The Gezira Family Medicine Project (GFMP)

A scientific evaluation of a Master program for family physicians in Gezira, Sudan

Khalid Gaffer Mohamed

Thesis for the Degree of Philosophiae Doctor (PhD)
University of Bergen, Norway
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Allah says in Quran, Surat Al-'Alaq (The clot) 96

In the name of Allah the most Gracious, the most Merciful

اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ - خَلَقَ الْإِنسَانَ مِنْ عَلَقٍ - اقْرَأْ وَرَبُّكَ الْأَكْرَمُ -
الَّذِي عَلَّمَ بِالْقَلَمِ - عَلَّمَ الْإِنسَانَ مَا لَمْ يَعْلَمْ

"Read! In the Name of your Lord, Who has created (all that exists), Has created man from a clot. Read! And your Lord is the Most Generous, Who has taught (the writing) by the pen. Has taught man that which he knew not," [Al-'Alaq 96: 1-5].

(This is the first phrases ever from Allah to prophet Mohammed-peace upon him).

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Khalid Gaffer Mohamed

The candidate has been enrolled in the doctoral education programme at the Faculty of Medicine at the University of Bergen, Norway. The scientific environment has been the research group for general practice at the Department of Global Public Health and Primary Care, Faculty of Medicine, University of Bergen and at my workplaces at the Gezira University and Taibah University

Current place of employment:
University of Taibah
Kingdom of Saudi Arabia

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1. Acknowledgements

I finished my specialty in family medicine in Norway in August 2008. I visited my home country Sudan in 2009 without any plans to stay there; because few knew about my family medicine specialty there. I visited my old "friend" professor Elzubair Bashir Taha who was the director of Khartoum University when I was a student there, and now he was the governor of the Gezira state in 2009. He asked me to lead a project for implementing family medicine in Gezira state, he had a positive experience with family medicine during his previous stay in UK. He was convinced about the importance of family medicine in providing accessible, equitable and high quality health service for people in Gezira. Health must not just be in cities, we must bring health to people where they live, in Gezira we have three thousand scattered villages. My answer was "Yes", I can participate in such a great mission. But I asked myself, how can I do that when I am the only family physician in Gezira with little experience? Who can help me in such a mission?

Professor Steinar Hunskaar, the author of the famous family medicine book in Norway was the first I thought about. He did not know me from before, I found his email on the net and contacted him, told him who am I, and asked if he is able to visit Sudan and help in implementing family medicine there. Unexpectedly he said immediately "Yes", and was able to visit Sudan many times. He has been presented a "Honorary professor ship" from the University of Gezira due to his great efforts. Thanks for help in implementing the GFMP.

The GFMP started in 2010, curriculum was structured, candidates were enrolled, health services were provided and people started to feel the difference and to be happy for that. We presented the GFMP experience to other states and partners in Sudan and in international conferences. We were asked every time to document and provide a detailed scientific description of the project and its outcomes. Here came the idea of the PhD research project; and again I asked professor Hunskaar if he can help me to

apply for a PhD at the university of Bergen and to guide me on that. Again he said immediately "Yes", and agreed to be my main supervisor.

My high gratitude to professor Steinar Hunskaar again as a main supervisor. He was able to hold supervision meetings anywhere at any time. He gave continuous support, constructive feedbacks and valuable advices, and never let me down.

I was also lucky to have Professor Samira Hamid, an eminent female professor in public health from Sudan, as a co-supervisor; together with Dr. Elfatih Malik. They were co-authors for the four articles included in this thesis together with Professor Hunskaar, my sincere gratitude to all of them.

I would like to thank also the candidates of the first batch of the GFMP who participated in this study, and the staff of the GFMP who helped in data collection and provided me with the essential reports.

Thanks to the Department of Global Public Health and Primary Care at the University of Bergen who has funded the projects. Thanks for those who provided a scientific environment for me including the research group for general practice at the Department of Global Public Health and Primary Care at the University of Bergen and at my workplaces at the Gezira University and Taibah University

Thanks to Dr. Abdulmohsin Alzalabani, the head of the department and to my colleagues at the Department of Family and Community Medicine, University of Taibah for their support and collaboration.

Last, but not least, great thanks to my beloved mom and wife who supported, encouraged and took care of me and of our children during many periods of heavy workload and long travelling. Many thanks to my fine kids also, who were patient enough and tried to let me have time for writing.

2. Abbrevations

EMR: Electronic Medical Records

FM: Family Medicine

GFMP: Gezira Family Medicine Project

ICT: Information and Communication Technology

LMIC: Low and Middle Income Countries

MDG: Millennium Developmental Goals

NCDs: Non Communicable Diseases

PHI: Public Health Institute

PPOS: Patient-Physician Orientation Scale

SSA: Sub-Saharan Africa

SMSB: Sudan Medical Specialization Board

WHO: World Health Organization

3. Abstract

3.1 English summary

Background

Family medicine based health systems are accepted worldwide as the best suitable model to provide integrated, high quality health services. In Sub-Saharan Africa, there is a recent movement towards implementing family medicine in health system; consequently, high up scaling of family medicine training is targeted and is going on like a fast track.

Sudan faces the same challenges found in other Sub-Saharan African countries including the predominance of the tropical diseases that over-shadow the emerging problem of Non-Communicable Diseases (NCDs). The Gezira Family Medicine Project (GFMP) was established in 2010 as a collaboration project between several local partners including the State Ministry of Health and the University of Gezira. The project aimed to train qualified family physicians who can participate in providing high quality, accessible, and affordable primary health care services in Gezira. A two-year Master curriculum was designed as an "in-service" model of training to meet both service provision and training's goals. A total of 207 candidates were enrolled in the first batch of the program in 2010. The project used information and communication technology (ICT) in a comprehensive way; it is used to provide health care in a distance (telemedicine), to facilitate and increase the accessibility in medical education (e-learning) and to manage patients' information (Electronic Medical Records- EMR).

Study objectives

This study aimed to:

1. Describe the GFMP during its first batch (2010-2012), its implementation, curriculum structure, baseline data of the trainees and their health centres.

2. Assess the candidates' utilization of information and communication technology at the GFMP, and their perception of its use.

3. Assess the impact of the Master programme on candidates' confidence to perform certain manual and cognitive clinical skills.

4. Assess the impact of the GFMP on candidates' adherence to the core values of family medicine including patient-centeredness.

Methods

Three comprehensive questionnaires were used to collect data both at the start of the Master program for the first batch and again at its end. The first questionnaire included background data regarding the candidates and their self-assessment of confidence to perform certain skills. The second questionnaire was a checklist for the health centres including the buildings, available equipment and provided services. The third questionnaire aimed to assess candidates' practice including adhesion to the core values of family medicine during patient consultations.

A cross sectional, questionnaire and administrative data based observational design was used in paper 1 and paper 2. Self-evaluation questionnaire was used to collect data about the trainees' skills, while a checklist was used to collect data from the health centres. Administrative data was used to describe the project implementation, its curriculum design and candidates' utilization of ICT during the master period.

A prospective cross sectional study with a before-and-after design was used in paper 3 and paper 4 to assess the progress change of the trainees during the Master period

2010-2012 (cohort observational design). Self-evaluation questionnaire and practice-based data were used to assess trainees' confidence in performing certain clinical skills and to assess their adhesion to some family medicine core values. The Patient-Practitioner Orientation Scale (PPOS) was used to assess patient-centeredness.

Results

The 2-year in-service Master program at the GFMP could recruit 207 physicians to be trained in family medicine and to provide health services in 158 health centres, of which, 84 centres had never been served by a doctor before. The mean age of the enrolled trainees was 32.5 years, 57% were males and one third of them were graduated from the University of Gezira. Self-evaluation in confidence to perform certain clinical skills showed significant variations between individual skills, between medical disciplines, and between genders. Health centres were generally equipped to deal with tropical diseases, but poorly equipped to deal with Non Communicable Diseases (NCDs)

Information and communication (ICT) reports showed a performance of 3808 online telemedicine consultations in the period April 2011 to December 2012. Over 165000 new patients' electronic medical records (EMRs) were established by the candidates at their graduation (N: 125 candidate). Candidates were generally highly satisfied with the use of ICT during their master period. They highlighted some patients' concerns regarding the use of EMR and telemedicine during consultations.

To assess candidate's improvement after the Master program, self-assessment of 46 clinical skills was done before and after the master program using a five-grade Likert scale (1-5). It showed an overall improvement of 21.7% from 3.23 (before) to 3.92 (after). Improvement variation is observed between the different medical disciplines.

Males have constantly scored higher confidence than females, while females showed higher progress percentage in improvement compared with males. Statistically significant improvement is also detected regarding candidates' development in certain role skills like leadership, health promotion, and communication with colleagues and the community. In contrast, there was an overall significant decrease in orientation towards patient-centred care by 4% using the Patient-Practitioner Orientation Scale (PPOS).

Conclusion

GFMP represented a good model for local collaboration, which resulted in performing training goals and providing high quality primary health care services. The in-service model of training was attractive for trainees (207 joined the program) and promising for health service provision (158 health centres were served by GFMP, of which 84 had never been served by physicians before). Information and communication technology (ICT) supported both training goals and service provision goals at the GFMP. The GFMP curriculum had a positive impact on candidates' confidence to perform the targeted clinical skills. Practice data showed a positive impact of the Master program on candidates' adherence to family medicine core values. Patient centred care was a weak point in candidates' training that needs more attention in future curriculum planning and implementation.

Recent assessment of the status of the GFMP and family medicine training in Sudan as a whole done in Apr 2018, showed still high up-scaling of family medicine training in the whole country, presented by several institutes including the University of Gezira and the National Public Health Institute (PHI). The development of the GFMP as a project is affected by economical challenges and a decline in the political commitment, which affected the partnership between the University of Gezira and the State Ministry of Health.

3.2 Norwegian summary – norsk sammendrag

Bakgrunn

Helsesystemer som bygger på en sterk primærhelsetjeneste er anerkjent som den beste modellen for å levere godt integrerte helsetjenester med høy kvalitet. I Afrika sør for Sahara har det de siste årene vært mange forsøk på å utvikle helsetjenester som omfatter allmennmedisin slik vi kjenner det fra Europa og Nord-Amerika. Dette betyr at man har hatt stort fokus på å utvikle utdanningssystemer med dette formålet, med stort nok kapasitet og kvalitet.

Sudan har mange av de samme helseutfordringene som andre land sør for Sahara. Dette inkluderer stort omfang av tropesykdommer samtidig som man ser fremveksten av tradisjonelle kroniske sykdommer. Gezira Family Medicine Project (GFMP) ble etablert i 2010 som et samarbeid mellom flere lokale partnere, inkludert helsedepartementet og universitetet i delstaten Gezira. Målet med prosjektet var å utdanne allmennleger som kunne gi befolkningen i Gezira primærhelsetjenester av høy kvalitet, samtidig som hjelpen var lett tilgjengelig og billig. Et to-årig Masterprogram for leger ble planlagt. Man valgte samme utdanningsmodell som i Norge; man utdanner seg til allmennlege samtidig som man arbeider ved et helsesenter. I alt starter 207 kandidater på det første kullet i 2010. Prosjektet benyttet moderne teknologi i form av telemedisin og e-læring og for første gang i Sudan benyttet man et elektronisk journalsystem.

Forskningsprosjektet

Det ble planlagt et forskningsprosjekt med følgende formål:

1. Beskrive selve programmet og det første kullet kandidater i GFMP (2010-2012). Dette inkluderte planleggingen, programstrukturen og –innholdet, beskrivelse av studentene og helsesentrene.
2. Undersøke bruken av telemedisin, e-læring og bruken av elektroniske journaler.
3. Undersøke programmet effekter når det gjeldt kandidatenes praktiske og kliniske ferdigheter.

4. Undersøke programmets effekter når det gjaldt kandidatenes holdninger til allmennmedisinske kjerneverdier, inkludert pasientsentrert arbeidsmetode.

Metoder

Tre omfattende spørreskjemaer ble brukt for å innhente opplysninger ved starten og slutten av det to-årige programmet. Det første skjemaet inkluderte data om bakgrunnen til kandidatene og deres selv-bedømte nivå av ferdigheter. Det andre skjemaet registrerte forhold ved helsesentrene, som bygninger, rom, utstyr og de tjenestene man tilbød. Det tredje skjemaet hadde som formål å undersøke kandidatenes kliniske praksis, inkludert hvordan man arbeidet i pakt med allmennmedisinske arbeidsmetoder og verdier.

Resultater fra spørreskjema og administrative data ble brukt som datagrunnlag for avhandlingens to første artikler. Selv-evaluering ble brukt for å undersøke praktiske ferdigheter. Administrative data ble brukt for å registrere prosjektets gjennomføring, undervisningsprogrammet og bruken av IKT.

Avhandlingens to siste artikler bruker før-og-etter-data for å undersøke endringer som kan være en effekt av Masterprogrammet i årene 2010-2012. De samme spørreskjemaene ble brukt som ved starten.

Resultater

Det to-årige Masterprogrammet GFMP rekrutterte i alt 207 leger til utdanning i allmennmedisin. De gjorde praktisk tjeneste ved i alt 158 helsesentre, av disse hadde 84 senter aldri hatt ansatt lege før. Gjennomsnittsalderen på legene var 32,5 år, 57% av dem var menn og en tredel var utdannet ved Universitetet i Gezira. Nivået på de praktiske ferdighetene, målt ved selvevaluering, viste en klar økning, men varierte mye mellom ulike ferdigheter, mellom ferdigheter fra ulike medisinske spesialiteter og mellom kjønnene. Helsesentrene var generelt godt utstyrt etter lokale forhold, spesielt for å kunne diagnostisere og behandle

tropesykdommer. Utstyr med tanke på kroniske sykdommer var i liten grad tilgjengelig.

Det ble registrert 3808 telemedisinske konsultasjoner i tidsrommet april 2011 til desember 2012. Mer en 165 000 journaler hadde blitt opprettet hos de 125 kandidatene som avsluttet programmet i 2012. Kandidatene var generelt svært fornøyd med det digitale tilbudet i programmet. Det kom fram noen problemer og bekymringer sett fra pasientenes side når det gjald elektroniske hjelpemidler og telemedisinske konsultasjoner med pasientene til stede.

Bedømmelsen av nivået på 46 praktiske ferdigheter ble gjort ved selvevaluering før og etter programmet på en 5-gradig Likert skala (verdier 1-5, med 5 som beste). Det ble funnet en samlet forbedring på 21,7%, fra 3,23 før til 3,92 etter programmet. Det var forskjeller i forbedring mellom ferdigheter fra ulike medisinske spesialiteter. Menn skåret systematisk høyere enn kvinner, mens kvinner hadde størst prosentvis fremgang. Det ble også statistisk signifikant forbedring i faktorer som angår legerollen, eksempler er lederskap, helsefremmende arbeid og samarbeid og samhandling med både legekolleger og lokalsamfunnet. Noe overraskende ble det funnet en liten nedgang på 4% når man målte kandidatenes pasientsentrerte arbeidsstil. Dette ble målt ved et internasjonalt brukt spørreskjema kalt PPOS.

Konklusjoner

GFMP har vist seg som en god samarbeidsmodell i delstaten Gezira i Sudan for å oppnå utdanning i allmennmedisin og samtidig økt kvalitet i primærhelsetjenesten. Masterprogrammet rekrutterte godt og et stort antall helsesentre og landsbyer fikk allmennpraktiserende leger for første gang. Moderne digitale løsninger og programvare støttet opp om både utdanningen og det kliniske arbeidet. Utdanningsprogrammet førte til økte praktiske ferdigheter i allmennmedisinske prosedyrer og praksisdata viste at kandidatene økte bruken av allmennmedisinske arbeidsmetoder og arbeidet i pakt med allmennmedisinske verdier. Men manglende

fremgang når det gjaldt pasientsentrert arbeidsstil viser at det må arbeides mer med dette i det videre arbeidet med programmet.

Det ble gjort en statusoppdatering for GFMP i april 2018 ved besøk i Gezira og Khartoum for å innhente ferske synspunkter og erfaringer. Det finnes nå flere programmet i Sudan som bygger på GFMP. Flere institusjoner tilbyr allmennmedisinprogram, ikke bare Universitetet i Gezira, men blant annet også det nasjonale folkehelseinstituttet i Kharthoum. Flere kull studenter er tatt opp i Gezira. Totalt sett har over 1000 kandidater blitt tatt opp i de ulike programmene og nærmere 700 har fått sin mastergrad. Det opprinnelige gode samarbeidet mellom Universitetet og Helsedepartementet i Gezira møtte både økonomiske utfordringer og fallende politisk støtte, og har opphørt i sin opprinnelige form. GFMP som visjon og modell er imidlertid høyst levende i Sudan og er også anerkjent i andre afrikanske land og i den vitenskapelige litteraturen.

4. List of publications

This thesis is based on the following four articles:

Paper I

Mohamed KG, Hunskaar S, Abdelrahman SH, Malik EM. Scaling up family medicine training in Gezira, Sudan - a 2-year in-service Master programme using modern information and communication technology: a survey study. Human Resources for Health. 2014: 12:3.

Paper II

Mohamed KG, Hunskaar S, Abdelrahman SH, Malik EM. Telemedicine and E-Learning in a primary care setting in Sudan: The experience of the Gezira family medicine project. International Journal of Family Medicine. 2015:716426.

Paper III

Mohamed KG, Hunskaar S, Abdelrahman SH, Malik EM. Confidence in procedural skills before and after a two-year master's programme in family medicine in Gezira state, Sudan. Advances in Medicine. 2017: 6267015.

Paper IV

Mohamed KG, Hunskaar S, Abdelrahman SH, Malik EM. Impact on core values of family medicine from a 2-year Master's programme in Gezira, Sudan: Observational study. Submitted July 2018.

Reprints were made with permission from Human Resources for Health Journal, International Journal of Family Medicine, and Advances in Medicine Journal, respectively.

The articles are referred to as **Paper I**, **Paper II**, **Paper III** and **Paper IV** in the thesis.

5. Introduction

5.1. The emergence and development of family medicine as a discipline

5.1.1. The global emergence and development

The discipline of Family Medicine (named also as General Practice in certain regions) has steadily developed since its establishment 50-60 years ago [1]. Before the 20th century turn, all physicians were generalists, and as a consequence of the knowledge revolution at the 20th century, the specialties and sub-specialties emerged, leading to a fragmentation process that threatened the local health system. The desire to have a generalist in the community who has a broad knowledge and can coordinate health services appeared again. The development of the discipline showed variation in different countries and regions of the world, it started as early as 1960s in certain areas like north Europe and Canada, while other areas are still struggling to start its implementation. Family medicine is now an integral part of the curricula in the majority of medical schools worldwide [1-2].

The discipline of family medicine gets its importance from its central role in the primary health care system and its commitment to the objectives mentioned in the Declaration of Alma-Ata in 1978, which is still a valid and important document for politicians and stakeholders [3-5]. World Health Organization (WHO) reports and accumulated research evidences continuously stated that primary care is effective for preventing diseases and reducing deaths, and in providing more accessible, equitable and affordable health care for people [3-8]. On its comprehensive report "Primary Health Care, Now More Than Ever" [5] the WHO called for PHC reforms that respond to the social changes and rising expectations; such reforms constitute the agenda for the renewal of PHC. These reforms aim to cope with the arising inequity, changes in the nature of diseases like the emergence of NCDs and ageing, in addition to the recent political and economical changes including wars. The call for PHC system reform

increased in the last decades and found response in many areas around the world, including Sub-Saharan Africa. In Europe, research showed that countries with best primary health care systems have achieved that mainly due to reforms aimed to transfer of power and tasks to general practitioners [9]. Research evidences were followed by concomitant political commitment, and now there is a worldwide emphasis on the importance of family medicine and its role as a corner stone in the health system in many countries [10].

There are many success stories both in the developed and in developing countries [11] where family medicine could make a real change in the health system and consequently a high progress in health indicators. In Sub-Saharan Africa, family medicine is a newly emerging discipline and is supposed to participate in strengthening the fragmented health system and to lead the primary health care system.

5.1.2. Family medicine in Sub-Saharan Africa

Family medicine is a relatively new emerging discipline in Sub-Saharan Africa [12]. The emergence and development of the discipline is naturally affected by the context and the complexity of the health system in Africa with its many challenges. The world health statistics report 2017 showed that, at least half of the world's 7.3 billion population still lacks full coverage with the essential health services. In Africa, healthy life expectancy at birth is 52.3 years (the global number is 63.1 years). Maternal mortality per 100000 live births is 542 deaths (the global number is 216). Under-five years mortality rate per 1000 live births is 81.3 (the global number is 42.5) and the skilled health professional density per 10000 population is 14.1 (the global number is 45.6) [13]

Almost 24% of the global burden of disease is experienced in Africa, while Africa produces only 2% of the global supply of doctors, 3% of the global health workers. Africa also spends less than 1% of the world health expenditure [14]. The African primary health care system in fact is driven by nurses [15] and is characterized by the

presence of vertical programs like HIV, malaria, tuberculosis and several other individual programs. These programs provide respected efforts in fighting against individual targeted diseases, but unfortunately, they lead to more fragmentation of the health system [4-7]. In addition, the outcome of such programs is generally poor compared with the allocated resources [16].

The idea of implementing family medicine in the African health systems appeared in the last decade, and many countries started seriously the implementation of the new discipline [17-20]. It is a part of the global desire of PHC system reforms. The presence of family physicians in Africa is expected to strengthen the health care system, to promote more integrated team work, and consequently to attain the targeted global health coverage goals[21-22]. How family physicians fit in the Sub-Saharan health system and their role has been a pertinent question [23].

The PRIMAFAMED collaboration network leads family medicine development in Sub-Saharan Africa. It defines itself as "an institutional network gathering family physicians, health professionals, academics and researchers with an aim to develop and improve Family Medicine training and strengthen Primary Health Care in Africa "[24]. The network has adopted the strategy of south-south cooperation where member institutes can learn from and support each other. The department of family medicine and primary health care at the University of Ghent in Belgium took the initiative to coordinate this work and to support it academically; the head of the department Professor Jan De Maeseneer lead this work. The fruitful cooperation of these institutions resulted in a fast track towards family medicine training in Sub-Saharan Africa. Ten universities (including University of Gezira), in eight Sub-Saharan member countries were able to start family medicine training in a short period [12, 25].

The concept of family medicine has not been clearly defined in the African context until recently [26], generally the scope of FM in Sub-Saharan Africa carries the same values and share most of the principles of family medicine elsewhere in the world. However, family physicians in Africa are required to express these values in a

different way; they are supposed to perform a wider range of both clinical and professional skills, this is due to the contextual difference and the wide range of diseases [27]. In the majority of African countries including South Africa, family physicians are trained and required to be health team leaders at rural hospitals [28, 29]. Their clinical training includes major surgery and anaesthesia; this is in contrast with the North American and European model, where a certain group of patients are allocated to a certain family doctor who is responsible for these individuals and their families; the physician thus acts as the personal family doctor.

Although family medicine specialization has only recently emerged in Africa, research has shown that African governmental and academic leaders have recognized the role of skilled family physicians as a positive asset [30, 31]. Researchers tried to explore the definition of the African family medicine, the expected role and the needed procedural skills of the family physicians [28-32]. However, there is still a need for further research to reflect the training experiences, to evaluate the impact of the training programs on the trainees and the impact of the trained family physicians on the service provision.

5.1.3. Family medicine in East Mediterranean Region (EMR)

Sudan has a unique geographical location linking North Africa with Sub-Saharan Africa. In some instances, Sudan is recognized as a Sub-Saharan country and in others as a Northern African country. The WHO allocated Sudan to the East Mediterranean WHO region (EMR) which includes North Africa and extends to other areas in Middle East like the gulf counties, Iran, Pakistan and Afghanistan. In this region, the variation in the countries' economies from reach oil-producing countries to poor resource limited countries resulted in a similar variation from national based health systems to mixed national and private based health systems. In both systems, the primary care sector faces many different challenges; one of the most important challenges is the scarcity of health care providers, and especially family physicians [33].

Although family medicine is growing rapidly across the EMR, there is still a huge gap between the need and the available numbers of family physicians. Moreover, health systems are hospital based and need major modulations to utilize the graduated family physicians in building a primary care based health system. Such change is supposed to be led by family physicians themselves, who need to show strong leadership and effective role models to obtain the due recognition in the fast-changing health care delivery system [34].

5.1.4. Family medicine in Sudan before GFMP start

In Sudan, the specialty started in 2004 at the Sudan Medical Specialization Board (SMSB), and was called "General Practice". It was a 4-year MD at hospital training program. The training aimed to graduate health team leaders who practice at a rural hospital, rather than a personal family doctor this is similar to the models used in some other African countries including South Africa. Candidates were trained in major surgical and gynaecological procedures and anaesthesia. Few physicians joined the program and the speciality did not have the expected impact, because the health system in Sudan is more health centres built rather than rural hospitals built.

The curriculum of the SMSB was changed in 2010, just after the start of the Gezira Family Medicine Project (GFMP). The staff of the GFMP were enrolled at the national family medicine board of the SMSB and participated in the curriculum refiguring workshop. The MD curriculum has been changed to be similar more or less to the European model (personal doctor), and the specialty is now called "Family Medicine". The preference of the (personal doctor) model in Sudan can be due to the relatively high production of doctors in Sudan compared with other African countries (Over 30 medical schools in Sudan) and the high number of health centres compared with the number of rural hospitals. Family physicians are also needed in cities to organize the health system and relieve the work load on urban hospitals.

Before the start of the GFMP, the University of Gezira provided a one-year Diploma in Family Medicine in 2008 and 2009. The training was at the University "in house model" of training, it was a collaboration project supported by PRIMAFAMED. There were 12 candidates who joined the first batch of the diploma and 14 candidates who joined the second one. Part of the diploma candidates joined the GFMP thereafter to upgrade their certificate from a one-year Diploma to a two-year Master grade. The Diploma program was cancelled after the start of the GFMP master program.

5.2. Family medicine training and core values

5.2.1. Family medicine training

The discipline of family medicine and consequently its training is unique in its nature. It encompasses training of a wide range of intellectual and manual skills from several medical disciplines. Moreover, it is more concerned about the humanistic dimension of the client, taking care about the client's social and psychological aspects as well as the biological aspect [35]. It is concerned about the community as well as the individual and responds to the community needs worldwide. Qualified, well-trained family physicians lead to higher quality of healthcare services, better clinical outcomes and better patient satisfaction in countries with advanced health care systems [9].

The discipline showed high flexibility to meet health system and community needs, skills and functions of family physicians varied according to the need in the different regions of the world. In certain countries like Australia and UK, the number of primary care physicians represents more than half of the physicians, in other areas like Sub-Saharan Africa and Asia, there is a problem of brain drain both from rural to urban areas and from low and middle-income countries (LMIC) to rich countries [36, 37]. Consequently the "gate-keeping " role of the family physician in Europe might not be a priority in Africa, the preferred role will usually be a health team leader in the community, manager and resource allocator [38, 39].

This context dependent function of the family physician leads to a lack of clarity and consequently a variation in many family medicine scales, including the definition of the discipline, its core values, the role of the family physician, and content of training and the position of family medicine in the health system.

Family medicine training programs also show clear variation in the content of the curricula, length of the training period, training site, method and pedagogic approach. The training period varies from two years (like Canada) to five years in other countries (like Norway). The training site varied also from hospital-based training to primary care based 'in-service' training.

As an example of family medicine training models, the College of Family Physicians in Canada highlighted two major training domains for the Canadian family medicine residency [40]:

I.   Clinical care domain which is arranged by:
- Care of patient across the life cycle (In childhood, adolescent, adult life and at the end of life)
- Care of patient across the clinical setting (Urban or rural, Emergency or long term follow up, in office or hospital)
- Clinical responsibilities (Preventive, diagnostic, rehabilitation and palliative care)
- Procedural skills that needs continuous updating.
- Care of underserved patients

II.   Evolving professional competencies
- Communicator including ICT and EMR
- Collaborator (team worker)
- Manager (leadership, patient safety, quality improvement, Information retrieval and management)
- Health advocate (Community responsiveness and social accountability)

- Scholar (teacher, researcher and lifelong learner)
- Professional (professionalism in ethics, boundaries and self-care)

5.2.2. Core-values of family medicine

Defining the discipline's principles and core values is essential in the training strategy. It is however difficult to find a unified clear definition of family medicine worldwide, and while some family medicine core values are unique and universal in their nature, there are other values that are still controversial[35-38].

The World Organization of Family Doctors (WONCA) defines family physicians as practitioners who *"care for patients of all ages; ensure access to comprehensive primary and secondary services; manage infectious and chronic diseases; provide emergency, active, and long-term care; and coordinate individual clinical, community, and public health services"*. [41]

Ian McWhinney was the first Canadian professor in family medicine and one of the discipline pioneers; he described the principles of family medicine as follows: *"Nine principles of family medicine can be described: an open-ended commitment to patients; an understanding of the context of illness; the use of all visits for preventive purposes; the view of the practice as a population at risk; the use of a community-wide network of supports; the sharing with patients of the same habitat; the care of patients in office, home and hospital; a recognition of the subjective aspects of medicine; and an awareness of the need to manage resources"*.[42]

The American Association of Family Physicians (AAFP) describes family medicine discipline as: *" Family medicine is the medical specialty which provides continuing, comprehensive health care for the individual and family. It is a specialty in breadth that integrates the biological, clinical and behavioural sciences. The scope of family*

medicine encompasses all ages, both sexes, each organ system and every disease entity. (1984) (2016 COD) ". [43]

The core values of family medicine discipline worldwide can thus be said to include:

- Social accountability and commitment to the local needs of the community and health system. This is a universal value in all regions, family physicians practice often as managers, resource allocators and health team leaders in primary care.
- Comprehensiveness: The discipline deals with every disease entity in all age groups for both sexes; this requires a wide range of clinical competencies.
- "Patient Centred Care" is an integral value of general practice, patient's ideas, concerns, feelings, perspectives and expectations are highly appreciated. It leads to comprehensive care, taking the patient as a whole including the surrounding context and family members.
- Continuity of care is regarded as the essence of family medicine; it has emerged from the presence of the family physician inside the community. It leads to a valuable rapport between family doctors and their patients and the whole community, such rapport leads to a better communication and health outcomes.
- Family doctors are concerned about preventive care both at the individual and community level. They use the preventive approach in community health planning, in patient management plans and as opportunistic care during consultations.

Hence, what distinguish family medicine is:

- Community oriented
- Continuity of care
- Care about prevention and risk factors
- Close relationship with the patient

- Comprehensive approach
- Coordination of care
- Cost effective care

- Central patient's role

- Cocktail variation in clinical encounter

- Communication, consultation and counselling skills

- Clinical symptoms oriented consultation

- "Common things are more common" is a respected rule

5.2.3. The expected role of the family physician

Family physicians are expected to work inside the community and to deal with primary health care services. Although family physicians share major principles more or less everywhere, health systems in different settings have various needs for family physicians. In certain areas like rural Africa, family physicians are expected to work in rural hospital as health team leader, manager and resource allocator. In their clinical practice, African family physicians do major surgery and anaesthesia and they are competent in dealing with tropical diseases. In Europe, family physicians are trained to follow up chronic diseases of their patients 'personal doctor' and to deal as a gatekeeper in the health system [10]. Cuba represents a success story where family doctors are trained to satisfy the community needs. It is a country with low economy and high health outcomes, all graduated doctors in Cuba are allocated to the community in a two years training program in family medicine, they can either continue in primary care or get other specialty in order to work at the "community polyclinics" or at hospitals [11].

