“Knowledge, attitudes and practice of healthcare workers on the use of Health Information Technology: A mixed method descriptive survey among healthcare workers in Princess Marina Hospital, Gaborone, Botswana”

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Thesis submitted in partial fulfilment of the requirements for the degree of Master of Philosophy in Health Systems & Services Research (MPhil HSSR), Division of Health Systems and Public Health, Department of Global Health, in the Faculty of Medicine and Health Sciences, Stellenbosch University

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List of abbreviations

BDF	Botswana Defense Force
DHMT	District Health Management Team
DHIS	Health Information system
EHR	Electronic Health Record
EMR	Electronic Medical Record
HI	Health Informatics
HMIS	Health Management Information System
HIS	Health Information System
HIT	Health Information Technology
HIV/AIDS	Human Immuno-deficiency Virus and Acquired Immuno-Deficiency Syndrome
IDCC	Infectious Disease Care Clinic
ICT	Information Communication Technology
PIMS	Patient Information Management System
IPMS	Integrated Patient Management System
KAP	Knowledge, Attitudes and Practice
MEDITECH	Medical Information Technology
MOHW	Ministry of Health and Wellness
NHIS	National Health Information System
NGO	Non-governmental Organisation
PMH	Princess Marina Hospital
PHC	Primary Health Care
TB	Tuberculosis
WHO	World Health Organisation

Definition of terms

Electronic Health Record (EHR): "This involves use of health information system to exchange clinical information of an individual patient across different healthcare workers" [1].

Health Informatics (HI): "The application of computer technology to problems in healthcare, as well as all aspects of the generation, handling, communication, storage, retrieval, management, analysis, discovery and synthesis of data, information and knowledge in the entire scope of healthcare" [2]

Health Information System (HIS): "Refers to the interaction between people, process and technology to support operations, management in delivering essential information in order to improve the quality of healthcare services" [3].

Health information technology (HIT): "The various communication and information technologies that are used to collect, save, transfer and display the patient's data. It is also a concept that describes the use of computer systems for accessing health care information by patients, health care providers, insurance companies, and other governmental organisations" [4].

Information and Communications Technologies (ICT): "Digital devices that can acquire, record, organize, retrieve, display, manipulate and disseminate information" [5].

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ABSTRACT

Background: To date, studies of Health Information Technology (HIT) in Botswana have focused on the evaluation of development, implementation and utilisation of the District Health Information System (DHIS). However, health professionals are facing many challenges regarding the transition from paper to electronic-based system, as throughout the development and implementation of an integrated HIS at district and national levels. This study aims to assess the knowledge, attitude and practice of HIT among healthcare workers from Princess Marina Hospital in Botswana.

Methods: A descriptive survey was carried out on 107 randomly selected healthcare workers using both quantitative and qualitative methods for data collection from November 2017 to March 2018. A piloted self-administered questionnaire was used to assess knowledge, attitudes and practices of healthcare workers regarding health information technology. Quantitative data was analysed and reported using descriptive analysis using the Statistical Package for Social Scientists (SPSS) version 24. Qualitative data was analysed using Nvivo software.

Results: Overall, 107/110(97.3% response rate) healthcare workers agreed to participate. 67(62.6%) were doctors, 30(28%) pharmacy staff, 8(7.5%) nurses and 2(1.9%) medical records staff. The majority 81(75.7%) reported not receiving any computer training, 43(40.2%) reported a moderate level of proficiency. The majority did not carry out electronic patient documentation, 48(44.9%) or performed the task manually. With regard to attitude, 65(60.8%) were eager to learn.

Conclusion: In general, the staff presented a lower level of knowledge and practice of HIT even though they showed positive attitudes. Provision of in-service training is needed in order to up-skill the health professionals regarding the use of HIT for patient care and management.

KEY WORDS: Health information system; Health Information Technology; healthcare workers; knowledge, attitudes, practice

1. BACKGROUND

1.1. Health Information Technology in the health system

An effective health system is one that aims at accessibility, affordability and delivery of the best quality services to all people. The health system is not just a single entity but is an embedded social system consisting of different institutions, providers and settings with people at the center [6]. Sustainable financing mechanisms must be in place to maintain infrastructure, hire, pay and provide needed skills and expertise in human resources and improve service delivery through well-organized logistics and technologies [7]. It is essential for the health system to have health information available, which should be reliable, adequate and of good quality to guide decision-making in policy development and priority setting during planning, designing and implementation of health interventions and programs. Continuous monitoring, evaluation, and recommendations help in enhancing the quality of these services and subsequently lead to improved health outcomes [8].

Improvement of healthcare at minimum cost whilst ensuring effective patient safety and satisfaction is difficult without the utilisation of technology. Health Information Technology (HIT) is a tool that has emerged to help bridge the information and communication gaps across different components of the health system [6]. Health information technology improves not only individual patient care, but also brings many public health benefits including early detection of infectious disease outbreaks around the country, improved tracking of chronic disease management and valuation of health care especially where there is timely, reliable and efficient and comparative data [7].

1.2. Healthcare, Health Information Technology and Health Informatics in Botswana

Health service delivery in Botswana is through public sector, private sector and traditional medicine practices. All these sections fall under the Ministry of Health and Wellness (MOHW) which is responsible for drafting policies, regulations, guidelines and overseeing the overall healthcare service delivery to the nation. There is a wide range of health facilities, which includes hospitals, clinics, health posts, mobile clinics, and community-based preventative and promotive services falling under this ministry,

which are managed by the District Health Management Teams (DHMTs). There is also the Ministry of Local Government (MLG) that collaborates with MOHW to ensure an enabling environment through the maintenance of infrastructure to improve the quality of services provided. Other recognized service providers within the country are the Botswana Defense Force (BDF), Police and Prison Services, Non-governmental organisations (NGOs) and mission facilities [9]. Princess Marina Hospital is one of the 27 hospitals in the Botswana healthcare delivery system. Overall training of healthcare professionals is provided for by a combination of national and international institutions, however, there is much reliance on international arrangements, such as numerous expatriates deployed in the health sector following limited production of skilled healthcare professionals [10].

The state of health care in Botswana is dominated by the HIV/AIDS epidemic; therefore, there is a need for investment in HIT to adequately measure and monitor the epidemic through good quality health information. Overall, there is a high degree of awareness of the importance of HIT and e-Health and the country continues to invest in systems for tracking and reporting utilisation, viz. the centralised Integrated Patient Management System (IPMS), and the decentralised Patient Information Management System (PIMS II); and initiatives for effective information communication technologies ICTs [11].

One of these investments (according to July 2016 corporate press release [12] is the deployment of the Medical Information Technology (MEDITECH) solution to all hospitals and clinics. The press release revealed that after the implementation of MEDITECH in the last remaining 7 hospitals, all of the 27 public hospitals in Botswana will have deployed the technology.

1.3. Problem statement

There has been an attempt by MOHW to improve health management information system (HMIS) through several initiatives, including training of health providers on HIT, information capturing and processing through computers and communication through web-based portals within the system. HMIS is one of the six building blocks essential for health system strengthening. HMIS helps with decision-making within the other five

building blocks: service delivery, health workforce, access to essential medicines, financing and leadership/governance in health systems. It also helps in data collection, processing, and management, therefore, guides planning, management and decision-making in health facilities and organisations [13].There are several factors that need to be in place for an effective HMIS establishment. Firstly, there must be a good HMIS strategic plan, policy and legal framework for health information reporting, medical records policy, framework for a central data repository, computerised District Health Information System (DHIS) for data capture, aggregation and generation of management reports and an established Centre for Health Information at central level [14]. However, there is still a room for improvement to address the key issues identified and to properly plan and provide timely services to all and above all to continuously monitor and evaluate the whole programme [15]

The country has so far made significant progress in rolling out a clinical information system called the Integrated Patient Management System (IPMS) with some modules supplied by MEDITECH [12]. Implementing such systems like the IPMS will enhance information availability and the integration of health care across the country. It is therefore vital to make sure that the workforce and users have the skills, knowledge, and ability to operate these technologies and realize the value in their utilization [11].

Lack of information communication technologies (ICTs) knowledge and skills among healthcare workers is a significant concern in Botswana, because it denies healthcare workers the opportunity to utilize the considerable benefits offered by ICT in terms of healthcare management and administration [16]. This lack of knowledge and skills subsequently poses a negative impact on the attitudes and practice of HIT by the healthcare workers. According to the Global Knowledge 2012 IT Skills and Salary Report as cited by Pearson Education, healthcare workers perform more effectively on their jobs after obtaining IT certification because this brings a sense of confidence, trust and proves that one has acquired experience, knowledge and skills of a particular profession or practice. It is also reported to validate ability to comprehend new and complex technologies [17].

Even though Botswana Ministry of Health and Wellness (MOHW) has made an enormous contribution to ICT by implementing and rolling-out different systems, some

studies have shown that there have been some challenges in interoperability, integration and full utilisation of these systems due to poor infrastructure, inadequate resources, and limited skilled personnel [18, 19, 20]. This was also supported by a study done in Princess Marina Hospital in 2014, which also showed incomplete, unreliable and poorly integrated electronic systems, which end up creating a burden to the healthcare workers because of double reporting between both paper-based and electronic records. It also showed limited IT support at all levels with poor maintenance and updating of health electronic systems due to computer crashing, viruses and misfiling of the electronic data. Therefore, the healthcare workers end up having limited accessibility to computer-based files in most instances [21]. Given the lack of research conducted to date targeting the healthcare workers in Botswana in relation to their knowledge, attitudes and practice towards HIT, this study was conducted in Princess Marina Hospital.

1.4. Review of the literature

Developing countries face many challenges like poor accessibility and limitation of healthcare facilities, shortage of healthcare professionals and high costs for medical consultations. Health Information Technology (HIT) was introduced in order to improve the quality of healthcare service delivery, increase patient safety as it helps to decrease medical errors [22]. HIT also helps to strengthen interactions between patients and healthcare service providers. However, there is still very low acceptability to HIT systems [23]. There is evidence of many factors that influence acceptability to HIT in the workplace, including technical infrastructure, healthcare workers' knowledge, skills, experience, and attitudes of potential users, which need attention before presenting computers in healthcare settings, particularly rural settings [22].

Evidence shows that use of ICT makes a significant positive impact on healthcare, particularly for home follow-ups [23] and in rural areas [22]. Investing in electronic devices like computer systems (computers, printers, scanners, and routers) and enhancing their accessibility, as well as provision of training will improve healthcare workers' adeptness at using computers, thereby facilitating the rate of technology diffusion in the health sector [24]. Many studies have shown poor computer training, attitudes, and practices of HIT use among healthcare workers [25]. This is mainly

because countries have no structured training programme, limited computer resources, and poor accessibility [26].

