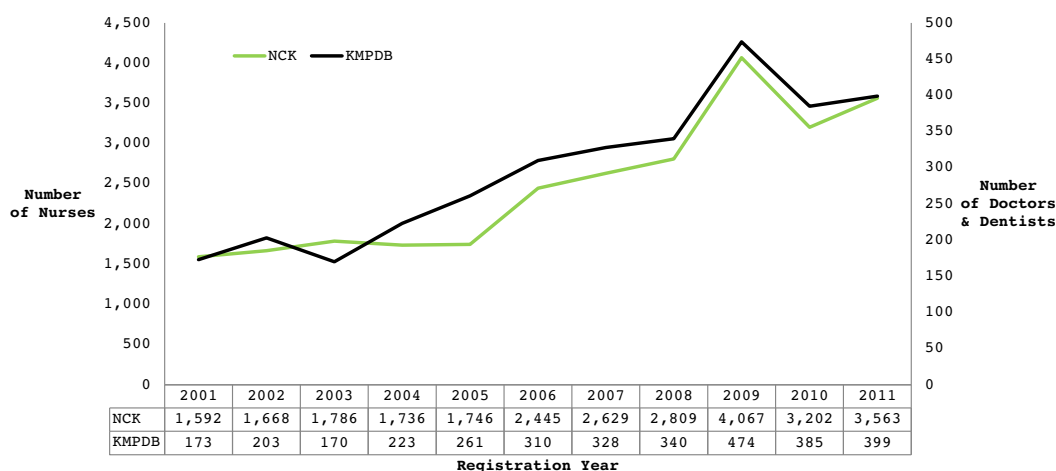


Fig. 1 – Registrations at Nursing Council of Kenya and Kenya Medical Practitioners and Dentists Board.
Source: KHWIS, NCK and KMPDB.

were: changes observed after KHWIS became functional, its impact, how KHWIS data affected policy, planning and management, and identifying specific data elements that fostered change. All interviewees provided informed consent prior to their participation in the study. The interviews took place during October 2011 and on average lasted 30–45 min. The primary investigator (PI) led the interviews using a semi-structured questionnaire and took comprehensive notes throughout. The PI was accompanied by a co-author also taking notes. Notes were then transcribed into Microsoft Word. These data were thematically analyzed through a process of familiarization, identification of themes, organization of data into those themes, and review.

In addition, the KHWIS Project Analyst was granted permission to extract quantitative data from KHWIS databases maintained at each of the four regulatory bodies and the DON, to substantiate qualitative findings from the interviews and to examine the associated trends.

A snowball methodology was employed to identify and retrieve key health sector policy documents through recommendations by the project supervisors, in-country project team, interviewees; forward and backward citation searches; Internet searches, and accessing the official MOMS and MOPHS websites. These materials were reviewed using a standardized data abstraction tool to assess whether use of KHWIS data influenced any change in policy or practice. Standard elements abstracted included any references to KHWIS by name, or by function, and any references to data produced from KHWIS, or inclusion (i.e. use) of KHWIS data.

The study protocol was cleared for Institutional Review Board (IRB) compliance by the Associate Directors for Science at CDC Kenya and CDC Atlanta's Division of Global HIV/AIDS. Both CDC offices determined the protocol was program evaluation activity and did not comprise human subjects research. As Kenyan Government ministries have delegated authority to approve research work in their domain, the protocol underwent further review by the Director of Medical Services (DMS) at MOMS. The DMS also determined the study was not human subjects research, did not require local IRB review, and provided official approval to conduct the activity.

3. Results

3.1. Quantitative results

Fig. 1 illustrates the number of nurse registrations recorded at NCK and doctors and dentists at KMPDB over the past 10 years. The registration trend at NCK shows a marked increase from 2006, and there is a sharp increase for both boards in 2009.