5.2.4. Clinical procedural skills in family medicine

Family physicians need to be prepared to work in areas with less access to hospital specialist services or advanced procedures. Hence, clinical procedural skills is a major and important part in family practice and training. However, the expected competencies for family doctors is somewhat context dependent. Factors like disease spectrum, epidemiology, economy and geography may play a role in selecting targeted clinical skills for family physicians. For example, the Canadian list of required skills [44] will naturally differ from the required skills in Sub-Saharan Africa [39].

The targeted level of competency of the trainees should be figured by the curriculum. Miller's framework is widely used to assess clinical skills [45]. The base of the pyramid starts with knowledge (Know), followed by competency (know how), performing (show how) and finally the action (does). Since family physicians usually work alone and independent, the targeted level is usually "does". While work-based assessment targets the highest level in real practice "does", multiple choice questions target usually the lowest level "know".

The Dreyfus model was first proposed in 1980 by Dreyfus and Dreyfus [46,47]. It provides a framework that describes how individuals develop their competency through the various levels in the process of skills acquisition. It breaks down the process in five developmental stages. It starts with "novice", followed by "advanced beginner", "competent", "proficient", and "expert" [48]. The progress is a result of a successive transformation in four developmental mental functions: recollection, recognition, decision and awareness. Every developmental stage has its criteria and description. In the nursing field, the model was adapted by Benner and criticized by others [49,50].The current form of the Dreyfus model is accepted worldwide by physicians and educators in the medical field, and it plays an important role in configuring the process of skills acquisition in the field.

5.2.5. Challenges facing family medicine training

There are many factors affecting the training of family physicians and the development of the discipline as a whole. These factors are universal, but they are more prominent in low and middle-income (LMI) regions like SSA and EMR. Since the discipline is relatively recently implemented in these areas, big numbers of family physicians are needed in order to fill the huge gap [33]. This requires more economical resources in an area already suffering economical constrains, making it difficult to achieve the minimum goals of universal health coverage there (UHC) [51]. Another challenge is the scarce number of family medicine trainers, many family medicine training

programs used to train family physicians predominantly at hospitals, missing the role models and the needed primary care training setting.

The discipline is also not well understood in many areas, the function of the family physician and the targeted skills might not be obvious. In some regions, the whole health system is hospital based and the power and facilities are allocated to the specialist health care, ignoring the importance of primary care and the trained family physicians. Primary care is represented in such health systems by the vertical programs, which are internationally funded, missing the value of the integrated health care team [23]. Brain drain is another threatening challenge [36-37,52]; it can discourage health policy makers to invest in training family physicians who will not stay long in their communities. Reasons for immigration of African health care professionals who work in primary care include poor income, poor career path, poor working environment with unmanageable workload, and deficient basic medications, equipment and professional support [53].

5.3. The Gezira Family Medicine Project (GFMP)

5.3.1. The Gezira state of Sudan

Picture 1: Gezira state map
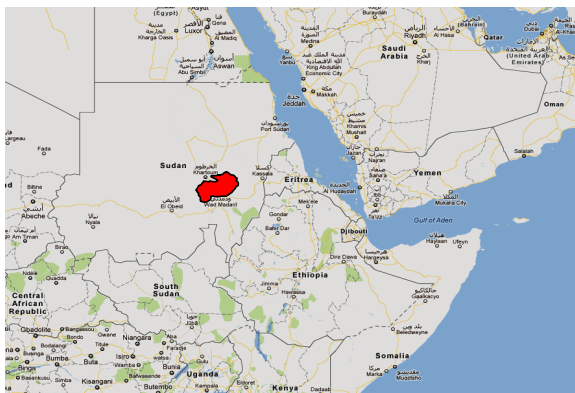
The Gezira state of Sudan (in red colour), lies in the middle of Sudan south to the capital "Khartoum".

Sudan lies in northeast Sub-Saharan Africa covering 1.861.484 km2, with an estimated population of about 39 millions (in 2016) [50]. According to official reports from the Ministry of Health, Sudan has an infant mortality rate of 52 deaths per 1000 live births, maternal mortality of 720 deaths/100 000 live births, and a life expectancy at birth of 63 years(2016) [54,55]. Gezira state is one of 17 states in Sudan, centrally located in the country, with a total area of about 25 500 km2. Gezira state has a total population of about 3.7 million. Rural population constitutes about 80% of the total population in Gezira, scattered over more than 3000 villages. According to the state Ministry of Health, the main causes of morbidity and mortality are infectious and parasitic diseases. Tropical diseases like malaria and bilharzias are endemic . Non-communicable diseases (NCDs) follow the regional emerging trend [55-56], increasing the responsibility of an already exhausted health care system and sharing resources with traditional diseases.

5.3.2. The establishment of the GFMP

The Gezira Family Medicine Project emerged together with other many family medicine training programmes worldwide in the last decades in order to promote the specialty as a part of health system reforms [10, 12, 33]. The first proposal for the GFMP was made by Professor Mohi-Eldin Magzoub, a Sudanese professor in Medical education at King Saud Bin Abdelaziz University in Saudi Arabia, a previous staff at the Gezira University. He did the proposal together with Professor Elzubair Bashir Taha, the Gezira state governor and a professor in clinical psychology; he is also an expert in the field of Information and Communication Technology (ICT) as he had been the federal ICT minister in Sudan.

Picture 2: Start of the GFMP

The official start of the GFMP in 2010 by the governor of the state. On the picture appears the director of the GFMP (the author of the thesis), to the right appears Mr. Elhindi (State minister of youth), followed by Professor Elzubair Taha (the governor), Dr. Elfatih Malik (State minister of health) and Dr. Moghira (Director of the state health insurance fund.

Before the emergence of the GFMP, primary health care services were provided in Gezira state through health centres, which are served either by nurses (medical assistants) or by medical officers (medical doctors without postgraduate training). The number of doctors working in primary care before 2010 was about 115, thus providing a ratio of primary health care doctor to population of 1:32000. This ratio is far from the ratio proposed by Barbara Starfield; one family doctor for each 1000-1500 inhabitants in order to have a proper health care system [57].

The three main city hospitals in Medani, Managil and Kamlin represented the second line for referrals in Gezira, and less commonly used are the rural hospitals, which are served by few hospital specialists and/or medical officers.

The mission of the project was to provide high quality, accessible, and affordable primary care based health services. This was planned to be achieved by providing well-trained primary care doctors and by rehabilitation of the health centres.

The project was able to recruit 207 physicians to join the training programme, some of the enrolled physicians were medical officers already working in existing centres, but another group was new candidates recruited into primary care for the first time. All applicants were interviewed before their intake. There was no restriction according to age or medical experience except for performing internship (12 months) after graduation and permanent registration in Sudan Medical Council.

Table 1 describes the students baseline data at the start of the Gezira Family Medicine Project (N = 207), it describes sex distribution, age groups, university of graduation, working experience and why they preferred family medicine as a future career.

Table 1: Description of the students at the start of GFMP (N= 207). Results as percentages unless otherwise stated.

Description		Males (N=118)	Females (N=89)	All (N=207)
Gender		57	43	100
Age (years)				
	Mean (SD)	34.0 (7.9)	30.4 (4.5)	32.5 (6.9)
	Median	32	30	30
	25-75 quartiles	28 – 36	27 – 33	28 – 35
	Range	24 – 62	24 – 47	24 – 62
University background (%)				
	Gezira	27	38	32
	Khartoum	12	8	10
	Other Sudanese	48	50	49
	Other countries	9	3	6
	Missing	4	1	3
Working experience (years) (%)				
	< 2	30	44	37
	2-5	41	39	39
	6-10	17	15	16
	>10	12	2	8
Reason(s) for choosing family medicine (%)				
	Economy	29	18	24
	Easy specialty	13	4	9
	Short duration of program	20	23	21
	Only available	31	31	31
	Other reasons	21	24	22

5.3.3. The political support and stakeholders

High political commitment and community engagement characterized the successful start of the GFMP. The board of trustee of the GFMP was headed by the state governor. It included also the state Health Minister, the director of the University of Gezira, the head of the Sudanese Medical Specialization Board (SMSB), Dean of the Faculty of Medicine at the Gezira University, the director of the National Insurance Fund in Gezira state, community representatives in addition to the director of the GFMP unit. Local media like newspapers, TV and radio advocated for the project.

Picture 3: Presentation to the president

President Elbashir together with state governor and the leaders of the health sector receiving demonstration of telemedicine activity at the GFMP by the project director. In the picture appears on the far left Professor Osman Taha (Head of the SMSB), followed by Dr. Hassabu (Federal health minister), Mr. Omer Elbashir (President of Sudan), Professor Elzubair Taha (The governor), Dr. Faith Malik (state health minister) and Dr Abd-Elaal, a GFMP candidate.

The roles of the stakeholders were specified from the start. The Faculty of Medicine at the University of Gezira was responsible for the academic training component including curriculum development. The Ministry of Health was responsible for providing the health centres with the required staff, including jobs for the new enrolled doctors, equipment, and buildings, in addition to paying the candidates' tuition fees to the university. After the recruitment of doctors, the health centres were screened and other health-care workers such as laboratory technicians and nurses were employed and paid by the Ministry.

The Sudan Medical Specialization Board approved that graduates from the 2-year Master programme eventually can continue for 2 years more in order to obtain the full MD degree in family medicine at the national level. The local communities in Gezira state provided housing for the doctors, especially in rural areas. The National Health Insurance Fund had decided to provide health insurance services at all health centres included in the GFMP centres; moreover, it provided all enrolled candidates with laptop computers to be used in their academic and service work. Tele communication company "Sudani" provided reasonable internet fees for the candidates, which was paid by the Gezira state government.

5.3.4. GFMP administration unit

This is an administrative unit, which is under the umbrella of the state Ministry of Health. The author of this thesis worked as the director for the GFMP unit and as an assistant professor at the University of Gezira at the same time. He took his specialty of family medicine in Norway and worked there in the period 2003-2009 as a family physician. The author has also previous relationship with the state governor since the author was student at the University of Khartoum while the governor was the director of the university. These positions and background relations assisted the project director to coordinate the work between the stakeholders, to get a strong political support, and to communicate with the Norwegian partners. The main role of the GFMP unit is to

lead the executive work, to coordinate between the different stakeholders and to utilize and manage the available resources.

The Federal Ministry of Information and Communication Technology (ICT) (Professor Izz-Eldin Elkamil), evaluated the use of ICT at the GFMP as a good model and therefore supported the project both technically and financially. The financial support included buying a big building of three floors for the GFMP, it includes administration offices for the GFMP unit, lecture hall, and telemedicine studios. The Ministry of ICT also supplied the ICT section at the GFMP with a data centre and modern telecommunication equipment. The three telemedicine studios were used for telemedicine activity and for broadcasting the online lectures and seminars. Telemedicine activity was arranged at the GFMP unit by setting certain times for the various disciplines that are known for the candidates (timetable). Data from telemedicine and E-learning activities was registered and archived at the GFMP office.

The GFMP unit arranged also field supervision visits to the candidates at their health centres, both in rural and urban centres to discuss any challenges facing their training or service activities. These visits aimed also to meet the community leaders and to get their feedback. They could reflect their feedback about the practicing physician, and the health centre needs like deficient equipment. The federal and state ministry of health supplied the GFMP store with such needed equipment. The GFMP unit took also the responsibility of distributing the candidates to the health centres, it received also all complaints from the trainees regarding both their training and service activities. The unit also followed and coordinated the fee payments from the state Ministry of Health to the university to keep on training. Family medicine practice exams and some other academic activities were also arranged at the GFMP unit.

5.3.5. The Norwegian participation

The Norwegian participation started from the beginning of the GFMP. This was achieved through a series of visits of five experts; Professor Steinar Hunskaar lead this

collaboration, he has been awarded the degree of «Honorary Professorship» from the University of Gezira due to his great efforts and high commitment. Other Norwegian visitors to Gezira included Professor Guri Rortveit (Head of the department of global public health and primary care in Bergen), Professor Gunnar Bondevik (Professor of family medicine, University of Bergen), Dr. Hans Hovik (family physician from Bergen-Norwegian Association of Family Physicians), and Professor Toralf Hasvold (Professor of family medicine from the university of Tromso). The visits started with an advocacy campaign to highlight the principles of family medicine and to discuss the expected role of the future family physicians. The Norwegian model was used as an example and workshop for training of the trainers (TOT) was conducted at the early start. This was crucial since the majority of the trainers at the GFMP were hospital specialist doctors and not family physicians.

Picture 4: TOT workshop

Professor Hunskår holding a training of trainers (TOT) workshop. In the picture appears part of the faculty staff who will participate in the training process.

The Norwegian consultants provided continuous consultations, evaluations and observations, they performed field visits to the trainees in urban and rural areas. Moreover, the University of Bergen funded this PhD program to get a scientific evaluation of the GFMP, which can be of benefit for both Sudan and other neighbour countries in the region who aim to implement family medicine. The University of Bergen together with the University of Gezira also applied for a project funding from the Norwegian Agency for Development Cooperation (NORAD) [57]. The Norwegian Programme for Capacity Development in Higher Education and Research for Development (NORHED) was a new programme launched by NORAD in 2012. Educational institutes in Africa, Asia and Latin America was encouraged to apply for project funding. The GFMP joint proposal nominated by the University of Bergen aimed to strengthen family medicine implementation and development in Sudan and nearby countries. Unfortunately, the project was not prioritized by NORHED and did not get funding.

Picture 5: Three Norwegian family medicine professors from Bergen visiting Gezira

The director of the University of Gezira and the dean of the Faculty of Medicine providing presents to the visitors from the Department of Global Public Health and Primary Care, Faculty of Medicine, University of Bergen during their visit to Sudan.

5.3.6. The curriculum development and the program structure

The Faculty of Medicine of the University of Gezira arranged series of curriculum workshops in order to prepare the academic plan for the GFMP, it included family physicians together with experts from other medical disciplines. The in-service model of training represented the main feature of the approved curriculum. The curriculum was structures as a 2-years program (four semesters) and the awarded degree was decided to be a Master of Science in Family Medicine. The total academic load of the first three semesters is 48 credit hours (one credit-hour equals 15 theoretical-hours or 30 practical/clinical-hours). Semesters are divided into teaching blocks (modules). The fourth semester was allocated to research (Master's dissertation). Table 2 shows the distribution of credit hours between the specialties.

Table 2   Summary of courses in the Master curriculum

Course name	Credit hours	%
Family medicine	8	16.6
Community medicine	3	6.3
Internal medicine	5	10.4
Diagnostic imaging and laboratory medicine	2	4.1
Research methodology	1	2.0
Pediatrics and child health	5	10.4
Obstetrics and gynecology	5	10.4
Otolaryngology	3	6.3
Surgery and orthopedics	4	8.3
Psychiatry	3	6.3
Dermatology	3	6.3
Ophthalmology	3	6.3
Accident and emergency medicine	3	6.3
Total	48	100

The Master program started with an introductory course in family and community medicine, its aim was to give an orientation about the discipline and its core values.

Thereafter the candidates were distributed to their health centres and allocated one day per week to the different clinical rotations at hospitals, to be trained in clinical procedural skills. Theoretical teaching was presented as online lectures and case discussions. Table 3 demonstrates how varieties of modern pedagogical principles are used as training methods at the GFMP.

The assessment was performed through a series of examinations at the end of each clinical module. The electronic medical records were used to assess their real practice as a work based assessment (WBA), it included topics like clinical governance, holistic approach, evidence-based practice, and guidelines follow up. This assessment was done by checking a random number of patients' files. The assessor discussed the findings, notes, decisions, management with the student, and gave feedback in a direct and personal audit process.

Social accountability, community mobilization, and health-promotion activities of the candidates were also evaluated. They were asked to document their activities in the community through pictures, reports, and minutes of relevant meetings. Every candidate was asked at the examination to present the data from his/her catchment area including population, age and sex register and any chronic diseases' registries in the catchment area/practice population, such data was collected by the community members. The candidates also displayed pictures and reports about any community participation regarding rehabilitation of the health centre by local resources. Any participation of the candidate in health promotion in the community or at schools should be presented and documented. All candidates had to present and discuss a Google map poster of his/ her catchment area, and to present the population pyramid of the village or catchment area.

Table 3: Training methods used at the GFMP

Training activity	Way of conducting	Time of the training	Aim of the training
Introductory course	Meeting at the university	At the start of the master course	To cover important areas in family and community medicine, before start
Distance learning	Formal Internet based lectures, tutorials or discussions, using Web Ex program (virtual class room); lecturer communicates with candidates (voice and picture), share desktop, slides, films and documents	Usually at the end of the day, evenings or weekends	To teach the different disciplines in rotations (medicine pediatrics, etc.)
Hospital visits	Clinical rounds, outpatient clinic, referral clinic, theatre, etc.	Once a week	To learn the required clinical skills, candidates should fill their logbooks where all the required skills are listed
Telemedicine	Specialists from all specialties are connected with the candidates by videoconference to discuss real life cases	One hour during the working day	Both clinical management and case discussion learning
Field supervision	Supervisors visit the candidates at their health centres	During the working day	To assess the setting, attend and evaluate consultations, evaluate the use of the filing system
Primary care work	Candidates are practicing family medicine at their centres	4 days a week	Learning through practice, candidates communicates with specialists and colleagues through videoconferencing
Courses	Crash courses arranged at the university	Usually 3-5 days per course	To cover certain important topics (examples: mental health, malaria and HIV)
Monthly meetings	Meeting at the university	Once a month	Family medicine teaching and administrative issues
Electronic library	Every candidate is equipped with a laptop computer and free wireless Internet	At any time	Evidence based medicine: Candidates should know national and international resources, guidelines, medical websites etc.
Classical library	Available at the university, some books were distributed free to the candidates	During the university days	Mainly for background knowledge

The in-service model

The curriculum was designed and structured to meet both training and service provision. That allowed the candidates to work clinically at their centres during the programme period. The in-service model of training is used worldwide [58-60], performing the training at the community levels and in the context of primary care increases the candidates' awareness about the community and its health needs.

The service provision and the training component were complementary for each other. Before the start of the GFMP doctors were not encouraged to work in district areas because they miss the career and training there, this problem was managed by the in-service model which encouraged the physicians to provide health services in areas never been served by doctors before (84 health centres). The presence of the trainee candidates in district areas is supposed to increase both the accessibility and quality of health services. Family physicians are expected to provide continuous, comprehensive care, to mobilize the community resource, and to lead the health team within the catchment area. The 207 enrolled candidates could provide health services in 158 health centres, 84 of which (53%) had never been served by a doctor before the project. The base line characteristics of these centres is surveyed by a checklist at the start of the program and presented in Table 4.

Table 4: Rooms available at the health centres of GFMP at baseline (N= 158)

Description of room	N	%
Doctor's consulation room	158	100
Laboratory room	149	94
Pharmacy	136	86
Ward/observation beds	136	86
Vaccination room	102	65
Minor surgery room	86	54

Maternal room	70	44
Storage room	57	36
Registration and filing room	50	32
Nutrition room	30	19
X-ray or ultrasound room	25	16
Major surgery room	21	13

The GFMP was also a matter of health system reform, first by providing more resources to primary health care regarding staff, equipment and buildings, and secondly by transforming the health system from its verticality to a more horizontal system, focusing on the integrated health team rather than the health programmes. In-service model of training could not be performed without utilizing information and communication technology (ICT).

Picture 6: District community visit

Community visit to encourage community participation and to assess the needs. In the picture appears three community representatives, three from the GFMP unit and three from the health affairs for south Gezira locality.

Information and communication technology (ICT) in GFMP

The recent revolution of information and communication technology in the last decades, lead to great advances in all fields including medical services (e-health) and medical education. The world health organization (WHO) encourages governments to increase their use of ICT in health services provision in order to increase efficiency and to support the achievement of the Millennium Developmental goals MDGs [61]. E-health is now an integral part of the national health plans in many countries including Sudan [62].

The Gezira Family Medicine Project has used ICT in a comprehensive way, it was used to provide health care in a distance (telemedicine), as online medical education (e-learning) and in managing patients' information (Electronic Medical Records-EMR)

Telemedicine

Telemedicine is defined in several ways [63], but broadly it is the exchanged of medical information from one place to another using electronic communications to improve a patient's health. At the GFMP, the term "telemedicine" is used to describe the online interaction between specialist doctors and the family doctors in a videoconference like meeting; it aimed to break down the geographical barrier and to provide a higher quality of care at a specialist level to the whole Gezira state.

The telemedicine program was implemented at the GFMP in April 2011, telemedicine studios were established; they were equipped with the necessary equipment including computers, LCD screens, cameras, microphones, telephone lines and internet lines. All trainees who joined the program were provided computer laptops with an in-built camera to be used for telemedicine and training purposes; free 24-hour's internet service was also provided. Internet services are available in most parts of the Gezira state; the Gezira government has paid the costs of the computers and internet services,

"Sudani" telecommunication company provided internet services in affordable prices, there was no donor funding.

In a videoconference like setting family doctors (together with the patient) at the health centres were connected with the specialists at the GFMP headquarter. They communicated by means of voice, picture, and chatting. Family doctor could show the specialist some clinical signs on the patient such as skin manifestations or some investigations like ECG. A free of charge telecommunication program at that time ooVoo® [64] was used for this purpose. Specialist doctors who participated at telemedicine activities had a weekly scheduled program with certain days and times. Trainees could communicate with the needed specialist at the selected times, telemedicine was not planned to be used for emergency cases. Telemedicine consultations resulted either in a general management advice to the family doctor or the patient; or specific advice like starting a new drug or increasing the drug dose. In other situations, the patient needed to be sent to the outpatient clinic for certain procedures or investigations. Telemedicine communication between primary and secondary care doctors established a better rapport and opened a new window for collaboration between the two health care lines.

Picture 7: Telemedicine studio

Professor Ahmed Mohamed Elhassan (a consultant of "Ear Nose and Throat- ENT") is receiving a telemedicine consultation from Dr Limiaa (a GFMP candidate) at a district health centre.

Electronic Medical records (EMR)

Electronic medical records is an essential tool for today's clinical practice. It facilitates providing comprehensive continuous care, it is used in medico-legal issues and provide us with practice statistics. Its use increases patients' safety and provides a better quality of care. Electronic medical records are used globally and in various settings; it has been used in hospitals as well as primary care, sometimes used for certain diseases like HIV in Africa [65] or for the follow up of chronic diseases [66].

Few health centres have been using medical records before the start of the GFMP, even as paper notes. Family Clinic® is an electronic medical record program specially designed for the GFMP at its start ,and funded by the state ministry of health. A data programmer who is expert in electronic medical records from Egypt was invited to Gezira, the GFMP medical staff used their previous experience in using medical records and a dialogue for developing the aimed program took many months. The programme copes with the local needs, and it includes modern criteria like the 10th

version of the International Statistical Classification of Diseases and Related Health Problems (ICD10- the last version at that time). It included also a database for the commonly used medications, a page on pregnancy, well child clinic, chronic diseases, patient's personal and family data, laboratory data and previous visits and investigations. Candidates were encouraged to use the program. Statistical data could be elaborated from the program, assessment and evaluation of the trainees' practice was done using consultation notes written by the trainees themselves. The programme was installed on the trainees' computers at the start of the master program, and a course on the technical use of the program was provided at that time.

Picture 8: A workshop about how to use the EMR

A training workshop at the start of the GFMP about the use of the Electronic Medical records (EMR) presented by the designer of the "Family clinic" program who came from Egypt

Distance education

E-learning provides great educational opportunities for the students and increases faculty effectiveness and efficiency [67]. Distance education in family medicine

training was used in many countries, the University of Monash in Australia used to provide a Master degree in family medicine by distance education since 1992 [68].

E-learning at the GFMP means the provision of online education using virtual class rooms, it is used to facilitate the in-service model of training. This could facilitate scaling up family medicine training, which is a regional, and a national goal [23]. Educational activities like online lectures and seminars were broadcasted from the same studios used for telemedicine; candidates used their computer laptops to receive the educational activities. The program Cisco-WebEx® [69] was used to connect the lecturer with all candidates at their different centres. The lecturer could share his desktop with the candidates to show them pictures, slides presentations, films or text documents. Candidates could see, hear, speak and chat with the lecturer, online discussions and full interaction between the candidates themselves or with the lecturer was possible. The "host" role could be taken by any trainee to present a tutorial or other activity to the other trainees and the lecturer. Online activities were also available to be downloaded later from the GFMP website, this was especially helpful in case of troubles due to internet connectivity and broadcasting.

5.3.7. The recent status of the GFMP and family medicine in Sudan

Our study articles described and evaluated the GFMP and its candidates during the study period of the first batch (2010-2012). We believe that it is important to have a look to the recent situation of GFMP and family medicine training in Gezira and Sudan as a whole. An evaluation visit was performed in April 2018 where new data was collected from administrative reports and interviews. Interviewee included GFMP present director, head of the Department of family and community medicine at the University of Gezira, state minister of health and finally the coordinator of family medicine training at the Public Health Institute (PHI), which is a national training institute under the umbrella of the Federal Ministry of Health (MoH).

One of the important recent changes at the GFMP is the change in the training institute. At the start of the program in 2010, the University of Gezira was the official training institute while the state ministry of health provided funding including payment of training fees to the university. The GFMP administration unit is officially governed by the state ministry of health, but it worked as a link between the state ministry of health and the Gezira University. It coordinated the training and service provision, provided facilities for information and communication technology like telemedicine, distance education and EMRs. In the recent years, the state ministry of health could not afford this payment and consequently the training program for the GFMP candidates at the University of Gezira has stopped. On the other side, the PHI, which is a nationally funded training institute, offered a collaboration program where the PHI took the responsibility of training instead of the University of Gezira without training fees. PHI has actually a mission of training family medicine in other states also. In other words, the PHI took the experience from Gezira to other states and supported Gezira economically as other states. The GFMP office took the administrative responsibility in Gezira, facilitated distance education, telemedicine, electronic filing system and coordinated with the local trainers in Gezira-who are actually the same university trainers, but they are paid by the PHI.

The GFMP second batch was trained at the University of Gezira, constituted of 125 candidates, it took time due to economical constrains for fees payment before 106 of them were graduated in 2016. The third GFMP batch is trained by the PHI, it has 80 candidates, and 46 are still under training and expected to be graduated in March 2019. The curriculum is generally similar at the PHI and university of Gezira, a recent change is the increase of hospital training days from one day to two days, and this second day is either at hospital or as structured teaching by family physician at a health centre. The training number at the GFMP is expected to continue with a rate of about 50 candidates every year as the PHI plans to train this number for each state.

The state minister of health Dr. Imad Eljak would prefer the University of Gezira to continue to be responsible for the training of the GFMP candidates, but he feels sorry

that the government of the state could not afford fee payments. The PHI represented a good alternative since it follows the national family medicine plan and it is free of charge. The head of the Department of family and community medicine at the University of Gezira, Dr. Salwa Elsanosy, feels also sorry that the State Ministry of Health could not afford the training payments, and consequently used the PHI as a training institute in Gezira rather than the University of Gezira. That can actually be attributed to the present low political commitment, recognized after the previous governor professor Elzubair Bashir Taha left the state.

The university of Gezira continues family medicine training on a private basis, for candidates who can afford paying fees themselves. The first Master batch trained at the University of Gezira was for the actual GFMP first batch of 207 candidates, 125 of them were graduated. The second batch was 106 candidates, 103 of them were graduated in 2016. The third batch constituted of 39 candidates, 32 of them were graduated in 2017. The fourth batch was 35 and the fifth is 21 candidates, both are still under training. In addition, the branch of the University of Gezira in Khartoum started family master training where 113 candidates are graduated. The university also started recently a training program for Sudanese physicians who are employed in some gulf countries, none of them are graduated yet.

The PHI on its turn took the initiative to train family physicians at the national level. A total of 48 Master candidates were graduated in 2013 as the first batch. The second batch was graduated in 2016, and constituted of 170 candidates from five Sudanese states. The third batch includes 272 candidates from nine states including Gezira state. This batch is expected to be graduated in March 2019. The national coordinator of family medicine training at the PHI Dr Taj Adlan is optimistic about family medicine training and the future of the discipline as general in Sudan. He thinks that there is a good political commitment at the national level towards family medicine, there is no economical constrains at least in this period when the training program is funded by a global fund as a part of the "Primary health care expansion program". At the same time, he admits certain training challenges like the scarcity of the qualified trainers and

the need for equipped training centres as a training setting especially in the far districts. Other universities in Khartoum like "El-Azhary University" and "Sudan University of science and technology" also started a Master of family medicine training. A total of 180 candidates are graduated from El-Azhary Uiversity and 68 are under training there. Data from Sudan University of science and technology is unavailable yet.

In conclusion, economical constrains and less political commitment affected the partnership between the State Ministry of Health and the University of Gezira; however, there is still high up-scaling of family medicine training both by the university of Gezira and the PHI. The number of the staff family medicine trainers in Gezira is increased from "none" before the GFMP to eight staff members in 2018, that increased the training capacity of the University of Gezira. The majority of the staff are graduates of the first batch of the GFMP.

At the national level, over one thousand candidates are trained in family medicine in the period 2010-2018, a total of 661 of them are already graduated with a master of family medicine. The GFMP first curriculum is used in all institutes with minor changes. The Sudan Medical Specialization Board (SMSB) is receiving more candidates who would continue two years more to get their full four-year MD in family medicine after finishing their two-year master training. Some of them are graduated, got their MD, and works as department members at universities like the University of Gezira.

6. Aims of the studies included in the thesis

The overall aim of the whole thesis is to perform a scientific evaluation of the Gezira Family Medicine Project (GFMP), which is an ongoing postgraduate training enterprise. Several data collections were performed to obtain this goal based on three major questionnaires and administrative data. Two sub-studies were conducted to achieve this goal; results from each study was published as two scientific articles.

6.1. Study I:

The first study is a descriptive study, aiming to describe the implementation, organization and curriculum structure of the GFMP and how information and communication technology (ICT) has been utilized. The results were published in **Paper I** and **Paper II**.

Paper I describes the preparations and implementation of the GFMP, the different roles of the stakeholders, the curriculum development and its implementation. The article also describes the health centres where candidates practiced and got their training: health centres' buildings, available equipment, and provided services. The characteristics of the recruited candidates and their baseline competencies are also discussed in this article.

Paper II describes how information and communication technology (ICT) was implemented and utilized at the GFMP, both as distance education (DE) and service provision (Telemedicine and Electronic Medical Records - EMRs). The paper also describes the physicians' perception of the use of ICT during the master period.

6.2. Study II:

The second study aimed to assess the impact of the GFMP Master program on candidates' confidence to perform certain clinical skills. It also evaluated its impact on

candidates' adherence to the core family medicine values. The results were published as **Paper III** and **Paper IV**.