A study done in Taiwan showed that it is important to investigate the attitudes of the HIT users in order to consider and eliminate barriers which may facilitate or hinder user acceptance. Computer self-proficiency was also reported to be a strong predictor of the attitudes. The nurses and physicians in the study had positive attitudes towards Electronic Medical Records (EMRs) but were however concerned with time consumption and quality of care [27].

The literature shows that positive attitudes of healthcare workers towards the use of HIT are mostly influenced by the perceptions of HIT value, the clinical benefits and user-friendliness of the system [22, 28, 29]. A study done in a Brazilian hospital among pharmacists showed that the full potential of electronic tools has not been realized due to significant knowledge gaps and lack of training, whether at an undergraduate program or during professional education [30]. Similar studies in sub-Saharan Africa have also reported low computer knowledge among health workers [23]. A Ugandan study revealed positive attitudes towards e-health but still low-to-moderate skills among healthcare professionals [31]. Another study showed that nurses had positive attitudes and knowledge about health ICT and affirm the potential benefits. Such benefits included: reduced documentation errors, improvement in recording, easier reporting and access to information as compared to paper-based records (where information at most times is either missing or duplicated, or misfiled, hence taking a lot of time during patient consultations) [32]. Encouragingly, the literature has demonstrated positive attitudes of nurses towards computer use in hospitals [33].

Evidence showed that knowledge is a positive influence of attitudes towards telemedicine. It is reported that knowledge of users of telemedicine builds their confidence towards use of it. Support and use of telemedicine by professionals in the field motivates others also to have positive attitudes towards it [34]. The willingness of the healthcare workers to use telehealth has been reported to be determined by knowledge, perception of its benefits together with reduced barriers [35]. A study conducted in Poland showed skillful nursing students in computer use, medical

informatics and technology with positive attitudes towards the use of telenursing [36]. Similar to these results, are results of a study conducted in Bangladesh assessed the knowledge of eHealth as average for majority of the doctors who also showed positive support towards eHealth [37].

Several studies were conducted in Nigeria to assess knowledge and perceptions of professional towards eHealth and Telemedicine. One study showed a small number of participants with good computer and IT knowledge. It was reported that the reported limited knowledge levels subsequently affected their utilization patterns [38]. These are similar to the results of another study, which showed generally poor knowledge of eHealth applications with good knowledge reported in only a few professionals. Among these, only 13% of the respondents reported to have attended workshops on telemedicine even though majority of them supported the use of telemedicine. The respondents in the study also reported issues of poor infrastructures, power supply and internet services which ended up limiting full usage of the eHealth system [39]. Another study, in a Federal Medical Centre in Nigeria showed high awareness of telemedicine and understanding of what it entails. However, the majority of the respondents (82%) reported to have never used it, while a very small percentage (15%) reported to use it occasionally with 3% using it when appropriate. Of these respondents, only 7% had received training with majority showing willingness to go for training [40]. These are however different to another study which showed .only 21% of the respondents reporting awareness of the telehealth programme and most of the participants affirming that they will use and recommend it to others [41]. Another study showed physicians in medical institutes using electronic medical records more than those in small medical institutes with less usage reported in clinics [42].

1.5. Rationale and justification of the study

The national ICT policy for Botswana was developed in 2005 as one of the initiatives to attain one of the aims of Vision 2016 for literacy in information technology. The primary aim of the national ICT policy was to help the country achieve social, economic, political and cultural transformation through teaching and equipping citizens with skills and expanding technical infrastructure [11]. The country has had a long-term commitment to strengthening ICT in health, through the National Health

Information System (NHIS), by scaling up of skills in healthcare and ensuring sustainability of health information even though it is still facing some structural constraints [20].

Studies done in Botswana to date have focused on the development and evaluation of the National Health Information System, utilisation of the District Health Information System (DHIS) in terms of a transition from paper to electronic-based system and development and implementation of an integrated HIS at district and national levels. These studies showed that effective development of health information system was mostly hindered by weak policy, regulatory frameworks and limited resources, which subsequently lead to lack of integration and coordination, lack of standardised data collection tools and poor quality of information from different health facilities. Moreover, some of the challenges observed were poor internet connectivity, unavailability of computing equipment and data storage devices and limited human resources [43].

However, there is limited information on the knowledge, attitudes, and practices (KAP) of healthcare workers on the use of health information technology. The health professionals in Botswana, as in other developing countries are still facing many challenges regarding the transition from paper to electronic-based system, as throughout the development and implementation of an integrated HIS at district and national levels. Therefore, it is important to explore and understand how much they know, what are their views and attitudes towards HIT and how much do they really utilise it. Therefore, it is important to explore and understand the views of the healthcare workers towards the adoption of ICT. This study into KAP of healthcare workers in the use of HIT in Princess Marina Hospital will add to the body of knowledge about the HIT and its implementation in Botswana.

2. METHODS

2.1. Study aim and objectives

The aim of the study was to explore knowledge gaps, attitudes and practices of healthcare workers that may facilitate or create barriers to the use of health information technology in Princess Marina Hospital in Botswana interviewed from November 2017 to March 2018. The study objectives were: 1) assessing knowledge level of healthcare workers of health informatics (HI) used in Princess Marina Hospital, 2) investigating their training level, acquired skills and proficiency in HIT, and 3) describing the attitudes of healthcare workers in relation to use of HIT and their actual practice of HI.

2.2. Study setting

The study was conducted from 25 November 2017 to 31 March 2018, in Princess Marina Hospital (PMH), Botswana. PMH is one of the three referral hospitals in Botswana and was selected because it is the largest. Patients are referred from primary healthcare institutions to secondary healthcare institutions that provide specialised healthcare services. PMH currently offers a wide spectrum of services both preventive and curative as well as serving as a primary, district and tertiary hospital. Some of the services offered by the hospital are surgical, pharmaceutical, medicinal, social work, laboratory, dental, occupational therapy and intensive care services to mention but a few [44]. The hospital was designed to have an inpatient population of 567 per day; however, this number is often exceeded due to high demands in healthcare services. It has a staff complement of 1300 distributed across 32 departments. There are about 600 nurses and 137 doctors. On average 2500 patients are seen daily in the hospital's outpatient department. [45]

The Infectious Disease Care Clinic (IDCC) was selected as the specific unit in PMH to study. It was opened in 2002 for the provision of Highly Active Antiretroviral Therapy (HAART) in accordance with Botswana National Antiretroviral Treatment Guidelines to qualifying citizens. The IDCC medical staff started using paper-based data capturing method, but due to rapid increase in numbers of Human Immunodeficiency virus (HIV) positive people, it was realized that there was a need for electronic-based patient tracking system. The electronic system was introduced in 2003 but was later replaced

by an integrated patient management system (IPMS) to centralise the health data [46].

Most of the staff working in IDCCs including doctors, nurses, pharmacy staff were required to have a standardized theoretical training called KITSO. Kitso is an abbreviation for “Knowledge Innovation and Training Shall Overcome HIV/AIDS” and it provides quality, multidisciplinary, sustainable and standardized training in HIV and AIDS care and was crafted specifically for Botswana’s health professionals. This training consisted of a 12-lecture series that included presentations and case-based learning supplemented by relevant scientific articles and a CD-ROM that provided additional reading. The doctors at all antiretroviral treatment sites participating in the national program were also receiving on-site supportive training that is led by mentors [47].

2.3. Study design

A mixed methods survey was conducted from November 2017 to March 2018. Participants included doctors, Infectious Disease Care Clinic (IDCC) nurses, pharmacy and medical records staff employed in the hospital during the study period.

2.4. Study Population and Sampling

For quantitative data collection, different cadres of healthcare workers including doctors, pharmacy and medical records staff who are the predominant end-users of the HIT were included. Only nurses from IDCC were included because they are nurse prescribers who do patient consultations using the IPMS system on a daily basis. Nurses from other departments were excluded because they carry out doctors' orders in the wards and do not do any patient consultations. The administration and other support workers were excluded as they are not end-users. The sample was selected from a sampling frame which was obtained from hospital administration (doctors; n= 137, nurses; n=10, pharmacy staff; n=49 and medical records staff; n=4). The sample size was determined using a sample size calculation formula [48] and the margin of error was set to 5% with a 95% confidence interval and a distribution of 50% [49]. The non-response rate of 10% was added to the final sample size calculation. Stratified sampling was used to select the required sample of the healthcare workers (n=110). Simple random sampling was used to select the required sample from each stratum.

The participants were approached randomly, and study procedures explained. For qualitative data collection, participants were selected to include all the different healthcare workers in the study following the self-completion of questionnaires.

2.5. Data collection

Quantitative data were collected from a total of 107 healthcare workers using a self-administered questionnaire (Appendix A) adapted from a validated tool to fit the study [50, 51]. The questionnaire consists of four major components: 1) demographic content; 2) knowledge content with a total of 6 (six) items mainly assessing computer literacy and training in health informatics (HI); 3) attitudes towards learning about computers which consisted of four questions; and 4) practice, which consisted of 3 questions. The last question of the attitudes section, and the fourth part of the practice section used a 6- point Likert scale, with 6 denoting strongly agree and 1 denoting strongly disagree. Participants were considered to be knowledgeable and practicing HIT if their level of agreement was 50% and not knowledgeable or practicing if their level of disagreement was 50%. Respondents were considered in favour of HIT when they scored above the computed mean for the subscale. In addition, there were 5 open-ended questions that required healthcare workers to express their abilities, concerns, barriers, and solutions in relation to HIT use in general. The questionnaire was tested for validity and reliability with pre-test on 8 healthcare workers (7% of the sample) prior to main data collection. The language used for the questionnaire was English.

Qualitative data: The principal investigator used an interview schedule to guide the in-depth interviews (Appendix B), also adapted from a validated tool to fit the study [52]. 5 (five) participants were purposively selected to include all the different cadres of healthcare workers in the study (doctors, nurses, pharmacy and medical records staff) following completion of semi-structured questionnaires. The principle investigator conducted the in-depth interviews, and the interviews took 45-50 minutes. They were recorded and transcribed manually from audio. Written informed consent was obtained from the healthcare workers and questionnaires and interviews were conducted at a time convenient to them.

2.6. Statistical analysis

Quantitative analysis

The descriptive analysis was carried out using means and standard deviations for the quantitative variables while frequencies and percentages were used for summarising the categorical variables. Besides the summary statistics, bar charts and pie charts were also used. To compare the factor variables across the different levels of categorical variables, the student's t-test was used for gender, profession and informatics interest, while one-way analysis of variance was used for the experience, age and education variables. The significance of the comparisons was determined sing p-values and confidence intervals of means. All tests for statistical significance were carried out at a 5% level of significance and all the analysis was carried out using the Statistical Package for Social Scientists (SPSS) version 24. Data reduction analysis was carried out using factor analysis. All the items under the knowledge section were excluded from this analysis because the participants answered these items in the same way. The factor analysis was carried out for the attitudes, use of health informatics computers (practices) and evaluation of the health informatics system (practices) separately. This analysis identified five factors namely (Factor 1) support of the HI system, (Factor 2) resource sufficiency, (Factor 3) data management, (Factor 4) learning and communication, and Factor 5 (HI system evaluation). These factors are the ones that were used in the onward significance testing analysis. Finally, spearman correlational analysis was carried out for the overall results.