Fig. 2 shows the annual number of relicensures at NCK and KMPDB over the past 5 years. From 2009 to 2011 the number of relicensures documented at NCK increased from 2228 to 17,706. From 2010 to 2011, the number of relicensures at KMPDB increased from 669 to 3602.

Fig. 3 displays the nursing workforce by age group and province. Such information was used to project the percentage of GOK nurses who would retire between 2009 and 2014. The data illustrate 2814 (17.4%) GOK nurses were aged 51–55 years, and 3246 (20%) were aged 46–50 years. At the same time, a mere 1049 (6.5%) were aged 21–30 years, the age most nurses join the workforce.

3.2. Qualitative findings

Summaries from all nine semi-structured interviews were consistent in reporting the efficiency of the electronic system in reducing the number of staff work hours to perform tasks that would otherwise involve locating paper files and manually processing them. The following qualitative findings are grouped according to KHWIS's impact on health workforce regulation, policy change, and human resources management.

3.2.1. Impact on health workforce regulation

For the question "Please can you tell me what you think has been the key impact of KHWIS?" senior officials at NCK and KMPDB reported KHWIS had helped strengthen regulation by enabling efficient monitoring of registration and license renewals. NCK officials elaborated that prior to KHWIS the council was unable to track whether nurses had registered or

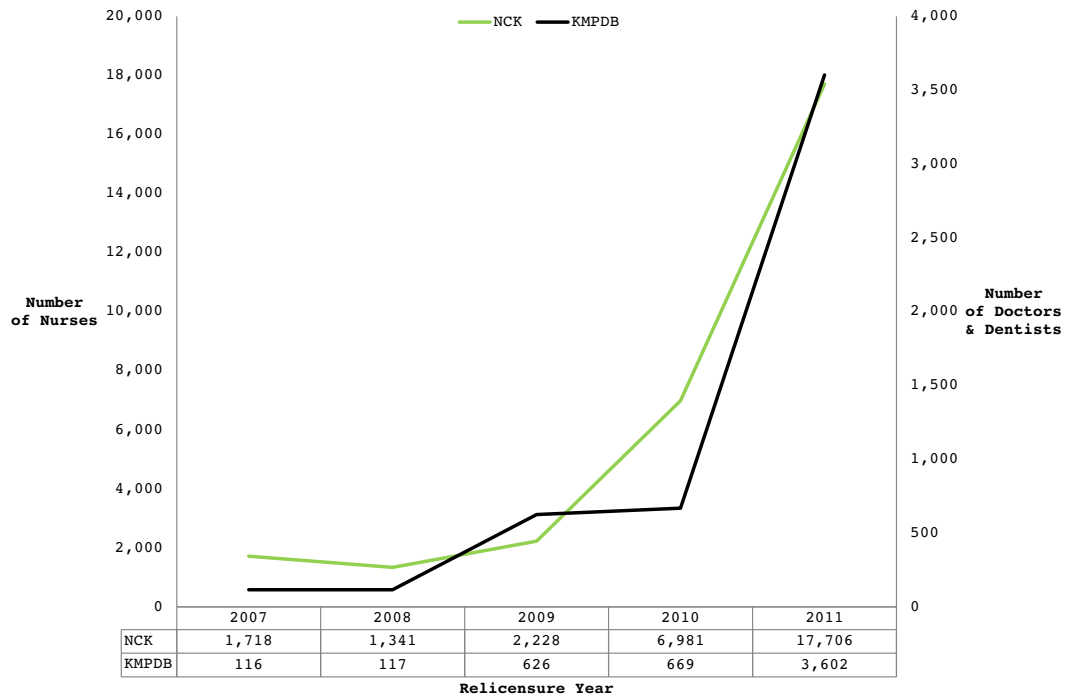


Fig. 2 – Licensure renewals at Nursing Council Kenya and Kenya Medical Practitioners and Dentists Board.
 Source: KHWIS, NCK and KMPDB.