Paper III shows results of data related to the impact of GFMP Master program on candidates' self-assessed confidence to perform 46 cognitive and psychomotor clinical skills. The paper also describes which factors that could affect the candidates' confidence. Candidates' scoring in the different medical disciplines are also presented.

Paper IV aims to evaluate the impact of the GFMP on the candidates' practice, including adherence to some core values of family medicine, like continuity of care, comprehensive care, and orientation towards patient-centred care.

7. Materials and methods

7.1. Questionnaires

Data collection was done at the early start of the first batch at the GFMP, this is the "before" phase, and again at the end of the-two year program, "after". Three main questionnaires were collected at both times:

- Questionnaire 1: Doctor's questionnaire
- Questionnaire 2: Health centre's questionnaire
- Questionnaire 3: Patient's questionnaire, taken by physicians during patient consultations and called.

Data from these questionnaires were used according to the scope of each study and article; we used relevant data from the different questionnaires for each article. Not every data in the questionnaires was used in our study, e.g. data taken during consultations in patient questionnaire regarding diagnosis and prescribed drugs were not included in the published articles of this thesis. None of the questionnaires included the name of the participant, an identifiable number was used to help in the follow up of the candidates who either dropped out or continued to the end of the Master period. There was a list, which included the number of each candidate; this list was available to one of the GFMP staff who gave the researcher an update, about which candidate numbers dropped out at the end of the Master program.

7.1.1. Questionnaire 1 (Doctor's questionnaire):

Targeting the 207 candidates of the first batch at its start and 125 at its end, it included three subdivisions:

The first part included demographic data of the candidate. It assessed also the candidates' use of the filing and registration system, whether the candidates practiced health education (for patients with diabetes, smoking, nutrition and in breast-feeding).

It assessed also, whether the candidate followed the national management guidelines, and what he/she meant about the psychosocial dimension during consultations. The candidates' satisfaction was assessed regarding the community, colleagues at job and with the income, and whether he/she was interested in the family medicine specialty. It included also a description of the weekly physicians' timetable.

The second part of the first questionnaire included a list of 46 psychomotor and intellectual clinical skills. Candidates were asked to evaluate their confidence to perform these skills. A scale of five grades was used, starting from "very confident" and ending with "not able".

The third part of the first questionnaire was the Patient Practitioner Orientation Scale (PPOS), which is a validated questionnaire used to assess physician's orientation towards patient centred care. It has 18 questions with a six-grade scale, starting from "strongly agree" and ending with "strongly disagree".

A fourth part was added to the "after" questionnaire. It is about the candidates' own perception about the use of information and communication technology (ICT) during the Master period. It assesses also candidates` evaluation of the training program as general and his/her future career plan.

7.1.2. Questionnaire 2 (Health centres questionnaire):

This is a survey questionnaire for the health centres (N: 158) where the 207 candidates practiced. It assessed the available provided health services (vaccination, antenatal care, etc.), investigations (malaria, pregnancy test, haemoglobin, etc.), equipment (ECG, sphygmomanometer, nebulizer, etc.), drugs, buildings and staff (midwife, pharmacist, nurse, vaccination technician, etc.). It assessed also opening times and the number of consultations, the distance to the nearest hospital, number of beds and the referral destination(s).

7.1.3. Questionnaire 3 (Patients' questionnaire):

The candidates filled this questionnaire during patient consultations, data is related to the patient and the clinical encounter. Every candidate was asked to fill 100 questionnaire sheets (during 100 patient consultations) at the "before" data collection, and 50 sheets at the "after" data collection. The questionnaire included demographic data about the patient, reason for encounter, whether today's contact is the first contact or a planned one, whether the patient contacted other health personnel or healer before consultation and whether the patient took any treatment before coming to the doctor. It included also the final diagnosis, investigations, use of diagnostic and therapeutic equipment, management plan and prescribed drugs. The questionnaire contained also data about the duration of the consultation, whether the patient was referred, had a planned control and if there was a payment difficulty.

7.2. Study designs and populations

7.2.1 Study 1:

Cross sectional observational study describing the GFMP, curriculum, candidates, health centres and the use of ICT. Data was taken from doctors' questionnaire., targeting all candidates who joined the GFMP on its start (N: 207 candidates). Health centres' questionnaire was used for the evaluation of the health centres (N: 158 health centres), that includes the buildings, equipment, available services and staff.

Telemedicine activity was assessed using administrative data from GFMP telemedicine annual reports for the years 2011 and 2012 (April 2011-December 2012). Self-evaluation (from the "after" doctors' questionnaire) was used to assess candidates' (N: 125) perception regarding the use of ICT during the Master period.

7.2.2. Study 2:

This was designed as a "before-and-after" study to investigate the impact of the Master program on candidates' confidence to perform certain clinical skills and some core values in family medicine. For this purpose, we used self-administered doctors' questionnaire together with practice-based data (from patient questionnaire) and administrative data. We compared the same data for the same candidates at the "before" data collection with the "after" data collection. The targeted study population was the 207 candidates who joined at the GFMP at its start "before" and the 125 candidates who continued to the end of the Master programme "after". Only candidates who responded both to the "before" and "after" questionnaires were included in this study.

7.3. Materials and methods of the individual articles

7.3.1. Paper I

This paper reflects the baseline data of the project structure, candidates and health centres (organizations); it is a survey study using self-administered questionnaire (doctors' questionnaire) to collect data regarding the enrolled candidates at the start of the GFMP. The health centres questionnaire was used for data regarding health centres (organizations). Both questionnaires were designed based on discussions with senior researchers in the field. Administrative data from the GFMP was used to describe the project structure.

Data taken from doctors' questionnaire for this paper includes candidates' background and personal data, university of graduation, previous experience and the activities performed in their practice. The paper also assesses candidates' baseline confidence in performing certain clinical skills using a five-grade scale starting from "not able" to "very confident". Data from this questionnaire was used to compare between the confidence in different skills and between the different disciplines.

Health centres' questionnaire targeted 158 health centre where GFMP candidates work, the questionnaire was filled by the practicing doctor at the health centre and the GFMP staff. Items included in **Paper I** from this questionnaire include the health centres' building, distance from the nearest hospital, number of rooms, provided health services, available laboratory investigations and available diagnostic and therapeutic equipment.

Administrative data was used to describe the emergence and structure of the Master`s program, the curriculum design, teaching methods and the use of information and communication technology (ICT).

7.3.2. Paper II

An observational study design was used in this paper to assess telemedicine (TM) activity and the utilization of electronic medical records (EMR) and distance education (DE). Administrative data from the GFMP office was used for this purpose targeting the 207 candidates enrolled at the GFMP Master program. Candidates' perception at graduation (N: 125) regarding the use of information and communication technology (ICT) during the Master period was also assessed using a self-administered questionnaire.

Data for telemedicine activity was first registered by the consultant physicians during the telemedicine consultations at the GFMP office (telemedicine studios). A special form was designed for this purpose; it includes the date, name of the consulted physician, consulting family physician trainee, patient's age, sex, tentative diagnosis and management plan. This data were provided as monthly and annual reports by the GFMP. In this paper, we used data for the period April 2011-December 2012 (from annual reports of the years 2011 and 2012).

Data regarding electronic medical records and distance education were taken from administrative and exam data. During the family medicine exams, candidates were asked to bring their practice laptops and to present their use of ICT activities. That includes the number of the newly initiated electronic medical records, the quality of the registered file notes, the number of health home visits, the number of telemedicine consultations by the candidate, and candidate's participation in distance learning.

At the end of the Master program, trainees were asked to evaluate their experience in utilizing the various ICT elements. A self-administered questionnaire with a six grades scale was used, starting from "strongly agree" to "strongly disagree". Questions included if telemedicine was of benefit for the candidate and the patients, evaluation of the use of EMR and e-learning during the Master period.

7.3.3. Paper III

The study design used for this paper was a "before-and-after" design aiming to compare the candidates' confidence to perform certain clinical skills before and after the Master program. The questionnaire targeted the 207 candidates who joined the Master program on its start, and targeted again the 125 candidates who continued to the end of the Master program at their graduation. Only candidates who participated both in the before and after questionnaire were included in the comparison calculations, paired t-test was used for this purpose.

A five grades scale questionnaire was designed and distributed to the candidates both at the start of the Master program and again at its end. The scale started by "very confident", followed by "confident", "not fully confident", "uncertain" and finally "not able" to perform the targeted 46 skills. Values of 5,4,3,2 or1 were assigned consequently. Most of the targeted skills were taken from the curriculum, but some of them like major surgical operations were not a part of the curriculum, a high progress in such irrelevant skills represents a deviation from the intended learning outcomes of

the curriculum. The list of skills included a range of difficulty from simple skills to more advanced skills in the various medical disciplines.

Self-administered questionnaire was used to assess candidates' practice of certain skills including health promotion and patient education for "smoking cessation", "insulin use in diabetes", "women breast self-examination", and "feeding of a malnourished child". A three-grade scale was used for this purpose, the candidate could answer either "Yes", "sometimes or "No". Values of 2, 1 and 0 were adopted consequently for the calculation of the means in this scale.

7.3.4. Paper IV

The Patient- Practitioner Orientation Scale (PPOS) [70,71] is a part of the "doctors' questionnaire" and was used to assess candidates' orientation towards patient-cantered care. This questionnaire was used both at the start of the program and at its end. It is a validated scale and used in many countries and different settings. It has 18 items, nine of which representing the "sharing" sub-scale and another nine representing the "caring" subscale. The "sharing" subscale reflects the physician's attitudes towards sharing information, power and control with the patient, while the "caring" subscale reflects physician's attitude towards caring about patients' expectations, concerns and preference. The scale is answered using a 6-point Likert-type format, options starting from "strongly agree" to "strongly disagree". High total score gained in the scale indicates more orientation towards patient-centred care, while low total score indicates tendency toward physician-centred model. At the start of the GFMP 188 candidates responded to the PPOS questionnaire out of the targeted 207 candidates (91% response rate), while 108 responded to the second questionnaire of the targeted 125 candidates (86% response rate). Candidates who responded to both the "before" and "after" questionnaires were included in the comparison study (N: 103). *Paired t-test* was used to compare mean total values distributed by gender in both the "before" and "after" questionnaires.

In **Paper IV** we used also another section of the doctors' questionnaire which is related to the candidates' perception of own practice and work environment. Candidates were asked if they follow the national management guidelines for certain diseases, if they care about patients' psychosocial aspects, practice health promotion at the community level, satisfied with the level of communication with the local community and with other employees, their interest in family medicine and if they feel confident as team leaders. We calculated the percentage for each option in the answers and compared the response before, after GFMP, and between males and females. McNemar test was used to calculate the P-value.

Questions related to the candidate's practice were taken from the patients' questionnaire, they show candidates' adhesion to the core values of family medicine, an example is whether the patient was appointed a planned control consultation in the future, which indicates "continuity of care". Candidates were asked to provide 100 consultation questionnaire sheets at the start of the GFMP and another 50 sheets at its end. Data provided by 91 candidates who responded both to the "before" and "after" questionnaire was used in comparing the two groups. We calculated the percentage of the answers for each candidate, and used the mean percentage when we compared the results in gender and between "before" and "after".

7.4. Statistical analysis:

Data management and statistical analyses were performed using the program IBM SPSS® (supplier: IBM corp., Armonk, NY, USA) version 19 (**Paper I**), version 21 (**Paper II and III**) and version 23 (**Paper IV**).

Standard descriptive statistics were used to present the results in means, proportions and percentages. "Paired sample t tests" were used to test the significance of quantitative data, while McNamar test was used to test differences in categorical data.

In **Paper III** we performed regression analyses to analyse whether personal background factors, university of graduation, locality, personal interest in family medicine or clinical activity affected the change in candidates' self-evaluation of own competence in clinical skill.

7.5. Ethical and privacy approvals

The Ethical Review Committee at the Gezira State Ministry of Health has approved the whole study. The Regional Committee for Medical and Health Research Ethics, Western Norway also approved the study proposal (2012/937/REK West). The Norwegian Data Protection Office for Research has approved the privacy issues and patients' file management related to the study (2012/31743).

8. Summary of the results

8.1. Paper I

This paper describes the GFMP, its implementation, structure, roles of stakeholders, Master curriculum, baseline data of the trainees and the health centres. A total of 207 candidates joined the program, 57% of them were males, the mean age was 32.5 years (range 24-62) and 76% of them had experience of less than five years. About one third of them were graduates of the University of Gezira. Candidates' self-evaluation to perform certain clinical skills at the start of GFMP showed clear variation in the evaluated 46 skills, for example 79% of the respondents felt confident or very confident to manage a patient with asthma, while only 12% felt confident to manage depression, this is shown in Figure 1.

The Faculty of Medicine at the University of Gezira lead the training component. Family physicians together with representatives from the other disciplines participated in a workshop for the configuration of the academic plan and curriculum development. The in-service model was adopted to ensure service provision beside the training component. Table 2 (page 41) shows the different modules (courses) and their academic load in the Master curriculum. E-learning together with a variety of pedagogic approaches were used to support the in-service model of training, this is shown on Table 3 (page 43).

Figure 1
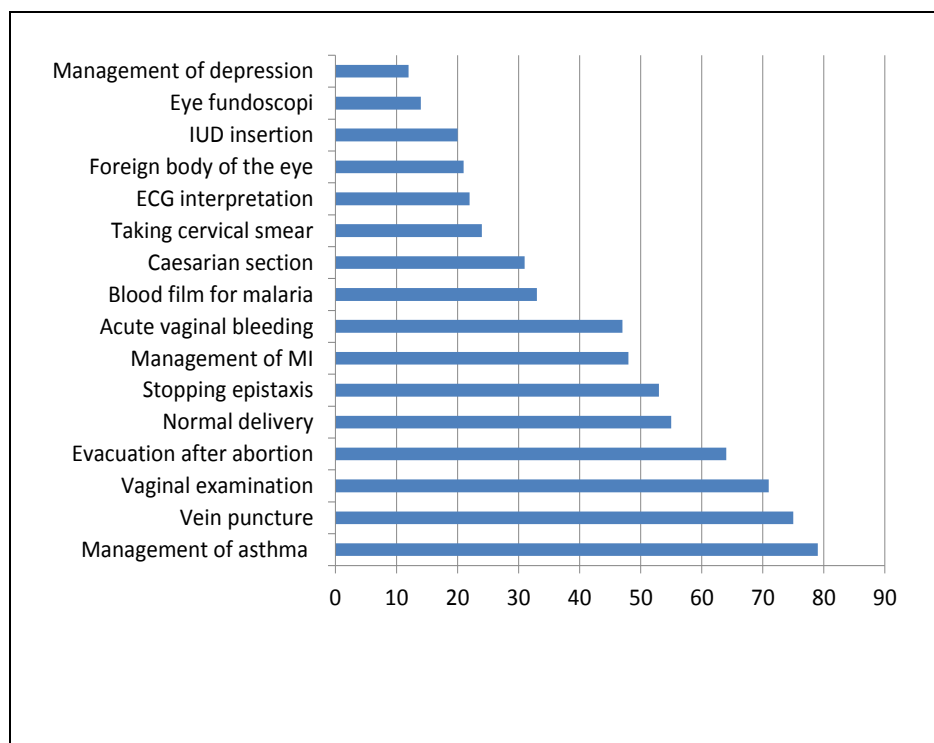
Self-assessed evaluation of the ability to perform 16 of a total of 46 recorded skills. Figures shown are the sum of the scores from the alternatives "very confident" and "confident" (percentages) on a category scale with 5 alternatives (Very confident, Confident, Not fully confident, Uncertain and Not able).

The base line survey of the health centres (N: 158), done at the start of the GFMP, showed that all included centres had a consultation room for the doctors, 94% of them had laboratory room, and 86% had a pharmacy. The least available rooms included the registration and filing room (32%), nutrition education room (19%) and radiology room (16%). Blood film for malaria was on the top of the available laboratory investigations (90%), while 16 % had any of the HIV tests. The survey showed lack of many important equipment especially for Non Communicable Diseases (NCDs). Only one centre had defibrillator, 4% had emergency bag and spirometer and 10% had ECG machine (Table 5).

Table 5 Laboratory equipment, instruments and other diagnostic or therapeutic equipment available at the health centers of GFMP at baseline (N= 158)

Description	N	%
Laboratory investigations		
Blood film for malaria	142	90
Pregnancy test	137	87
Standard urinalysis	136	86
Standard stool investigation	134	85
Sedimentation rate (ESR)	134	85
Hemoglobin	132	84
White blood cell count (TWBC)	132	84
Widal test for typhoid	121	77
Blood glucose	111	70
ICT for malaria	57	36
HIV test	25	16
Diagnostic or therapeutic equipment		
Microscope	140	89
Sphygmomanometer	131	83
Centrifuge	124	78
Colorimeter	111	69
Nebulizer	108	68
Surgical equipment for minor surgery	92	58
Autoclave	79	50
Gynecological examination equipment	43	27
ECG machine	16	10
Ear syringe	16	10
Surgical equipment for major surgery	14	9
Ophthalmoscope	8	5
Spirometer	7	4
Emergency bag with relevant content	7	4
Defibrillator	1	1

8.2. Paper II

8.2.1. Telemedicine

Telemedicine activity

GFMP candidates performed 3808 telemedicine consultations in the period 1. April 2011 to 31.12.2012. Female candidates were more active in using telemedicine, 74% of the consultations were held by female doctors. Mean consultation number was 31 per female doctors, compared with 8 per male doctors.

Almost one third of the consultations were related to the discipline of internal medicine (32.6%), followed by paediatrics (21.8%). Least consultations were related to surgery and ophthalmology. Figure 2 shows the distribution of telemedicine consultation by clinical disciplines and gender.

Monthly variation was also recognized, the maximum number of consultations registered was 299 in March 2012, followed by a decline to zero in September 2012, and a new increase again to a maximum of 309 in December 2012.

Figure 2
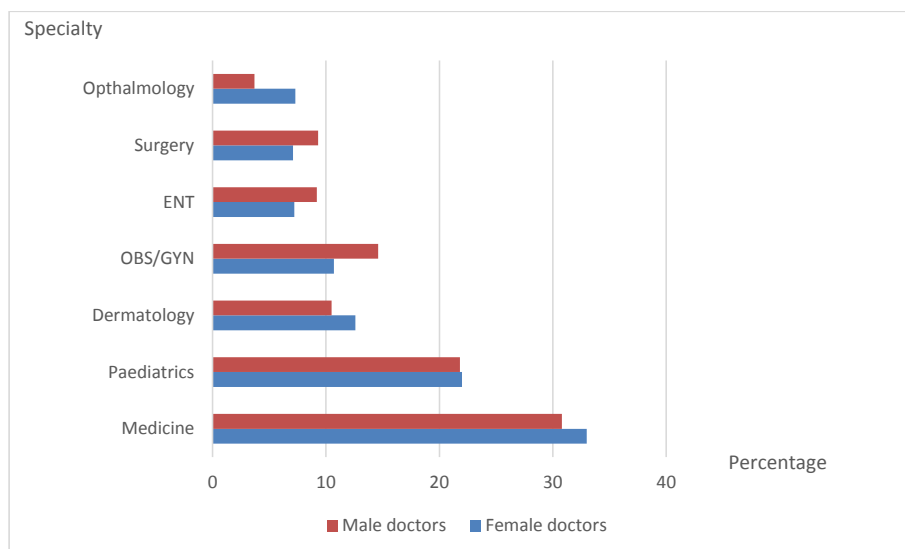
Distribution (%) of telemedicine consultations by specialty and doctor's gender (N = 3749, 59 missing for doctor's gender). ENT = Ear, Nose and Throat; Obs/Gyn = Obstetrics and Gynaecology

Telemedicine evaluation by the candidates

All respondents agreed on the importance of telemedicine for the care of their patients and as a training tool for the candidates themselves. Regarding the use of telemedicine during consultations, the majority (89%) stated that patients were satisfied, although one fifth of the trainees stated that patients might miss confidence on their primary care doctors when they use telemedicine during consultation.

8.2.2. Electronic medical records (EMR)

Electronic medical records activity

At their graduation, the candidates at the GFMP (n=125) has registered 165993 new patient's electronic medical records. The mean was 1328 files per doctor for the whole group, 1413 files per doctor for male and 1273 files for females. The use of EMR was a part of the evaluation of the trainees on their family medicine exam. The evaluation

included both the comprehensiveness of the recorded notes as well as the number of the new opened files.

Electronic medical records evaluation by the candidates

The majority of the responding candidates (two thirds) "strongly agreed" on the importance of the EMR for their patients' care, while the remaining third "agreed" or "somewhat agreed". Even though, the majority agreed in different grades that patients were not satisfied with the candidates' use of EMR during consultations.

8.2.3. E-learning

E-learning activity

Online educational activities were organized using the software program Cisco-Webex. A total of 240 lectures and 29 meetings were presented in the period May 2011 to October 2012. That was dominated by family medicine discipline, which represented 38% of the presented lectures followed by internal medicine which represented 23%.

E-learning evaluation by the candidates

Two fifths of the respondents "strongly agreed" that online lectures was a good teaching method while almost one-half of them either "agreed" or "somewhat agreed". Only 9% "disagreed", "somewhat disagreed" or "strongly disagreed" on that. Regarding the easiness of combining work with the training activities, a percentage of 71.4% "agreed" in different grades that it was easy to combine work with the study, while 28.6% "disagreed. Males had more positive attitude to the use of e-learning than females, although the statistical difference did not reach the significance level.

8.3. Paper III

A self-evaluation questionnaire was used with a five-grade Likert scale (1–5) to assess candidates' confidence in performing 46 clinical skills. The group of 108 candidates

who responded both to the "before" and "after" questionnaires were included in this study. A positive progress was detected in all evaluated 46 skills. The increase was statistically significant for all skills except for tonsillitis management and uterine evacuation after abortion, these two skills had a high scoring at the baseline evaluation. The mean skill value after the programme for all skills was 3.93 with a progress percentage of 21.7% compared with the "before" value which was 3.23. This represents also a statistically significant difference ($P < 0.001$).

Results also showed an increase of 49 percent in the 10 skills with lowest "base line scores", compared with a 22-percent increase for all skills. Eight of 11 skills with lowest "score change" between "after" and "before" had a baseline value of more than 4.0 at the start (that gives a narrow space for further progress) and the other 3 skills were major surgical procedures which are not a part of the curriculum.

Comparing the different clinical disciplines, candidates scored highest in minor surgical skills and internal medicine both before and after the master programme; however, the relative competency change was highest positive in psychiatry and ophthalmology. Males constantly got higher values in self-evaluation compared with females in all clinical disciplines including both before and after assessment, while females showed more positive progress change after the Master program compared with males (Figure3)

Figure3
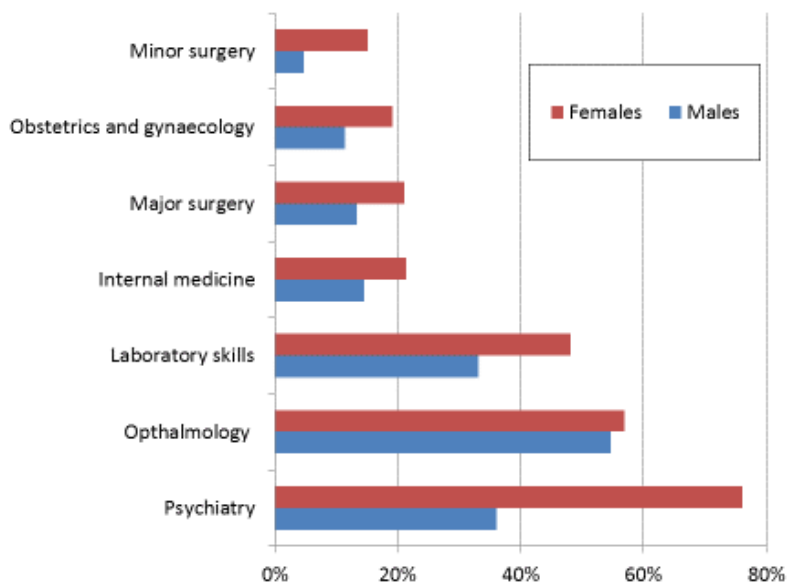
Gender variation in relative competency change in clinical disciplines among master's programme candidates of GFMP, Gezira state, Sudan. (N= 108, 46 males and 62 females)

Due to the drop out the number of candidates during the master program from 207 at its start to 125 at its end, we compared the baseline data of the whole groups of respondents (N: 188) with the baseline data of the group of 108 candidates (this group is a part of the group of 188 candidates, it represents candidates who did not drop out and continues to the end of the master program and responded to the after questionnaire). A total mean difference of 0.04 was observed between the respondents of the two groups (N: 188 and 108) in all skills at the start of the programme. Although the difference is statistically significant (P <0.001), it represents only a 1.2% difference in percentage compared with the difference between "before" (N= 108) and "after" (N= 108) which was 0.70 and representing a 21.7% difference.

The study also found statistically significant improvement in candidates' competency to conduct certain health educational and promotional skills like education for diabetic patients, smoking cessation, breast self-examination and feeding malnourished child.

8.4. Paper VI

Results from this paper showed the impact of the Master program on the candidates' interest in family medicine, professional role skills, patient centeredness and other core values of family medicine.

8.4.1 Family medicine interest and role aspects

In this section, the included group was 110 candidates who responded to this part of the questionnaire both in the "before" and "after" surveys. Data for both males and females showed generally a high interest in family medicine and a significantly increased interest at the end. The relative increase in the category of "very much interest" increased by 56% in males and 78% in females, however, males showed still higher interest.

Results showed also a large, and statistically significant improvements in health team leadership, communication with other colleagues, communication with the local community, practicing health promotion, and caring about patients' psychosocial aspects. Both males and females showed statistically significant increases in adherence to the national guidelines for the management of diabetes mellitus and hypertension. Adherence to malaria guidelines was high both before and after the program without significant change.

8.4.2. Patient-Practitioner Orientation Scale (PPOS) for patient centeredness

The group included in this study is the group of 103 candidates who responded both to the "before" and "after" PPOS questionnaires. Results from PPOS showed less orientation towards patient-centeredness (p= 0.007). Statistically significant decrease of 4% in the overall PPOS score was detected, mostly due to a decrease of 7% in the sharing subscale. A decrease in all scores was detected for males, while for females

there was an increase in the caring subscale, which was not statistically significant; however females had higher overall scoring in PPOS compared with males, both in the "before" and "after" surveys. This difference was not statistically significant.

8.4.3. Core values during clinical consultations

We studied in this section a group of 91 candidates who delivered data for both the "before" and "after" questionnaires. Large and statistically significant improvements was detected in all investigated indicators of family medicine core value. That includes knowledge of the patients' family history ($p < 0.001$) and medical history ($p < 0.001$). A significant increase in planned controls was observed ($p < 0.001$), and there was an increase in referral rate by 3% ($p = 0.040$), from 14% to 17%.

9. Discussion

9.1. Methodological considerations

9.1.1. Study I (Paper I and Paper II)

Study design

Study I is a scientific description of an ongoing enterprise (GFMP), where cross sectional observational and survey designs were used. Observational studies are non-experimental studies where the investigator just observes the condition without intervention. Cross-sectional studies is a type of observational studies where the investigator ascertain a condition/disease at a certain point of time [72].

Paper I describes the emergence and implementation of the GFMP, enrolled candidates and the organizations (health centres). Data from the "before" doctors' questionnaire was used to describe the candidates at the start of the Master program using a self-assessment method; while data from health centres questionnaire was used for the description of the health centres. Administrative data from the Faculty of Medicine, University of Gezira was used to describe the curriculum design and implementation. **Paper II** assesses the utilization and perception of the use of information and communication technology (ICT) at the GFMP (Telemedicine, electronic medical records and e-learning). Both administrative data from the GFMP office and questionnaire-based data was used in this paper.

Questionnaires

Doctors questionnaire (questionnaire 1) is a comprehensive one, includes a wide spectrum of data used in this study; it consists of three major sections. The first section contains personal data about the candidates and the practice where they work and some questions about how they deal with certain issues related to family medicine core principles. Data from this part of the questionnaire are simple factual data. The second part of the questionnaire was a self-assessment, and used to assess candidates'

confidence to perform 46 clinical skills before and after the Master program. The third section of this questionnaire was the Patient-Physician orientation scale (PPOS) questionnaire, which is a validated worldwide used [73-75] questionnaire. It is used to assess candidates' attitude towards patient-centeredness before and after the Master program. A fourth section was added only to the "after" questionnaire to assess candidate's perception including the use of information and communication technology. The *Health centres questionnaire* (questionnaire 2) was designed as a checklist to assess the available facilities at the health centres. Data from this questionnaire was used in **Paper I** for the description of the baseline status of the health centres.

Data collection

Doctors' questionnaire was filled at the classroom in the university. Candidates' participation was voluntary, it does not contain the name, we used an identifiable number for the purpose of the follow up of participants and for the registration of the dropped out candidates. The questions were in English language, although the candidates have Arabic as a mother language, the undergraduate study of medicine is in English, and therefore there was few language barriers. The researchers were also at the classroom for further clarification. Health centres questionnaire was filled at the health centres by the candidates practicing at the targeted health centres and by the GFMP office staff who visited them there.

In **Paper I**, all candidates joined the GFMP at its start were included in this cross sectional study, the response rate was 91%. The response rate for the health centres questionnaire was 100% since data was collected from all health centres (N: 158).

In **Paper II** we used administrative data from the GFMP office to measure the use of the different scales of information and communication technology (ICT). Questionnaire based data was collected to assess candidates' perception of the use of ICT, it targeted 125 candidates at their graduation, 113 of them responded to the questionnaire (90% response rate)

The quality of information gained by the questionnaires will depend on the ability of these questions to measure what was intended to be measured (*validity*), and whether these measurements are reproducible (*reliability*). However, the *accuracy* of the study implies that the measured value of the parameter will be with little error. Errors are traditionally classified as random errors (statistical fluctuations in different directions, occurring randomly due to limited precision of the measurement) or systematic errors (*bias*). The opposite of *bias* is *validity*, so studies with little systematic errors may be described as valid. Analogously, *precision* is the opposite of *random errors,* so studies with little random errors may be described as precise. *Accuracy* consists of both *validity* and *precision* [72].

Validity on its turn is usually divided into internal and external validity. Internal validity implies that the results and conclusions of a study are based on unbiased data, while external validity (generalizability) implies that the results and conclusions holds true also for people outside the studied population. Internal validity is affected mostly by three factors: Confounding, selection bias and information bias. The latter is a result of mismeasurement of the study variables; in observational studies occurs from errors in obtaining the required information from the selected individuals.

Several methodological issues arise in our study and are worth to be discussed, that includes the following:

Selection bias

Occurs when individuals participating in the study are not representative of the population. It can occur either due to systematic error in inclusion or randomization. We assume that selection bias are unlikely to occur in **Study I** since all population was targeted (candidates and health centres) in the study, we got also a good response rate. However; when we discuss **Study II**, the problem of drop out will represent a type of selection bias, which is called *attrition bias*; and we will discuss later how we managed this problem.

Information bias

Occurs when data is incorrectly recorded in a systematic manner during data collection. The investigators followed up data collection and data entry, control of entered data was done systematically both manually and by using SPSS program. However, one of the types of information bias is "central tendency bias", it arises when we use Likert scale, which is an ordinal scale of responses to a question ordered in a hierarchical sequence such as that we used in the skills assessment (very confident, confident, not fully confident, uncertain and not able). In such a case the respondents tends to use the mid scores [76], such bias are difficult to avoid when we use Likert scale.