Qualitative analysis

Recorded interviews were transcribed and imported to NVivo software and thematic content analysis was done where themes were identified and summed up. The results were then presented in narrative form and triangulated with quantitative data for thoroughness and to ensure precision.

2.7. Validity, Trustworthiness and reliability

The data collection tools were prepared by the researcher and presented to and reviewed by three supervisors who did face validity. They were also presented to the

Stellenbosch University, Botswana Ministry of Health and Wellness, and the Princess Marina ethics committees for detailed review and assessment for validity. The questions were validated to obtain relatively reliable responses and were administered to 8 healthcare workers who answered the questions easily without any queries.

2.8. Ethical Considerations

The Stellenbosch Human Research Ethics Committee, (IRB S16/04/074), Botswana Ministry of Health and Wellness Ethics Committee, (HPDME 13/18/1) and Princess Marina Ethics Committee (PMH 5/79(291-2-2017)) approved the study. All participants were given an opportunity to sign an informed consent form before study participation and confidentiality was ensured throughout the study process.

3. RESULTS

3.1. Demographic description

The survey yielded a 97% response rate, with 107 of 110 health care workers taking part in the study. The hospital has 137 doctors, 49 pharmacy staff, 10 infectious disease care clinic nurses and 4 medical records staff therefore proportional sampling was used to ensure adequate representation of each of these different categories in the entire population. Of the 107 participants in the study, 67 (62.6%) were doctors, 30 (28%) pharmacy staff, 8 (7.5%) nurses and 2 (1.9%) medical records staff. Not included in the study were all healthcare workers who chose not to take part in the study. The questionnaires were distributed and followed-up or collected by the investigator during the doctors' morning meetings everyday while for pharmacy and other departments, they were distributed early in the mornings before they start their service and collected either at lunch or the following day early in the morning.

Table 1: Socio-demographic characteristics

Characteristic		n	(n/N=107)%
Gender	Male	59	55.1
	Female	48	44.9
Age groups (years)	20 – 30	54	50.5
	31 – 40	35	32.7
	41 – 50	15	14
	51 – 60	3	2.8
Education Level	High School	1	0.9
	Professional Certificate	1	0.9
	Pharmacy Diploma	11	10.3
	Nursing Diploma	8	7.5
	Bachelor's Degree	51	47.7
	Master's degree	13	12.1
	Medical Doctorate	22	20.6
Profession	Data Clerk	2	1.9
	Pharmacist	30	28
	Registered Nurse	8	7.5
	Medical Doctor	67	62.6
Experience	<1	28	26.2
	1 – 5	39	36.4
	6 – 10	15	14
	11 – 15	12	11.2
	16 – 20	8	7.5
	> 20	5	4.7

Gender

With respect to gender, the two groups were almost equally represented with 59 (55.1%) male and 48 (44.9%) female participants. These results are shown in table 1 above.

Age group

With respect to age, the results shown in table 1 above show that about half of the participants were in the 20-30 years age group (54 (50.5%)) followed by the 31-40 years age group with 35 (32.7%) then 15 (14.0%) in the 41-50 years age group and

the rest were over 50 years old.

Educational level

According to the results in table 1 above, most of the participants, 51 (47.7%) had a bachelor's degree followed by those 22 (20.6%) with a medical doctorate; 13 (12.1%) had a Master's degree, 17 (10.3%) had diploma and the rest of the categories of educational level had less than 10% representation each.

Experience

Most of the respondents, 39 (36.4%) were those with 1-5 years' experience, followed by 28 (26.2%) with less than a year, 15 (14%) with 6-10 years, 12 (11.2%) with 11-15 years, 8 (7.5%) with 16-20 years and lastly 5 (4.7) participants with more than 20 years' experience as per table1 above. Table 2 below shows response rate for each stratum.

Table 2: Distribution of participants by response rate

Category	**Respondents**	**N**	**%**
Doctors	67	75	89.3
Nurses	8	8	100
Pharmacy	30	49	61.2
Medical records	2	2	100

What is the distribution of time spent across different activities?

Table 3: Distribution of participants on time spent on their job

Activity	**N**	**Mean**	**Lower 95% CL**	**Median**
Patient Care and Treatment	105	68.4	64.0 - 72.8	70
Teaching	97	18	13.5 - 22.5	10
Supervision	97	18.3	13.4 - 23.1	10
General Administration	94	14.4	10.8 -18.1	10
Other	54	15.8	10.2 - 21.4	10

This question was asked to all the participants in the study for them to self-identify with how much of their time they spent doing the listed activities (table 3). The results show that the workers spent most of their time on patient care and treatment activities,

spending an average of 68.4% of the time with a 95% confidence interval of (64.0-72.8%). Most of the participants take part in teaching and supervision activities, spending an average of 18% of the time on these activities, respectively. Those who carry out some general administration activities dedicate an average of 14.4% of their time to it.

3.2. Knowledge

What is the level of computer proficiency and knowledge of IPMS among healthcare workers? (As a proxy for knowledge of health informatics and health information technology in the work context).

The frequency of computer use

The majority of participants, 105 (98.1%) reported to use computers on a daily basis. The results of the healthcare workers who did not receive any formal computer training were so overwhelming as compared to those who were trained. The results show that 81 (75.7%) of the participants did not receive any formal computer training. Most of the study participants, 67/107 (62.6%) were doctors who have a possibility of receiving medical school computer training. However, 100 (93.5%) did not get certified workshop/conference training, 91 (85.0%) did not receive non- certificate workshop/conference training and 105 (98.1%) did not receive other training. Sixty (56.1%) participants went through self-guided learning about computers as per table 4 below.

Table 4: Distribution of participants by type of computer training

Training	**Yes n (%)**	**No n (%)**
Formal computer training	26 (24.3)	81 (75.7)
Medical school computer Training	27/67 (40.2)	80 (74.8)
Formal workshop/conference certificate	7 (6.5)	100 (93.5)
Non-certificate workshop/conference	16 (15)	91 (85)
Self-training	60 (56.1)	47 (43.9)
Other training	2 (1.9)	105 (98.1)

Note: Majority of the participants had tertiary educational level especially Bachelor's degree (table 1) where computer studies were part of the curriculum therefore they could have undergone formal computer training, while some could have undergone

formal workshops while already on professional practice.

Self-reported computer proficiency

As for computer proficiency, the majority, 43 (40.2%) believe that their computer proficiency level is at the moderately sophisticated level, followed by 40 (37.4%) sophisticated, then 12 (11.2%) claim to have very sophisticated computer proficiency. In overall, 11% indicated perception of self-sufficiency as unsophisticated while 89% as sophisticated. The rest of the participants admitted that their proficiency is either unsophisticated or very unsophisticated. The percentages are shown in figure 1 below.

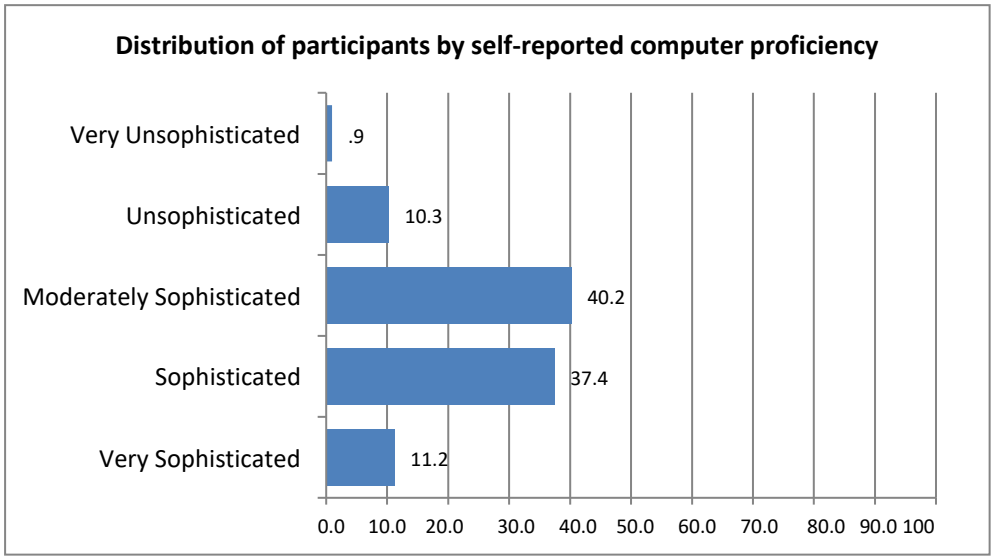

Fig 1: Percentage distribution of participants by self-reported computer proficiency

Rating of quality of computer training

In as much as the healthcare workers stated not to have received any formal computer training, a majority of them has shown that they are proficient in computer use as a result of self-training. This, therefore, could have formed their basis for comparisons for computer training rating between those who actually received computer training. Thirty-three (30.8%) participants rated the training provided to health care workers as poor and 24 (22.4%) rated the training as none. This shows that while training is provided for health care workers, most respondents had not received the training sufficiently that they could not evaluate the training programme. This means that 53.2% of the participants had negative evaluations of the training programme. The remaining set of respondents rated the training as fair (24.3%), good (14%), very good (7.5%) and excellent (0.9%) as shown in figure 6 below.

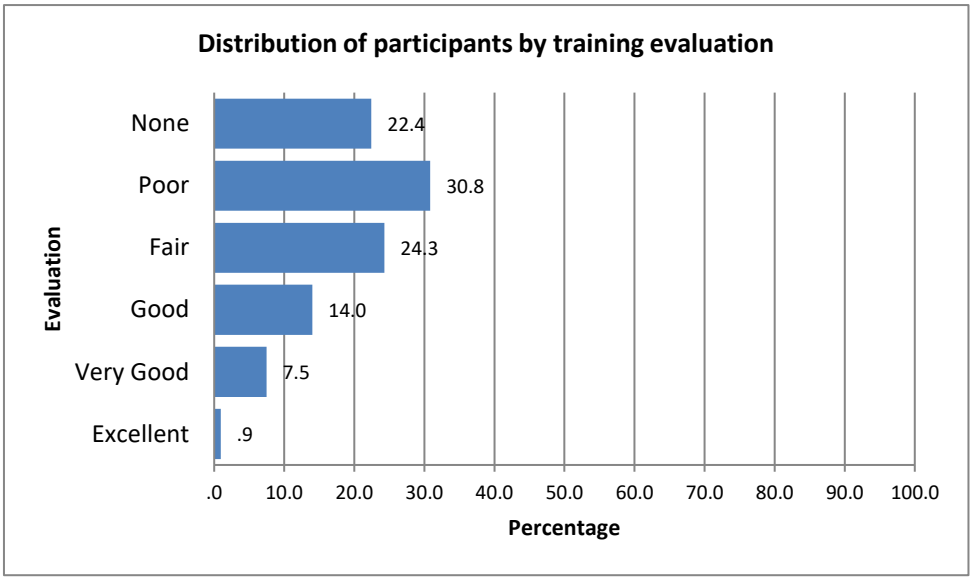

Fig 2: Percentage distribution of participants by computer training rating

Cross tabulation of computer use rating and computer training are shown in table 5 below.