not, allowing nurses (who may have been unqualified) to work without professional registration: “We can identify fraudulent applications, a person not in the system – student nurses are captured from entry [into a training institution], through to registration.” Another senior NCK official reported “Now if a nurse is in the database we can be 99.9% sure they are

alive and working.” Additionally, several senior NCK officials reported that the increase in relicensures since the installment of KHWIS had generated significant additional revenue for the Council. Asked to quantify the impact KHWIS had had on revenue, one senior official at NCK in October 2011 responded “This year we were expecting to receive 3 million

Source: Kenya Health Workforce Information System (KHWIS) at Department of Nursing, August 2009

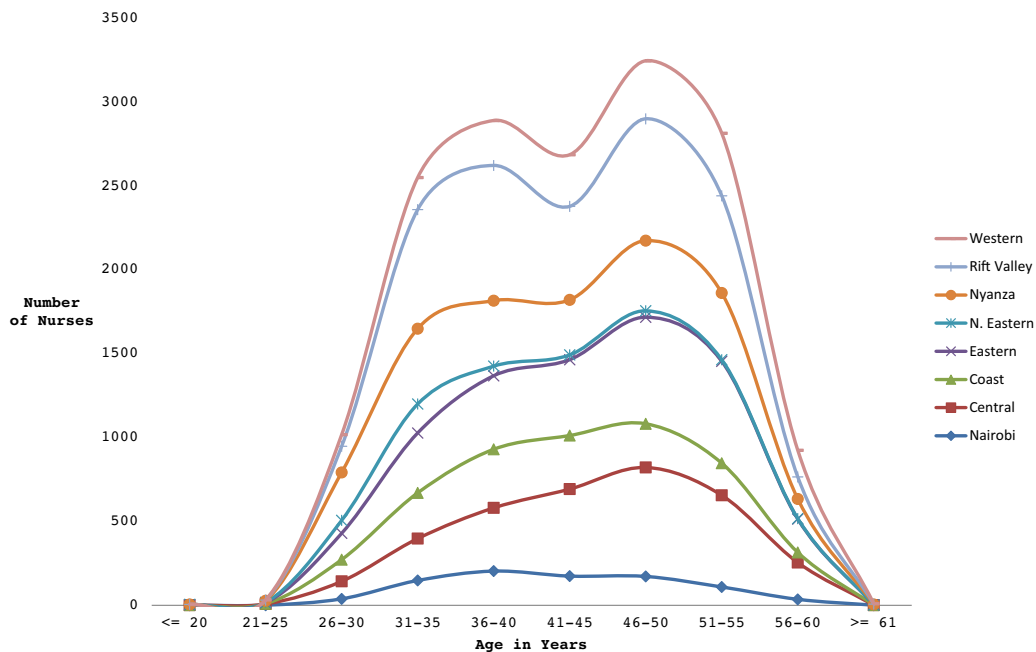


Fig. 3 – Kenyan public sector nurses by province and age group.
 Source: KHWIS, Department of Nursing, August 2009.

Kenyan shillings [USD35,993] from relicensure, the actual total we have collected is around 10 million [USD119,975].”

Similarly, senior officials at KMPDB reported that, with respect to regulation of doctors and dentists, the impact of KHWIS was “nothing less than a paradigm shift, in two main areas – record keeping, and communication with practitioners.” Up-to-date records in KHWIS helped KMPDB make their clients aware of professional requirements and opportunities: “There has been an increase in registrations because of more frequent communication; it is easier to contact doctors and advise them to apply for specialties.” Doctors and dentists must renew their license annually. Senior officials at KMPDB reported they no longer needed to pay staff overtime to work at weekends to get renewals processed. Previously, recertification involved staff locating hard copy files and writing the documents by hand. This activity was described as taking up to a month to complete. The process using soft copies and automated templates in KHWIS meant “if the signatory is available, practitioners can pay and receive it on the same day.” KMPDB officials stated they were developing a website for online relicensing and payment, facilitated by data in the KHWIS. Further, KMPDB intends to make relicensing dependent on fulfillment of CPD requirements that are captured in KHWIS. Senior officials at the KMPDB reported the increase in registrations and renewals had led to “a steady increase in revenue for the board.”