Recall bias

Defined as systematic error due to differences in accuracy or completeness of recall to memory of past events or experiences [77]. This is unlikely to occur in our study since the evaluation is for current skills or situations. However, in rarely performed skills, candidates might find it difficult to remember/evaluate how good they were to perform them.

Social desirability bias

Occurs when respondents answer the question in a way that they think the investigator will accept. That was not actual in a personal way because the questionnaire did not contain a name; however, candidates "as a group" might have intended to show more confidence in performing skills at the "after" questionnaire, to show that they have learned from the Master program.

Self-assessment method

This was used in the study to assess candidates' confidence in performing 46 clinical skills in **Paper I.** This method of evaluation represents a limitation and raises the question about the relationship between confidence (which is subjective) and competence (which is objective and gives more validity and reliability of data). This

relationship between confidence and competence is unclear [78,79]. However, self-assessment reflects individual's confidence and is valuable and widely accepted as an assessment tool for further development [80-82], and for that reason it has been used in our study. Self-assessment represents also a feasible method compared with other objective methods like Objective Structured Clinical Examination (OSCE), which is usually used to assess small amount of skills [83]. It is unfeasible to assess 46 clinical skills for 207 candidates within real practical conditions for research purposes. To perform such exam we needed huge number of examiners, patients or simulated patients with 46 different conditions, in addition to the economical costs. Objective assessment of 207 candidates in 46 different clinical skills was not obtainable and difficult to organize in the actual setting.

The patients' perception regarding the use of ICT

The questionnaire section about candidates' perception regarding the use of information and communication technology contains questions related to patients' perception like "My patients are usually satisfied with telemedicine" and "the patients are usually not happy when I write on the computer during consultations". Such questions are best answered by the patients themselves; rather than the candidates. Answers collected by the candidates might be biased by the candidates own perception. We did not perform a direct questionnaire, which can be filled by the patients. A large proportion of the patients are non-alphabet; ethical permission for patients' data might need written consent, which is difficult to obtain from non-alphabet patients. Patients might also assume that they are evaluating the contacted physician, such perception leads to biased results. A third person might be needed to perform such questionnaire; that was not available in all GFMP health centres.

9.1.2. Study II (Paper III and Paper IV)

Study design

The design of **Study II** is a "before-and after" cohort observational design. The results are shown in **Paper III** and **Paper IV.** The "before" data was collected in three

questionnaires at the early start of the GFMP. The same three questionnaires were used again at the end of the Master program of the first batch. The purpose of the study was to detect the impact of the Master program on candidates' procedural skills (**Paper III**) and its impact on the core values of family medicine discipline (**Paper IV**). Self-assessment method was used in **Paper III** to assess candidates' confidence to perform a selected 46 clinical skills; data for this purpose was taken from "doctors' questionnaire". In **Paper IV,** we used practice-based data from "patients' questionnaire" which indicates adhesion to the core value of family medicine; we used also the Patient-Physician Orientation Scale (PPOS) to assess the attitude of the candidates towards patient-centeredness in **Paper IV**.

Questionnaires

We use the same questionnaires described above in **Study I**, however in **Study II**, we used to compare the "before" data with the "after" data. For **Paper III**, we used the section of clinical skills in doctors' questionnaire, which includes self-evaluation of 46 clinical skills using Likert scale. For **Paper IV**, we used the PPOs from "doctors' questionnaire" and self-evaluation questions related to core values of family medicine from "patients' questionnaire". The PPOS is a six categories Likert scale which contains 18 items and subdivided into "sharing" and "caring" subscales.

Data collection

In **Study II**, data from "doctors' questionnaire" was registered two times, both "before" and "after" for the skills and PPOS. In addition, we used data from "Patients' questionnaire", in which candidates were asked to collect data from 100 patient consultations at the start of the GFMP and 50 consultations at the end of the Master program. To minimize selection bias, all candidates started at the same day together to collect data from patients. Patients were taken consecutively; every patient at any age could be included in this questionnaire, and no special criteria for selection. The number of the required consultations was reduced from 100 in the "before questionnaire" to 50 consultations in the "after questionnaire" because the candidates

were busy with exams and found it practically difficult with registering100 consultations.

A large dropout rate was recognized in the number of candidates enrolled at the GFMP Master program, from 207 to 125 for the first batch. When we compared the skills of the two groups, we included only participants who participated in both the before and after questionnaires (N: 108). High response rate was recognized in both the before questionnaire (91%) and the after questionnaire (90%).

Methodological considerations for **Study II** include some considerations discussed in **Study I**, including self-evaluation as an assessment tool. In addition, there are other considerations to be discussed related to **Study II** which include:

Using a control group

Using a control group in this study could have added more strength to the study design. District practicing physicians who have been working before the start of the GFMP were planned to be an actual control group at the start of our study, but we found out that the vast majority of them had joined the GFMP at its start and no other suitable group could have been suitable for this purpose. The GFMP recruited both newly graduated doctors and those who had been working from before.

The drop out of candidates

The number of candidates, that dropped out from 207 at the start of the GFMP to 125 at graduation, represent a major challenge both for the project administration and for our study. The project administration and the stakeholders look at the issue as an ongoing expected problem, and it was managed from the start by recruiting huge number (207 candidates) to compensate for an eventual loss. In the scientific study, the decline would represent a threatening attrition bias if candidates who dropped out did so due to academic troubles. The drop out problem was managed in our study by three ways:

I. In the comparison process between "before" and "after", we included only candidates who participated both in the before and after questionnaires, aiming to compare the same individuals.

II. We used administrative reports from GFMP to find out the reason(s) for drop out. The GFMP office asked candidates who left the program to fill a short questionnaire about the reason for withdrawal. Administrative data from the GFMP office showed that almost 80 % of the dropped out candidates left to Saudi Arabia due to economic reasons. This represents a global problem of physicians' brain drain from low-income countries to high-income countries, where reasons [84] and possible solutions [85] are worth to study.

III. The dropout issue was assessed in **Paper III** by comparing the different groups of respondents. The group of respondents to the questionnaire at the start of the program "before" was 188 candidates out of the 207 candidates. At the end of the Master program "after", we found that 108 candidates answered both the "before" and "after" questionnaire.

First, we assume that, the effect of the drop out can be assessed by comparing the baseline data of the two groups. The "Before" data of the whole group of respondents (N: 188) with the baseline data "Before" of the group of respondents who were able to continue to the end of the program and answered both "before" and "after" questionnaires (N: 108). When we compared these two groups (at baseline), we found a percentage difference of 1.2%, which is statistically significant, but of very low "clinical" significance.

Second, to assess the impact of the GFMP master program we compared data of the 108 candidates who responded both before and after questionnaires. Comparing the before data of the 108 respondents with the after data of the same group revealed a percentage difference of 21.7% positive progress.

The progress change in clinical skills

Measuring the educational outcomes and the impact of a training program is an area of vital discussion in medical education. During curriculum planning, we usually target certain skills, knowledge, attitudes that we intend to teach our candidates. We aim also to assess the fulfilment of the intended learning outcomes (ILOs), either on the individual candidate level or on the level of the training program, this occurs during, and after the training program. Various tools and models are used and discussed about how to assess the progress performance in clinical skills.

A pertinent question in our study is how good is the achieved progress value of 21.7% in the total mean score? Does it reach the targeted goal of the Master program? Moreover, can we compare the five-grade Likert scale we used in our study with the Dreyfus model [46, 87] of skills? In our study, we designed a five-grade scale from "not able" to "uncertain", "not fully confident", "confident", and finally "very confident". The assigned values for each level was consequently 1, 2, 3, 4 or 5. Study results showed a statistically significant increase (P < 0.001) with a percentage change of 21.7% (from 3.23 at the program start to 3.93 at its end).

The Dreyfus model [46] is widely accepted in the clinical educational field [86], it describes the developmental phases of skill acquisition in five phases, starting with "novice" followed by "advanced beginner" to "competent", "proficient" and ending as an "expert" . When we match our five-grade scale with the five grades described by the Dreyfus model, the observed progress change (from 3.23 to 3.93) would correspond to a mean change from "competent" to close to "proficient". Pena presented a critical perspective on the Dreyfus model [86]. He describes the third stage "competent" as "when the candidate gets considerable experience", while "proficient" is used for individuals who use intuition in decision-making and can formulate plans from their own rules. By that way, it is reasonable to suggest that the candidates' confidence at the end of the master program reached the level of "proficient" in competency described by the Dreyfus model.

In real practice, the Faculty of Medicine at the University of Gezira managed the assessment; candidates were assessed both theoretically and in practice, including work-based assessment (WBA). Exam results showed that the majority of candidates reached the targeted level of the master program and very few has failed to reach it (Administrative data from the faculty through personal communication). This reflects reasonable correlation between candidate's confidence and the competence assessment done through exams. It seems reasonable to conclude that the achieved increase of 21.7% in the total mean score is relevant, and represents an absolute change as a result of the Master program.

Patient Practitioner Orientation Scale (PPOS)

Although the PPOS is validated and is used worldwide, there is still concerns about cross cultural variability, reliability and validity [87]. The questions in the PPOS explores also the physicians` attitude towards patient centeredness, but that does not necessarily reflect their real practice, that raises the question of the correlation between attitude and behaviour.

9.2. Discussion of the results

9.2.1. Paper I

The GFMP represented a good model of how close collaboration between partners can lead to successful outcomes in the health sector. The high commitment from the University of Gezira supported by the high economic and political support from the Gezira state government resulted in the recruitment of 207 candidates who provided health services in 158 health centres, 84 of which have never received health services by a physician before. This will naturally result in a surge in the quantity and quality of the provided health services for the local communities.

The in-service model of training facilitated by the use of ICT was the prominent feature of the curriculum. Recruiting physicians for family medicine training programs

in developing countries is a major challenge [88,89]. Although there has been a big drop out at the GFMP, the number of 125 candidates is still very high and represents a high up-scaling of family medicine training in the country and the region. The problem of brain drain is known for the government. The government is satisfied with that candidates present health services in the two years' training period; candidates will support the national economy when they are abroad, and they usually return in the future with more training and experience.

In Sudan, there are over thirty faculties of medicine, however, one third of the GFMP candidates were graduated from the University of Gezira. This represents how a local university can serve its local community. In Cuba, a school of medicine is established in each state, to encourage high community based health services [11]. The undergraduate curriculum of the University of Gezira is highly community oriented and students gets their training inside the community and in far rural villages. At the international level, the University of Gezira joins other institutions concerned with social accountability; as example, it is a member of "THE network towards unity for health" [90].

The survey done to assess the available facilities at the health centres reflected how Non Communicable Diseases (NCDs) are underestimated. This occurs despite the local and regional data warning about their high emergence [56,91].The challenge is that NCDs are competing for resources with tropical diseases like malaria and bilharzias, HIV, and tuberculosis, which are still endemic there [92].

Self-evaluation of the baseline skills at the start of the GFMP showed clear variation in candidates' confidence to perform the assessed skills. Management of depression scored least, alarming about the situation of mental health and psychiatric illnesses. The low confidence in dealing with patients with psychiatric illnesses can be due to the scarcity of patients of cultural reasons; it can also be due to less attention devoted to mental health in Sudan and other countries in the region, both at the educational level (undergraduate curricula) and service provision level (Ministry of health) [93].

9.2.2. Paper II

Information and communication technology represented the spirit of the GFMP. The in-service model of training could not be performed without the use of e-learning. The study showed a successful, comprehensive (telemedicine, distance education and EMR), integrated utilization of ICT.

The high use of telemedicine reflects the high need in the community for such innovative solutions. There are over 3000 villages in the Gezira state, many of them are in far districts and are very isolated especially during the raining season. This confirms the idea that low resource areas are in higher need for telemedicine compared with areas of advanced health systems where other alternatives are available. The successful use of telemedicine use is also coherent with a worldwide success [94], also in developing countries [95-97]. This is confirmed further by several reports from WHO [62,98].

Telemedicine communication created also an important link between primary care physicians and their colleagues at hospitals in the second line care, this link was missing before. Referral rate was increased at the end of the Master program compared with the start data, this is in contrast with our expectations, we assumed less referral after 2-year training, the new developed link between primary care and secondary care physicians could have facilitated communication and increased thereby the reference rate. Telemedicine was not used in emergencies at the GFMP; this is mainly due to logistic reasons, in other settings, telemedicine was used only in emergencies and disasters [99]

The use of telemedicine was not without challenges. Cost effectiveness of telemedicine is always discussable [100], both at the establishment period and for the running costs. Even in the presence of high political and economic support from the government, monthly reports showed fluctuations in the number of telemedicine

consultation, mainly due to economic reasons. Technical training before the start of telemedicine was done and it was crucial; moreover, continuous technical support was available at the IT section of the GFMP office. The federal ministry of information and communication technology provided both technical and financial support. Although the candidates were generally committed and satisfied with telemedicine use, they reflected a concern that patients might miss the confidence on their family doctors when they use telemedicine during consultation and contact other specialists.

The GFMP used e-learning in a blended way, candidates got their face to face training for manual skills both at hospitals and during practice in a structured way shown in the curriculum description. Research comparing the blended way of teaching with the traditional methods in medical education, revealed either better and promising results with blended teaching or no statistically significant difference between the two methods in the majority of studies. This was revealed in a review article in LMIC [101]. Similar finding of higher satisfaction with blended teaching was shown in a study from Iran [102].

Although 71.4% of the candidates agreed in different grades about the easiness of combining the training with work "in-service model", the combination was not easy for another group (28.6%); several factors might affect their evaluation including the variation in work load and the geographical position of the health centres.

The presence of efficient medical records is crucial in keeping the quality of care. Its presence is important since it keeps patient history, provides statistical reports and can be used in medico-legal aspects. Very few filing system and documentation was available before the start of the GFMP. During the Master period, the candidates were able to create a new EMR for 165993 patients. This high activity was influenced by the Work-based assessment (WBA), it enhances self directive learning atmosphere, which is an important element in continuous professional development [103]. Candidates were asked during family medicine Master exam to provide the number of new created EMRs and to show the quality of notes from their laptops.

Almost all candidates agreed in different grades about the importance of the EMRs; however, the majority of the candidates agreed that patients were not happy to see the doctor using the computer during consultations. That can be due to cultural reasons, patients are not accustomed to that; it can also be due physicians' low experience in using the computer during consultations, concentrating more on the computer rather than the patient. In contrast, the majority of patients were satisfied with using telemedicine during consultation that might be due to their feeling of direct benefit when using telemedicine.

9.2.3. Paper III

This paper reflects the impact of the GFMP Master program on candidates' confidence to perform certain clinical and manual skills. It showed a positive progress development in almost all assessed skills. Inter-disciplinary and gender variation was observed. The baseline inter-disciplinary variation is thought to be due to undergraduate curricula that give less weight to disciplines like psychiatry and ophthalmology. The skills and disciplines of lowest scoring like psychiatry and ophthalmology showed higher mean change scoring after the Master program, this can be due to the available space for development when they started low. The in-service model of training allowed the candidates themselves to find the gaps and to strengthen the weak points. The in-service model could have also participated in competency variation between the candidates; centres with high workload and wide spectrum of diseases are supposed to provide better training setting for the practicing candidates.

Gender variation in confidence to perform the assessed skills is observed in our study. While males showed higher mean scoring both before and after the Master program, females showed higher mean progress change. Does that mean males are more competent or more confident than females? Blanch et al [104], on their research about the issue of confidence and gender in medical students, concluded that the literature on self-reports of confidence are convincing that males report usually higher confidence

than their female colleagues. Another question is that, does higher progress percentage by female candidates imply higher skills gain during the Master period compared with their male colleagues? Does the higher baseline self-evaluation of the males gave them narrower space for further development? Regression analysis was performed to investigate the issue and whether it is due to ceiling or floor effects; assuming that previous lower scores give higher chance for development while higher scores give less chance for development. Residualized or regressed change scores were used to remove the effect of initial scores, results showed the same pattern.

9.2.4. Paper IV

This paper investigated the impact of the GFMP Master program on the core values of family medicine. Positive progress results were shown in values and competencies like continuity of care, comprehensiveness, leadership and adhesion to the national management guidelines for the common diseases. In contrast, statistically significant reduction in "patient-centeredness" was found using the Patient Physician Orientation Scale (PPOS).

Candidates showed high interest in family medicine discipline before the Master program for both genders, increased interest was observed also after the Master program. Strong media momentum was used for the GFMP targeting both physicians and the public. TV, radio, newspapers and direct meetings were used in this campaign to recruit physicians and to promote community commitment and participation. The majority of the physicians who applied to the GFMP were primary care physicians and the new offer from the GFMP represented a good chance to improve their practice and to get postgraduate education while they are keeping their jobs. The increased interest after the Master program might give a positive sign that the programme could meet candidates' expectations. The trend of increased interest after orientation about the discipline was also recognized in a study from Egypt [105].

Results revealed also substantial increase in community health promotion, increase in competencies like leadership, communication with the community and colleagues at job. Candidates were highly encouraged to show such competencies, during exams and follow up meetings, they were asked to show the map of the "catchment area" where the candidate was practicing, they were also asked to show pictures and write reports reflecting their activity in the community. Many candidates showed amazing results, they were able to mobilize the local community and to get financial support from the community and the community members who are working abroad in the gulf countries; they used these resources in the rehabilitation of the health centres, and even in building new health centres by the community. Candidates were asked to present their activities in exhibitions and meetings with the public and politician and they were honoured for that.

Candidates self-evaluated their adherence to the national guidelines for the management of malaria, diabetes and hypertension. Candidates scored highest adhesion to malaria both at the start and at the end of the Master program. Malaria program is one of the vertical programs, it gets both national and international support to "roll back malaria" [106]. Candidates showed less adhesion to the national guidelines for diabetes and hypertension; however, they showed significant increase at the end of the master program. Diabetes and hypertension guidelines are not widely available or advocated compared with malaria; this reflects how tropical diseases are still overshadowing NCDs at the national level. It reflect also the international attention towards vertical programs and the decreased focus on NCDs.

In contrast to the above-mentioned positive progress development in competencies and core values, there were statistically significant reduction in the total scores for "patient-centeredness" from 3.75 to 3.60 out of 5. Such decrease in the PPOS scores after clinical rotations have been recognized in other studies [88,107-108]. This is explained by the shift from a theoretical ideal teaching of communication skills to a biological oriented teaching at hospitals. Such explanation is plausible in our setting;

our candidates got a theoretical teaching of communication skills at the early start of the Master program and before the PPOS questionnaire.

Comparing the results from our study with results from other countries, candidates total scoring is higher than that of Pakistani students (score 3.4) [73], and lower than Brazilian students (score 4.66) [74], and Greek students (score 3.81) [75]. Our study shows also higher scoring in "sharing" subscale compared with the "caring" subscale, which indicates less engagement of the patient in decision-making and in information, this can be due to the paternalistic biomedical model recognized at the hospital training setting, cultural influence can also be considered.

Continuity of care is an important principle and core value in family medicine discipline. Results from our study suggests that the practice of the candidates at the end of the Master period was characterized by more continuity of care, that was indicated by the increased percentage of "follow up" encounters done by family physicians. It is also indicated by the increased knowledge about the patients' medical history, family medical history and family situation.

Factors that contributed to the increased "follow up" encounters and continuity of care in general might include the change in the spectrum of diseases from acute to more chronic and complicated conditions after the Master program. Candidates after the Master program had more knowledge and confidence to deal with such diseases. Telemedicine lead also to the fact that a percentage of the patients came to their family physicians in order to meet hospital doctors together with their family physician through telemedicine activity. The electronic medical records could also facilitate continuity of care by saving data from before and planning control consultations in the future. The relative stability of family physicians at the health centres encouraged continuity of care. There is also an increased interaction between patients and their family physicians. Candidates became more trained in consultation and communication skills; patients are also more confident on their family doctors and feel more comfortable to meet for follow up. Candidates are more active in the community,

and know better about families, they stated in this study more satisfaction regarding the communication with the local community after the Master program, this can encourage continuity of care. Lastly and not least they learned during the Master program about the importance of continuity of care and follow up of their patients and practiced that.

Referral rate was unexpectedly increased from 14% to 17% after the Master program, but it is still within the internationally accepted level [109]. Barbara Starfield assumes normal referral rate from primary care lies between 15-25% [110]. The increased referral rate was in contrast to expectations, it is assumed that the referral rate will decrease when candidates get more skills and experience after the Master program.

There are many factors that might explain this increase in referral rates. The relationship between primary health care physicians and secondary care physicians was increased after the start of the GFMP. During the training days at hospitals, the GFMP candidates met their colleagues and senior consultants at hospital, they discussed with them the relevant conditions and patients. The candidates also communicated with hospital consultants through telemedicine activity, they discussed patients with them, and in many times, the discussion resulted in referring the patient to hospital for further investigations and/or procedural management. At the end of the Master program, we assume that the candidates are dealing with a new spectrum of diseases; they meet more chronic and complicated diseases, which need referral. Before the Master program, primary care physicians were dealing more or less with acute diseases like malaria and respiratory tract infections; patients with chronic conditions were usually followed up at hospitals without coming through health centres. At graduation, candidates are expected to know better about the health system, where to refer, when to refer and to whom; they know also better about the diseases and indications for referral, they are more confident to refer when it is needed. Even though, the increased referral rate is still within the acceptable rates.

10. An overall evaluation of the GFMP (2010-2012):

Gezira family medicine project represents an inspiring model to Sudan and other countries in the region [111,112]. Postgraduate family medicine training is expanding globally; many African countries have implemented or initiated such programs, GFMP could achieve relatively high up scaling of family medicine training in the region [12,17-20]. The success keys were political commitment, community engagement and close collaboration between the partners, including the Ministry of Health and the Faculty of Medicine at the University of Gezira.

Providing health services by physicians in 158 centres, 84 centres of which have never been served by a doctor before, is a breakthrough in primary health care service provision. The presence of the candidates in such rural areas increased the accessibility of health services which is a WHO target (MDG). Community mobilization is an important success factor for health service programs [113]. GFMP candidates were able to encourage the community to participate in health promotion and in financially in building and rehabilitation of new health centres.

The geographical features and infrastructure of the Gezira state are similar more or less to other areas in Sub-Saharan Africa (mean distance to the nearest main hospital was 31 km). Destroyed roads and flooding canals are typical, especially in the rainy seasons. Therefore, applying the ideas and strategies of the GFMP will be reasonable and more accepted in areas with similar resources and context.

Recruited candidates showed high interest in family medicine discipline at the start, and even more, at the end of the Master program. Information and communication technology was successfully utilized in an integrated and comprehensive way (telemedicine, EMRs and e-learning). Candidates' high satisfaction with the use of information and communication technology is in harmony with their high utilization of its components. High use of telemedicine activity reflects high need of technology in resource constricted settings. Medical records is an essential tool

in health service provision, creating EMRs for over 165000 patients provides also a rich data pool for statistics and research.

The baseline questionnaires done at the start of the GFMP, reflected the needs of the health centres to be satisfied. It reflected also the gaps in clinical skills of the candidates that needed more focus during training.

The developed curriculum responded to the local community needs [114], it is a product of a long history of the Faculty of Medicine at Gezira University as a socially accountable medical school [115]. The training methods used at the GFMP included a variety of modern pedagogic principles. Online education was accompanied by "at hospital" training of clinical skills. Crash courses were used to cover areas of high needs like mental health, while field visits were essential as a tool for work-based assessment.

The in-service model of training shown to be a suitable model; candidates got paid jobs and learned from practice. The work-based assessment (WBA) showed high effect in promoting candidates to increasing their competencies and community activities, especially in leadership and community mobilization. This method of assessment is getting more validation as an assessment tool [116].

The GFMP had a broad positive impact on candidates clinical skills and core values of family medicine discipline; candidates showed respectable development in leadership and other family medicine core values and competencies, however, "Patient Centred Care" remains a weak point in the training program. More attention is needed to be paid to Non Communicable Diseases (NCDs), both in service provision and training.

The two-year period of the Master program was suitable in many ways. From the service point of view, the Ministry of Health and the community were happy to have the candidates for at least 2 years at the health centres during the training

period at least. From a training point of view, the two year period is expected to be enough to get the essential training in the most important parts of the discipline. Candidates were satisfied, because the period is not long and they can decide later if they would like to continue to an MD grade; the Master certificate is also promising for the candidates since it can almost guarantee an immediate job in the gulf states after graduation.

In Sudan, the role of the family physician as a "personal doctor" at a health centre was preferred, while many Sub-Saharan African countries preferred the "team leader" model at a rural hospital. The variation in the required role of the family physicians and the variation in the curricula and the training models between countries and regions is a characteristic feature of family medicine discipline.

Missing sustainability remains a hazard for many successful programs, especially in developing countries. Decline in political commitment, economical constrains and doctors emigration were the most threatening factors for GFMP.

11. Conclusion

By bringing together several stakeholders, the GFMP was able to perform a 2-year in-service family medicine Master program. Its implementation lead to high up-scaling of family medicine training and higher quality expanded health services. The use of ICT facilitated both the training process (e-learning) and service provision (telemedicine and EMRs).

The Master program had a high impact on candidates' confidence to perform selected clinical skills; moreover, it had a good impact on their acquisition of core family medicine values. Patient centred care shown to be a weak point in the training process and needs to be prioritized in future curriculum development.

GFMP can possibly be used as a good model for high up-scaling for family medicine training in other settings; however, that will be dependent on the community needs and available resources. Sustainability factors should always to be considered.

12. Future research

Research remains an important component to support and guide the process of high up-scaling of family medicine training in the region. Research is supposed to be oriented towards both the ongoing training programs and to their impact on health services.

There are several family medicine training programs in the different countries; partners can learn from each other and share experiences through research. Research on training modalities can include research on the suitable length of the training period, the content of the curricula, e-learning, training outcomes, and impact on the trainees.

Little research was done in the region to assess the impact of the trained family physicians on the health system and the provided health services [31,117]. Research from developed countries showed how family physicians participated in health systems and health service outcomes [9]. It might be early at this stage to detect the impact of family physicians in our region, due to their scarcity and short experience, but future research can assess the effect of the presence of family physicians in the health systems, their effect on the spectrum of diseases and even on health indicators. Indeed, research on patient satisfaction regarding the presence of family physician and health services provided by them is needed.

Brain drain is a challenge that threatened the GFMP and even the whole health system in Sudan and other LMIC. In our study, the number of candidates declined during the Master period and it is assumed that the vast majority left after graduation. It is worth to follow the fate of the 207 candidates and to find the reasons and possible suggested solution for the problem.

Although there is still high up scaling of family medicine training in Sudan, we recognized how the GFMP is affected by both political changes and economic

challenges. Advocacy for community based PHC to policy makers is highly prioritized by academic family physicians [118]. We need to consider more studies related to sustainability factors in training and health service projects in our settings.

The GFMP also is a great opportunity for health service research, the EMR system could make it possible to study reasons for encounter, diagnosis, diagnostic activity, treatments given, and referrals, to an extent not possible before. Such research activities are scarce, but should be encouraged. Research will further strengthen the GFMP, the academic competence among researcher and relevant departments, and increase our knowledge about the Gezira patients and population needs.

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Doctors questionnaire (Before)

Doctors' number ....   Locality:…………….

Please fill this page according to your situation before starting at the Gezira family medicine project:

1. Age: …………..(Years)

2. Sex: Male☐   Female ☐

3. Year of graduation: ……………… .

4. University of graduation: …………………………………………….. .

5. How long have you been working in general practice?..................... years.

6. How many hours do you use for academic reading per week?............... hours?.

7. Why did you choose the specialty of family medicine?

   Economy ☐   Easy specialty ☐   Short time☐

   Only available opportunity ☐,   Others:

8. Do you have age register?   Yes ☐   No☐

9. Do you have sex register?   Yes ☐   No ☐

10. Do you have a disease register (List of patients with specific diseases) ?   Yes ☐   No ☐

11. Do you make notes for every consultation which are available for next time?   Yes ☐   No ☐

12. Do you have comprehensive medical files system for documentation of all medical activities (Notes, letter, lab x-ray results..) ?   Yes ☐   No ☐

13. Do you know exactly what is you catchment area?   Yes ☐   No ☐

14. Do you have Maternal death register?   Yes ☐   No ☐

15. Do you participate in the periodic health check up for children-school?   Yes ☐   No ☐

16. How do you feel confident as a health team leader in your health center? Very confident ☐

    Confident ☐   Not fully confident ☐

    Uncertain ☐   Not able ☐

17. I use to show diabetes patients how to use Insulin injections themselves.

    Yes ☐   No ☐   Some times ☐

18. I use to show women how to examine their breasts for ca. breast.   Yes ☐   No ☐   Some times ☐

19. I use to discuss with smoking patients the bad effects of cigarette smoking.

    Yes ☐   No ☐   Some times ☐

20. I use to advice mothers who have children with malnutrition how to feed them.

    Yes ☐   No☐   Some times ☐

21. Do you have regular meetings with the community to encourage them to participate in health services?

22. Do you practice rehabilitation role for patients with special needs like psychiatry patients?

    Yes ☐   No ☐   Some times ☐

23. Do you usually think about the psychosocial aspects of your patients? Yes ☐   No ☐   Some times ☐

24. Do you follow the national guidelines for Malaria management in your patient management?

    Yes☐   No☐   Some times ☐

25. Do you follow the national guidelines for diabetes management in your patient management?

    Yes ☐   No☐   Some times ☐

26. Do you follow the national guidelines for Hypertension management in your patient management?

    Yes ☐   No ☐   Some times ☐

27. **Please fill inn values for all days in a typical week – use the number you think is close to the average**

Day	Day working hours.		Number of consultations during the day.	Evening working hours		Number of consultations during the evening	Number of consultations during the night. (After 22:00)	Number of home visit	
	From	To		From	To			Day	Night
Sunday									
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									

For the next table, fill in a X for the appropriate category of your opinion

	Very much	Much	Somewhat	Little	Not
28. Are you interested in family medicine specialty?					
29. Are you satisfied regarding the communication with the local community?					
30. Are you satisfied regarding the communication with the other employer in your center					
31. Are you satisfied regarding your income?					

How do you evaluate your ability to perform the following *skills? (Mark X)*

No	Question	Very confident	Confident	Not fully confident	Uncertain	Not able
1	Measuring blood pressure					
2	Hemoglobin measuring					
3	Urine analysis					
4	Glucose measuring.					
5	Blood film for malaria					
6	Insertion of nasogastric tube					
7	ECG taking.					
8	ECG interpretation					
9	Inhaler technique					
10	Vein puncture and drip start					
11	Cardiopulmonary resuscitation.					
12	Chest X ray in infections.					
13	Vaginal examination.					
14	Taking cervical smear					
15	Evacuation after abortion					
16	Normal delivery.					
17	Caesarian section.					
18	IUCD insertion.					
19	Abscess drainage.					
20	Suturing of wounds.					
21	Urethral catheterization .					
22	Knee examination					
23	Insulin treatment in hyperglycaemia					
24	X-Ray interpretation in trauma.					