Table 5: Cross tabulation of Computer use rating and Computer training

Variable	Rating	Cell contents	Computer training		Total
			Formal	Informal	
Computer use rating	Very Sophisticated	Count	7	5	12
		% within Computer use rating	58.30%	41.70%	100.00%
		% within Computer training	15.20%	8.20%	11.20%
		% of Total	6.50%	4.70%	11.20%
	Sophisticated	Count	19	21	40
		% within Computer use rating	47.50%	52.50%	100.00%
		% within Computer training	41.30%	34.40%	37.40%
		% of Total	17.80%	19.60%	37.40%
	Moderately Sophisticated	Count	17	26	43
		% within Computer use rating	39.50%	60.50%	100.00%
		% within Computer training	37.00%	42.60%	40.20%
		% of Total	15.90%	24.30%	40.20%
	unsophisticated	Count	3	8	11
		% within Computer use rating	27.30%	72.70%	100.00%
		% within Computer training	6.50%	13.10%	10.30%
		% of Total	2.80%	7.50%	10.30%
	Very unsophisticated	Count	0	1	1
		% within Computer use rating	0.00%	100.00%	100.00%
		% within Computer training	0.00%	1.60%	0.90%
		% of Total	0.00%	0.90%	0.90%
Total		Count	46	61	107
		% within Computer use rating	43.00%	57.00%	100.00%
		% within Computer training	100.00%	100.00%	100.00%
		% of Total	43.00%	57.00%	100.00%

Integrated Patient Management System training

Only 40 (37.4%) of the participants had received some training in the Integrated Patient Management System. This leaves a majority of the healthcare workers (62.6%) as not to have received the training.

Rating of quality of Integrated Patient Management System (IPMS) training

About a third of the participants 32 (30.2%) evaluated the training in IPMS as fair followed by 28 (26.2%) who felt that the training is of poor quality and 21 (19.8%), who may be part of the 62.6% respondents who did not receive IPMS training and could not give a rating to the quality of IPMS training. Only 25 (23.5%) participants rated the training as good or better. Only 37.4% of the healthcare workers received formal training on IPMS. The majority however reported to have trained themselves on how to use computers (56.1%) and 89% stated to be sophisticated with computer use (Table 4 and figure 1 respectively). This, therefore, could have influenced their rating of the computer and IPMS training offered in the hospital.

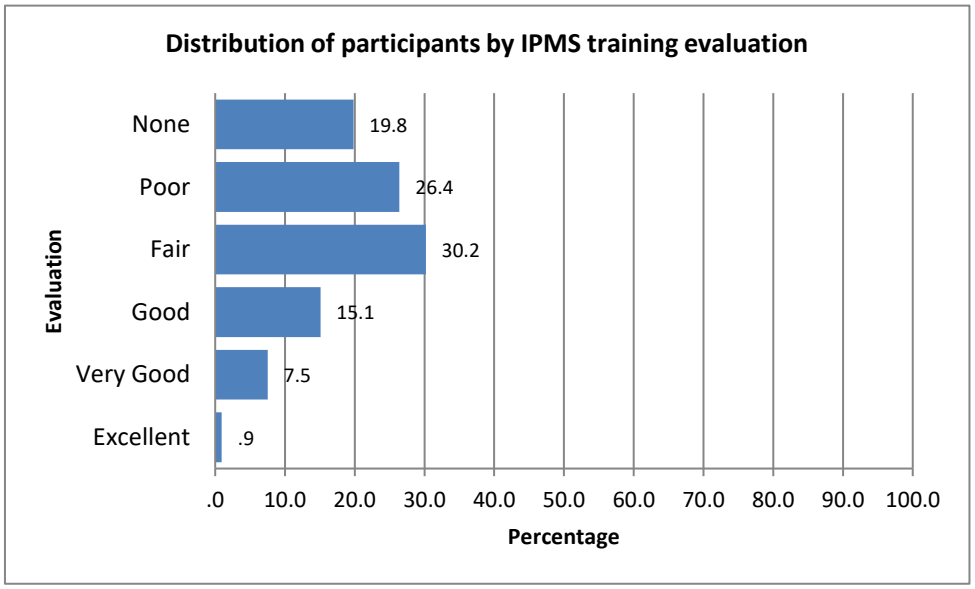

Fig 3: Distribution of participants by IPMS training

3.3. Attitudes

What are the attitudes of healthcare workers towards health informatics?

Interest in computer use

Table 4 below shows that 65 (60.8%) participants are eager to learn both computer and 66 (61.7) non-computer health informatics (other information included in health informatics that can also be accessed or learnt manually like clinical guidelines). These are followed by 32 (29.9%) and 30 (28.0%) who liked to learn more of computer and non-computer related clinical tasks, respectively. In both cases, 10 (9.3%) expressed willingness to learn if their jobs required them to. Only one participant expressed disinterest in informatics to the extent that he/she would rather avoid the subject of informatics and none of the participants expressed hostility towards computers. All the participants agreed that access to information improves their ability to make good patient care decisions. This is supported by their eagerness and willingness to learn informatics as depicted in the table 6 below.

Table 6: Distribution of participants by computer informatics learning interest

Interest level	**Computer Informatics n (%) N=107**	**Non-computer health informatics* n (%) N=107**
Eager to learn	65 (60.8)	66 (61.7)
Would like to learn more	32 (29.9)	30 (28.0)
Can learn if needed for my job	10 (9.3)	10 (9.3)
Avoid the subject	0 (0.0)	1 (1.0)
Hostile to computers	0 (0.0)	0 (0.0)

* e.g. clinical guidelines that can be accessed manually

Ninety-nine (92.5%) participants agree that they personally support the health information system. They also perceive that 91 (85%) of their co-workers support the system as well. Eighty (74.8%) participants also found it easy to adapt to the system. This suggests that health care workers appreciate the value of the health information systems. However, they seem to have concerns over the sufficiency of learning resources and technical support, as reflected with the majority disagreeing (disagree, moderately disagree and strongly disagree) that these issues are sufficient. With

respect to learning resources, 78 (72.9%) disagree that learning resources are sufficient while 72 (67.3%) at least disagree that there is sufficient technical support as shown in table 7 below.

Table 7: Distribution of participants by the health information system support and use

Opinion on health information system N=107	Strongly Disagree n (%)	Moderately Disagree n (%)	Disagree n (%)	Agree n (%)	Moderately Agree n (%)	Strongly Agree n (%)
Personal support of health information System	7 (6.5)	1 (0.9)	0 (0)	17 (15.9)	12 (11.2)	70 (65.4)
Coworker support of health information System	5 (4.7)	6 (5.6)	5 (4.7)	38 (35.5)	27 (25.2)	26 (24.3)
Easy adaptation to the system	7 (6.5)	5 (4.7)	15 (14.0)	37 (34.6)	18 (16.8)	25 (23.4)
Sufficiency of learning resources	28 (26.2)	14 (13.1)	36 (33.6)	18 (16.8)	7 (6.5)	4 (3.7)
Sufficiency of technical support	26 (24.3)	12 (11.2)	34 (31.8)	24 (22.4)	9 (8.4)	2 (1.9)

3.4. Practices

What are the health informatics related practices of healthcare workers?

Computer use for professional tasks

The study showed that the performance of computer-related tasks differs across different healthcare workers. Some are not involved in any way with the tasks while some often use a computer to perform the tasks but some perform the tasks manually. Forty-eight (44.9%) participants in this study did not carry out the electronic patient documentation 45(42.1%) clinical data capturing and patient appointment scheduling 46 (43.0%) tasks. However, 25 (23.4%), 17 (15.9%) and 24 (22.4%) healthcare workers reported to perform the tasks manually. Thirty-two participants (29.9%) sometimes use computers to access clinical diagnosis guidelines, 23 (21.5%) often use computers and 17 (15.9%) always use computers. The rest of the participants either never use computers to access clinical diagnosis guidelines. . For

medical literature searches, 39 (36.4%) always use computers, 33 (30.8%) often use computers and 21 (19.6%) sometimes use computers. For the remainder, half of them never use computers for literature searches although they do literature searching and the rest do not do any literature searching.

Twenty-one (19.6%) participants reported that they never perform patient education, 29 (27.1%) never use computers for patient education, 29 (27.1%) sometimes use computers for patient education and the remainder at least often use computers for patient education. For the purposes of communicating with colleagues, 34 (31.8%) sometimes use computers, 17 (15.9%) often use computers and 13 (12.1%) always use computers. This shows that most of the participants use computers for communicating with colleagues. There were 25 (23.4%) who reported that they never used computers for communication with colleagues and the rest did not communicate with colleagues electronically. An overwhelming majority of 64 (59.8%) always use computers for electronic mailing, 18 (16.8%) often use computers and 15 (14.0%) sometimes use computers for electronic mailing. The results are shown in table 8 below.

Table 8: Distribution of participants by use of computers for specific tasks

Task (N=107)	**None n (%)**	**Never n (%)**	**Sometimes n (%)**	**Often n (%)**	**Always n (%)**
Documenting patient Information	48 (44.9)	25 (23.4)	17 (15.9)	8 (7.5)	9 (8.4)
Clinical data capturing	45 (42.1)	17 (15.9)	10 (9.3)	17 (15.9)	18 (16.8)
Patient appointment Scheduling	46 (43.8)	24 (22.9)	18 (17.1)	14 (13.3)	5 (4.8)
Clinical diagnosis Guidelines	21 (20)	14 (13.3)	32 (30.5)	23 (21.9)	17 (16.2)
Medical literature Searching	7 (6.7)	7 (6.7)	21 (20)	33 (31.4)	39 (37.1)
Patient education	21 (20)	29 (27.6)	29 (27.6)	18 (17.1)	10 (9.5)
Communication with Colleagues	18 (16.8)	25 (23.4)	34 (31.8)	17 (15.9)	13 (12.1)
Electronic mailing	7 (6.5)	3 (2.8)	15 (14.0)	18 (16.8)	64 (59.8)

Usefulness of computers

Participants were asked to evaluate the level of usefulness of computers. Most of them, 50 (51.5%) felt that computers are highly beneficial followed by 29 (29.9%) who felt that computers are generally beneficial. There were 11 (11.3%) who felt that computers are highly detrimental, and the rest felt that computers are generally detrimental or were not sure whether to categorise computers as detrimental or beneficial. The distribution is shown in figure 4 below.