A senior official at COC stated “Prior to KHWIS we knew nothing; everything was packed in a paper store, ordered by date, hard to find, and [the information was] hard to trust. When clinical officers came to renew we couldn’t tell if they owed for past years. Now we can search the database with a single [data element] – the registration number.” A senior laboratory official at KMLTTB reported “KHWIS is very useful, provides quick and easy information, on licensed institutions and individuals, compared to hard copies. . . the project must not be abandoned halfway.”

3.2.2. *Impact on health workforce policy*

In response to the question “What changes to policy have occurred since the implementation of KHWIS?” a senior DON official explained that, in December 2008, KHWIS data revealed a “big percentage of nurses were retiring and not being matched with equivalent numbers of younger nurses coming into the workforce.” The official stated these data were shared with the Prime Minister. Then in April 2009, the GOK’s civil service human resources policy requiring mandatory retirement at 55 years of age was increased to 60 years for all GOK public servants: “The idea to change the policy had been in development, KHWIS data helped shape it [and] sped up the ratification.” Senior officials at the DON and the MOPHS also reported KHWIS data were shared with the Permanent Secretary warning that shortages and maldistribution of nurses were resulting in understaffing at many health facilities, especially in rural areas. The Permanent Secretary presented these findings to Members of Parliament and the GOK subsequently changed its policy regarding disbursement of the Constituencies Development Funding (CDF). The DON and MOPHS officials reported “CDF had been used to construct new health facilities across Kenya, but could not be used to pay the salaries of health workers to staff those facilities.”

The GOK decided to reallocate “. . . a percentage of money that was supposed to go to CDF to the Economic Stimulus Project (ESP) instead.” Since the ESP did support workforce salaries, the newly gained resources enabled an increase in the local hiring of nurses to work at understaffed health facilities. The senior officials at the DON and MOPHS reported that between 2009 and 2011 ESP created 10,500 new health worker posts, 7350 of which were for nurses.

3.2.3. *Impact on health workforce management*

Senior officials at both the Ministries of Health (MOH) reported KHWIS data are being used to ensure appropriate staffing deployment. “This real time information helps decision making; we can query the existing numbers of nurses, their training and their current place of work.” Asked for an example of how these data facilitate deployment decisions, a senior DON official recounted that in 2011: “We used KHWIS to trace ICU (intensive care unit) nurses for Nakuru Province General Hospital. We didn’t know there were any ICU nurses available – but [we] did a search on [nurse] qualifications, skills and found five that could be redeployed where the need was greater.” DON officials reported KHWIS impact on workforce management in the areas of promotion, payroll verification, and attrition. Examples included using the KHWIS to facilitate rectifying the backlogged promotion of approximately 1000 GOK nurses: “The KHWIS has been of major help in preparing lists of nurses who are due for promotion.” Prior to the KHWIS, paperwork alerting the MOH of absconders often arrived after the absconders salaries had already been paid, “tracking attrition dates and types in the KHWIS means this is no longer the case.” Officials also reported the KHWIS enables comparison of nurse deployment data with payroll disbursements, thereby more efficiently resolving payment of non-existent employees (ghost workers).

3.3. *Policy review*

Forty-six Kenyan health sector policy documents were identified from searches of the MOMS and MOPHS websites. After eliminating duplicates (4), damaged files or broken links (5), and files which did not pertain to health workforce information (10), 27 documents were reviewed. The documents discussed the need to strengthen Kenya’s health information systems in general, improve the health infrastructure and increase the supply and management of human resources for health, to produce quality HRH data for evidence-based policy and decision making. Three documents contained references to KHWIS. A performance report [7] listed the “Nursing workforce database system” among outputs attained by the DON. A report commissioned by PEPFAR and other partners [20] made several references to KHWIS as being “. . . in use by the Chief Nurse and colleagues in the MOMS.” “. . . already being used to influence policy and planning in the nursing workforce. . .”, “As it expands the records on Physicians, Laboratory Technicians and Clinical Officers, [KHWIS] offers significant potential to develop sector-wide scenario-based planning linked to burden of disease. . .”. A review of the National Health Sector Strategic Plan [21] cited KHWIS’s impact on health workforce management: “[. . . data from] the nursing database developed as part of the Kenya Nursing Workforce Project have improved the HR

information available to plan, manage and develop the health workforce.”