25	Stopping epistaxis				
26	Eye fundoscopi				
27	Visual acuity.				
28	Appendectomy operation.				
29	Caesarian section.				
30	Acute abdomen operation.				
31	Management of diabetic coma				
32	Management of asthma				
33	Management of myocardial infarction.				
34	Management of tuberculosis				
35	Cholesteatoma operation				
36	Acute vaginal bleeding				
37	Management of iIridocyclitis				
38	Malnutrition in children.				
39	Tonsillitis.				
40	Acute psychosis				
41	Management of major depression				
42	Removal of foreign body from the eye				
43	Management of urinary retention				
44	Diagnosis of hearing loss				
45	Plaster of minor fractures				
46	Stabilization of major fractures.				
46	Thoracal drainage.				

	ITEM		Strongly agree	Somewhat agree	Agree	Disagree	Somewhat disagree	Strongly disagree
1	The doctor is the one who should decide what gets talked about during a visit	PPOS01						
2	Although health care is less personal these days, this is a small price to pay for medical advances.	PPOS02						
3	The most important part of the standard medical visit is the physical examination.	PPOS03						
4	It is often best for patients if they do not have a full explanation of their medical condition.	PPOS04						
5	Patients should rely on their doctors' knowledge and not try to find out about their conditions on their own.	PPOS05						
6	When doctors ask a lot of questions about a patient's background, they are prying too much into personal matters	PPOS06						
7	If doctors are truly good at diagnosis and treatment, the way they relate to patients is not that important.	PPOS07						
8	Many patients continue asking questions even though they are not learning anything new.	PPOS08						
9	Patients should be treated as if they were partners with the doctor, equal in power and status.	PPOS09						
10	Patients generally want reassurance rather than information about their health.	PPOS10						
11	If a doctor's primary tools are being open and warm, the doctor will not have a lot of success.	PPOS11						
12	When patients disagree with their doctor, this is a sign that the doctor does not have the patient's respect and trust.	PPOS12						
13	A treatment plan cannot succeed if it is in conflict with a patient's lifestyle or values.	PPOS13						
14	Most patients want to get in and out of the doctor's office as quickly as possible	PPOS14						
15	The patient must always be aware that the doctor is in charge.	PPOS15						
16	It is not that important to know a patient's culture and background in order to treat the person's illness	PPOS16						
17	Humour is a major ingredient in the doctor's treatment of the patient.	PPOS17						
18	When patients look up medical information on their own, this usually confuses more than it helps.	PPOS18						

Health centers' questionnaire (Before)

1) Name of the health center:_____

2) Locality: _____

3) When was the health center built? : _____ (Year)

4) Number of rooms: _____

Please, define and specify these rooms:(put X)

1. ( ) Doctor's room ( )
2. ( ) Pharmacy.
3. ( ) Vaccination room.
4. ( ) Maternal room.
5. ( ) Lab. room.
6. ( ) Ward(s) ( )
7. ( ) Registration and filing room.
8. ( ) Storage room.
9. ( ) Nutrition room.
10. ( ) Minor surgery room.
11. ( ) Major operation room.
12. ( ) X-ray or ultrasound room
13. ( ) Other room(s): _____.

5) How long is the distance to the nearest health center? _____ Kilometer.

6) How long is the distance to the nearest hospital?._____ kilometer. **Which hospital?** _____

7) Is this center covered with health insurance?

☐Direct ☐ in direct ☐ Not covered

8) Is the doctor on call during the night?

Yes ☐   No ☐

9) How long response time(from contact or call to see the patient) ? _____(minutes).

10) Is there laboratory? Yes ☐   No ☐

11) Which of the following investigation are available at the lab:

1. Hemoglobin: Yes ☐   No ☐
2. Blood glucose: Yes ☐   No ☐
3. Blood film for Malaria: Yes ☐   No ☐
4. ICT for malaria: Yes ☐   No ☐
5. widal test for typhoid: Yes ☐   No ☐
6. Pregnancy test: Yes ☐   No ☐
7. Urine general: Yes ☐   No ☐
8. Stool general :   Yes ☐   No ☐
9. HIV test: Yes ☐   No ☐
10. ESR :   Yes ☐   No ☐
11. TWBC: Yes ☐   No ☐
12. Other investigations:

_____ _____ _____

_____ _____ _____

12) Available lab. equipments:
☐Centrifuge   ☐ Microscope
☐ Cholometrer ☐ Autoclave
Other lab equipments: _____ _____.
_____ _____ _____
_____ _____ _____

13) Is there pharmacy? Yes ☐   No ☐

14) Available medications at the health center:

- **Antibiotics:** 1- _____ 2-_____
  3-_____. 4-_____ 5-_____
  More_____

- **Antihypertensive:** 1-_____2- _____
  3-_____ 4-_____ 5- _____
  More_____

- **Ant diabetes:** 1-..._____ 2-_____
  3-_____ 4_____

- **Antimalarial:** 1-_____2-_____
  3-_____ .4_____

- **Other medications:** : 1- _____ 2 _____
  3-_____ 4-... _____. 5-_____
  More_____

15) Is there ward at the health center?

Yes ☐   No☐

16) How many beds available
_____beds.

17) Available staff at the health center: Put the number please (0,1,2,3,4,5….)

Doctors ( )   Nurses ( ).   Lab technician ( ).

Pharmacist ( ). Secretary ( ) House keeper ( ).

Midwife ( ).   Vaccination technician ( ).

Others _____ ( ) _____ ( )

18) Services presented at the health center:

Vaccination: Yes ☐   No ☐ .

Maternal follow up.	Yes □	No □ .	

Maternal follow up.   Yes □   No □ .

Childhood and school follow up.   Yes □   No □ .

Nutrition.   Yes □   No □ .

Labor.   Yes □   No □

Minor operations(Like suturing of cut wound,

Inngrowing nail, lipoma excision…) Yes □   No □ .

Major operations Like appendectomy, caesarian

section…).   Yes □   No □

Available equipments:

Surgical equipments for minor :   Yes □   No □

Surgical equipments for major: Yes □   No □

Ophthalmoscope: Yes □   No □

ECG machine: Yes □   No □

Neublizer: Yes □   No □

Sphyngomanometer   Yes □   No □

Ear syringe   Yes □   No □

Spirometer   Yes □   No □

Doctor's emergency bag (Contains important

medications and equipments).   Yes □   No □

Weight scale for adults: Yes ☐   No ☐

Ped iatric scale   Yes □   No □

Heart starter   Yes □   No □

Gynecological examination equipments: Yes □ No □

19) Furniture: please write the number available:

Cautch (   )   Office tables (   ) Chairs (   )

Beds   (   )

Office telephone   Mobile telephone (   ) Computer

or laptop (   )

Other equipments_____ (   ) _____ (   )

_____ (   )

20) Is there any patients referred to the health center from other health units   Yes □   No □

21) The patients from this health center is mainly referred to:

□The nearest rural hospital.

□The nearest locality hospital

□ Madani hospital.

□ Khartoum hospital.

□Private sector.

22) Regarding the health center, please fill inn values for all days in a typical week – use the number you think is close to the average

Day	Day opening hours.		Total Number of consultations during the day.	Evening opening hours		Number of consultations during the evening	Number of consultations during the night. (After 22:00)
	From	To		From	To		
Sunday							
Monday							
Tuesday							
Wednesday							
Thursday							
Friday							
Saturday							

Patients' questionnaire (Before)

Doctor's no: _____   **Patient no:_____**

Patient's:

Age: ____years   Sex: □ Male   □Female

Cohabitation: □ Married   □ Single

Day of consultation: _____day (Sun-Sat)
Time of consultation: _____ hour (00-23)

Reason(s) for encounter this consultation

Symptom(s):   1_____

2_____

3_____

Known diagnosis: 1_____

2_____

3_____

Today's contact

□ Patient initiated control for chronic disease

□ Scheduled revisit for known disease/symptom

□ First contact for main symptom

□ Second   □Third   □Fourth   □More

If first contact; how long has the symptom lasted
before the consultation: _____ days

In the past

Before consultation, has the patient for the
new/main problem:

Used self management? □ Yes □ No

if yes: □ life style change   □ drugs

□ other:

Visited:

□ Local healer □ Other primary care doctor

□ Other primary care worker   □ Specialist

Has the patient visited you before? □ Yes □No

Are you the personal doctor for this
patient over time?   □Yes □No

Do you for this patient know

- the patient's medical history?   □Yes □No

- the patient's family situation?   □Yes □No

- important parts of the family's
     medical history?   □Yes □No

Diagnosis and use of equipment

Clinical examination:

□None   □Full clinical

Partly, which organ:_____

Lab. investigations requested:

□Hb   □Glucose   □BFFM

□TWBC □S-creatinin □S-cholesterol

□Urine general   □Others:

Equipment/procedure(s) used/done today:

1_____

2_____

3_____

Management/therapy

Was the patient given therapeutic procedures or
any treatment in the room during the
consultation?   □ Yes □ No

If YES, what:

Prescriptions: Write down medication(s) and
circle the kind of use

(A)New, short   (B)New chronic (C) Renewal

1_____ A B C

2_____ A B C

3_____ A B C

4_____ A B C

Final diagnosis of main problem today

1- _____

2- _____

Follow up

Was the patient referred?

□ No   □ Hospital

□ Radiology unit   □ Private doctor/clinic

□ Other:

Planned control in this center:

□ Not needed   □ Within 1 week

□ Within 1 month   □ More than a month.

Evaluation of the consultation

How long did the consultation last?

□ 0-5 min   □ 5-10 min

□ 10-15 min   □ 20-25 min

□ 20-25 min   □ > 25 min; how
long:…….

Do you think the patient have payment
difficulties for medical problems?

□ Yes, for today's consultations& lab.

□ Yes, for hospital stay fees.

□ Yes, for X-ray or lab

□ Yes, for medications.

Is the patient a member of the health insurance
fund? □ Yes □ No

Overall severity of problem today (mark one):

□ Not at all a serious problem

□ Not very serious, low impact on health

□ Somewhat serious

□ Serious/high impact on health

□ Very serious, potential life threatening

Doctors' questionnaire (After)

Doctors' number ....   **Locality:…………….**

Please fill this page according to your situation As it is now:

1. Do you have age register?   Yes ☐   No☐

2. Do you have sex register?   Yes ☐   No ☐

3. Do you have a disease register (List of patients with specific diseases) ?   Yes ☐   No ☐

4. Do you make notes for every consultation which are available for next time?   Yes ☐   No ☐

5. Do you have comprehensive medical files system for documentation of all medical activities (Notes, letter, lab x-ray results..) ?   Yes ☐   No ☐

6. Do you know exactly what is you catchment area?   Yes ☐   No ☐

7. Do you have Maternal death register?   Yes ☐   No ☐

8. Do you participate in the periodic health check up for children-school?   Yes ☐   No ☐

9. How do you feel confident as a health team leader in your health center? Very confident ☐

Confident ☐   Not fully confident ☐

Uncertain ☐   Not able ☐

10. I use to show diabetes patients how to use Insulin injections themselves.

          Yes ☐   No ☐ Some times ☐

11. I use to show women how to examine their breasts for ca. breast.   Yes ☐   No ☐ Some times ☐

12. I use to discuss with smoking patients the bad effects of cigarette smoking.

          Yes ☐   No ☐ Some times ☐

13. I use to advice mothers who have children with malnutrition how to feed them.

          Yes ☐   No☐ Some times ☐

14. Do you have regular meetings with the community to encourage them to participate in health services?

15. Do you practice rehabilitation role for patients with special needs like psychiatry patients?

          Yes ☐   No ☐ Some times ☐

16. Do you usually think about the psychosocial aspects of your patients? Yes ☐ No ☐ Some times ☐

17. Do you follow the national guidelines for Malaria management in your patient management?

          Yes☐   No☐ Some times ☐

18. Do you follow the national guidelines for diabetes management in your patient management?

          Yes ☐   No☐ Some times ☐

19. Do you follow the national guidelines for Hypertension management in your patient management?

          Yes ☐   No ☐ Some times ☐

20. How many hours do you use for academic reading per week?............... hours?.

21. Why did you choose the specialty of family medicine?

          Economy ☐   Easy specialty ☐   Short time☐

          Only available opportunity ☐,   Others:

22. **Please fill inn values for all days in a typical week – use the number you think is close to the average**

Day	Day working hours.		Number of consultations during the day.	Evening working hours		Number of consultations during the evening	Number of consultations during the night. (After 22:00)	Number of home visit	
	From	To		From	To			Day	Night
Sunday									
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									

For the next table, fill in a X for the appropriate category of your opinion

	Very much	Much	Somewhat	Little	Not
23. Are you interested in family medicine specialty?					
24. Are you satisfied regarding the communication with the local community?					
25. Are you satisfied regarding the communication with the other employer in your center					
26. Are you satisfied regarding your income?					

How do you evaluate your ability to **perform the following** *skills? (Mark X)*

No	Question	Very confident	Confident	Not fully confident	Uncertain	Not able
1	Measuring blood pressure					
2	Hemoglobin measuring					
3	Urine analysis					
4	Glucose measuring.					
5	Blood film for malaria					
6	Insertion of nasogastric tube					
7	ECG taking.					
8	ECG interpretation					
9	Inhaler technique					
10	Vein puncture and drip start					
11	Cardiopulmonary resuscitation.					
12	Chest X ray in infections.					
13	Vaginal examination.					
14	Taking cervical smear					
15	Evacuation after abortion					
16	Normal delivery.					
17	Caesarian section.					
18	IUCD insertion.					
19	Abscess drainage.					
20	Suturing of wounds.					
21	Urethral catheterization .					
22	Knee examination					
23	Insulin treatment in hyperglycaemia					
24	X-Ray interpretation in trauma.					

25	Stopping epistaxis					
26	Eye fundoscopy					
27	Visual acuity.					
28	Appendectomy operation.					
29	Caesarian section.					
30	Acute abdomen operation.					
31	Management of diabetic coma					
32	Management of asthma					
33	Management of myocardial infarction.					
34	Management of tuberculosis					
35	Cholesteatoma operation					
36	Acute vaginal bleeding					
37	Management of ilridocyclitis					
38	Malnutrition in children.					
39	Tonsillitis.					
40	Acute psychosis					
41	Management of major depression					
42	Removal of foreign body from the eye					
43	Management of urinary retention					
44	Diagnosis of hearing loss					
45	Plaster of minor fractures					
46	Stabilization of major fractures.					
46	Thoracal drainage.					

#	ITEM	Strongly agree	Somewhat agree	Agree	Disagree	Somewhat disagree	Strongly disagree
1	The doctor is the one who should decide what gets talked about during a visit						
2	Although health care is less personal these days, this is a small price to pay for medical advances.						
3	The most important part of the standard medical visit is the physical examination.						
4	It is often best for patients if they do not have a full explanation of their medical condition.						
5	Patients should rely on their doctors' knowledge and not try to find out about their conditions on their own.						
6	When doctors ask a lot of questions about a patient's background, they are prying too much into personal matters						
7	If doctors are truly good at diagnosis and treatment, the way they relate to patients is not that important.						
8	Many patients continue asking questions even though they are not learning anything new.						
9	Patients should be treated as if they were partners with the doctor, equal in power and status.						
10	Patients generally want reassurance rather than information about their health.						
11	If a doctor's primary tools are being open and warm, the doctor will not have a lot of success.						
12	When patients disagree with their doctor, this is a sign that the doctor does not have the patient's respect and trust.						
13	A treatment plan cannot succeed if it is in conflict with a patient's lifestyle or values.						
14	Most patients want to get in and out of the doctor's office as quickly as possible						
15	The patient must always be aware that the doctor is in charge.						
16	It is not that important to know a patient's culture and background in order to treat the person's illness						
17	Humour is a major ingredient in the doctor's treatment of the patient.						
18	When patients look up medical information on their own, this usually confuses more than it helps.						

	ITEM	Strongly agree	Somewhat agree	Agree	Disagree	Somewhat disagree	Strongly disagree
1	Telemedicine is of high benefit for my patients						
2	It is a good teaching tool for family doctors						
3	It is the only way of communication with hospital specialists						
4	I used it for the follow up of my patients in more than one consultation						
5	I use it usually when the patient is in my office						
6	My patients are usually satisfied with telemedicine						
7	The patients miss the confidence on family doctor when telemedicine is used						
8	I use the program to get second opinion from other family medicine colleagues						
9	The electronic filing system is highly important for my practice						
10	The patients are not happy when I write on the computer during consultation						
11	I register all my patients on the electronic filing system						
12	One line lectures are a good teaching method						
13	The training at hospital was closely related to our needs in practice						
14	It was easy to combine the work with the training activities						
15	I am generally satisfied with the training program during the master period						
16	I am planning to continue the family medicine speciality to get the MD or PhD						
17	I recommend that the idea of the Gezira Family Medicine Project should be replicated in other places						
18	I am planning to leave Sudan shortly after finishing the master program						

Health centers' questionnaire (After)

1) Name of the health center:_____

2) Locality: _____

3) When was the health center built? : _____ (Year)

4) Number of rooms: _____

Please, define and specify these rooms:(put X)

1. (   ) Doctor's room (   )
2. (   ) Pharmacy.
3. (   ) Vaccination room.
4. (   ) Maternal room.
5. (   ) Lab. room.
6. (   ) Ward(s) (   )
7. (   ) Registration and filing room.
8. (   ) Storage room.
9. (   ) Nutrition room.
10. (   ) Minor surgery room.
11. (   ) Major operation room.
12. (   ) X-ray or ultrasound room
13. (   ) Other room(s): _____.

5) How long is the distance to the nearest health center? _____ Kilometer.

6) How long is the distance to the nearest hospital?._____ kilometer. **Which hospital?** _____

7) Is this center covered with health insurance?

☐Direct ☐ in direct ☐ Not covered

8) Is the doctor on call during the night?

Yes ☐   No ☐

9) How long response time(from contact or call to see the patient) ? _____(minutes).

10) Is there laboratory?   Yes ☐   No ☐

11) Which of the following investigation are available at the lab:

1. Hemoglobin: Yes ☐   No ☐
2. Blood glucose: Yes ☐   No ☐
3. Blood film for Malaria: Yes ☐   No ☐
4. ICT for malaria: Yes ☐   No ☐
5. widal test for typhoid: Yes ☐   No ☐
6. Pregnancy test: Yes ☐   No ☐
7. Urine general: Yes ☐   No ☐
8. Stool general :   Yes ☐   No ☐
9. HIV test: Yes ☐   No ☐
10. ESR :   Yes ☐   No ☐
11. TWBC: Yes ☐   No ☐
12. Other investigations:

_____ _____ _____

_____ _____ _____

12) Available lab. equipments:

☐Centrifuge   ☐ Microscope

☐ Cholometrer ☐ Autoclave

Other lab equipments: _____ _____.
_____ _____ _____
_____ _____ _____

13) Is there pharmacy?   Yes ☐   No ☐

14) Available medications at the health center:

- **Antibiotics:** 1- _____ 2-_____
  3-_____.   4-_____ 5-_____
  More_____
- **Antihypertensive:** 1-_____2- _____
  3-_____ 4-_____ 5- _____
  More_____
- **Ant diabetes:** 1-…_____ 2-_____
  3-_____ 4_____
- **Antimalarial:** 1-_____2-_____
  3-_____ .4_____
- **Other medications:** : 1- _____ 2 _____
  3-_____ 4-… _____. 5-_____
  More_____

15) Is there ward at the health center?

Yes ☐   No☐

16) How many beds available_____beds.

17) Available staff at the health center: Put the number please (0,1,2,3,4,5….)

Doctors (   )   Nurses (   ).   Lab technician (   ).

Pharmacist (   ). Secretary (   ) House keeper (   ).

Midwife   (   ).   Vaccination technician   (   ).

Others _____ (   ) _____ (   )

18) Services presented at the health center:

Vaccination: Yes ☐   No ☐ .

Maternal follow up.   Yes ☐   No ☐ .

Childhood and school follow up.   Yes □   No □ .

Nutrition.   Yes □   No □ .

Labor.   Yes □   No □

 Minor operations(Like suturing of cut wound,

Inngrowing nail, lipoma excision…) Yes □   No □ .

Major operations Like appendectomy, caesarian

section…).   Yes □   No □

Available equipments:

 Surgical equipments for minor :   Yes □   No □

 Surgical equipments for major: Yes □   No □

 Ophthalmoscope: Yes □   No □

 ECG machine: Yes □   No □

 Neublizer: Yes □   No □

 Sphyngomanometer   Yes □   No □

 Ear syringe   Yes □   No □

 Spirometer   Yes □   No □

 Doctor's emergency bag (Contains important

medications and equipments).   Yes □   No □

 Weight scale for adults: Yes ☐   No ☐

Ped iatric scale   Yes □   No □

Heart starter   Yes □   No □

Gynecological examination equipments: Yes □   No □

19) Furniture: please write the number available:

 Cautch (   )   Office tables (   ) Chairs (   )

 Beds   (   )

Office telephone   Mobile telephone (   ) Computer

or laptop (   )

Other equipments_____ (   ) _____ (   )

 _____ (   )

20) Is there any patients referred to the health center from other health units   Yes □   No □

21) The patients from this health center is mainly referred to:

   □The nearest rural hospital.

   □The nearest locality hospital

   □ Madani hospital.

   □ Khartoum hospital.

   □Private sector.

22) Regarding the health center, please fill inn values for all days in a typical week – use the number you think is close to the average

Day	Day opening hours.		Total Number of consultations during the day.	Evening opening hours		Number of consultations during the evening	Number of consultations during the night. (After 22:00)
	From	To		From	To		
Sunday							
Monday							
Tuesday							
Wednesday							
Thursday							
Friday							
Saturday							

Patients' questionnaire (After)

Doctor's no: _____

Patient no:_____

Patient's:

Age: _____years   Sex: □ Male   □Female

Cohabitation: □ Married   □ Single

Day of consultation: _____day (Sun-Sat)

Time of consultation: _____ hour (00-23)

Reason(s) for encounter this consultation

Symptom(s):   1_____

2_____

3_____

Known diagnosis: 1_____

2_____

3_____

Today's contact

□ Patient initiated control for chronic disease

□ Scheduled revisit for known disease/symptom

□ First contact for main symptom

□ Second   □Third   □Fourth   □More

If first contact; how long has the symptom lasted before the consultation: _____ days

In the past

Before consultation, has the patient for the new/main problem:

Used self management? □ Yes □ No

if yes: □ life style change   □ drugs

□ other:

Visited:

□ Local healer □ Other primary care doctor

□ Other primary care worker   □ Specialist

Has the patient visited you before? □ Yes □No

Are you the personal doctor for this patient over time?   □Yes □No

Do you for this patient know

- the patient's medical history?   □Yes □No

- the patient's family situation?   □Yes □No

- important parts of the family's

medical history?   □Yes □No

Diagnosis and use of equipment

Clinical examination:

□None   □Full clinical

Partly, which organ:_____

Lab. investigations requested:

□Hb   □Glucose   □BFFM

□TWBC   □S-creatinin □S-cholesterol

□Urine general   □Others:

Equipment/procedure(s) used/done today:

1_____

2_____

3_____

Management/therapy

Was the patient given therapeutic procedures or any treatment in the room during the consultation?   □ Yes □ No

If YES, what:

Prescriptions: Write down medication(s) and circle the kind of use

(A)New, short   (B)New chronic   (C) Renewal

1_____ A B C

2_____ A B C

3_____ A B C

4_____ A B C

Final diagnosis of main problem today

1- _____

2- _____

Follow up

Was the patient referred?

□ No   □ Hospital

□ Radiology unit   □ Private doctor/clinic

□ Other:

Planned control in this center:

□ Not needed   □ Within 1 week

□ Within 1 month   □ More than a month.

Evaluation of the consultation

How long did the consultation last?

□ 0-5 min   □ 5-10 min

□ 10-15 min   □ 20-25 min

□ 20-25 min   □ > 25 min; how long:.......

Do you think the patient have payment difficulties for medical problems?

□ Yes, for today's consultations& lab.

□ Yes, for hospital stay fees.

□ Yes, for X-ray or lab

□ Yes, for medications.

Is the patient a member of the health insurance fund? □ Yes □ No

Overall severity of problem today (mark one):

□ Not at all a serious problem

□ Not very serious, low impact on health

□ Somewhat serious

□ Serious/high impact on health

□ Very serious, potential life threatening

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HUMAN RESOURCES FOR HEALTH

RESEARCH   Open Access

Scaling up family medicine training in Gezira, Sudan – a 2-year in-service master programme using modern information and communication technology: a survey study

Khalid G Mohamed[1,2,3], Steinar Hunskaar[1,2*], Samira Hamid Abdelrahman[1] and Elfatih M Malik[3]

Abstract

Background: In 2010 the Gezira Family Medicine Project (GFMP) was initiated in Gezira state, Sudan, designed as an in-service training model. The project is a collaboration project between the University of Gezira, which aims to provide a 2-year master's programme in family medicine for practicing doctors, and the Ministry of Health, which facilitates service provision and funds the training programme. This paper presents the programme, the teaching environment, and the first batch of candidates enrolled.

Methods: In this study a self-administered questionnaire was used to collect baseline data at the start of the project from doctors who joined the programme. A checklist was also used to assess the health centres where they work. A total of 188 out of 207 doctors responded (91%), while data were gathered from all 158 health centres (100%) staffed by the programme candidates.

Results: The Gezira model of in-service family medicine training has succeeded in recruiting 207 candidates in its first batch, providing health services in 158 centres, of which 84 had never been served by a doctor before. The curriculum is community oriented. The mean age of doctors was 32.5 years, 57% were males, and 32% were graduates from the University of Gezira. Respondents stated high confidence in practicing some skills such as asthma management and post-abortion uterine evacuation. They were least confident in other skills such as managing depression or inserting an intrauterine device. The majority of health centres was poorly equipped for management of noncommunicable diseases, as only 10% had an electrocardiography machine (ECG), 5% had spirometer, and 1% had a defibrillator.

Conclusions: The Gezira model has responded to local health system needs. Use of modern information and communication technology is used to facilitate both health service provision and training. The GFMP represents an example of a large-volume scaling-up programme of family medicine in Africa.

Keywords: Family medicine, In-service training, Telemedicine, Sudan, Curriculum development

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Background

There is a global emphasis on the importance of family medicine and its role as a cornerstone in the modern health system [1]. The International Conference on Primary Health Care (in Alma-Ata, former USSR, 1978) called for urgent and effective national and international action to develop and implement primary health care throughout the world and particularly in developing countries [2]. This was further emphasized and detailed by the 2008 World Health Organization report *Primary Health Care: Now More than Ever* [3].

Many studies have shown that better health service outcomes are related to the quality of primary health care available [3,4]. European countries that have the strongest primary health-care systems could achieve this mainly due to reforms aimed at transferring power and tasks to general practitioners [1,5]. Vertical programmes for diseases such as HIV, malaria, and tuberculosis, and also for vaccinations, should be implemented in the context of primary health-care teams to be more effective and comprehensive [6]. Although much money has been invested in vertical programmes, the overall performance of disease control programmes is generally poor [7].

Family medicine is a very recent discipline worldwide, started in the 1960s as a postgraduate training programme [8]. There are a variety of tasks, roles, and settings for family physicians worldwide [1]. Internationally there are two basic models for family medicine training, hospital-based training and primary care-based training. The latter is usually called primary care in-field-training or in-service training. Many countries use mixed models. Norway and the United Kingdom are examples of countries using mainly in-service training programmes for family physicians. In Norway the specialty period is 5 years, where 4 years should be training at a health centre (in-field) and 1 year at a hospital [9].

Africa experiences 24% of the global burden of disease, but has only 2% of the global supply of doctors [10]. Until recently, the concept of family medicine has not been clearly defined in the context of sub-Saharan Africa [11]. How family physicians can best be used in primary health care in Africa is therefore a pertinent question [12]. The 2nd African Regional WONCA Conference (World Organization of National Colleges, Academies and Academic Associations of General Practitioners/Family Physicians, in Rustenberg, South Africa, 2009) developed a consensus statement on family medicine within an African context, as well as the role and training requirements of family physicians [13]. A number of family medicine training programmes have been established in Africa during the last decade [14]. Implementation of family medicine in Africa faces many challenges; for example, poverty, limited funding, focusing on hospital care, poor training capacity, and drainage of doctors towards rich or more developed countries [10].

Barbara Starfield has claimed that the most successful health systems should plan for between 1000 and 1500 inhabitants per full-time family doctor [15]. The Gezira state of Sudan had 115 medical officers (graduated doctors without postgraduate training) and no family medicine specialist at the start of 2010, reflecting a ratio of primary health-care doctors to population of about 1:32 000. To bridge this huge gap, the Gezira Family Medicine Project (GFMP) was planned. The project aims to train doctors in family medicine by means of a 2-year in-service master's degree programme.

This paper describes the GFMP, including its implementation, the different roles of partners, the curriculum, and the use of modern information and communication technology. The paper also focuses on the background and baseline competences of the recruited candidates, characteristics of primary health centres used for the training, and instruments and methods used in the training.

Methods

The GFMP is the first of its kind in the region. A scientific evaluation of the project was therefore planned to be performed alongside with the first batch of candidates. The evaluation is planned to cover the development of the organization (health centres, equipment), the students (fulfilment of the programme, competence in family medicine and practical skills, patient-centred approach), teaching methods (use of distance learning and telemedicine), and some patient perspectives (catchment area, doctor's knowledge of the patient, management of major conditions).

Study area

Sudan lies in north-east sub-Saharan Africa covering 1 861 484 km^2, with an estimated population of 34 million (in 2012). According to official reports from the Ministry of Health, Sudan has an infant mortality rate of 68 deaths per 1000 live births, maternal mortality of 750 deaths/100 000 live births, and a life expectancy at birth of 55 years. Gezira state is one of 17 states in Sudan, centrally located in the country, with a total area of about 25 500 km^2. Gezira state has a total population of about 3.7 million. Rural population constitutes about 80% of the total population in Gezira, scattered over more than 3000 villages. According to the state Ministry of Health, the main causes of morbidity and mortality are infectious and parasitic diseases. Noncommunicable diseases are also emerging due to the change in socioeconomic and lifestyle conditions.

Study design

A survey study was designed to collect baseline data from both the GFMP candidates (medical doctors) and from the health centres (training sites). The same design will be used to collect data after graduation, thus defining a follow-up study of the first student batch (cohort observational design).

Study population

The study population comprises the GFMP candidates and the health centres selected for the project. A total of 188 (91%) candidates responded and filled in the questionnaire. All health centres (158) were reviewed in the study.

Data collection

Data were collected using a checklist and a self-administered questionnaire. The list and the questionnaire were both developed by the GFMP project group and discussed by senior researchers in the field. The checklist was used to collect data from the health centres involved in the project. The data were collected by both doctors and by the administrative staff from GFMP headquarters. Examples of variables included are location, distance to the nearest main hospital and health centre, buildings/rooms, available laboratory services, vaccination programme, available medications, diagnostic and therapeutic equipment, staff, opening hours, and workload.