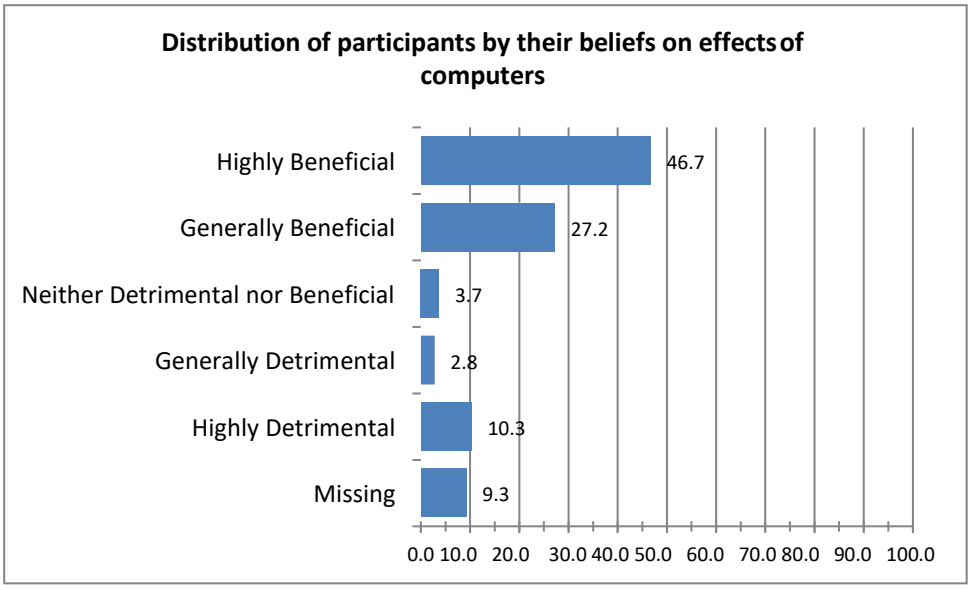

Fig 4: Distribution of participants by usefulness of computers

Opinions on the system-practices

Ninety-nine (92.5%) participants agree that they personally support the health information system. They also perceive that their co-workers;91 (85.0%) support the system as well (table 6). Eighty (74.8%) participants also found it easy to adapt to the system (table 7). This suggests that health care workers appreciate the value of the health information systems. However, they seem to have concerns over the sufficiency of learning resources and technical support, as reflected with the majority disagreeing (disagree, moderately disagree and strongly disagree) that these issues are sufficient. With respect to learning resources, 78 (72.9%) disagree that learning resources are sufficient while 72 (67.3%) at least disagree that there is sufficient technical support.

There were more participants; 37 (34.6) who agreed that the system is integrated into

their workflow than those who disagreed; 25 (23.4%). Sixty-one (57%) participants at least agreed that the system is integrated into their workflow and these were slightly more than 46 (43%) who at least disagree. A similar distribution pattern as the one for integration of the system into workflow was found for acceptability of system security with 60 (56.6%) at least agreeing and the rest at least disagreeing that the system has acceptable security. With regards to the user- friendliness of the system, 66 (61.7%) at least agree that the system is friendly, and the rest at least disagreed that the system is user-friendly. On this item, a majority of 44 (41.1%) of participants agreed that the system is friendly. Thirty-six (33.6%) participants disagreed that the system is reliable, 9 (8.4%) moderately disagreed and 5 (23.4%) strongly disagreed. This means the most of the participants at least disagreed that the system is reliable. While most of the participants, 34 (31.8%) agree that the system is excellent in overall, there are almost as many, 51 (47.7%) who at least agree as there are those who at least disagree, 56 (52.3%). This shows that the participants have reservations about the system on the whole. The results are shown in table 9 below.

Table 9: Distribution of participants by opinions on the system use

Item (N=107)	**Strongly Disagree n (%)**	**Moderately Disagree n (%)**	**Disagree n (%)**	**Agree n (%)**	**Moderately Agree n (%)**	**Strongly Agree n (%)**
Ease of use	9 (8.4)	7 (6.5%)	13 (12.1)	47 (43.9)	17 (15.9)	14 (13.1)
Acceptable response time	9 (8.4)	13 (12.1)	33 (30.8)	28 (26.2)	18 (16.8)	6 (5.6)
Integration into workflow	11 (10.35)	10 (9.3)	25 (23.4)	37 (34.6)	17 (15.9)	7 (6.5)
Acceptable system security	12 (11.4)	13 (12.3)	21 (19.8)	38 (35.8)	16 (15.1)	6 (5.7)
User-friendliness of system	6 (5.6)	12 (11.2)	23 (21.5)	44 (41.1)	13 (12.1)	9 (8.4)
Reliability of system	25 (23.4)	9 (8.4)	36 (33.6)	28 (26.2)	3 (2.8)	6 (5.6)
Overall excellence of the system	16 (15.0)	12 (11.2)	28 (26.2)	34 (31.8)	12 (11.2)	5 (4.7)

3.5. Factor analysis for variables

The scree plot was used as an exploratory tool for identifying the number of factors. The factor analysis grouped the items as shown in the results below and the factor variables were derived as an arithmetic means of the items making up the respective factors. The scree plots and the factor patterns are presented for each section below.

Attitudes

Figure 5 and Table 10 below shows that the five attitude items can be reduced to two factors based on the eigenvalue greater than 1 criterion. The two factors identified were support and resources with three and two items, respectively.

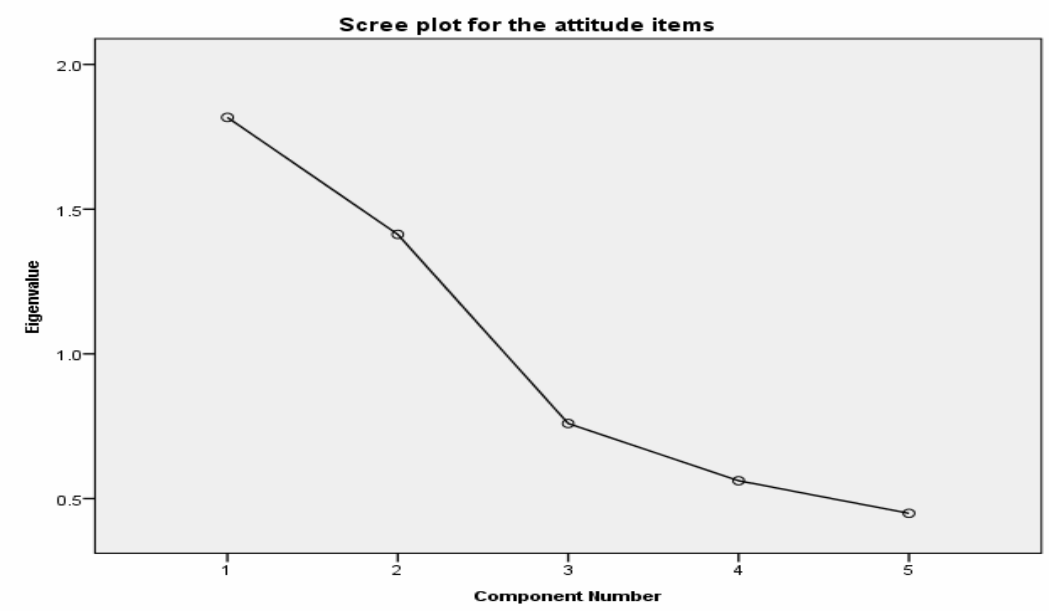

Fig 5: Factor pattern for IT support and resources

Table 10: Rotated Component Matrix for IT support and resources

	Component	
	Support	Resources
Coworkers support health information system	0.832	
Personal support for health information System	0.821	
Easy adaptation to the system	0.532	
Sufficiency of learning resources		0.854
Sufficiency of technical support		0.831

Practices - computer use

Figure 6 below corresponds to the factor analysis of the eight items on the healthcare workers' uses of computers. Just like in the above case, figure 11 below shows that the eight items can be reduced to two factors. This suggests that the uses of computers by healthcare workers can be divided into two groups based on the same criterion as the one used above.

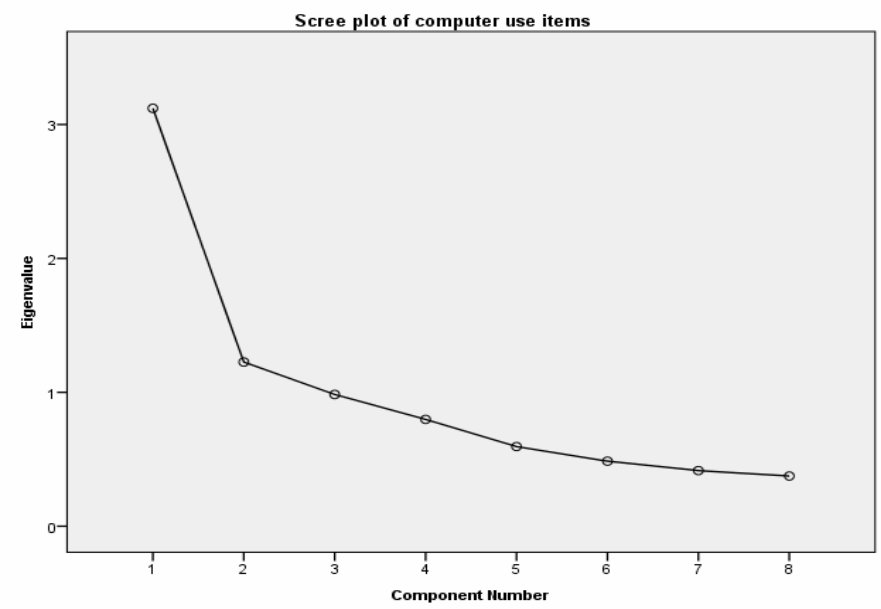

Fig 6: Factor pattern for computer use

Table 11 below shows the eight computer use items defined in two groups of uses. The two groups of uses can be summarised as one group of five items referring to access and sharing of information (obtaining clinical diagnosis guidelines, medical literature searching, patient education, communication with colleagues and electronic mailing) and another group of three items (documenting patient information, clinical data capturing and patient appointment scheduling) referring to data entry and processing.

Table 11: Rotated Component Matrix for data access, sharing, entry, and processing through IT

	Component	
	Information access and sharing	Data entry and Processing
Medical literature searching	0.795	
Communication	0.782	
Patient education	0.738	
Obtaining clinical guidelines on patient Diagnosis	0.716	
Electronic mailing	0.561	
Clinical data capturing		0.813
Patient information documentation		0.737
Patient appointment scheduling		0.518

Practices–System evaluation

Figure 7 below corresponds to the factor analysis of the seven items on the healthcare workers' evaluation of the HI system. Based on the eigenvalue greater than 1 criterion, this scree plot shows that the system evaluation items can be grouped into a single group. This means all the items on system evaluation represent one group, the system evaluation group. Since only one factor was identified, there is no real need to display the item groupings table as in the cases above.