4. Discussion

Interviewees at the MOH and regulatory bodies all agree KHWIS is a critical information system with a demonstrated ability to generate useful data. Due to the phased rollout, the use of KHWIS data is more advanced at NCK where the system has been deployed longest; thus the impact of the data is more evident on the nursing workforce. The success of the nursing KHWIS resulted in expansion of the system in 2005 to capture data on Kenya's medical and dental, laboratory, and clinical officer cadres.

The results of interviews with key officials at the independent regulatory bodies indicate that the ability to track registrations and relicensures in KHWIS has strengthened their capacity to regulate the workforce. The ability of the MOH to now verify credentials before offering employment provides motivation for health professionals to register. Rises in recorded registrations correspond to the years KHWIS became functional at NCK (2006) and KMPDB (2009). The KMPDB has roughly one-fifth the number of health professionals at the NCK, thus was able to develop its KHWIS and realize impacts in less time. The KHWIS at COC and KMLTTB were at data cleaning stages during the interview period. Once completed, more comprehensive data about the Kenyan health workforce will be available. KHWIS is facilitating Kenyan regulatory bodies' credentialing requirements, such as monitoring CPD participation. Thereby ensuring their health professionals are receiving current and updated professional training, ultimately resulting in improved quality care. Prior to KHWIS, tracking CPD participation and licensure renewals relied on inefficient paper-based systems. As a result, professional enforcement of regulations was weak and few health workers complied with relicensing requirements. The number of relicensures documented at NCK increased from 2009 to 2011 by nearly eight times, and the number of relicensures at KMPDB from 2010 to 2011 increased more than fivefold. The associated revenue was more than three times that which officials at the NCK were expecting to collect. The steady increase in revenue reported at KMPDB can also be assumed substantial based on the numbers of retained practitioners and higher relicensure fees. Based on the unanimity of qualitative findings, the KHWIS has helped each of the regulatory boards streamline and automate their respective licensing processes. Furthermore, the burden of professional relicensing has been minimized. This is evidenced by KMPDB's decision to develop an e-licensing system, which will enable practitioners to renew their credentials online instead of traveling to the capital to complete this task in person, thereby allowing clinicians to spend more time delivering healthcare. The use of the KHWIS at the DON to trace and redeploy ICU nurses demonstrates the system has the functionality to target geographical areas (down to health facility level) where health workers are most needed at the granularity of workers' specific specialties and skillsets. The KHWIS is also enabling the DON to ensure unqualified nurses, who might provide sub-standard care, are not employed. Used effectively, reliable HRH

data from KHWIS can facilitate more efficient employment and deployment of scarce health workforce resources, thereby contributing to Kenya's goal to meet the MDGs and helping save lives.

Access to KHWIS data is orienting officials to base Kenyan HRH policies on evidence, rather than relying on conjecture. Although mandatory retirement at 55 years was known to account for the majority of nurse attrition [14,22], the idea to change the GOK's retirement policy to 60 years languished without traction until projections from KHWIS of worsening nurse shortages were presented to the Prime Minister. Over the previous 10 years an average of 500 nurses retired annually [13], suggesting that following the retirement age extension a comparable annual figure remain eligible for another 5 years of service, thereby facilitating more effective succession management and skills transfer from experienced senior workers to younger generations.