All doctors joining the project filled in a comprehensive anonymous questionnaire about themselves, their background, and their previous experience. The questionnaire also included information about their style of practice, their participation in maternal and childhood care, their competence as leaders for the health team, and their role in all health services: prevention, treatment, patient education, health promotion, and rehabilitation. Moreover, the questionnaire recorded their workload, and their interest in family medicine as a specialty. Their self-assessed confidence and competence in performing 46 different procedures was reported using a five-level score (from not able to very confident). The doctors' questionnaire also included the Patient–Practitioner Orientation Scale, which is an 18-item scale on patient-centredness [16]. Data from the Patient–Practitioner Orientation Scale are not presented in this paper. The questionnaire data were collected after each student had started the programme, and for the last questionnaires this meant several weeks into the first term.

Ethical and privacy approvals and data analyses

The study was reviewed and approved by the Ethical review committee at the Ministry of Health, Gezira State, Sudan. The study was also reviewed by the Regional Committee for Medical and Health Research Ethics, Western Norway. Privacy issues and patients' file management related to the scientific evaluation were also approved by the Norwegian Data Protection Official for Research.

Data management and statistical analyses were done by the IBM SPSS® program version 19 (supplier: IBM corp., Armonk, NY, USA). Results are presented as descriptive statistics with means and proportions and percentages.

Results

Gezira Family Medicine Project (GFMP)

In early 2010, following advocacy campaigns about the GFMP, a total of 207 doctors were accepted for the programme, distributed to 158 health centres. The project is a product of collaboration between several partners including the Ministry of Health at Gezira state, University of Gezira, the Sudan Medical Specialization Board, the National Health Insurance Fund, and the community. The mission of the project is to provide high-quality, accessible, and affordable primary care-based health services.

The roles of the different partners were specified from the start. The Faculty of Medicine, University of Gezira, was responsible for the academic training component including curriculum development. The Ministry of Health was responsible for providing the health centres with the required staff, including doctors, equipment, and buildings, in addition to paying the candidates' tuition fees. After the recruitment of doctors, the health centres were analysed according to the need for expanding the workforce and, when needed, other health-care workers such as laboratory technicians and nurses were employed and paid by the Ministry. The Sudan Medical Specialization Board approved that any successful graduate from the 2-year master's programme eventually can continue for 2 years more in order to obtain the full MD degree in family medicine at the national level. The local communities in Gezira state provided housing for the doctors, especially in rural areas. The National Health Insurance Fund has decided to provide health insurance services at all health centres included in the GFMP.

Results and descriptions here will cover the three main components of the GFMP; training, service, and information and communication technology.

The training component

The University of Gezira adopted a community-oriented training approach. The Faculty of Medicine prepared an academic plan for the GFMP through curriculum workshops, led by family physicians together with experts from other medical disciplines. The main feature of the approved curriculum was the in-service approach. This

implies that the curriculum was designed and structured to meet both training and service requirements. The awarded degree was decided to be a Master of Science in Family Medicine.

Structure of the programme

The structure of the 2-year programme is based on four semesters. The first three semesters, with a total academic load of 48 credit-hours (one credit-hour equals 15 theoretical-hours or 30 practical/clinical-hours) are divided into teaching blocks (modules). The fourth semester has been allocated to research (master's dissertation). The distribution of credit-hours between the specialties is described in Table 1. Modern pedagogic principles are used as demonstrated in Table 2, which shows the training methods used in the GFMP.

The candidates were assessed through a series of examinations at the end of each clinical module. The electronic medical records were used to assess their real practice, which includes topics such as clinical governance, holistic approach, evidence-based practice, and guideline follow up. This assessment was done by checking a random number of patients' records. The assessor discussed the findings, notes, decisions, management, and so forth, with the student, and gave feedback in a direct and personal audit process.

The candidate's social accountability, community mobilization, and health-promotion activities were also evaluated. The candidates were asked to document their activities in the community through pictures, reports, and minutes of relevant meetings. At the examination the students were asked to present the data (which were collected by the community members) regarding the population, age, and sex register and any chronic

diseases' registries in the catchment area/practice population. The students also displayed pictures and reports about any community participation regarding rehabilitation of the health centre. Any participation of the doctor in health promotion in the community or at schools should be presented and documented. All candidates had to present and discuss a Google map poster of his/her catchment area, and to present the population pyramid of the village or catchment area.

Enrollment of candidates

All applicants were interviewed before their intake. There was no restriction according to age or medical experience except for performed internship (12 months) after graduation and permanent registration in Sudan Medical Council.

The service presentation component

The GFMP is also a matter of health system reform, first by transforming the health system from its verticality to a more horizontal system, focusing on the health team rather than the health programmes, and secondly by providing more resources to primary health care regarding staff, equipment, and buildings. The expected role of the family medicine candidates is to provide continuous and comprehensive care for all people of all ages and both genders with their broad spectrum of needs, health problems, and diseases [3]. They are supposed to mobilize the community resources and to respect its needs. They are also supposed to lead the health team within the catchment area.

Information and communication technology component

These technologies are used to facilitate both training and service. They include telemedicine using the video-conferencing software program ooVoo® [17]. Family doctors were connected with hospital specialists from different medical specialties, and clinical signs or investigations such as electrocardiography (ECG) could be shown and discussed. For distance learning, the software Cisco WebEx® [18] is used. Candidates were connected electronically to a virtual classroom with full interaction of life voice, picture, and chatting. An electronic filing system was developed for the GFMP (Family Clinic®). This system incorporates also the ICD-10 diagnostic system, and statistical reports can be generated.

Health centres – the clinical training environment

The 158 health centres were distributed all over Gezira state, but the majority was clearly rural. The mean distance to the nearest of three main hospitals was 31 km (SD 26). Distribution of the distances was otherwise as follows: less than 10 km (30% of the centres), and more than 50 km (20%). The longest distance was 100 km.

Table 1 Summary of courses in the Gezira Family Medicine Project curriculum

Course name	Credit-hours	%
Family medicine	8	16.6
Community medicine	3	6.3
Internal medicine	5	10.4
Diagnostic imaging and laboratory medicine	2	4.1
Research methodology	1	2.0
Paediatrics and child health	5	10.4
Obstetrics and gynaecology	5	10.4
Otolaryngology	3	6.3
Surgery and orthopaedics	4	8.3
Psychiatry	3	6.3
Dermatology	3	6.3
Ophthalmology	3	6.3
Accident and emergency medicine	3	6.3
Total	48	100

Table 2 Training methods used in the Gezira Family Medicine Project

Training activity	Way of conducting	Time of the training	Aim of the training
Introductory course	Meeting at the university	At the start of the master's course	To cover important areas in family and community medicine, before start
Distance learning	Formal Internet-based lectures, tutorials or discussions, using Web Ex program (virtual classroom); lecturer communicates with candidates (voice and picture), share desktop, slides, films, and documents	Usually at the end of the day, evenings, or weekends	To teach the different disciplines in rotations (medicine paediatrics, and so forth)
Hospital visits	Clinical rounds, outpatient clinic, referral clinic, theatre, etc.	Once a week	To learn the required clinical skills, candidates should fill their logbooks where all the required skills are listed
Telemedicine	Specialists from all specialties are connected with the candidates by videoconference to discuss real-life cases	One hour during the working day	Both clinical management and case discussion learning
Field supervision	Supervisors visit the candidates at their health centres	During the working day	To assess the setting, attend and evaluate consultations, evaluate the use of the filing system
Primary care work	Candidates are practicing family medicine at their centres	4 days a week	Learning through practice, candidates communicate with specialists and colleagues through videoconferencing
Courses	Crash courses arranged at the university	Usually 3 to 5 days per course	To cover certain important topics (examples: mental health, malaria and HIV)
Monthly meetings	Meeting at the university	Once a month	Family medicine teaching and administrative issues
Electronic library	Every candidate is equipped with a laptop computer and free wireless Internet	At any time	Evidence-based medicine: candidates should know national and international resources, guidelines, medical websites, etc.
Classical library	Available at the university, some books were distributed free to the candidates	During the university days	Mainly for background knowledge

All centres had a consultation room, but otherwise they were very diverse in number of rooms (Table 3). A few centres had an available X-ray and/or ultrasound room and major operation room because of sharing facilities with small local village public hospitals. Availability of laboratory equipment, instruments, and some other diagnostic or therapeutic equipment is shown in Table 4. Most centres had the most relevant blood tests available, while more advanced equipment was rather seldom present. Typical opening hours for a health centre are 7 to 8 hours 5 days a week, with rather small variations (data not shown).

Table 3 Rooms available at the health centres of the Gezira Family Medicine Project at baseline (N = 158)

Description of room	n	%
Doctor's consultation room	158	100
Laboratory room	149	94
Pharmacy	136	86
Ward/observation beds	136	86
Vaccination room	102	65
Minor surgery room	86	54
Maternal room	70	44
Storage room	57	36
Registration and filing room	50	32
Nutrition room	30	19
X-ray or ultrasound room	25	16
Major surgery room	21	13

The students – background and baseline experience and skills

The students' mean age was 32.5 years; the male candidates were somewhat older than the women (Table 5). Males also had a wider age range, and more working experience as 12% of them had more than 10 years of experience before entering the programme. About one third of the students were graduates of the University of Gezira, while 6% came from outside Sudan. A variety of reasons for choosing the family medicine specialty was given (Table 5). Examples of self-assessed evaluations of the ability to perform 46 different skills are shown in Figure 1. Almost 79% were confident or very confident in managing asthma, some confidence was also found for some major surgical operations, while only 20% felt confident in intrauterine device insertion and 12% in managing depression.

Discussion

The GFMP succeeded in scaling up family medicine training in Sudan by recruiting 207 candidates who were

Table 4 Laboratory equipment, instruments, and other diagnostic or therapeutic equipment available at the health centres of the Gezira Family Medicine Project at baseline (N = 158)

Description	n	%
Laboratory investigations		
Blood film for malaria	142	90
Pregnancy test	137	87
Standard urinalysis	136	86
Standard stool investigation	134	85
Erythrocyte sedimentation rate	134	85
Haemoglobin	132	84
Total white blood cell count	132	84
Widal test for typhoid	121	77
Blood glucose	111	70
Immunochromatographic test for malaria	57	36
HIV test	25	16
Diagnostic or therapeutic equipment		
Microscope	140	89
Sphygmomanometer	131	83
Centrifuge	124	78
Colorimeter	111	69
Nebulizer	108	68
Surgical equipment for minor surgery	92	58
Autoclave	79	50
Gynaecological examination equipment	43	27
Electrocardiography machine (ECG)	16	10
Ear syringe	16	10
Surgical equipment for major surgery	14	9
Ophthalmoscope	8	5
Spirometer	7	4
Emergency bag with relevant content	7	4
Defibrillator	1	1

providing health services in 158 health centres, 84 of which (53%) had never been served by a doctor before the project.

Recruitment of doctors to join family medicine training programmes in developing countries has been a major challenge [19,20]. This was not the case in the GFMP. One third of the candidates were graduated from the University of Gezira followed by one tenth from the nearby University of Khartoum. This reflects the role of the local universities in developing its surrounding communities by being the main provider of health-care personnel for the area.

Distance to the nearest main hospital reflects the rural nature of Gezira state, including widespread population, inadequate insurance coverage, and limited accessibility to health services. However, in the rainy season transportation of patients over even rather short distances may be hindered by flooding canals and destroyed roads.

The available diagnostic or therapeutic equipment reflects the practice in these centres before the GFMP. Equipment necessary for noncommunicable diseases and emergency cases were inadequate. This is in spite of evidence showing these problems as emerging threats while the health system shows clear gaps in low-income and middle-income countries [21]. Until now Sudan has had an almost absence of a well-functioning referral system. Combined with low medical competence and a lack of even basic equipment, this makes it understandable that many primary care patients are treated at a specialist level. Only 16% had HIV tests available. Such patients are usually referred to specific HIV centres or to secondary care even before confirming the diagnosis. This weak contact between HIV patients and primary care services represent one of the cons of vertical disease programmes [7], seen also in Sudan.

The candidates stated clearly a lack of confidence in the management of depression. This may be due to the scarcity of psychiatric illness presented at a primary care level, but might also be due to insufficient attention devoted to mental health issues in general [22]. The candidates stated also high confidence in caesarean section, but much less confidence in inserting an intrauterine device, reflecting the need for family planning skills [23]. Although malaria is a common disease we found that only about one third of the candidates stated that they were confident in detecting malaria by means of a blood film.

Many developing countries are now aware of the importance of family medicine and its commitment to the Millennium Development Goals [24]. Research from regions such as Europe reflects evidence that family medicine plays an important role in the development of the health system and in improving primary health-care services outcomes [5]. Unfortunately there is still scarce research providing such evidence in sub-Saharan Africa.

Comprehensive studies regarding primary care doctors in Sudan are few, but some studies describe clinical skills in certain areas. A study on malaria showed that the rate of false-positive diagnosis of malaria by clinicians was 76% [25], emphasizing the importance of training for primary care doctors. Another study showed good outcome after a 3-week programme for doctors working at rural hospitals in Sudan [26]; post-training field assessment revealed that 60 to 80% of the trainees were using recently learned techniques.

A study from Saudi Arabia described a 1-year diploma programme in family medicine that started in 2007 [27]. The sample size was 34 trainees (all of the candidates in

Table 5 Description of the students at the start of the Gezira Family Medicine Project at baseline (N = 207)

Description	Males (*n* = 118)	Females (*n* = 89)	All (*N* = 207)
Gender	57	43	100
Age (years)			
Mean (standard deviation)	34.0 (7.9)	30.4 (4.5)	32.5 (6.9)
Median	32	30	30
25th to 75th quartiles	28 to 36	27 to 33	28 to 35
Range	24 to 62	24 to 47	24 to 62
University background			
Gezira	27	38	32
Khartoum	12	8	10
Other Sudanese	48	50	49
Other countries	9	3	6
Missing	4	1	3
Working experience (years)			
< 2	30	44	37
2 to 5	41	39	39
6 to 10	17	15	16
>10	12	2	8
Reason(s) for choosing family medicine			
Economy	29	18	24
Easy specialty	13	4	9
Short duration of programme	20	23	21
Only available	31	31	31
Other reasons	21	24	22

Results presented as percentages unless otherwise stated.
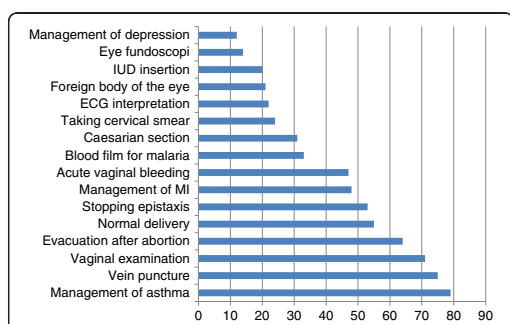
Figure 1 Self-assessed evaluation of the ability to perform 16 of a total of 46 recorded skills. Data shown are the sum of the scores (%) from the alternatives 'very confident' and 'confident' (percentages) on a category scale with five alternatives ('very confident', 'confident', 'not fully confident', 'uncertain', and 'not able'). The data were collected after each student had started the programme, and for the last questionnaires this meant several weeks into the first term. ECG, electrocardiography; IUD, intrauterine device; MI, myocardial infarction.

the second batch), and the response rate was 91%. The short training period (1 year) was reported as a barrier by 84% of the trainees. But the importance of increased use of information and communication technology in order to improve the training was highly emphasized by the candidates in the study. The GFMP could solve two of the problems recognized, as the duration of training is longer and the use of information and communication technology is much more comprehensive.

A study from Brazil and Chile evaluated an in-service model of training for primary health-care workers. Based on pretests, post-tests, and evaluations of students' projects, it was demonstrated that participants had increased knowledge as well as skills after in-service training [28]. Another study from Brazil evaluated the impact of a family medicine-based programme on the infant mortality rate during 1990 to 2002 [29]. Such studies emphasize that new educational developments such as the GFMP should be followed by evaluation research and, if possible, clinical outcomes. We have developed a research plan to investigate a variety of effects of the GFMP.

The consensus document from the Annual PRIMA-FAMED Network Conference held in Victoria Falls, Zimbabwe, in 2012 stated the GFMP as a good example for scaling up family medicine and primary health care in Africa [30]. This has been important feedback from the scientific community, showing that we are on the right track and that our ideas and models are appreciated. The GFMP is thus now a well-known example that inspires other countries in the region. This fact is also inducing a commitment to conduct a scientific evaluation of the programme.

Strengths and limitations of the study

Our cross-sectional study included all trainees and health centres in the GFMP, resulting in a representative and comprehensive information. The response rate of the doctors' questionnaire was 91%, with only 19 candidates not responding. The response rate for health centres' questionnaire was 100%, giving an important and complete database about the setting for training and service prior to the programme launch. Most parts of the questionnaires had face and content validity as they recorded simple and factual data that were checked by both administrative and research staff of the project.

One clear study limitation is the self-reporting of clinical skills and other self-evaluations by the trainees. Validity and reliability studies could have increased the quality of such data. However, self-report represents a feasible method of data collection, since it requires little administration and allows large samples to be included [31]. Objective checking of the competence of 207 candidates regarding how they perform 46 different clinical skills is not obtainable in a running training enterprise.

Conclusions

The GFMP represents a modern model in family medicine training that responds to local needs. The project copes with the regional strategy for up-scaling of family medicine training. Information and communication technology is a cornerstone in performing such a mission. The GFMP will hopefully provide a suitable model to other low-income and middle-income countries that share similar health-care challenges as Gezira state in Sudan.

Abbreviations

GFMP: Gezira Family Medicine Project.

Competing interests

KGM is an assistant professor at the University of Gezira, Sudan, and the director of the GFMP at the Ministry of Health. SH is a professor of family medicine at the University of Bergen, Norway, is honorary professor at the University of Gezira, and acts as a consultant for the GFMP and Ministry of Health in Gezira state. EMM is a researcher and, at the present time (2013), is the state Minister of Health in Gezira state, Sudan. SHA is a professor of community medicine at the University of Gezira, and is also the Dean of the Blue Nile National Institute for Communicable Diseases.

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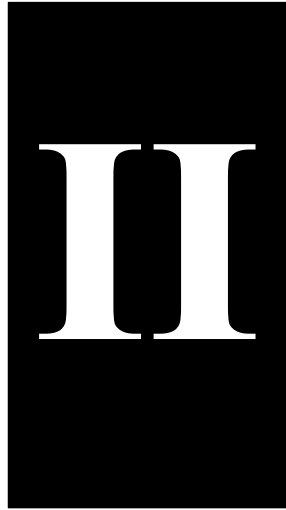Chapman & Hall/CRC press; 2005.

Research Article

Telemedicine and E-Learning in a Primary Care Setting in Sudan: The Experience of the Gezira Family Medicine Project

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Information and communication technology (ICT) is progressively used in the health sector (e-health), to provide health care in a distance (telemedicine), facilitate medical education (e-learning), and manage patients' information (electronic medical records, EMRs). Gezira Family Medicine Project (GFMP) in Sudan provides a 2-year master's degree in family medicine, with ICT fully integrated in the project. This cross-sectional study describes ICT implementation and utilization at the GFMP for the years 2011-2012. Administrative data was used to describe ICT implementation, while questionnaire-based data was used to assess candidates' perceptions and satisfaction. In the period from April 2011 to December 2012, 3808 telemedicine online consultations were recorded and over 165000 new patients' EMRs were established by the study subjects (125 candidates enrolled in the program). Almost all respondents confirmed the importance of telemedicine. The majority appreciated also the importance of using EMRs. Online lectures were highly rated by candidates in spite of the few challenges encountered by combining service provision with learning activity. Physicians highlighted some patients' concerns about the use of telemedicine and EMRs during clinical consultations. Results from this study confirmed the suitability of ICT use in postgraduate training in family medicine and in service provision.

1. Introduction

The progressive development in the field of information and communication technology (ICT) during the last decades has led to great advances also in the health sector (e-health). There is a global, regional, and national awareness about the importance of e-health. The World Health Organization (WHO) Millennium Development Goals (MDGs) Gaps Task Force has encouraged the governments to increase the use of ICT in the provision of health services in order to increase its efficiency and support the achievement of the MDGs [1]. The WHO Eastern Mediterranean Regional office took a strategic direction to emphasize the importance of using ICT in health, "Leveraging e-Health: Use of ICT in Health in the Eastern Mediterranean Region" [2]. At the national level, many countries (including Sudan) include e-health in their national health plans. However there is a large variation between countries in their commitment and implementation of e-health strategies [3].

The Gezira Family Medicine Project (GFMP) is a collaboration project between the Faculty of Medicine, University of Gezira, and the Ministry of health in Gezira state of Sudan. It aims to improve the quality of primary care health services, through training of family doctors and improving service delivery at this level. GFMP provides a two-year master's program in family medicine since 2010 for the practicing doctors in both urban and rural areas [4]. ICT was implemented in three main areas: telemedicine, e-learning, and the electronic medical records (EMRs).

Telemedicine is defined as the use of medical information exchanged from one site to another via electronic communications to improve a patient's clinical health status [5]. In this paper the term is used to describe online interaction between specialist doctors and the candidates enrolled in GFMP through a videoconference-like meeting. Telemedicine at the GFMP aims to break down the geographical barrier and to increase access to a high quality care at the specialist level to

patients all over Gezira state. It was also meant to facilitate the goal of scaling up family medicine training [6]. Although there are some articles evaluating telemedicine in developing countries [7], a literature review in the Eastern Mediterranean region showed that e-health has not yet been well studied [2]. Numerous telemedicine articles are found from developed countries, but in general there has been relatively scarce telemedicine research from developing countries [8].

In this study "e-learning" means the provision of online education using virtual class rooms. It was selected on basis of the great educational opportunities it provides for the students and its enhancement of faculty effectiveness and efficiency [9, 10].

Use of electronic medical records (EMRs) is expected to increase patients' safety and is of high value in effective service provision [11]. Many EMR programs are developed worldwide for both hospital and primary care levels and are sometimes used for specific diseases like HIV in Africa [12] or for follow-up of chronic diseases [13].

This study evaluates the comprehensive experience of using ICT both in education and in service provision at GFMP. It describes the physicians' experience of e-learning as a training method and its role in facilitating the in-service model of training at the GFMP. Administrative data was used to show the actual utilization of ICT in education and practice while questionnaire-based data was used to assess candidates' perception and satisfaction regarding the use of ICT.

2. Methods

2.1. Study Area. Gezira state lies in the central part of Sudan and has a total population of 3.7 million; about 80% are living in rural areas. Health services are provided through over three hundred health centers which are served by medical doctors or medical assistants (nurse); the second line is rural hospitals or city hospitals. Infectious diseases like malaria represent the major cause of morbidity and mortality in Gezira; however Noncommunicable Diseases (NCDs) are emerging. Internet services are available throughout the state by many companies.

2.2. Study Design and Study Population. A cross-sectional observational design was followed to collect administrative and questionnaire-based data. The study targeted the 207 candidates (medical doctors) of the first batch enrolled in the GFMP master program. The number of candidates declined gradually from 207 at the program start to reach 125 candidates at their graduation exam; the main reason was migration to other rich countries. Administrative data collection for the use of telemedicine has targeted all the 207 candidates (from the program start), while questionnaire-based evaluation has targeted the 125 candidates at their graduation.

2.3. Data Collection. Registration forms were filled at every telemedicine session. The form included date of the consultation, age and sex of the patient, clinical symptoms, tentative diagnosis, management, and any referral to secondary care,

besides the name of the consulting family doctor and consulted specialist doctor. Data from GFMP annual reports for the period from April 2011 (telemedicine start) to December 2012 were used in this paper.

Data collected for EMRs and "e-learning" was obtained from administrative data and exam results' data. The candidates' use of the ICT tools was a part of their evaluation at the family medicine exams, which included the number of initiated and opened electronic patient files (quantity), the comprehensiveness of the data in the files (quality), the candidates participation in telemedicine activity (number of consultations), and the candidate's participation in the online e-learning activities.

Candidates' own evaluation of the use and effect of the different ICT elements, that is, telemedicine, EMRs, and e-learning, was registered through an anonymous questionnaire filled by them at the end of their study period of the master's program. We used a six grades' scale: "Strongly agree" (6), "Somewhat agree" (5), "Agree" (4), "Disagree" (3), "Somewhat disagree" (2), and "Strongly disagree" (1). A total of 113 candidates responded to the ICT self-evaluation questionnaire out of the total number of 125 graduating candidates, a response rate of 90.4%.

2.4. Telemedicine Program Implementation. At the start, all of the 207 trainees were provided with computer laptops with an in-built camera for telemedicine and training purposes; they were also provided with free internet service; all was paid by Gezira state government. Two telemedicine studios were established and equipped with computers, LCD screens, cameras, microphones, Internet, and telephone lines.

The software program ooVoo [14] was used to connect family doctors (together with the patient) at the health centers all over Gezira state with the specialists at the GFMP headquarter in Madani town (capital of the state). They communicated by means of voice, picture, and chatting in a videoconference-like setting, allowing the family doctor to show the specialist some clinical signs on the patient such as skin manifestations or some investigations like ECG. A weekly scheduled program was set for specialist doctors in telemedicine activities, provided to the candidates so that they could communicate with the needed specialist at the scheduled times.

2.5. Electronic Medical Records' Implementation. Before the start of the GFMP, there were few health centers in Gezira state that were not using medical records at all, even as paper notes. GFMP developed a specially designed electronic medical record program called Family Clinic. The program copes with local needs and includes the ICD10 classification of diseases.

2.6. E-Learning Implementation. The same studios used for telemedicine were also used for educational activities. Cisco-WebEx software [15] was installed in the computers of the candidates and at the studios; it is used to connect all candidates with the lecturer. Candidates could see, hear, and interact with the lecturer who could share his desktop screen with

the candidates to show them pictures, slide presentations, videos, or text documents. Full interaction through online discussions between the candidates and the lecturer was possible. Any trainee could also take the "host" role and present a tutorial or other activity to the other trainees and the lecturer. It was also possible to download the online activities later from the website of the GFMP; some candidates preferred to attend the lectures on portable devices, especially when there were problems with internet connectivity.

2.7. Statistical Analyses. The IBM SPSS program version 21 (supplier: IBM corp., Armonk, NY, USA) was used for data management and statistical analyses. Results are presented as descriptive statistics with means, proportions, and percentages.

2.8. Ethical and Privacy Approvals. The study was reviewed and approved by the Ethical Review Committee at the Ministry of Health, Gezira state, Sudan. The study proposal was also approved by the Regional Committee for Medical and Health Research Ethics, Western Norway. Privacy issues and patients' file management related to the scientific evaluation were also approved by the Norwegian Data Protection Official for Research.

3. Results

3.1. Telemedicine. The telemedicine activity at the GFMP started on April 1, 2011, almost six months after the start of the program. A total of 3808 telemedicine consultations have been registered in the period from April 1, 2011, to December 31, 2012. The monthly distribution of consultations is shown in Figure 1. The mean number of consultations per month was 181, with a slight monthly increase during the first year, reaching its maximum of 299 consultations in March 2012; this was followed by a large decrease to a minimum of zero consultations in September 2012 (due to internet disconnection), followed again by an increase reaching its maximum of 309 consultations in December 2012.

The majority of the consultations (N = 2763, 74%) were held by female doctors (mean 31 consultations per female doctor), compared with 8 per male doctor. Almost one-third of the consultations were related to the discipline of internal medicine (32.6%) followed by paediatrics (21.8%). Male doctors used to have more consultations in obstetrics and gynaecology, surgery, and ENT, while female doctors used to consult specialists in ophthalmology, dermatology, and internal medicine in a higher proportion than men (Figure 2).

The vast majority of telemedicine consultations were done by doctors working in Madani locality (2234 consultations, mean 35 per doctor), followed by El-Kamlin locality (469 consultations, mean 19 per doctor). Least consultations were registered from East-Gezira locality (55 consultations, mean 3 per doctor).

3.1.1. Trainees' Evaluation of the Use of Telemedicine. Findings from the candidates' evaluation of the use of telemedicine are shown in Table 1. All respondents agreed to varying degrees on the high importance of telemedicine to their patients' care.
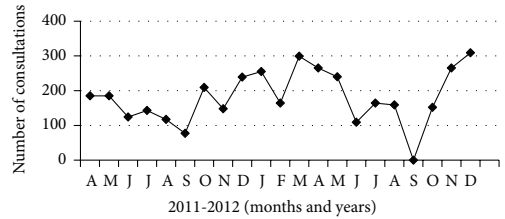

Figure 1: Monthly distribution of consultations (N = 3808) from April 1, 2011, to December 31, 2012.
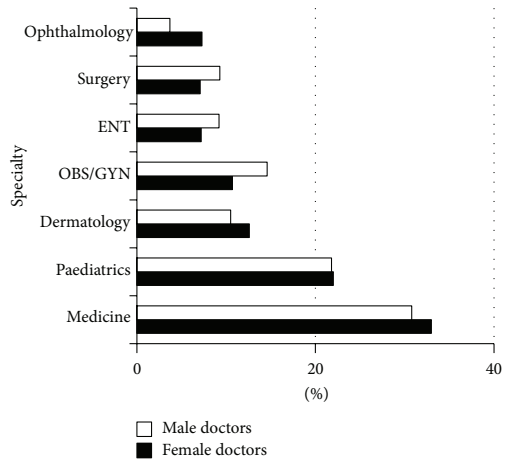

Figure 2: Distribution (%) of telemedicine consultations by specialty and doctor's gender (N = 3749). ENT: ear, nose, and throat; Obs/Gyn: obstetrics and gynaecology.

They also agreed that it was a good training method for them. The vast majority (89%) agreed that patients were satisfied with telemedicine. The majority (81%) usually preferred taking telemedicine consultations with the patient being in the office. However, almost one-fifth of the candidates agreed (in varying grades) that patients might lose the confidence in their family doctors if telemedicine consultations were used. In general, males demonstrated more positive attitude, compared with females, regarding several aspects of telemedicine, although this was not statistically significant (Table 1).

3.2. Electronic Medical Records (EMRs). A total of 165993 new patients' EMRs were created by the study subjects, 125 candidates, mean of 1328 files per doctor (maximum 5470, minimum 104, and median 1178). The mean number of files opened by male doctors was 1413 (N: 49 male doctors), while the mean for female doctors was 1273 (N: 76 female doctors).

3.2.1. Trainees' Evaluation of the Use of Electronic Medical Records, EMRs. Almost two-thirds of the respondents strongly agreed that EMR is important for the care of their

Table 1: Doctors' evaluation of the ICT tools used at the GFMP (using Chi square test) ($n = 113$).