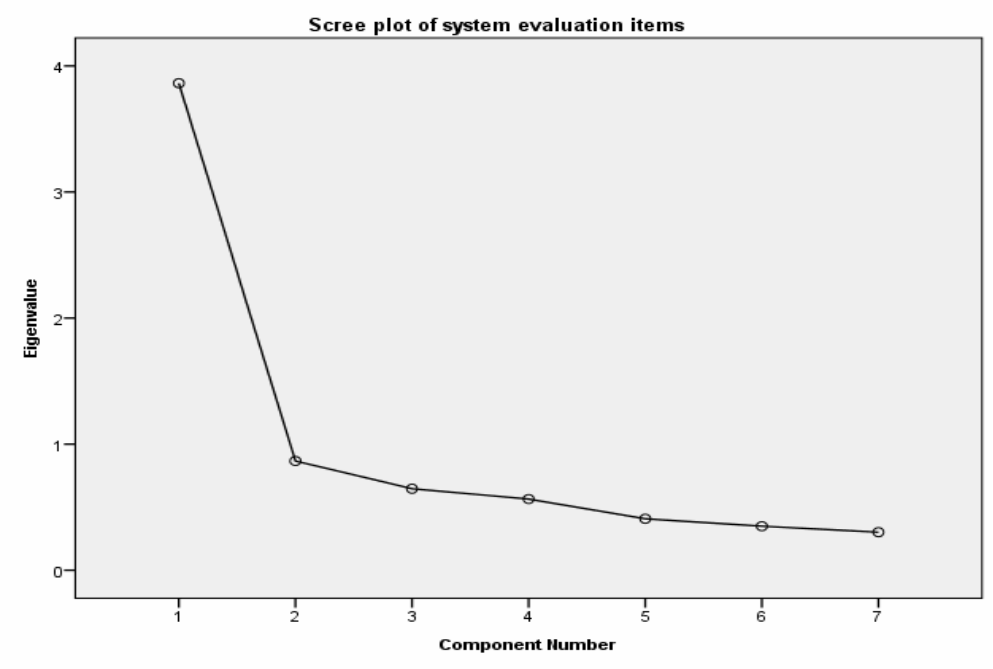

Fig 7: Factor pattern of system evaluation

Based on this analysis, instead of the 20 items on attitudes and practices, only five variables can be used to represent those many items. The five factors were derived as explained above and below is the descriptive analysis of those five factors. Table 12 below shows the descriptive analysis of the five-factor variables derived from the five factors. The results show that the participants scored highest on the system support factor with a mean score of 4.6 out of a possible 6 and the lowest was data management with a mean of 2.2 out of a possible 5.

Table 12: Descriptive summary statistics for the factor variables

Factor variable	N	Range	Min	Max	Mean	Std. Dev
System support	107	4.67	1.33	6	4.6	1.017
Resource sufficiency	107	5	1	6	2.8	1.175
Data management	107	4	1	5	2.2	0.986
Learning and communication	107	4	1	5	3.3	0.909
System evaluation	107	5	1	6	3.5	0.984

Spearman correlation analysis

The next analysis was to test if there are any significant pairwise relationships among the five factors. The Spearman's correlation analysis was used for the tests for relationships. The results show that system support has statistically significant positive linear relationships with learning and communication (r=0.21; p=0.031) and system evaluation (r=0.30; p=0.002). This means that high scores on the system support factor are associated with high scores on system evaluation and learning and communication factors. Similarly, high scores on the resource sufficiency factor are associated with high scores on the system evaluation factor (r=0.31; p=0.001). This is shown in table 13 below.

Table 13: Spearman correlation analysis

Spearman Correlation Coefficients, N = 107 Prob > |r| under H0: Rho=0				
	System support	**Resources**	**Records**	**Learning and communication**
Resources	0.16 0.103			
Records	0.13 0.194	0.10 0.327		
Learning and communication	0.21 0.031	0.15 0.132	0.34 < 0.001	
System evaluation	0.30 0.002	0.31 0.001	0.09 0.384	0.21 0.032

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 14: Comparisons of factor variables across gender

	Gender	**N**	**Mean**	**95% CI**	**T**	**p-value**
System Support	Male	59	4.7	4.4- 5.0	1.01	0.316
	Female	48	4.5	4.2- 4.8		
Resource sufficiency	Male	59	2.9	2.6- 3.2	1.01	0.317
	Female	48	2.7	2.3- 3.0		
Data management	Male	59	2.3	2.1- 2.6	1.11	0.269

No significant gender effects were detected. Note that all p-values are greater than the significance level of 0.05 and the 95% confidence intervals for males and females overlap for all the factor variables. This is evidence that the males and females are not significantly different in terms of the five-factor variables as shown in table 14 above. The hypothesis that males and females are the same, in terms of the factor variables, is not rejected.

Table 15: Comparisons of factor variables across profession

	Profession	**N**	**Mean**	**95% CI**	**T**	**p-value**
System Support	Doctor	67	4.6	4.4- 4.8	-0.21	0.835
	Other	38	4.6	4.3- 5.0		
Resource Sufficiency	Doctor	67	2.9	2.6- 3.2	1.11	0.270
	Other	38	2.6	2.3- 3.1		
Data Management	Doctor	67	2.2	2.0- 2.4	-0.23	0.822

No significant profession effects detected. All p-values are greater than the significance level of 0.05 and the 95% confidence intervals for doctors and other healthcare workers overlap for all the factor variables. This is evidence that the doctors and other healthcare workers are not significantly different in terms of the five-factor variables as shown in table 15 above. The hypothesis that doctors and other healthcare workers are the same in terms of the factor variables is therefore not rejected. Regardless of the profession, the responses of healthcare workers on the factor variables are similar.

Table 16: Comparisons of factor variables across computer informatics interest

Factor Variable	**Computer Informatics**	**N**	**Mean**	**95% CI**	**T**	**p-value**
System Support	Eager	65	4.7	4.4-5.0	1.09	0.280
	Willing	42	4.5	4.2- 4.8		
Resource sufficiency	Eager	65	2.7	2.4-3.0	-1.22	0.224
	Willing	42	3.0	2.7- 3.3		
Data management	Eager	65	2.3	2.0- 2.5	0.23	0.821

No significant computer informatics interest effects detected. Note that all p-values are greater than the significance level of 0.05 and the 95% confidence intervals for the eager and the willing overlap for all the factor variables. This is evidence that the eager and the willing are not significantly different in terms of the five-factor variables as shown in table 16 above. This implies that respondents who are eagerness or willingness to learn computer informatics scored the same in terms of system support, resource sufficiency, learning and communication, data management and system benefits. The scores of the eagerness and the willingness to learn on these constructs are not significantly different. The hypothesis that the eager and the willing are the same in terms of the factor variables is not rejected.

Table 17: Comparisons of factor variables across non-computer informatics interest

Factor variable	Manual informatics Tasks	N	Mean	95% CI	T	p-value
System support	Eager	66	4.7	4.5- 5.0	1.36	0.175
	Willing	41	4.4	4.2-4.7		
Resource sufficiency	Eager	66	2.8	2.5- 3.1	-0.35	0.731
	Willing	41	2.9	2.5-3.2		
Data management	Eager	66	2.3	2.0- 2.6	0.71	0.477
	Willing	41	2.2	1.9- 2.4		

No significant non-computer informatics effects detected. Note that all p-values are greater than the significance level of 0.05 and the 95% confidence intervals for the eager and the willing overlap for all the factor variables. This is evidence that the eager and the willing are not significantly different in terms of the five-factor variables as shown in table 17 above. This means that the respondents who are eager and willing to learn about non-computer tasks are the same in terms of system support, resource sufficiency, learning and communication, data management and system benefits. The scores of the eagerness and the willingness to learn on these constructs are not significantly different. The hypothesis that the eagerness and the willingness to learn are the same in terms of the factor variables is not rejected.

Table 18: Comparisons of factor variables across experience

Factor variable	Experience	N	Mean	95% CI	F	p-value
System support	<1yr	28	4.7	4.3- 5.0	0.42	0.742
	1-5yrs	39	4.5	4.2-4.8		
	6-10yrs	15	4.8	4.4- 5.3		
	>10yrs	25	4.6	4.1- 5.1		
Resource sufficiency	<1yr	28	2.8	2.4- 3.2	0.64	0.588
	1-5yrs	39	2.6	2.2- 3.0		
	6-10yrs	15	2.8	2.1- 3.6		
	>10yrs	25	3.1	2.6-3.5		
Data management	<1yr	28	2.2	1.7- 2.6	0.61	0.608
	1-5yrs	39	2.1	1.9-2.4		
	6-10yrs	15	2.4	1.7- 3.2		
	>10yrs	25	2.4	2.0-2.8		
Learning and communication	<1yr	28	3.5	3.2- 3.8	0.66	0.579
	1-5yrs	39	3.3	3.0- 3.6		
	6-10yrs	15	3.3	2.6- 4.0		
	>10yrs	25	3.2	2.9-3.5		
System benefits	<1yr	28	3.6	3.3- 3.9	0.49	0.693
	1-5yrs	39	3.5	3.2- 3.8		
	6-10yrs	15	3.5	2.9- 4.1		
	>10yrs	25	3.3	2.8- 3.8		

No significant experience effects detected. All p-values are greater than the significance level of 0.05 and the 95% confidence intervals for experience levels overlap for all the factor variables. This is evidence that the factor variable scores are the same regardless of the level of experience (table 18 above).

Table 19: Comparisons of factor variables across age group

Factor variable	Age	N	Mean	95% CI	F	p-value
System support	<30yrs	54	4.6	4.4- 4.8	0.48	0.618
	30-40yrs	35	4.5	4.1- 4.9		
	>40yrs	18	4.8	4.2- 5.4		
Resource sufficiency	<30yrs	54	2.6	2.3- 2.9	3.15	0.047
	30-40yrs	35	2.8	2.4- 3.2		
	>40yrs	18	3.4	2.8- 3.9		
Data management	<30yrs	54	2.1	1.9- 2.4	0.61	0.545
	30-40yrs	35	2.3	1.9-2.7		
	>40yrs	18	2.4	1.9- 2.9		
Learning and communication	<30yrs	54	3.2	3.0- 3.5	1.17	0.314
	30-40yrs	35	3.5	3.2- 3.8		
	>40yrs	18	3.2	2.8- 3.7		
System benefits	<30yrs	54	3.5	3.3- 3.7	0.28	0.757
	30-40yrs	35	3.5	3.2- 3.9		
	>40yrs	18	3.3	2.7- 3.9		

Significant age group effects were detected for the resource sufficiency factor variable only (F = 3.15; p=0.047). Based on the F test, the age group effect was such that those older than 40 years had a significantly higher resource sufficiency score than those younger than 40 years. While the p-value for the resource sufficiency factor is less than 0.05, the 95% confidence intervals for this factor overlap. This means the differences in the resource sufficiency factor across age groups may not be high enough to suggest a real difference. Based on the confidence intervals, there are no significant differences in all factor variables (table 19 above).