Development funding was also redirected following the sharing of KHWIS data. From 2006 to 2007 CDF was used to construct 1000 new health facilities across the country [14], without addressing the health worker shortage. The 4200 nursing posts created by reallocating CDF into ESP (year 1) were additional to the estimated 400 new positions in the 2009–2010 recruitment plans [14] – a more than tenfold increase in nursing staff posts. The reallocation of CDF demonstrates if a case is convincing a MOH can overcome established staffing levels, which can be perceived as impassable ceilings in resource-constrained settings.

Our review of official GOK documents was to determine the extent to which KHWIS data impacted policy. Although there are few official records citing KHWIS, those that do noted the value of KHWIS-generated data and its utility in improving workforce planning and management [20]. The lack of written evidence regarding GOK's use of KHWIS data echoes Riley and colleagues' global HRIS review [11] finding that few HRIS were documented as being used for HRH planning and decision making. Managers of the KHWIS should therefore make efforts to ensure KHWIS data are used and referenced in applicable planning and policy documents.

Findings from this study have several limitations. Although we interviewed senior officials at both Kenya's ministries of health and each of the four regulatory bodies, we were unable to interview the parliamentary officials responsible for changing the GOK HRH policies; therefore, we are unable to ascertain to what extent KHWIS data influenced their decisions. General computerization and technological advances are taking place in Kenya. We cannot quantify how much the KHWIS contributed to increased registrations, next to other factors such as nurses upgrading through e-learning programs and recruitment strategies. In addition, verifying all reported qualitative findings is not possible without access to the ministries' payroll database and GOK documentation regarding staff promotions. As a result of the limitations, this study cannot demonstrate a causative link between KHWIS data and policy changes; however, the strength of conviction and consistent praise from interviewees together with the quantitative regulatory body and policy review findings, suggest a strong association.

In conclusion, upon reviewing the impact of one country's experience with HRIS, the evidence indicates KHWIS has led to

advancements in HRH practices that might not have occurred as quickly had there not been reliable and readily available health workforce information for the Kenyan Government's and their professional regulatory boards' utilization. Specific contributions resulting from this system include: the extension of retirement age for Kenya's civil service; the reallocation of development funding to support the recruitment of 10,500 new health worker positions; and the strengthening of health worker regulation through increased registration and relicensing resulting in unexpected and substantial rises in regulatory bodies' revenues. These revenue streams suggest that for regulatory bodies a HRIS can be a sustainable system – a central goal of the PEPFAR program that funds it [23]. Rakuom estimates that financial benefits now far outweigh the annual costs of the KHWIS at the NCK [13]. More precise investigation into costs is suggested to further substantiate the sustainability. The strategic vision is for Kenya's regulatory bodies to maintain and develop KHWIS independently of external support, to continue developing in-country capacity to collect and analyze data and turn them into information that can shape policies which will improve service delivery and health outcomes. As a successful example of the global community's call for action, KHWIS can be used as a model for other countries developing HRIS, especially for addressing health workforce shortages and maldistribution. For KHWIS's success to continue, the system must remain responsive and dynamically adaptable to organizational changes within Kenya, including county level policies. To maximize the benefits yielded by data use, we recommend strategies linking HRH data from KHWIS to broader health information (including population needs, service utilization, and patient outcomes) from other deployed healthcare, education, and personnel-related information systems. This paper can provide a foundation for similar studies examining the use of HR data in Kenya and other countries to strengthen investments in their health workforce. Since further rollout to current regulatory bodies and expansion to other cadres is planned in the near future, a follow up review of KHWIS's impact is recommended so as to further document Kenya's use of HRIS data in HRH policy and practice, as well as its transition from donor support to independence from external assistance.

Author contributions

PR and AZ conceptualized the study. AZ and KW designed the protocol and questionnaire. KW developed the data abstraction tool for reviewing policy documents. AW facilitated protocol approval. TO and AW provided guidance and discussed document review, RW and KW conducted documents retrieval and KW conducted document reviews. AW facilitated interviews, with assistance from RK and RW, and KW conducted the interviews. RK extracted quantitative data from KHWIS databases, KW conducted data analysis and interpretation of results. KW prepared first draft of the manuscript. AZ, RW, and PR contributed to subsequent drafts. All authors (KW, AZ, RW, RK, AW, TO, FK, PR) read and approved the final version.