Statement text	Distribution (%) of doctors' evaluation						Mean values			P
	Strongly agree (6)	Somewhat agree (5)	Agree (4)	Disagree (3)	Somewhat disagree (2)	Strongly disagree (1)	Total	Male	Female	
Telemedicine										
(1) Telemedicine is of high benefit for my patients	62.8	11.5	25.7	0	0	0	5.37	5.43	5.31	0.839
(2) It is a good teaching tool for family doctors	63.4	6.2	29.5	0.9	0	0	5.32	5.41	5.26	0.714
(3) I use it usually when the patient is in my office	25.2	15.3	40.5	14.4	0.9	3.6	4.39	4.41	4.37	0.924
(4) My patients are usually satisfied with telemedicine	28.2	20.9	40.0	6.4	0.9	3.6	4.58	4.74	4.48	0.571
(5) The patients miss the confidence on family doctor when telemedicine is used	6.4	6.4	7.3	48.6	5.5	25.7	2.83	2.95	2.74	0.516
Electronical medical records (EMR)										
(1) The EMR system is highly important for my practice	65.2	4.5	27.7	0.9	0	1.8	5.29	5.40	5.22	0.365
(2) The patients are not happy when I write on the computer during consultation	18.6	16.8	38.1	14.2	3.5	8.8	4.06	4.05	4.07	0.559
(3) I register all my patients on the EMR	27.0	18.9	26.1	18.9	8.1	0.9	4.35	4.47	4.28	0.695
E-learning										
(1) Online lectures are a good teaching method	40.5	15.3	35.1	5.4	2.7	0.9	4.83	5.23	4.57	0.072
(2) It was easy to combine the work with the training activities	23.2	11.6	36.6	16.1	4.5	8.0	4.09	4.45	3.85	0.070

patients, while a third agreed or somewhat agreed. On the other hand a fifth strongly agreed, and more than a half agreed or somewhat agreed that patients are not happy when the family doctor was using a computer during consultation. The majority of respondents stated that they register all or most of their patients in EMRs. Males reported a more positive attitude (statistically not significant) than females regarding the use of the EMR (Table 1).

3.3. E-Learning. Administrative data showed that 240 online lectures and 29 meetings were organized using the software program Cisco-WebEx in the period from May 2011 to October 2012. Family medicine constituted almost 38% of the presented lectures (*n*: 90), internal medicine 23% (*n*: 55), paediatrics 15% (*n*: 37), obstetrics and gynaecology 8% (*n*: 19), and surgery 8% (*n*: 18), and the rest was distributed between other medical disciplines.

3.3.1. Trainees' Evaluation of the Use of E-Learning. Almost two-fifths of the respondents "strongly agreed" that online lecture was a good teaching method. One-half of the candidates either "agreed" or "somewhat agreed," while 9% "disagreed," "somewhat disagreed," or "strongly disagreed" (Table 1). There was a large variation in the evaluation of the candidates regarding the easiness of combining work with the training activities; 28.6% reported degrees of disagreement, while 71.4% reported degrees of agreement. The difference between males and females is more prominent in the e-learning component although it did not reach statistical significance level ($P = 0.072$ and $P = 0.070$); thus males had a tendency of more positive attitude to the utilization of e-learning.

4. Discussion

A successful integrated utilization of ICT at the GFMP in Sudan is shown in this study. A high number of telemedicine consultations were achieved, with high satisfaction among the candidates. EMRs were introduced in this area for the first time, and more than 165,000 patient files were opened in a period of two years, reflecting a great need for such innovative solutions in primary care settings in developing countries. Using ICT at the GFMP has also contributed to universal health coverage and partially reduced the problem of brain drain which is a recognized challenge in developing countries [16]. GFMP recruited 207 doctors to work at primary health care facilities, where 84 health centers had never been served by a physician before [4]. This finding is in agreement with that of a study from Mali (2012) which reflected the positive significant influence of ICT on the recruitment and retention of health care professionals [17].

This successful use of telemedicine activity follows a global trend of positive experience in using telemedicine [18], which is also documented in developing countries [19–21]. A survey from the WHO in 2014 revealed encouraging findings in many countries regarding e-health and innovation in women's and children's health [22].

The monthly variation in the number of telemedicine consultations represents the expected challenges facing ICT implementation, including technical problems, academic obligations (exam periods), and sometimes economic constrains where the project was unable to afford internet fees. Discipline based variation in telemedicine utilization was prominent; this can be due to the spectrum of common diseases in the area. Telemedicine activity was not used in emergency cases at the GFMP, in contrast to other experiences where telemedicine has been used only in emergency and disaster settings [23]. The candidates were highly satisfied with telemedicine and found it as an effective pathway to communicate quickly and effectively with the physicians working in second-line care.

The huge number of electronic records establishes a data pool that is suitable for research as well as for patients' care. The variation in the number of registered patients between physicians could mainly be attributed to the size of population in the catchment area, in addition to the activity of each health center. The physicians' high activity in using the EMR system was influenced by the Workplace Based Assessment (WBA) method of evaluation in their Family Medicine Master's exam; both the quantity (number of files) opened by the candidate and the quality (comprehensiveness) of the files were evaluated in the exam. A systematic review of the impact of WBA on doctors' education and performance showed positive performance changes [24]. Physician's attitude towards the use of computer during consultation provided similar results to a study done in the United Arab Emirate (UAE), where concerns including effectiveness of patients' communication were also highlighted [25]. Other studies assessing patients' satisfaction with the use of computers during consultation revealed general satisfaction [26–28].

E-learning was used at the GFMP in a blended way, including both face to face teaching and e-learning. A review article compared the use of blended e-learning methods with the traditional approaches in medical education in resource constrained countries. It revealed either better-promising results or no statistically significant differences between the two approaches in the majority of studies [9]. A study from Iran comparing the effect of lecture and blended teaching methods on students' learning and satisfaction showed higher satisfaction among students using blended method [29].

Study Limitations. Several limitations should be recognized. Firstly, reduction of the number of enrolled candidates (207 to 125) within the 2-year training period, due to brain drain to rich countries. Secondly, information on patients' perception on the use of the EMR and telemedicine utilization during consultation was obtained from the study subjects (family physicians), instead of the patients themselves. This study collected physicians' perceptions about patients' feelings generally, not at an individual patient's basis. Finally, social desirability bias of self-administered questionnaires was reduced by blinding the name of the participants. In addition, administrative data reflects the real practice and could approve or disapprove the physicians' perception. In this case the high use of ICT tools was in harmony with the high satisfaction reported by the participants.

5. Conclusion and Recommendations

GFMP's experience in utilizing ICT in a comprehensive way, including telemedicine, EMRs, and e-learning, is rather unique in a developing low-resource country setting. Results from this study show how ICT implementation in primary care can participate in achieving important health care goals like universal coverage, accessibility, decreasing brain drainage, and increasing the training's capacity in the health sector. Although the project was politically and financially supported on a national level, the successful implementation was not without barriers and challenges, such as internet coverage and technical problems. The issue of sustainability deserves to be considered and further research is needed to explore the impact of using ICT on health indicators in the project.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Authors' Contribution

All the authors (K. G. Mohamed, S. Hunskaar, S. H. Abdel-rahman, and E. M. Malik) have contributed in the design and conception of this study; they have revised it critically and have given final approval for the paper to be printed. K. G. Mohamed and S. Hunskaar have contributed in data collection, interpretation, and analysis; K. G. Mohamed drafted the first draft while the other authors revised it critically and gave ideas. This paper has been read and approved by all the authors, all of them fulfill the requirements for authorship, and each author believes that the paper represents honest work.

Acknowledgments

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III

Research Article

Confidence in Procedural Skills before and after a Two-Year Master's Programme in Family Medicine in Gezira State, Sudan

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Many postgraduate family medicine training programmes have been developed to meet the worldwide dire need for practicing family physicians. This study was conducted in Gezira state of Sudan in a "before-and-after" design in the period of 2010–2012 with the aim to assess improvements in candidates' confidence in performing certain clinical skills. A self-evaluation questionnaire was used with a five-grade scale (1–5) to assess candidates' confidence in performing 46 clinical skills. A group of 108 participants responded for both the "before" and the "after" questionnaire: the response rate was 91% (before) and 90% (after). In general, a positive progress trend was detected. The mean skill value for all skills was 3.23 (before) and 3.93 (after) with a mean increase of 21.7% ($P < 0.001$). Male students scored constantly higher than females both before and after completing the master's programme, while females showed a higher percentage in progress. Scores in certain medical disciplines were higher than others. However, disciplines with low scores in the beginning, such as psychiatry and ophthalmology, showed the highest progress percentage. The results show a significant increase in confidence in performing procedural skills designed in the curriculum of the GFMP master's programme.

1. Introduction

Clinical skills represent a major and important part in family medicine practice. Family physicians should master a variety of clinical competencies and should be prepared to work in rural areas without easy access to specialist services or advanced technology. Quality control of postgraduate family medicine training programmes should facilitate the physicians' role and ensure patient's safety. During and after training, it is important to assess the training outcome either objectively (trainee's competence) or subjectively (confidence) individually or as part of the outcome evaluation of family medicine training programmes. The accelerated rate of growth in medical knowledge represents a challenge in medical education [1, 2]. The inculcation and assessment of clinical skills are an important issue that needs more attention. Additional research is needed in the medical educational context, particularly in view of the continuous reformations of the medical curricula [3, 4].

There are several theories, models, and teaching strategies when it comes to the teaching and learning of clinical skills. Miller's pyramid [5], as well as its steps, "know," "know how," "show how," and "do," is simple and is widely used. Bloom's taxonomy including the cognitive, affective, and psychomotor domains has been historically used to classify and formulate the educational learning's objectives. It arranges the educational objectives in a hierarchy from less to more complex [6, 7]. The Dreyfus model of skills acquisition [8] is generally accepted in the clinical field with some modifications [9, 10]. It is widely used to describe developmental phases of skills acquisition, starting from the "novice" and "advanced beginner" to "competent" and "proficient" and ending as an "expert."

There is only a small amount of literature on teaching and learning clinical skills and procedures in the field of family medicine related to such models and theories. Most curricula and programmes include lists of skills and procedures to be acquired by the students; evaluation studies of the results of such teaching strategies are scarce [11, 12]. Some institutions have published their lists of skills [13, 14]; however, competency in all domains is somewhat context-dependent, and economy, geography, disease spectrum, and epidemiology may play a role in selecting targeted skills.

In countries with advanced healthcare systems, strengthening of the system by qualified, well-trained family physicians leads to higher quality of healthcare services, more patient satisfaction, and better clinical outcomes [15]. In developing countries, various family medicine training programmes are established to fill the huge gap and to satisfy the need for skilled, qualified family physicians [16, 17]. Although family medicine specialization has been only recently emerging in Africa, research has shown that the role of skilled family physicians has been recognized by the African governmental and academic leaders as a positive asset [18, 19].

According to international reports, about 90% of the clinical situations at the community level are expected to be solved by family physicians at the primary care level [13, 20]. However, an extended list of skills may be required from African family physicians compared to areas with more developed clinical settings [21]. This is likely due to the contexts where African family physician practices, with more responsibilities, inadequate resources in healthcare facilities, long distances, and a poor referral and communication system with secondary hospitals. A WONCA consensus report on family medicine in Africa stated that the family physician must have a comprehensive set of skills which must be adapted to the local needs and resources [22].

The Gezira Family Medicine Project (GFMP), established in 2010 by the University of Gezira and the Gezira State Ministry of Health, Sudan, organized a two years' in-service master's programme in family medicine for medical doctors [23]. While the theoretical part of the curriculum was mainly provided as online lectures and seminars, practical clinical skills were mainly taught one day per week "at hospital training" and through the ongoing practice in the health centres. The GFMP model was described as "an inspiring example of family medicine training programme in Africa" in a consensus document of participants from 25 counties at the fifth annual PRIMAFAMED (Primary Care and Family Medicine Education Network) conference held in Victoria Falls, Zimbabwe, in 2012 [17]. The first batch of students of GFMP was included in an evaluation programme [23, 24] that also aimed to measure the training outcome, including confidence in the targeted clinical skills.

The aim of this paper is thus to assess in a "before-and-after" design the candidates' self-assessed confidence in performing both cognitive and psychomotor clinical skills included in the GFMP curriculum. In this study, clinical skills are defined as manual procedures and intellectual skills used in physical examination, history taking, diagnosis, and management. The study also evaluates demographic factors such as gender and age which affect confidence in clinical skills performance. It also compares the candidates' confidence and development in performing skills from different clinical disciplines.

2. Methods

2.1. Study Area. Gezira state lies mainly between the Blue Nile and the White Nile, in the central part of Sudan, south of Khartoum. It has a population of about 3.7 millions, relying mostly on agriculture and grazing; people reside mainly in about three thousand scattered small rural villages. Tropical diseases like malaria and bilharzias are endemic [25]. Noncommunicable diseases (NCDs) are following the regional emerging trend [25, 26], increasing the responsibility of an already weak healthcare system and sharing resources with traditional diseases.

The health system is composed of "healthcare centres" as the first line of primary care. Heath centres that differ in size and function are mainly served by nurses, "medical assistants," and doctors (medical officers). "Rural hospitals," the referral point from health centres, are led by medical officers. Many such hospitals have operating theatres and wards for inpatient care. Secondary care hospitals are found in cities and are served by specialist doctors. Tertiary care hospitals in Medani (state capital) represent the end referral point for the entire state and sometimes from neighbouring states. The secondary and tertiary hospitals are overburdened with patients who could have been managed at the primary care level, reflecting the need for qualified trained family physicians capable of providing higher-quality services with higher accessibility to the population.

2.2. The Gezira Family Medicine Project (GFMP). Gezira state of Sudan had 115 medical officers (graduated doctors without postgraduate training) and no family medicine specialist at the start of 2010, reflecting a ratio of primary healthcare doctors to population of about 1 : 32,000. To bridge this huge gap, the Gezira Family Medicine Project (GFMP) was planned [23]. The GFMP master's curriculum was developed at the Faculty of Medicine, University of Gezira, by a committee including family physicians and representatives from the other disciplines (departments); national family medicine experts from other universities were also invited. The content of the curriculum took into consideration the national, regional, and international guidelines and principles of family medicine training. The compatibility of the future family physician with the health system and the locally needed set of skills was also considered.

The trainees of the GFMP were allocated to the health centres in both urban and rural areas. The GFMP curriculum aimed to train them to present both curative and preventive care in a continuous comprehensive manner. An "in-service" training programme is used at the GFMP. One day per week, the candidates visited one of the three major hospitals in Gezira (according to their location). Here, the candidates participated in clinical rounds, outpatient clinics, referral clinics, theatre, and so forth. One major objective for this activity was to learn the clinical and procedural skills required

by the curriculum. Training methods used in the GFMP are described in detail in Table 2 in a previous paper [23].

It was decided that the curriculum should not include major surgical and obstetrical procedures like appendectomy, caesarean section, or management of ectopic pregnancy, as they are not part of GPs' clinical responsibilities in Gezira. These and other conditions needing major surgical intervention are referred to the nearby rural hospital and secondary or tertiary hospitals where relevant specialists in these disciplines or GPs with special training in such procedures are available.

Clinical manual procedures to be performed by the candidate were separately provided in a logbook that was distributed to all candidates at the start of the master's programme. The logbook is divided into sections according to the planned clinical rotations and includes a variety of clinical and practical skills. Teaching staff (hospital physicians) used to sign the candidates' logbooks, as part of their ongoing supervision; this normally occurs at their scheduled weekly hospital-based training. The signing attests to the skills the candidates observed or performed. Some skills needed to be signed more than once to confirm a higher level of competency. The logbook was recognized as a prerequisite to enter the final exam that included an essay, MCQs, and short and long OSCE cases. In addition to the hospital-based training, candidates also acquired clinical skills from their colleagues in the same health centre or through online communication with colleagues in other centres. Telemedicine communication with university professors was also used to support skills' development [24].

2.3. Study Population and Study Design.

A before-and-after design is used in this study. Data for the study was collected at the start of the master's programme in November 2010 and after two years (at the end of the study period, just before the exam). The "before" data collection targeted 207 candidates (total number enrolled in the first batch of candidates in GFMP); 188 of them responded (91% response rate). The "after" data collection targeted 125 candidates who were still affiliated with the master's programme at its end in 2013; 113 of them responded (90% response rate). When we compared the same respondents "before and after," only candidates who responded both "before" and "after" were included (108 candidates); candidates who did not respond to either the "before" or the "after" questionnaire were excluded in this comparison. The 108 respondents did not always answer all skill questions in both questionnaires; the range of the number of candidates responding to an individual skill was 82–108 candidates with a mean of 100 candidates; this could be automatically recognized by SPSS programme when using paired t-test to compare the two sets of responses.

2.4. Data Collection.

The designed questionnaire for this study included a selected list of 46 clinical skills (shown in Table 1). The selected skills were from all medical disciplines included in the curriculum (medicine, surgery, obstetrics, etc.); they were also different in their level of difficulty. Certain skills, including some major surgical skills, were included in the questionnaire, although they were not a part of the curriculum. That was meant to assess if the candidates gained a lot of such skills at the end of the training programme, which indicates a deviation from the targeted learning objectives.

A five-grade scale was used, starting from "very confident," followed by "confident," "not fully confident," "uncertain," and finally "not able" to perform the skill. Consequently, the candidates were assigned values of 5, 4, 3, 2, or 1. The questionnaire was anonymous but had an identifiable code. Data collection was done at the start of the programme and after the two-year study period for the purpose of evaluating the candidates' progress.

Four other skills related to patient-education were assessed in the questionnaire: the use of insulin by diabetics, breast self-examination in women, smoking cessation, and feeding of malnourished children. A three-grade scale consisting of "yes," "sometimes," and "no" was adopted.

2.5. Statistical Analyses.

Data were managed and statistically analysed using the SPSS® programme version 21. Results are presented as descriptive statistics with means, proportions, and percentages.

Regression analyses were performed to analyse whether personal background factors (age and gender), institutional factors (university graduation and locality), personal interest in family medicine, or clinical activity (reflected by number of electronic patient files opened by the candidate) affected the change in candidates' self-evaluation of own competence in clinical skills due to the master's programme.

Three different approaches were used for the analyses, all shown in Results. Firstly, to get the difference, we have simply subtracted the given skills' value before the master programme from the value chosen after the master program. Secondly, to remove the effect of initial scores, we computed residualized or regressed change scores. The procedure identifies cases where a person has changed more than would have been expected, based on the initial score. Regression analysis then is used to estimate (or predict) skill scores after the master's programme on basis of the correlation of skill scores after and before the programme. The predicted scores are then subtracted from the actual "after" scores. The remaining is the residual gain score, which means the amount of gain that is not due to the influence of the initial score. Thirdly, we calculated the amount of change as a percentage change. This was done by subtracting the "before" skill score from the "after" score, dividing the answer by the "before" score, and multiplying with 100 to convert this into ordinary percentage.

2.6. Ethical and Privacy Approvals.

The ethical review committee at the Ministry of Health, Gezira state of Sudan, reviewed and approved the study on 8 March 2011. The study proposal was also approved by the Regional Committee for Medical and Health Research Ethics, Western Norway. The Norwegian Data Protection Official for Research also approved the privacy issues and patients' file management related to the scientific evaluation.

3. Results

For our study, a total of 108 candidates responded to the evaluation questionnaires both before and after the master's training programme; 46 (43%) of them were males, while 62 (57%) were females. This gender distribution is almost the reverse of the distribution recognized at the start of the master's programme (males: 57%; females: 43%). The total mean age at the start was 32.7 years; for males the mean age was 35.4 years (range: 25–59), while for females it was 30.7 years (range: 24–47).

Table 1 shows self-evaluation in performing selected clinical skills (N = 46 skills) categorized in disciplines. Results are shown as means, changes in mean, and P values. Scale values started from 5, "highest confidence," to 1, "least confidence," for each skill (N = 108 candidates). Large variation in candidates' self-evaluation performance is detected at the start of the programme, "before," with a range of 1.72 to 4.78. Skills like measurement of blood pressure and abscess drainage scored highest at the start, "before," while skills like cholesteatoma operation and eye fundoscopy got the lowest scores. Variation between the various medical disciplines ranged from 3.9 (minor surgery) to 2.33 (psychiatry). The total mean scoring for all skills was 3.23 at the start of the training programme.

Evaluation after the master's programme showed higher values in all 46 skills. Also it followed the same trend in individual skills variation and interdisciplinary variation. The increase was statistically significant for all skills except for tonsillitis management and uterine evacuation after abortion. The mean skill value after the programme for all skills was 3.93 with a mean difference of 0.70 from the "before" value, which represents a statistically significant difference (P < 0.001) with a progress percentage of 21.7%.

The mean skill value change had a range of 0.09–1.61. The most positive mean value change was recognized in skills like measuring visual acuity and management of major depression, while the least mean value change was recognized in skills like tonsillitis management and blood pressure measuring. The range of recorded confidence levels was from 1 to 5 (all categories used) for all skills and procedures, except four.

The 10 skills with lowest scores increased from 2.20 to 3.28, an increase of 49%, compared with a 22% increase for all skills. Among the 11 skills with lowest score change, 8 had a start level of more than 4.0 and the other 3 were major surgical procedures (Caesarean section, abortion, and appendectomy).

Table 1 also shows the mean scoring for the candidates in the different clinical disciplines. Candidates scored highest values in minor surgical skills and internal medicine both before and after the master's programme; however, the mean change value was highest in ophthalmology and psychiatry skills.

Table 2 shows the number of candidates who had least scoring ("unable" or "uncertain") on performance of clinical skills before the programme and the change obtained during the training period. Skills with highest progress percentage are included (N = 23); the sequence is according to the progress percentage (N = 108). The change percentage
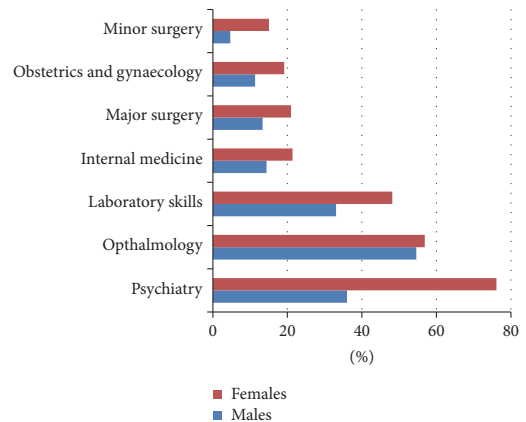

FIGURE 1: Gender variation in relative competency change in clinical disciplines among master's programme candidates of GFMP, Gezira state, Sudan (N = 108, 46 males and 62 females).

represents the percentage of candidates who left this group of least scoring; the change was highest in skills like visual acuity measuring, ECG interpretation, and management of major depression.

The number of candidates decreased through the course of the master's programme from 207 at start to 125 at the end. The number of respondents to the first questionnaire amounted to 188 candidates. At the end of the master's programme, 108 candidates of the original 188 candidates (and of the 125 remaining) responded to the second questionnaire. To assess if there was a difference between the two groups on the baseline, we compared the group of 188 candidates who represent all respondents to the first questionnaire with the group of respondents who answered the second questionnaire (108 respondents) at the start of the programme. A total mean difference of 0.04 was observed between the two groups in all skills at the start of the programme. Although the difference is statistically significant (P < 0.001), it represents only a 1.2% difference in percentage compared with the difference between "before" (N = 108) and "after" (N = 108), which was 0.70, representing a 21.7% difference.

The candidates' competency to conduct certain patient-educational skills is shown in Table 3. Improvement in teaching mothers how to feed their malnourished children is represented by the highest mean value; however, there were statistically significant positive changes in all four assessed skills (P < 0.001).

Table 4 shows discipline-based, intergender variation. Males have constantly higher value in self-evaluation compared with females in all clinical disciplines both before and after assessment. The difference was statistically significant in all disciplines before the master's programme except for ophthalmology, whereas after the master's programme, the difference was not significant in internal medicine, laboratory skills, and ophthalmology.

Figure 1 reflects the percentage change after the master's programme in medical disciplines (surgery, medicine, etc.)

Table 1: Self-assessment in performing 46 clinical skills before and after the GFMP, Gezira state, Sudan ($N = 108$). Numbers represent means for each skill. Change is the absolute difference between the "after" result and the "before" result. Ratio is the relative change calculated by the "after" result divided by the "before" result.

Clinical skills categorized in disciplines	Before	After	Change	Ratio	P value
Internal medicine	**3.56**	**4.24**	**0.68**	1.19	**<0.001**
ECG interpretation	2.54	3.83	1.29	1.51	<0.001
ECG taking	2.28	3.45	1.17	1.51	<0.001
Management of myocardial infarction	3.49	4.30	0.81	1.23	<0.001
Management of diabetic coma	3.76	4.38	0.62	1.16	<0.001
Cardiopulmonary resuscitation	3.50	4.11	0.61	1.17	<0.001
Insulin treatment in hyperglycaemia	3.92	4.47	0.55	1.14	<0.001
Inhaler technique	3.98	4.51	0.53	1.13	<0.001
Management of tuberculosis	3.63	4.08	0.45	1.12	0.012
Venipuncture and drip start	4.26	4.63	0.37	1.08	0.003
Management of asthma	4.25	4.60	0.35	1.08	<0.001
Laboratory skills	**2.62**	**3.70**	**1.08**	1.41	**<0.001**
Glucose measuring	2.42	3.75	1.33	1.55	<0.001
Urine analysis	2.30	3.47	1.17	1.51	<0.001
Haemoglobin measuring	2.79	3.86	1.07	1.38	<0.001
Blood film for malaria	2.98	3.75	0.77	1.26	<0.001
Obstetrics and gynaecology	**3.32**	**3.84**	**0.52**	1.16	**<0.001**
IUCD insertion	2.56	3.54	0.98	1.38	<0.001
Taking cervical smear	2.73	3.59	0.86	1.32	<0.001
Normal delivery	3.51	4.02	0.51	1.20	<0.001
Acute vaginal bleeding	3.44	3.84	0.40	1.12	0.018
Vaginal examination	4.10	4.43	0.33	1.08	0.012
Caesarean section	3.06	3.39	0.33	1.11	0.004
Evacuation after abortion	3.86	4.07	0.21	1.05	0.072
Minor surgery	**3.90**	**4.30**	**0.40**	1.10	**<0.001**
Plaster of minor fractures	3.21	3.80	0.59	1.18	<0.001
Management of urinary retention	3.70	4.18	0.48	1.13	<0.001
Urethral catheterization	4.13	4.49	0.36	1.09	<0.001
Suturing of wounds	4.47	4.65	0.18	1.04	0.010
Abscess drainage	4.38	4.54	0.16	1.04	0.038
Stopping epistaxis	3.51	4.14	0.63	1.18	<0.001
Major surgery	**2.56**	**3.07**	**0.51**	1.20	**<0.001**
Acute abdomen operation	2.11	2.76	0.65	1.31	<0.001
Appendectomy operation	3.01	3.38	0.37	1.12	0.003
Ophthalmology	**2.34**	**3.68**	**1.34**	1.57	**<0.001**
Visual acuity	2.64	4.25	1.61	1.61	<0.001
Eye fundoscopy	2.08	3.51	1.43	1.69	<0.001
Removal of foreign body from the eye	2.51	3.73	1.22	1.49	<0.001
Management of iridocyclitis	2.14	3.21	1.07	1.50	<0.001
Psychiatry	**2.33**	**3.63**	**1.30**	1.56	**<0.001**
Management of major depression	2.16	3.61	1.45	1.67	<0.001
Acute psychosis	2.49	3.65	1.16	1.47	<0.001
Other skills					
Diagnosis of hearing loss	2.71	3.78	1.07	1.39	<0.001
Tonsillitis	4.37	4.46	0.09	1.02	0.546
Chest X-ray in infections	3.20	4.09	0.89	1.28	<0.001
X-ray interpretation in trauma	3.26	4.04	0.78	1.24	<0.001
Cholesteatoma operation	1.72	2.48	0.76	1.44	<0.001
Thoracal drainage	2.28	2.93	0.65	1.29	<0.001

Table 1: Continued.

Clinical skills categorized in disciplines	Before	After	Change	Ratio	P value
Insertion of nasogastric tube	3.87	4.35	0.48	1.17	<0.001
Knee examination	3.90	4.32	0.42	1.11	<0.001
Malnutrition in children	3.99	4.41	0.42	1.11	<0.001
Stabilization of major fractures	2.71	3.24	0.53	1.20	<0.001
Measuring blood pressure	4.78	4.88	0.10	1.02	0.048
Total for all skills (mean)	**3.23**	**3.93**	**0.70**	1.22	**<0.001**

Table 2: Changes in the numbers and percentages of the master's programme candidates who were "unable" or "uncertain" when performing certain skills before and after the GFMP, Gezira state, Sudan ($N = 108$).

Sequence by change percentage	Skills	Unable or uncertain			
		Before (n)	After (n)	Change (n)	Change (%)
(1)	Visual acuity	46	3	43	93
(2)	ECG interpretation	41	5	36	88
(3)	Management of major depression	64	13	51	80
(4)	ECG taking	61	13	48	79
(5)	Glucose measurement	57	13	44	77
(6)	Eye fundoscopy	68	16	52	76
(7)	Acute psychosis	48	12	36	75
(8)	Haemoglobin measurement	44	11	33	75
(9)	Cardiopulmonary resuscitation	20	5	15	75
(10)	Diagnosis of hearing loss	38	10	28	73
(11)	Eye foreign body removal	53	14	39	74
(12)	Chest X-ray in infections	25	7	18	72
(13)	Urine analysis	59	18	41	69
(14)	Taking cervical smear	41	14	27	65
(15)	IUCD insertion	51	18	33	65
(16)	Blood film for malaria	32	13	19	59
(17)	Management of iridocyclitis	61	30	31	51
(18)	Caesarean section operation	25	14	11	44
(19)	Appendectomy operation	31	19	12	39
(20)	Acute abdomen operation	63	40	23	37
(21)	Stabilization of major fractures	39	25	14	36
(22)	Thoracal drainage	52	35	17	33
(23)	Cholesteatoma operation	75	52	23	31

in relation to gender. Females showed higher score change in all skills compared with males. Such change was most prominent in psychiatry. Least development for both genders was in scores for minor surgery followed by obstetrics and gynaecology.

3.1. Regression Analyses for Explanatory Factors in Change of Skills Level. None of the three chosen approaches for analysing the change variable gave an overall statistically significant model (Table 5). The coefficients of determination (R^2) were almost identical in the three analyses. However, we identified two single significant results. The doctors' interest in family medicine speciality after the master's programme turned out to have a positive and significant effect when residual gain score was used; that was performed while all other variables were controlled for in the analysis. The interpretation of the B coefficient is that one value increase

on the doctors' interest increases the gain score by 0.21. When change was measured as percentage, gender had a significant (positive) effect, indicating that female doctors changed 12.4% more than male doctors; that was performed while all other variables were controlled for in the analysis.

4. Discussion

The trainees themselves perceived general progress in clinical skills competencies, according to their self-evaluation feedback. Interdisciplinary and gender variations were detected. The interdisciplinary variation in candidates' baseline skills (before the master's programme) can be attributed to the inadequacies in some undergraduate curriculum designs, which include giving relatively low weight to certain disciplines like psychiatry and ophthalmology. These disciplines scored least in the baseline and showed the highest positive

TABLE 3: GFMP candidates' self-assessment of competences in certain patient-educational skills before and after the master's programme ($N = 108$) (scale: "yes" = 2, "sometime" = 1, and "no" = 0).

Patient-educational skill	Before (n)					After (n)					Change of mean value	P value
	Yes	Sometimes	No	Missing	Mean value	Yes	Sometimes	No	Missing	Mean value		
Teaching diabetic patients how to use insulin	45	41	20	2	1.24	69	35	3	1	1.62	0.38	<0.001
Teaching women breast self-examination	31	35	39	3	0.92	59	40	9	0	1.46	0.54	<0.001
Discussing smoking cessation with patients	56	36	12	4	1.42	81	24	3	0	1.72	0.30	<0.001
Teaching mothers how to feed malnourished children	82	16	8	2	1.70	96	10	2	0	1.87	0.17	0.009

TABLE 4: Gender variation in self-assessed competences in discipline-based groups of skills among master's programme's candidates at the GFMP, Gezira state, Sudan (N = 108, 46 males and 62 females).