Table 20: Comparisons of factor variables across education

Factor variable	Education	N	Mean	95% CI	F	p-value
System support	Diploma	21	4.5	4.0- 5.1	0.14	0.866
	Degree	51	4.6	4.3-4.9		
	Post Grad	35	4.7	4.4- 5.0		
Resource sufficiency	Diploma	21	3.0	2.5-3.5	0.38	0.685
	Degree	51	2.7	2.4- 3.1		
	Post Grad	35	2.8	2.4- 3.2		
Data management	Diploma	21	2.8	2.6- 3.3	4.02	0.021
	Degree	51	2.2	1.9- 2.5		
	Post Grad	35	2.0	1.7- 2.3		
Learning and communication	Diploma	21	3.2	2.8- 3.6	0.37	0.692
	Degree	51	3.3	3.0- 3.6		
	Post Grad	35	3.4	3.1- 3.7		
System benefits	Diploma	21	3.3	2.7 3.8	1.11	0.333
	Degree	51	3.6	3.4- 3.9		
	Post Grad	35	3.4	3.1- 3.7		

Significant education effects were detected for the data management factor only (F=4.02; p=0.021). The education effect was such that those with a diploma in education had a significantly higher data management score than those with a higher educational level. The confidence interval for the mean of this factor among the diploma holders is (2.6; 3.3) which is above and does not overlap with the confidence intervals of the undergraduate and postgraduate degree holders. The confidence intervals of the mean data management score for undergraduate and postgraduate degree holders overlap (table 20 above). This means these two groups are not significantly different from each other and are both significantly lower than diploma holders. No other significant education effects were detected.

3.6. Qualitative Analysis

The researcher selected 5 respondents from all the different healthcare workers to include doctors (2), nurses (1), pharmacy staff (1) and medical records staff (1),

following the completion of quantitative questionnaires. Most of the healthcare workers were generally not formally trained in the system used in the hospital other than the self-guided or learning from others on system use. Most themes emerged around the challenges on the overall logistics of the health information system. Almost all the respondents commend the Botswana Ministry of health for such a good initiative. However, they believe that the policy-makers should include different cadres of healthcare workers to get different views and challenges they face while on the job. Analysis of the following questions revealed recurring themes across the respondents:

- *Has the project been a success or a failure or some combination?*
- *Has the health informatics met the goals and expectations originally set forth?*
- *Did you meet or exceed expected milestones?*
- *Has the desired impact of Electronic Health Records (EHR) been realized?*
- *What have been the key challenges to success?*
- *What barriers or problems do you encounter and need to overcome?*
- *What can be done to better address these barriers?*
- *What anxieties or worries do you have in relation to health information technology in general?*

Recurring themes included the following:

Poor network and system integration were reported as the main challenges with HIT. The respondents reported that there were different systems used in different hospitals with integration and coordination which were inaccessible for them, therefore they were unable to have some of the patients' information. Non-linkage to other departments like X-ray department were also reported which could help doctors to read the results electronically thereby reducing patients' waiting times. They also reported the system to be provider-based and that they cannot communicate with the patients electronically.

Power outages were reported to be frequently leading to system interruptions and limited access to the system therefore a need for a backup power system. They articulated that even though they realize the positive impacts of the HIT in healthcare, the IPMS system had not reached its full potential hence underutilized because of different data collection tools used across the different healthcare settings. They raised

a need for collaboration with different donors to identify gaps and inconsistencies in order to improve data aggregation and sharing. The respondents reported that if well implemented, the system could be of great assistance especially from a medico-legal point of view. The system could also allow for proper auditing (monitoring and evaluation process), which would help with easier implementation of changes accordingly.

For staff preparation, lack of computer and IPMS training, unavailability of adequate resources such as computers and information technology (IT) personnel were reported. Most of the respondents reported not to have undergone any formal computer or IPMS training besides training on the job and learning from others. And that most of the time there was no or poor internet connectivity which could not be fixed in time because of limited IT support personnel thereby leading to underutilization of the system. The respondents pointed out a need for more resources, both human and computers to be increased and provided with IT and IPMS training. Most of the respondents also reported compromised system security due to viruses and computer crashing, therefore, a need for a consistent system update. The respondents showed great support of health information technology but raised concerns of it not being fully utilised because of limited number of staff trained. Recommendations were therefore for an extensive computer and IPMS training, however their concerns were limited staff leading to increased workloads. The respondents also recommended a need for induction of all staff to promote awareness and provide basic computer and IPMS training.

The inadequacy of the selected modules in the IPMS system leading to the inability to perform some procedures was one of the identified challenges, which further impacted on the ability to perform some of the required clinical tasks. A doctor pointed out that *"the system does not allow repeating important lab results within 48 hours especially for critical patients and accessibility to some of the modules and patient information from other facilities thereby limiting patient care"*. The respondents pointed out that all modules should be taught to healthcare workers such that they do not have to run around looking for a particular cadre allocated to a particular module if in need of information. Most of the doctors wished for mobile technologies to be used and for

them to be able to access the IPMs in their tablets. They stated that if was possible to access the results in their tablets, they could be able to check the results even at their own expense for the sake of the patients, especially during system outages.

One interviewee from pharmacy reported the inability of the system to monitor inventory. The pharmacy reported non-linkage to the laboratory where they can be able to see drug sensitivity results, also inability to book next refill dates for patients electronically. Nurses have a problem with limited access to other IPMS modules, some of the patients' information and also the inability to track defaulters which can subsequently lead to disease resistance and treatment failures.

4. DISCUSSION

Even though recommendations have been made by global and national health policies for management and integration of health information, the national health system is still made up of independent health programs and services, which have different data collection and reporting standards and practices. This leads to inconsistency, incomplete and fragmented information [53]. Several studies have shown that there are different health information technology systems used in developing countries [54]. The respondents from this study also reported different health information systems used across different health facilities making accessibility of patient information difficult.

Another HIS challenge identified was that the information systems are limited in terms of scope and are often overlapping and inefficient therefore covering limited information needs [55]. This is supported by the study respondents reporting limited IPMS modules and inability to access some modules. Data are mostly duplicated due to lack of data harmonisation with the use of multiple systems and data collection and reporting tools among different healthcare facilities and the community at large. It is difficult therefore to give a true representation of the health status in a population. Different healthcare facilities use a range of different formats, from paper reports to a mixture of different electronic outputs to present data, hence, complicating the analysis of such data [56]. The use of different software applications in different hospitals affects the systems' use and leads to under-utilisation of the entire system.

Referral hospitals like Princess Marina Hospital have limited availability of computers with at least one computer per ward while other departments have no computers at all. The healthcare workers also reported limited ICT awareness and training [19]. Personal computers and laptops have been reported by some studies to be the main equipment used for internet and network services. A study conducted in Ghana also revealed limited computers in major hospitals, having computers in front desks, records, and pharmacy departments only. It also showed that a minimal number of people who owned computers as compared to South Africans [57]. This study results showed significant age-group effect with older respondents having a significantly higher resource sufficiency than those younger, which may be ascribed to computer ownership and accessibility. Paper-based records are still used with a few hospitals having a fully functional electronic health record system. However, Ghana still faces challenges of poor infrastructures, limited skilled healthcare workers in health informatics with a few formally trained staff [57]. Only a few respondents in this study reported they underwent IPMS training and most of them also reported different health informatics modules in different health facilities which make access of information from other facilities difficult hence under-utilisation of the entire system. Power interruptions and limited internet connectivity were also reported. Other studies also reported the uneven distribution of human resources, lack of adequate computers and computer skills and overall limited knowledge of DHIS as the main challenges in rural areas for full utilisation of DHIS [22].

In addition to computer and IPMS skills, healthcare workers also need knowledge and data management skills. These involve collection, organisation, and interpretation of information through adaptation to change and coming up with strategies and solutions whenever the need arises. There is also a need to understand and be aware of organisational structures, standards of obtaining data, the ability to gather and analyze information from different sources, and the ability to communicate and exchange such information. Health managers have been shown to have limited use and understanding of information technology in health management [58].

The study results showed significant education effects for the data management factor only ($F=4.02$; $p=0.021$). The education effect was such that those with a diploma in education had a significantly higher data management score than those with a higher

educational level. The confidence interval for the mean of this factor among the diploma holders is (2.6; 3.3) which is above and does not overlap with the confidence intervals of the undergraduate and postgraduate degree holders. However, the confidence intervals of the mean data management score for undergraduate (1.9; 2.5) and postgraduate degree holders (1.7; 2.3) overlap. This means these two groups are not significantly different from each other and are both significantly lower than diploma holders.

Introduction of health information technology requires planning, preparation, and assessment of factors that may facilitate or hinder its use in the healthcare system. One of those significant factors is the attitudes of the healthcare workers who are expected to use the system [24]. Studies have shown that healthcare workers should be familiar with computer-based health interventions and have positive attitudes towards computer use [59]. A study done in Tanzania revealed that most efforts have been done on adoption of technology but little on understanding the attitudes of employees towards the adoption. It also showed that the healthcare workers are expected to use the health information system even without computer skills. The study also reported that having computer skills does not necessarily mean that the healthcare workers accept or will use the system [60]. The study results supported these results as most of the healthcare workers showed some skills in computer use, showed eagerness and willingness to learn about computers and IPMS but were however not formally trained on computers or IPMS even though it was required or they were already using the system.

The study results showed that majority of healthcare workers did not have any structured computer training, which included formal computer training, certificated or non-certificated workshops on computers. Of this majority study were doctors (62.6%) who could have received medical school computer training as part of their curriculum. This lack of skills subsequently poses a negative impact on the practice of HIT by the healthcare workers. The study results are different from one study conducted to investigate knowledge, experience and comprehension of eHealth by nurses who showed a majority of them reporting formal computer training and IT applications at school and confidence in using such. However, they had limited knowledge and training in eHealth which is similar to the study results [61].

Most of the participants (56.1) reported to have undergone self-guided learning about computers. Even though the results showed limited computer training, due to a need for computer and other electronic devices skills, most of them end up teaching themselves. This may be due to the fact that technology has advanced so much and so fast since the turn of the new millennium to the extent that almost everyone has a semblance of a computer in the form of smartphones and tablets. These are mini computers and most people, regardless of profession and occupation, find themselves with the need to learn more about their gadgets. Most of the study respondents had undergone tertiary education and in most cases, educational materials can be accessed online; there are also online teaching and presentations, which may help to equip students with computer knowledge and skills. Even though the majority rated themselves as proficient computer users, the study results showed generally low knowledge and use of health information technology therefore a need for further formal training.