Summary points

What was already known on the topic

- Global understanding of Human resources information systems (HRIS), used to monitor and address health workforce shortages and maldistribution, is minimal and information regarding their capability practically non-existent.
- The Kenya Health Workforce Information System (KHWIS), which began as a nursing database, has been identified as a promising example of a functioning HRIS.

What this study has added to our knowledge

- Access to key data from the KHWIS has empowered the Government of Kenya to make major contributions to health workforce policy without donor funds.
- KHWIS can be used as a model for other countries developing HRIS, especially for addressing health workforce shortages and maldistribution.

Conflict of interest statement

None declared.

Funding

This study was unfunded. Staff time and travel costs of the principal investigator were covered by the U.S. Centers for Disease Control and Prevention, Atlanta.

Acknowledgements

The authors would like to thank the many individuals at the Kenya Health Work Force Project Office, CDC Kenya, Kenya's ministries of health, and the four professional health regulatory bodies, for welcoming the authors and accommodating the study. The authors would also like to thank Alpa Patel-Larson and Katherine Robinson of CDC Kenya, and Martha Rogers of Emory University, for their assistance with protocol clearance.

REFERENCES

- [1] L. Chen, T. Evans, S. Anand, J.I. Boufford, H. Brown, M. Chowdhury, et al., Human resources for health: overcoming the crisis, *Lancet* 364 (9449) (2004) 1984–1990, Available from: <http://www.sciencedirect.com/science/article/pii/S0140673604174825> (cited 10.10.2012).
- [2] Taking Stock: Health Worker Shortages and the Response to AIDS, World Health Organization, Geneva, 2006, Available from: http://www.who.int/healthsystems/task.shifting/TTR_response.pdf (cited 18.03.2013).
- [3] Working Together for Health: The World Health Report 2006, World Health Organization, Geneva, 2006, Available from:

- http://www.who.int/whr/2006/whr06_en.pdf (cited 10.10.2012).
- [4] Health and the Millennium Development Goals, World Health Organization, Geneva, 2005, Available from: http://www.who.int/hdp/publications/mdg_en.pdf (cited 10.10.2012).
- [5] N. Dreesch, C. Dolea, M.R.D. Poz, A. Goubarev, O. Adams, M. Aregawi, et al., An approach to estimating human resources requirements to achieve the Millennium Development Goals, *Health Policy Plan.* 20 (5) (2005) 267–276, Available from: <http://heapol.oxfordjournals.org/content/20/5/267.full> (cited 10.10.2012).
- [6] A.S. Kanter, J. Negin, B. Olayo, F. Bukachi, E. Johnson, S.E. Sachs, Millennium Global Village-Net: bringing together Millennium Villages throughout sub-Saharan Africa, *Int. J. Med. Inf.* 78 (2009) 802–807 (cited 18.03.2013).
- [7] World Health Assembly Resolution 60.27: Strengthening Health Information Systems, World Health Organization, Geneva, 2007.
- [8] The Kampala Declaration and Agenda for Global Action. First Global Forum on Human Resources for Health, Global Health Workforce Alliance, Kampala, 2008, Available from: <http://www.who.int/workforcealliance/knowledge/resources/kampala.declaration/en/index.html> (cited 10.10.2012).
- [9] M. Chan, M. Kazatchkine, J. Lob-Levyt, T. Obaid, J. Schweizer, M. Sidibe, et al., Meeting the demand for results and accountability: a call for action on health data from eight global health agencies, *PLoS Med.* 7 (1) (2010), Available from: <http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.1000223> (cited 10.10.2012).
- [10] Outcome Statement of the Second Global Forum on Human Resources for Health. Second Global Forum on Human Resources for Health, World Health Organisation, Bangkok, 2011, Available from: <http://www.who.int/workforcealliance/forum/2011/Outcomestatement.pdf> (cited 10.10.2012).
- [11] P.L. Riley, A. Zuber, S.M. Vindigni, N. Gupta, A. Verani, N.L. Sunderland, et al., Information systems on human resources for health: a global review, *Hum. Resour. Health* 10 (7) (2012), Available from: <http://www.human-resources-health.com/content/10/1/7> (cited 10.10.2012).
- [12] P.L. Riley, S.M. Vindigni, J. Arudo, A.N. Waudo, A. Kamenju, J. Ngoya, et al., Developing a nursing database system in Kenya, *Health Serv. Res.* 42 (3) (2007) 1389–1405, Available from: <http://www.unfpa.org/sowmy/resources/docs/library/R210.Riley.etal.2010.Kenya.NursingDatabase.Kenya.pdf> (cited 10.10.2012).
- [13] C.P. Rakuom, E.O. Oywer, J. Arudo, P. Vidot, T. Jones, *Health Workforce Information System: Kenya's Nursing Experience Version, 10th ed.*, Commonwealth Secretariat, London, 2009.
- [14] C. Rakuom, *Nursing Human Resources in Kenya: Case Study*, International Centre for Human Resources in Nursing, Geneva, 2010.
- [15] J.M. Gross, P.L. Riley, R. Kiriinya, C. Rakuom, R. Willy, A. Kamenju, et al., The impact of an emergency hiring plan on the shortage and distribution of nurses in Kenya: the importance of information systems, *Bull. World Health Organ.* 88 (2010) 824–830, Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21076563> (cited 10.10.2012).
- [16] J.M. Gross, M.F. Rogers, I. Teplinskiy, E. Oywer, D. Wambua, A. Kamenju, et al., The impact of out-migration on the nursing workforce in Kenya, *Health Serv. Res.* (2011), Available from: <http://onlinelibrary.wiley.com/doi/10.1111/j.1475-6773.2011.01251.x/pdf> (cited 10.10.2012).
- [17] S.M. Vindigni, P.L. Riley, F. Kimani, R. Willy, P. Warutere, J.F. Sabatier, et al., The Effects of Kenya's Emergency Hire Nursing Program on the Delivery of Health Services, 2013 (in press).
- [18] K.L. Courtney, Visualizing nursing workforce distribution: policy evaluation using geographic information systems, *Int. J. Med. Inf.* 74 (2005) 980–988 (cited 18.03.2013).
- [19] Second Global Forum for Human Resources for Health, World Health Organisation, Bangkok, 2011, Available from: <http://www.who.int/workforcealliance/forum/2011/hwhawardscase/en/index.html> (cited 10.10.2012).
- [20] J. Campbell, Stilwell B. Kenya, Taking Forward Action on Human Resources for Health (HRH) with DFID/OGAC and Other Partners, 2008, Available from: http://www.who.int/workforcealliance/knowledge/publications/partner/tfa_kenya.pdf (cited 10.10.2012).
- [21] Reversing the Trends – The Second National Health Sector Strategic Plan: NHSSP II Midterm Review Report, Ministry of Health, Afya House, Nairobi, Kenya, 2007, Available from: <http://www.medical.go.ke/images/downloads/Medium-Term-Review-report-for-Strategic-Plan-II.pdf> (cited 10.10.2012).
- [22] S. Chankova, S. Muchiri, G. Kombe, Health workforce attrition in the public sector in Kenya: a look at the reasons, *Hum. Resour. Health* 7 (58) (2009), Available from: <http://www.human-resources-health.com/content/7/1/58> (cited 10.10.2012).
- [23] The U.S. President's Emergency Plan for AIDS Relief Five-Year Strategy, PEPFAR, 2009, Available from: <http://www.pepfar.gov/about/strategy/document/133251.htm> (cited 23.06.2013).