Group of skills	Before			After		
	Male	Female	*P* value	Male	Female	*P* value
Internal medicine	3.79	3.41	0.006	4.33	4.14	0.075
Laboratory skills	2.89	2.43	0.043	3.85	3.60	0.193
Minor surgery	4.24	3.62	<0.001	4.44	4.17	0.031
Major surgery	3.01	2.27	<0.001	3.41	2.74	0.001
Ophthalmology	2.47	2.27	0.243	3.82	3.56	0.110
Obstetrics and gynaecology	3.66	3.07	<0.001	4.07	3.67	0.002
Psychiatry	2.86	1.95	<0.001	3.89	3.44	0.014
All skills	3.52	3.02	<0.001	4.09	3.80	0.006

change in percentage development after the master's programme. The in-service model of training could have been attributed to the outcome competency variations, giving a higher chance for competencies related to the candidates' clinical practice. In certain skills and disciplines, candidates have evaluated themselves so high in the baseline that there was not much room for further progress; examples include management of tonsillitis and postabortion evacuation, which showed no statistically significant change after the master's programme. However, this effect was controlled using regression analysis, and the lack of change was confirmed.

Male trainees evaluated their own skills as being better than those of females both before and after the master's programme. This trend is also recognized in other studies in different settings, where males show higher confidence in their own competencies [27]. On the other hand, female trainees could potentially show a higher progress percentage in all disciplines. However, this does not necessarily imply that females objectively gained more skills, since baseline self-evaluation by males could have affected males' progress percentage. Why males show higher confidence in self-evaluation in this study and other studies is not clear and needs further specific clarification. Nevertheless, one may speculate from this and other studies that males rate their confidence as higher than females for the same level of competence.

The positive progress in the patient education competencies reflects the role of the GFMP master's curriculum in adding the value of health promotion and preventive care to the medical practice of the trainees. This is an integral indicator of successful implementation of family medicine principles.

We performed three different regression analyses based on different measures of change; there are problems associated with all of them. The results by raw score or percentage of change show whether the persons have improved or not. However, persons having extreme scores initially (low or high) are met by ceiling or floor effects. Those with previous low scores have higher chances of improving, since there is more room (technically speaking) for improvement; those with high scores have greater chances of getting lower scores. Hence, people previously scoring in the middle range of the

scale are more likely to experience changes, either negative or positive. To remove the effect of initial scores, we used residualized or regressed change scores, but the results came out with the same overall pattern.

Skills with low confidence scores at the baseline and skills with low change progress percent need to be given more attention both in undergraduate curricula and in family medicine postgraduate training. However, our results gave no grounds for concern about distribution or skewness in the acquisition of skills confidence based on starting level or small change in important procedures. On the contrary, skills with low positive change had a very high confidence level from the beginning. The only exceptions were the major surgical procedures, which had low priority in the curriculum.

4.1. Study Limitations. Firstly, the gradual decrease in the number of the trainees in the course of the training period can be regarded as a study limitation. However, this was managed by including candidates who responded to both the "before" and the "after" questionnaires in the study (108 candidates). A comparison of the results from the "before" questionnaire between the group of 188 candidates (all respondents before the dropout) and the group of 108 candidates included found only a minor difference at the starting point (1.2% mean difference) compared with the difference between the "before" and the "after" for the same 108 candidates (21.7% mean difference). If the candidates that dropped out of the programme did this due to academic problems related to skills acquisition, this would have added more limitations to the generalization of our results. It is, however, not the case; in this case, the dropouts reflect the serious problem of brain drain from underdeveloped to more rich countries; administrative data (personal communication) from GFMP based on a questionnaire filled by the candidates before leaving shows that more than 80% left to Saudi Arabia due to economic reasons. We believe this is rather independent of the skills acquisition.

A second limitation is the use of self-evaluation as an assessment method. It is unclear how well self-assessment methods correlate with the actual skills performance when externally evaluated [28, 29]. However, self-evaluation is valuable in reflecting an individual's own confidence in

TABLE 5: Regression analyses for factors influencing change in candidates' self-evaluation of own competence in clinical skills after the master's programme. Changes in skills are shown by three different measures: residual gain score, percent change, and raw score (see Methods for details).

Variable	Residual gain score			Percent change score			Raw change score		
	B	Beta	P	B	Beta	P	B	Beta	P
Gender	−0.10	−0.09	0.44	12.4	0.25	0.04	0.27	0.21	0.08
Age	0.00	0.02	0.88	0.51	0.14	0.26	0.01	0.14	0.26
Locality	0.07	0.07	0.57	1.89	0.04	0.75	0.07	0.05	0.65
Graduating university	0.07	0.07	0.52	1.34	0.03	0.80	0.05	0.04	0.71
Clinical activity	0.00004	0.09	0.39	0.002	0.07	0.50	0.00003	0.05	0.62
Interest in family medicine	0.21	0.24	0.02	3.44	0.08	0.43	0.15	0.14	0.17
Constant	−0.951		0.06	−31.08		0.22	−0.918		0.14
Determination coefficient (R^2)		0.089			0.084			0.087	
F-value		1.62			1.51			1.58	
All-over P value for model		0.15			0.18			0.16	

performing certain skills, which is widely accepted for use as an assessment tool for further development [30–32], and, for this reason, it has been used in this study. Self-assessment is also a feasible method and may cover a big number of skills compared with other assessment methods, including objective structured clinical examination (OSCE), which allows only a small number of skills to be tested [33]. Another issue in the use of self-evaluation as a subjective assessment method is whether the increase in the total mean score from 3.23 to 3.93 (21.7%) over two years is better or poorer than expected as a result of the curriculum or if it corresponds to a significant change of phase in the Dreyfus model of skills [8, 9]. If we assume a significant association between Dreyfus' five levels of competence and our five levels of confidence, the increase found would correspond to a mean change from "competent" to close to "proficient." "Competence" requires considerable experience [9], while level 2 (advanced beginner) does not require personal responsibility, which is clearly necessary to act as a clinical master candidate in family medicine. It seems reasonable to conclude that the achievement obtained may be relevant in both absolute change and level for a master's programme in family medicine. In his review article, Peña discusses several controversial points attached to the Dreyfus model [9]. He concludes that even if it may be an accepted and reasonable stair of competence to be adapted for medical education, it is debatable if it is based on current pedagogical and psychological knowledge and thus can explain the acquisition of clinical skills. The GFMP tried to assess competence in clinical skills both theoretically and practically during programme evaluations and exams. The results showed that candidates mostly reached their targeted level, and very few failed in formal settings (administrative data, GFMP personal communication).

It is important not to confuse competence with confidence: the first is objective and the second is subjective, and there is an interesting relationship between the two. Some students are overconfident, while others are not so confident relative to objective assessments of their skills. Both of these situations are problematic, particularly in the extreme, and should not be disregarded or minimized. The present study's scope was to show how development was reflected in candidates' confidence, and we have no data directly linking subjective confidence to objective competence.

Thirdly, a design that included a control group would have added more strength to this study. The project targeted all medical doctors in Gezira to be enrolled in the programme; the only requirement was one year of experience after graduation (internship). In addition to the newly graduated doctors after their internship and doctors from other medical disciplines, the vast majority of district practicing medical doctors (115 doctors of about 150) joined the programme. The group of district practicing doctors could have been a potential control group, but they were instead enrolled in the GFMP.

4.2. Implications for Practice. Family medicine is a rapidly developing and transforming discipline at the regional and worldwide levels. Unfortunately, there is scarcity of literature assessing the outcome of postgraduate training programmes [33]. The curriculum style of the GFMP master's programme was based on a modern postgraduate family medicine training approach [23] that relies heavily on information and communication technology [24] in a mixed, in-service model of training that follows a competency-based and community-centred curriculum. The curriculum design is also intended to assist in reaching an international target of high upgrading of family medicine training [7, 17]. It is therefore worthwhile to gain experience and learn from the GFMP training model and to assess its outcome. Sharing the outcomes of this experience with other family medicine training programmes is expected to contribute towards further upgrading of postgraduate training in family medicine, with emphasis on the quality of training and the training outcomes.

The study pays attention to certain issues that need further scrutiny and more research; these issues include family-medicine-related postgraduate skills and curriculum design, evaluation of training outcomes, gender and interdisciplinary variation, and correlation patterns between skills confidence and competence.

5. Conclusion and Recommendations

This study evaluates the impact of the GFMP training's curriculum on the candidates' own confidence in performing certain clinical tasks. Results showed a general positive progress trend with some interdisciplinary and gender variations. Further research is needed to measure the impact of the family physicians' training on the health system and patient care.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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IV

Research article

Impact on core values of family medicine from a 2-year Master's programme in Gezira, Sudan: Observational study

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ABSTRACT

Background

Training of family physicians should include not only clinical and procedural skills, but also core values as comprehensive care, continuity of care, leadership and patient-centeredness. The Gezira Family Medicine Project (GFMP) is a two years Master's programme in family medicine in Sudan. We assessed the impact of GFMP on the candidates' adherence to some core values of family medicine.

Methods

This is a cross sectional questionnaire based, prospective study with before-after design. We used Patient-Physician Orientation Scale (PPOS) to assess physicians' attitude towards patient-centeredness. Practice based data from individual patients' consultations and self-assessment methods were used to assess physicians' adherence to core values.

Results

At the end of the programme the candidates (N= 110) were significantly more active in community health promotion (p < 0.001), more confident as a team leader (p= 0.008), and showed increased adherence to national guidelines for managing diabetes (p= 0.017) and hypertension (p= 0.003). The responding candidates had more knowledge about patients' medical history (p <0.001), family history (p <0.001) and family situation (p <0.001). There were more planned follow up consultations (p <0.001) and more referrals (p= 0.040). In contrast, results from PPOS showed less orientation towards patient-centeredness (p= 0.007).

Conclusions

The GFMP Master's programme induced a positive change in adherence to several core values of family medicine. The candidates became less patient-centered.

Keywords

Background

Since the first university departments of family medicine were established 50-60 years ago, the discipline has steadily developed and is now an integral part of the curricula in the majority of medical schools worldwide [1, 2]. The importance of primary care was stated in the classical Declaration of Alma-Ata in 1978, which is still an important document for politicians and stakeholders [3-5]. However, excessive specialization of health care providers and fragmentation of health care systems still discourage a holistic approach to individuals and their families in most countries. This occurs in spite of the accumulated research evidences and also WHO reports which continuously state that primary care is effective for preventing diseases and reducing deaths, and provides more accessible, equitable and affordable care for the peoples [3-8].

The ideas of family medicine based primary care contains some core values that should guide family physicians not only during the curative work, but also during roles in preventive care, health promotion, community mobilization, research, leadership and resource allocation [5-9]. Many postgraduate family medicine training programmes have emerged worldwide to promote the specialty and its values, so also in low and middle income countries (LMIC) [10-12]. As an example, in Sub-Saharan Africa the Primafamed project has provided a network for collaboration, information, experience exchange and resources sharing for those engaged in such training [10].

While clinical spectrum and practice, necessary equipment, and competence in procedural skills may vary much in different geographical settings [13-15], there are some core principles of family medicine which are unique and universal [9, 13]. Examples of such

values include patient-centered care, a family perspective, continuity of care, and comprehensive care.

There is little research in the African context on family physicians' orientation towards patient-centered medicine or other core values of the specialty, and how such values eventually are practiced. Gezira Family Medicine Project (GFMP) is a two years, in-service based Master's programme in family medicine in Sudan, provided by the Faculty of Medicine, University of Gezira. Detailed descriptions and evaluations of the GFMP and its curriculum and teaching methods have been described in previous articles [16-18].

The aim of the present study is thus to evaluate the impact of the GFMP programme on the candidates' orientation towards patient-centeredness, their adherence to some core values of family medicine, also by investigating their practice on a patient level.

Methods

Study area

Gezira State is situated south to the capital Khartoum. Gezira population is of about 3.7 millions, with mainly rural areas in an agricultural environment. Tropical diseases like malaria are still endemic [19], overshadowing the growing global challenge of non-communicable diseases (NCDs) [19-21].

Primary health care is provided through health centers, which are served by generalist doctors without postgraduate training. The number of doctors working in primary care before 2010 was about 115, thus providing a ratio of primary health care doctor to population of 1:32,000.

This ratio is far from the ratio proposed by Barbara Starfield; one family doctor for each 1000-1500 inhabitants in order to have a proper health care system [6]. Small rural hospitals represent the second line for referral in Gezira, but more commonly used are the three main city hospitals in Medani, Managil and Kamlin. To bridge the huge lack of primary care doctors, the Gezira Family Medicine Project (GFMP) was planned. The project aims to train doctors in family medicine by means of a 2-year in-service Master's degree programme.

Gezira Family Medicine Project (GFMP)

The project was stablished in 2010, as a collaboration project between the Faculty of Medicine at University of Gezira, the State Ministry of Health and other relevant stakeholders [16]. The Faculty of medicine took the responsibility for the candidates' training in family medicine, while the Ministry of Health provided economic support to the health centers, equipment and staff, including jobs for the enrolled doctors. By providing salaried jobs and a potential achievable academic Master's certificate, the project was able to recruit 207 physicians to join the programme, and also to provide service in districts that had never been served by doctors before. The majority was new candidates recruited into primary care for the first time. There was, however, a continuous decline in the number of candidates participating during the course, and only 125 were still enrolled at the graduation time. The vast majority of those who did not complete the programme immigrated to other rich countries, reflecting the global trend of brain drain among physicians [22].

The curriculum was designed as a two years Master's programme in family medicine [16]. An in-service model of training was designed, thus allowing the candidates to work clinically at their centers during the programme period. The curriculum constituted of four semesters. There was an introductory course in family and community medicine, the aim was to give an

orientation about the discipline and its core values. Thereafter the candidates were distributed to their health centers and allocated to the different clinical rotations at hospitals One day per week they were allocated to one of the major hospitals to have training in clinical procedural skills, while theoretical teaching was presented as online lectures and case discussions. A continuous evaluation of candidates was performed, checking their knowledge, skills and attitudes. During exams the candidates were asked to show their social accountability and health promotional activities in reports, meetings minutes and pictures, they were also asked to present a map of their catchment area together with demographic data about his/her population, including a chronic disease register.

Study design and study population

Data were collected at the start of the GFMP in November 2010 "before", and at the end of the project just before the final exam "after". All enrolled candidates were targeted at start of the GFMP (N= 207) and at the end (N= 125). Only candidates who responded to both the "before" and "after" questionnaires were included when comparing the two groups.

Data Collection

Self-evaluation was used to assess candidates' interest in family medicine, confidence in performing certain professional skills and in following national clinical guidelines.

The Patient-Practitioner Orientation Scale (PPOS) [23, 24]. It differentiates between patient-centered approach and doctor-centered approach. It consists of 18 items with two subscales (dimensions), each with nine items. Items are answered using a 6-point Likert-type format. The sharing subscale is reflecting the physician's attitudes towards sharing information, power and control with the patient, while the caring subscale is reflecting physician's attitude

towards caring about patients' expectations, feelings and preference. High total scores indicate a more patient-centered attitude, while lower scores indicate a more doctor-centered attitude.

Another questionnaire was used to assess whether physicians' practice is in harmony with some core values of family medicine. Each candidate was expected to collect data from 100 patient consultations during the first programme period and 50 consultations during the last period. Results for each item were calculated as a percentage score for that candidate, with the number of valid patient questionnaires as the denominator. We then present the means of the percentages from all candidates. All questionnaires were anonymous with a coding number.

Statistical Analysis

SPSS® programme version 23 was used for data management and statistical analyses. Results are presented as descriptive statistics with means, proportions and percentages. "Paired sample t tests" was used to test the significance of quantitative data, while McNamar test was used to test differences in categorical data.

Results

Of the 207 candidates who were enrolled in the GFMP at the start, 188 candidates (91%) responded to the "before" questionnaire. At the end of the Master programme 115 (92%) of the targeted 125 candidates still in the programme responded to the "after" questionnaire, of whom 110 answered both the "before" and "after" surveys.

Interest in family medicine and progress in certain professional skills

Table 1 shows how the candidates evaluated their own interest in the specialty of family medicine and their self-assessment for competence in some professional roles as a family physician. There were no important differences found at the start between all candidates and those included in the before-after analyses. The candidates showed generally a high interest in family medicine specialty at the start, and a significantly increased interest at the end. The result the category of "very much interest" increased by 56% in males and 78% in females, although males were still more interested than females at the end.

Large and statistically significant improvements were also found in certain professional role skills, like health team leadership, communication with colleagues, communication with the local community, practicing health promotion, and caring about patients' psychosocial aspects. For males the increase did not reach statistical significance for all questions, but the changes were at the same magnitudes as for females, except for communication with the local community, where males scored higher than females both before and after.

Table 1 in here

Candidates showed a high very adherence to malaria guidelines both before and after the programme, with no statistically significant change and small gender differences. For diabetes mellitus and hypertension, we found statistically significant increases in adherence for both, with small gender variations (Table 2).

Table 2 in here

Patient-Practitioner Orientation Scale (PPOS) for Patient Centeredness

A total of 188 of the 207 available candidates answered the PPOS questionnaire at the start of the Master programme (91% response rate), while 108 of the 125 remaining candidates responded to the "after" questionnaire (86% response rate). Only results from candidates who responded both the "before" and "after" questionnaires are included (N= 103).

Table 3 presents PPOS mean values for total scores and subscales, standard deviations and P values by gender, for results before and after the Master programme. The PPOS scores revealed a statistically significant decrease of 4% in the overall score, mostly due to a decrease of 7% in the sharing subscale. For males, there was a decrease in all scores, while for females we found an increase in the caring subscale, although not statistically significant. Females had higher overall scoring than males, both in the "before" and "after" survey, but the differences were not statistically significant (p= 0.210 and p= 0.753).

Table 3 in here

Core values during clinical consultations

Of the 207 original candidates, 151 delivered patient based data (73%). At the end 116 out of 125 (93%) delivered data, and 91 delivered data for before and after comparisons.

The candidates had large and statistically significant improvements in all investigated family medicine core value topics, such as continuity of care and knowledge of the patients' family and medical history (Table 4). There was a shift in consultations from first contacts to more planned controls and follow-ups. The referral rate increased from 14% to about 17%.

Table 4 in here

Discussion

The candidates of this family medicine Master's programme in Gezira, Sudan, showed progress in most topics related to core values and competencies, including leadership, continuity of care, comprehensive care, and adherence to national clinical guidelines. However, the study revealed a reduction in candidates' self-assessed patient-centeredness.

Family medicine interest and role aspects

Not surprisingly, the enrolled candidates expressed a high interest in family medicine even at the start of the GFMP. However, at the end the group with "very much" interest had increased both for males and females. The GFMP was thus able to recruit a large group of motivated students, and to increase their motivation and interest during the programme. This is consistent with an Egyptian study, which showed increased interest in family medicine as a career after an orientation course in family medicine for house-officers [25].

The substantial increase in the candidates' participation in community health promotion may be explained by the high emphasis on this issue through the curriculum, by claiming pictures, reports, and meeting minutes as documentation at exams. We also observed significant improvements in competencies like leadership, communication with the local community, and communication with the other employees. Males self-evaluated themselves as more confident in leadership than females, while females reported larger progress.

Clinical guidelines

The self-evaluation for adherence to the national clinical guidelines concerning malaria, diabetes mellitus, and hypertension, showed high adherence already at the beginning. Many candidates obviously knew the guidelines from before. There was a significant increase in adherence for diabetes and hypertension, although the malaria guidelines still had the highest score at the end. The high score is most probably due to the high local and international emphasis on "rolling back" malaria [26]. Guidelines for hypertension and diabetes are not so widely distributed or advocated, and candidates might have followed guidelines and good practice even if they did not express recognition of national guidelines.

On the other hand, there are many studies concluding that guidelines are not adequately implemented, and that physicians' knowledge of guidelines in itself does not lead to better guideline implementation [27, 28]. In family medicine, there has also been a focus on negative consequences when obliged to apply a variety of single disease guidelines to multi-morbid patients, including increased risk of poly-pharmacy and overtreatment [29]. We have no data showing the actual compliance with the guidelines on an individual patient level. A prerequisite for use in clinical practice, however, is knowledge of their existence and a statement of adherence.

Patient centeredness

To our knowledge, this is the first prospective study measuring physician's attitude towards patient-centeredness in an African context. The results for the whole cohort showed a statistically significant reduction in the total score from 3.75 to 3.60. Compared with results from other countries, the total PPOS score in our study is higher than found among Pakistani students (score 3.40) [30], but lower than 4th year US medical students (score 4.46) [31], Brazilian students (score 4.66) [32] and Greek 6th year medical students (score 3.81) [33].

Cross-cultural variations are found also within the same country, as a US study using PPOS revealed significant differences between medical students of different ethnicity [31].

A decrease in PPOS scores after clinical rotations is found in other studies when comparing pre-clinical and post-clinical clerkship students [31, 34, 35], although the results are heterogeneous [30, 32, 36]. A decline is usually explained by the shift from the ideal theoretical teaching in pre-clinical years towards more biological teaching in hospital settings. This explanation may be plausible in our setting. Our candidates had a course in communication skills at the very beginning, and the PPOS questionnaire was distributed after this course.

Our scores in the sharing subscale are lower than in the caring subscale; this is consistent with other studies [24, 31]. If valid, the findings mean less involvement of patients in information and decision-making. This might be a result of the dominating paternalistic biomedical model in medical education and practice, well recognized also in our settings. Female gender is traditionally associated with more patient-centeredness [31, 33, 37]. Although females scored higher than males in our study, the differences were not statistically significant, consistent with studies from Pakistan [30] and Nepal [38].

Core values from clinical practice

The reduced number of first contacts and increased number of patients with planed follow-up reflect a practice of more continuous care, but may also reflect patients' satisfaction with and confidence in their family doctor. Increased knowledge of patients' medical history, family medical history, and patients' family situation, is an indication of improved patient-physician relationship. Unexpectedly, the referral rate was increased, mainly among the male

candidates. It may be assumed that the referral rate may decline if the physicians developed more clinical procedural skills, as described in a previous paper [16]. However, it can also indicate a shift towards patients with more chronic diseases and multi-morbidity, best managed in primary care but with some need of specialist investigations and evaluation. Another explanation is better and more communication and collaboration between the family medicine candidates and the hospital doctors, as a results of clinical rotations at hospitals [16] and telemedicine interaction [17]. The referral rate of 17% is still within the normal expected rate internationally [39], as Starfield assumed that between 15-25% of population needs referral from primary care to secondary or tertiary care [40].

Study limitations

Self-assessment is a subjective method, and may reflect candidates' confidence rather than competence [41, 42]. However, this method is widely accepted, used and easy as an assessment indicator for curriculum development [43, 44]. The drop out of candidates during the course of the Master's programme from 207 to 125 may be a study limitation, regarding both representability and statistical power. However, administrative data show that more than 80% left to rich countries due to economic reasons (GFMP, personal communication). Comparisons between the participants before drop out (N= 188) and the remaining (N= 110) revealed only minor differences, especially when compared with the differences obtained during the observation period.

The use of PPOS for measuring physician-patient relationship has a number of challenges, including cross cultural variability, reliability and validity [31]. We do not know if and how national or local societal cultures or educational and teaching practices could have had impact on the results. The PPOS explores the physician's attitude, but not the physician's practice

(behavior), reminding us again about the questionable link between attitude and actual behavior.

Conclusions

The GFMP Master's programme had a significant positive impact on the candidates' adherence to family medicine core values like leadership, continuity of care, comprehensive care, and compliance with national clinical guidelines. However, the study revealed a reduction in candidates' self-assessed patient-centeredness.

Practical implication and further research

Family medicine training programmes in sub-Saharan Africa and globally are progressing quickly, and results from scientific evaluations are important for sharing experiences and curriculum development. GFMP is now a well known example of how to scale up family medicine in Africa, and it has inspired other countries in the region [45]. Future curricula should aim to train and assess family physicians in core values as well as clinical work and procedural skills. Patient-centeredness is an area that needs focus, including further studies both at undergraduate and postgraduate level.

Declarations

Ethics approval and consent to participate

The ethical review committee at the Gezira State Ministry of Health approved the study. The Regional Committee for Medical and Health Research Ethics, Western Norway also approved the study protocol (2012/937/REK West). The privacy issues and patients' file management related to the scientific evaluation was approved by The Norwegian Data Protection Office for Research (2012/31743).

Consent for publication

Not applicable

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

Authors' contributions

All the mentioned authors have participated in the conception and design of this study; they gave final approval for the manuscript to be printed after revising it critically. KGM and SH have contributed in data collection, analysis and interpretation. The first draft was presented by KGM while the other authors revised it critically and gave ideas. All the authors read this manuscript, approved it, and all of them believes that the manuscript represents honest work. Each author fulfill the requirements for authorship.

List of abbreviations

GFMP: Gezira Family Medicine Project

ICT: Information and Communication Technology

LMIC: Low and Middle Income Countries

PPOS: Patient-Physician Orientation Scale

WHO: World Health Organization

NCDs: Non-Communicable Diseases

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Table 1: Physician's self-evaluation regarding interest in family medicine and certain professional skills

Question	All (N=188)	All (N=110)			Males (N=43)			Females (N=67)		
		Before	After	P value	Before	After	P value	Before	After	P value
Physician's interest in family medicine										
Not/Little/Somewhat	23.4	16.8	7.3	<0.001	16.7	7.0	0.022	16.9	7.6	0.002
Much	43.1	44.9	28.4		35.7	18.6		50.8	34.8	
Very much	33.5	38.3	64.2		47.6	74.4		32.3	57.6	
Self-evaluation regarding caring about patient's psychosocial aspects										
Yes	45.7	49.5	74.8	0.001	48.8	73.8	0.056	50.0	75.4	0.001
Sometimes	42.5	39.0	17.8		36.6	23.8		40.6	13.8	
No	11.8	11.4	7.5		14.6	2.4		9.4	10.8	
Practicing health promotion at the community level										
Yes	17.3	21.5	82.5	<0.001	33.3	86.2	<0.001	15.0	80.4	<0.001
Sometimes	3.2	2.2	2.5		3.0	3.4		1.7	2.0	
No	79.5	76.3	15.0		63.6	10.3		83.3	17.6	
Physicians' satisfaction regarding the communication with local community										
Not/Little/Somewhat	44.9	38.8	24.8	<0.001	26.8	11.6	0.077	46.8	33.3	0.001
Much	39.3	42.7	29.4		39.0	27.9		45.2	30.3	
Very much	15.8	18.4	45.9		34.1	60.5		8.1	36.4	
Confidence as a health team leader										
Very confident	16.8	19.2	35.5	0.008	26.8	41.9	0.378	14.3	31.3	0.018
Confident	54.1	53.8	52.7		48.8	48.8		57.1	55.2	
Not fully confident/Uncertain/Not able	29.1	26.9	11.8		24.4	9.3		28.6	13.4	
Physicians' satisfaction regarding the communication with other employees										
Not/Little/Somewhat	36.1	36.9	16.5	<0.001	26.8	14.0	0.015	43.5	18.2	<0.001
Much	41.5	43.7	33.0		51.2	34.9		38.7	31.8	
Very much	22.4	19.4	50.5		22.0	51.2		17.7	50.0	

Data compares before and after GFMP by gender including candidates who answered both before and after questionnaires (N= 110) and from all who participated in the before questionnaire (N= 188). All numbers are distribution percentages. P-values from McNemar tests.

Table 2

Candidates´ self-evaluation regarding adherence to the national clinical guidelines

National guidelines topic	All			Males (N=43)			Females (N=67)		
	Before	After	P value	Before	After	P value	Before	After	P value
Malaria									
Yes	83.0	88.1	0.259	78.0	92.9	0.142	86.2	85.1	0.362
Sometimes	13.2	7.3		17.1	4.8		10.8	9.0	
No	3.8	4.6		4.9	2.4		3.1	6.0	
Diabetes mellitus									
Yes	50.0	65.5	0.017	52.4	65.1	0.382	48.4	65.7	0.020
Sometimes	21.7	24.5		23.8	23.3		20.3	25.4	
No	28.3	10.0		23.8	11.6		31.3	9.0	
Hypertension									
Yes	49.5	67.3	0.003	48.8	60.5	0.133	50.0	71.6	0.013
Sometimes	18.7	20.0		17.1	27.9		19.7	14.9	
No	31.8	12.7		34.1	11.6		30.3	13.4	

It includes malaria, diabetes mellitus, and hypertension before and after GFMP master programme (N= 110), by gender. All numbers are percentages. P-values from McNemar tests.

Table 3

Patient-Practitioner Orientation Scale (PPOS) scores before and after GFMP master programme distributed by gender

| | PPOS score | | | | | | |
| | Before | | After | | | | |
	Mean	SD	Mean	SD	Change	P-value	
All (n=103)							
Total PPOS score	3.75	0.48	3.60	0.60	-0.15	0.007	
Caring subscale	3.37	0.63	3.36	0.73	-0.01	0.950	
Sharing subscale	4.14	0.56	3.85	0.60	-0.29	< 0.001	
Males (n=41)							
Total PPOS score	3.74	0.44	3.50	0.66	-0.24	0.011	
Caring subscale	3.43	0.62	3.20	0.77	-0.23	0.062	
Sharing subscale	4.05	0.51	3.82	0.65	-0.23	0.042	
Females (n=62)							
Total PPOS score	3.76	0.50	3.66	0.55	-0.10	0.182	
Caring subscale	3.33	0.64	3.47	0.68	0.14	0.120	
Sharing subscale	4.20	0.59	3.87	0.58	-0.33	<0.002	

P-values calculated by paired t tests.

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Table 4

Family medicine core values in relation to candidates' practice before and after GFMP.

Core value topic	All (N=91)			Males (N=40)			Females (N=51)		
	Before	After	P value	Before	After	P value	Before	After	P value
Patients presenting as a first contact regarding the main contact reason	78.5	62.7	<0.001	77.57	60.6	<0.001	79.3	64.4	<0.001
Patients whom the doctor is the personal doctor for the patient	34.7	74.6	<0.001	30.4	75.9	<0.001	38.0	73.5	<0.001
Patients with planned control in the future for follow up	47.6	61.0	<0.001	48.7	60.3	0.054	46.8	61.4	0.002
Patients who are referred	13.7	17.3	0.040	10.4	17.3	0.009	16.2	17.2	0.678
Patients whom the doctor knows their medical history	56.2	87.0	<0.001	44.3	85.3	<0.001	65.6	88.3	<0.001
Patients whom the doctor knows their family situation.	49.4	84.0	<0.001	41.0	84.7	<0.001	56.7	83.5	<0.001
Patients whom the doctor knows important parts of their family medical history	47.3	84.0	<0.001	34.4	82.3	<0.001	57.1	85.2	<0.001

Data based on questionnaires filled by the candidates during individual patients' consultations and presented as mean of the candidates' percentages of their own patients. P-values by paired t test

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