However, minimum training while training is provided for health care workers in the hospital, quite a good number of them had not received the training so much that they could not evaluate the training programme. Fifty-three percent of the participants had negative evaluations of the training programme. Of the remainder of the participants, 26 (24.3%) rated the training as fair and the rest (22.4%) rated it as good, very good or excellent. This implies that there is a need for the hospital to upgrade and enhance computer training among the healthcare workers. The same applies for IPMS training as well. The results of limited training were also shown in IPMs training where only 37.4% of the healthcare workers received formal training on IPMS. This non- IPMS training influenced the results for rating of the IPMS system as some of the healthcare workers could not even make a rating of the system they were not trained in.

The respondents also reported limited confidentiality of the IPMS system similar to the Tanzanian study were compromised confidentiality was reported. They also reported perceived threat to system security as one of the factors that could affect user-acceptance of the system [60]. Most of the respondents also stated that the system is not user-friendly, which is different from a study done in South Africa which showed most of the healthcare workers in both rural and urban areas indicating that the health information system was easy to use [62].

5. STUDY LIMITATIONS

One of the limitations of the study is that it was done in a referral hospital in the capital city of Botswana. Even though it covered different cadres of healthcare workers, it may not be a representative of the population within the healthcare system. It will not be adequate to give a general account on the knowledge, attitudes, and practice to the entirety of health facilities in Botswana. The settings are different especially in terms of essential needs like electricity for technology functioning and the allocation of resources. Another limitation was a number of available and willing IPMS formally trained healthcare workers for interviews. These few trained workers could have provided a more detailed insight into the successes or challenges faced by the IPMS used in the hospital, therefore, informing policy decision-making related to health information technology in general. The study answers were also based on self-report thus introducing bias to the findings conservatively. The small number of nurses in the study was selected from one site and this poses a threat to internal validity; however the participants were randomly selected to minimize selection bias. The small number also does not fully represent the hospital's nursing population but can however be used to represent challenges in terms of knowledge, attitudes and practice faced by Infectious Disease care clinic nurses in other hospitals and clinics. However, the sample size accounts for close to 50% of the doctors and medical records staff. The experiences in this hospital can be used to inform and set basis in training needs identification in other hospitals within the country. The results of this study therefore can be transferrable to other similar settings because they face similar health system challenges.

6. CONCLUSION

Extensive studies about the use of the health information systems could give an insight into successes, failures, and challenges, which could give relevant solutions and improve on health services and subsequently improve health outcomes [52]. The advances and benefits of HIT can only be realized when the healthcare workers become knowledgeable and willingness to learn and utilise computers and HIT. The country's main investment in healthcare should, therefore, be in education, training,

and provision of technical structures to the healthcare professionals. Many healthcare workers showed great eagerness and willingness to learn computers and IPMS. Recommendations made by the healthcare workers in the study were the inclusion of health information technology as one of the subjects in healthcare training institutions.

Even though the majority rated themselves as proficient computer users, the study results showed generally low knowledge and use of health information technology. The results also showed limited computer resources and IT support. It does help in setting needs and targets and can also be a benchmark in scaling up their skills and building competencies hence promoting healthcare. The study of knowledge, attitudes, and practice of healthcare workers on the use of health information technology could be expanded to other health facilities to help draw up learning programs that will help improve the quality of healthcare service delivery, maintenance and sustainability of health information systems, not only in Botswana but in other developing countries as well.

7. DECLARATIONS

Competing interest

The authors declare that they have no conflict of interest.

Consent for publication

Not-applicable

Availability of data and materials

All datasets used for the study are available on reasonable request from the corresponding author.

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Authors' contribution

Keamogetse J. Ngcobo was responsible for the initiation and design of the study, data collection and analysis and for the drafting of the manuscript. Kerrin Begg, Fidele Mukinda, Oathokwa Nkomazana supervised the study and critically revised the paper and added content expertise.

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APPENDIX A

SELF-ADMINSTERED QUESTIONNAIRE

Study title: Knowledge, attitudes and practice of healthcare workers on use of Health Informatics in Princess Marina Hospital.

DEMOGRAPHICS

1. Please give the percentage of time you spend doing your jobs.

Role	Percentage of Time
Patient Care and Treatment	_____%
Teaching	_____%
Supervision	_____%
General Administration	_____%
Others	_____%
	Total= 100 %

Other (Please specify your roles): ……..

2. What is your area of work? (Select one)

□ Internal Medicine … □ Infectious Disease Care Clinic…□Pediatrics …

□ Surgery … □Hematology/Oncology … □Emergency Medicine …

□Psychiatry … □Laboratory… □ □Orthopaedics □ □Radiology …

Others (Please specify): …….

3. What is your profession? (Select one)

□Medical Doctor □Registered Nurse □Laboratory Personnel

□Pharmacist □Data clerk □others (please specify):……..

4. How many years have you worked in this occupation? (Select one)

□Less than 1 year … □1- 5 years … □6-10 years …

□11-15 years … □16-20 years … □Over 20 years

5. Gender (Select one): □□ Male … □Female

6. Your age group (Select one)

□20-30 … □31-40 …□41-50 □□ 51-60 □□ Over 60

7. Your highest level of academic achievement (Select one)

□High School … □Associate Degree … □Bachelor's Degree …

□Master's Degree … □Medical Doctorate Degree (PhD) …

□ Professional Certification … □others (Please specify):

……..

Knowledge

a. How frequently do you use a computer (choose one)?
□Daily □Weekly □Monthly

□Rarely □Never

b. What training or experience with computers have you had? (Check all that apply)

□ Formal course(s) in computer science or related field

□ Formal medical school training in computers

□ Formal workshops or conferences on computers for which I received a certificate

□ Workshops or conferences on computers for which I did not receive a certificate

□ Self-guided learning about computers

□None

c. On the whole, how sophisticated a computer user do you consider yourself? (choose only one)

□Very sophisticated

□Sophisticated

□Neither sophisticated nor unsophisticated

□Unsophisticated

□Very unsophisticated

d. Rate the quality of computer training provided to healthcare workers in your hospital?

□Excellent □Very good □Good □Fair □Poor □None

e. Have you ever been trained specifically, on health informatics (Integrated Patient Management System) used in your hospital?

□Yes □No

f. Rate the quality of the Integrated Patient Management System (IPMS) training provided to healthcare workers in your hospital?

□Excellent □Very good □Good □Fair □Poor □None

Attitudes

a. On the whole, how interested are you in learning more about computers? (choose only one)

□Eager to learn more

□I'd like to learn more

□I'll learn more it I have to, to do my job

□I'd just as soon avoid the subject.

□I feel hostile when I hear the word “computer”.

b. On the whole, how interested are you in learning more about the non-computer aspects of health informatics (e.g. Evidence based medicine, Problem oriented medical record, etc.) (Choose only one)

□Eager to learn more

□I’d like to learn more

□I’ll learn more it I have to, to do my job

□I’d just as soon avoid the subject.

□I feel hostile when I hear the words “health informatics”.

c. Access to information improves my ability to make good patient care decisions.

□Yes □No

d. Please indicate the extent to which you agree with the following statements:

1. Strongly disagree 2. Moderately disagree 3. Disagree 4. Agree

5. Moderately agree 6. Strongly agree

□ I support health information system.

□ My co-workers support the system.

□I had no difficulty in adapting to the system.

□Sufficient resources were provided for me to learn to use the system.

□Sufficient technical IT support is available to operate the system.

Practice

a. To what extent do you personally use a computer for each of the following professional tasks? Please circle your answer.

1. Never perform this task
2. Perform this task but never use a computer
3. Sometimes use a computer
4. Often use a computer
5. Always use a computer

Documenting patient information (e. g history, progress notes)	1	2	3	4	5
Entering clinical data (e. g laboratory results)	1	2	3	4	5
Scheduling patient appointments	1	2	3	4	5
Obtaining clinical guidelines on a specific patient's diagnosis or therapy	1	2	3	4	5
Searching medical literature	1	2	3	4	5
Patient education	1	2	3	4	5
Communicating with colleagues	1	2	3	4	5
E-mail	1	2	3	4	5

b. Please indicate whether you believe the potential effects of computers on medicine will be beneficial or detrimental using the scale below:

□ Highly detrimental □Detrimental on the whole □Neither detrimental nor beneficial

□Beneficial on the whole □Highly beneficial

c. Please indicate your level of agreement or disagreement with each of the following statements below.

1. Strongly disagree 2. Moderately disagree 3. Disagree

4. Agree 5. Moderately agree 6. Strongly agree

□The system is easy to use

□The response time is acceptable

□The system is integrated with my workflow

□The system security is acceptable

□The system features enable me to perform my work well

□The system is reliable in its performance

□Overall, the quality of the system is excellent

Open Response Area (Use back of page if necessary)

1. Regarding health information technology in general, is there anything you might like to do or be able to do that you can't do right now.

_____

_____

_____

2. What barriers or problems do you encounter and need to overcome?

_____

_____

_____

3. What can be done to better address these barriers?

_____

_____

_____

4. What anxieties or worries do you have in relation to health information technology in general?

_____

_____

_____

5. What else do you want to share in relation to health information technology?

_____

APPENDIX B

Study Title: Knowledge, attitudes and practice of healthcare workers on the use of Health Informatics in Princess Marinas Hospital in Botswana.

INTERVIEW SCHEDULE

Knowledge, attitudes and practice of healthcare workers on use of health informatics in Princess Marina Hospital, Botswana

Health information technology (HIT) is information technology applied to health care. It provides the umbrella framework to describe the comprehensive management of health information across computerized systems and its secure exchange between consumers, providers, government and quality entities, and insurers.

Health informatics is an integral aspect of HIT. The health informatics tools include not only computers but also clinical guidelines, formal medical terminologies, and information and communication systems.

INTERVIEW QUESTIONS

1. What is your understanding of health information system used in your hospital?
2. Has the project been a success or a failure or some combination?
3. Describe where you have realized success and where it is deemed a failure.
4. Has the health informatics met the goals and expectations originally set forth?
    a. In relation to quality of care
    b. In relation to clinic efficiency and cost savings
    c. Patient safety d. Unexpected outcomes
    e. Other issues

5. Did you meet or exceed expected milestones? What were the major challenges and how were they addressed?
6. How well was staff prepared in relation to use of health informatics?
7. How did they react during the implementation?
8. What impact has the health informatics had on your hospital?
9. What have been the key challenges to success?
10. What have been the key facilitators to success?

11. Describe how workflow was impacted (lab results, prescription refills, tracking referrals etc). How have these changes benefited your practice?
12. Has this health informatics changed your goals for the organization?
13. Has the desired impact of EHR been realized? When do you expect to realize the full impact?
14. Who deserves credit for the success/or failure of the health information technology project?