

Medicine in a forgotten corner of Africa: how EMR can benefit the developing world – The FIMRC and EMR4DW experience

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Abstract. – OBJECTIVE: The aim of this study is to analyze the disease prevalence of a rural African village and discuss how to maximize the outcomes of health projects. The analysis was based on electronic medical records (EMR) at a clinic in Bududa, Uganda. The installation of EMR in such a low-resource setting enabled efficient statistical analysis.

MATERIALS AND METHODS: Medical records from January 2013 to September 2017 were analyzed. During the study period, the top five disease categories diagnosed in Bududa district were diseases of the respiratory system, certain infectious and parasitic diseases, diseases of the digestive system, diseases of the skin and subcutaneous tissue, and others.

RESULTS: Infectious and parasitic disease, diseases of digestive system, and diseases of skin and subcutaneous tissue are major diseases. With the exception of the year 2017, extracted data shows that there is a significant increased prevalence of malaria after the rainy season, April and May.

CONCLUSIONS: The authors expect an installation of EMR in the developing world in association with epidemiological research will guide different stakeholders including the government and healthcare providers to optimize the use of limited resources for which disease categories at what time. In addition, establishing a map of disease prevalence and incidence will yield more cost-effective strategies for enhancing the quality of life in low-resource settings.

Key Words:

EMR, Epidemiology, Africa, Uganda.

Introduction

The GDP per capita (PPP) of Uganda ranks 200 out of 216¹, making it one of the poorest countries in the world. At the base of Mount Elgon, approximately 260 km east of Kampala, the capital city of Uganda, there is a remote village called Bududa, which is often labeled as a “forgotten district”. The basic statistics of the region are provided by the Ugandan government^{2,3}, but no data have been available for disease prevalence making it difficult for the policymakers and local health workers to implement and maximize the outcomes of health projects with limited resources.

Previously, medical records in the region were hand-written and no statistical analysis was done; however, with the introduction of electronic medical records (EMR) by a British charity organization Electronic Medical Records for the Developing World (EMR4DW), Foundation for International Medical Relief of Children (FIMRC) clinic in Bududa has been keeping patient records electronically since 2013 making it convenient for statistical analysis. This research contains a statistical analysis of the entire disease entity by

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International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10). A number of papers regarding the implementation of EMR in certain health projects, such as HIV/AIDS⁴⁻⁷ in low-resource settings have been published so far; however, it is our understanding that this is the first study to provide holistic epidemiological descriptive statistics in low-resource settings using EMR.

The aim of this study is to analyze the disease prevalence of a rural African village and discuss methods to maximize the outcomes of health projects.

Materials and Methods

Data were acquired by using EMR4DW Patient Care Records: EMR4DW Core Version 2.4 SP3, a simple EMR developed by EMR4DW. The user-friendly EMR has sufficient functionality to make it efficient in challenging settings and workers with no computer knowledge have learnt the system in 8 hours. A video demonstrating the features of the latest EMR is posted on a Vimeo page⁸. Screenshots of the latest version are presented as Figures 1-4.

One clinical officer and several nurses work in the FIMRC clinic to provide medical service. All clinical data in the EMR including vital signs, diagnosis (ICD-10), treatments, and clinical memos were input by Ugandan health professionals. Later, doctors from the UK visited the clinic to both educate and learn from local workers. They copied clinical data accumulated in the EMR at the clinic and uploaded it to the server in the UK. All patient data have been modified and treated anonymously. With regards to Ethical issues, this research has met the criteria of Institutional Review Board (IRB No. 4-2017-0961) in Severance Hospital, Korea in December 2017.

Results

The data is from Bududa district in Eastern Uganda. This mountainous district has sparse public health facilities and the percentage distribution of households who are situated 5 km and over to the nearest public health facility is shown in Figure 5³. This data is obtained from a Government Report³.

Table I shows the number of patient visits by month from Jan. 2013 to Sep. 2016. The total number of patients per year almost doubled from

The screenshot shows a web-based form for entering patient details. At the top, there is a navigation bar with icons for Home, Add Patient, Reports, Administration, Address Builder, Pharmacy Stock, and Cash. The user's name 'Peter Smith' and language 'EN' are displayed in the top right. The main form is titled 'Patient Details' and contains the following fields:

- Patient ID: DEV-3306
- Health ID: 234
- Last Attended: 08/04/2019
- First Name * (required): [Text input field]
- Family Name * (required): [Text input field]
- Gender * (required): Radio buttons for Male and Female (Female is selected)
- Date of Birth * (required): 11/09/1998
- Next of Kin: [Text input field]
- Patient Status * (required): [Dropdown menu with 'Blood Precautions needed' selected]
- Smoking: [Text input field]
- Health ID: 234
- Address * (required): [Text input field with 'Add New' button]
- Mobile Number: [Text input field]
- Language: [Dropdown menu]
- Religion: [Dropdown menu]
- Patient Category: [Dropdown menu with 'Non-Payers' selected]
- Patient Type * (required): [Text input field]

Figure 1. Patient details in the EMR.

EMR can benefit the developing world

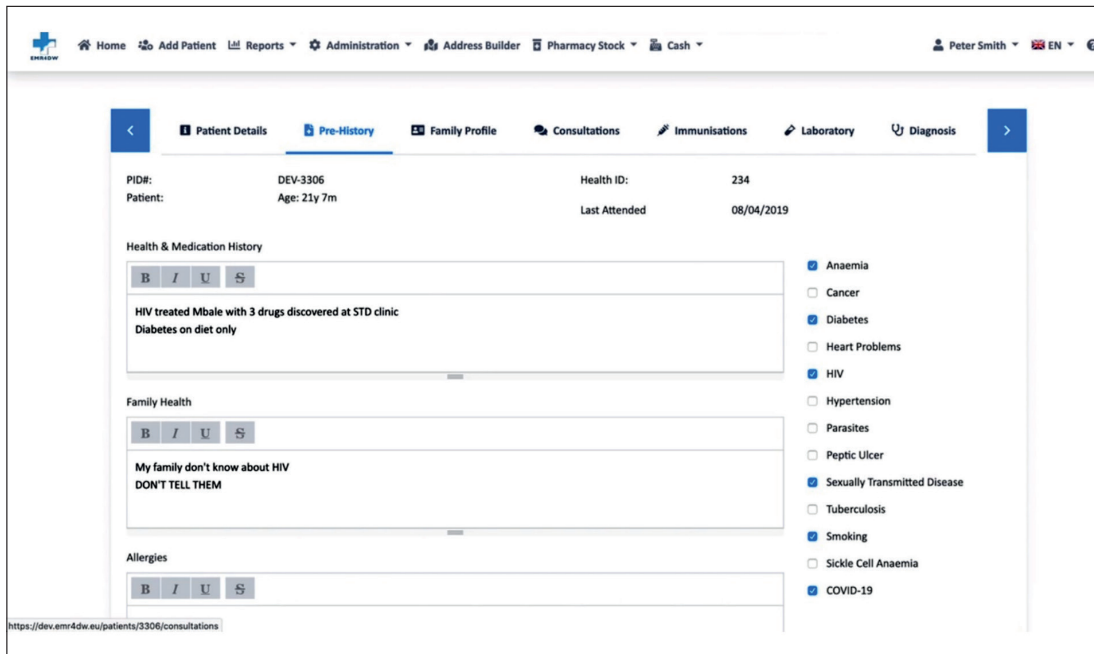


Figure 2. PreHistory in the EMR.

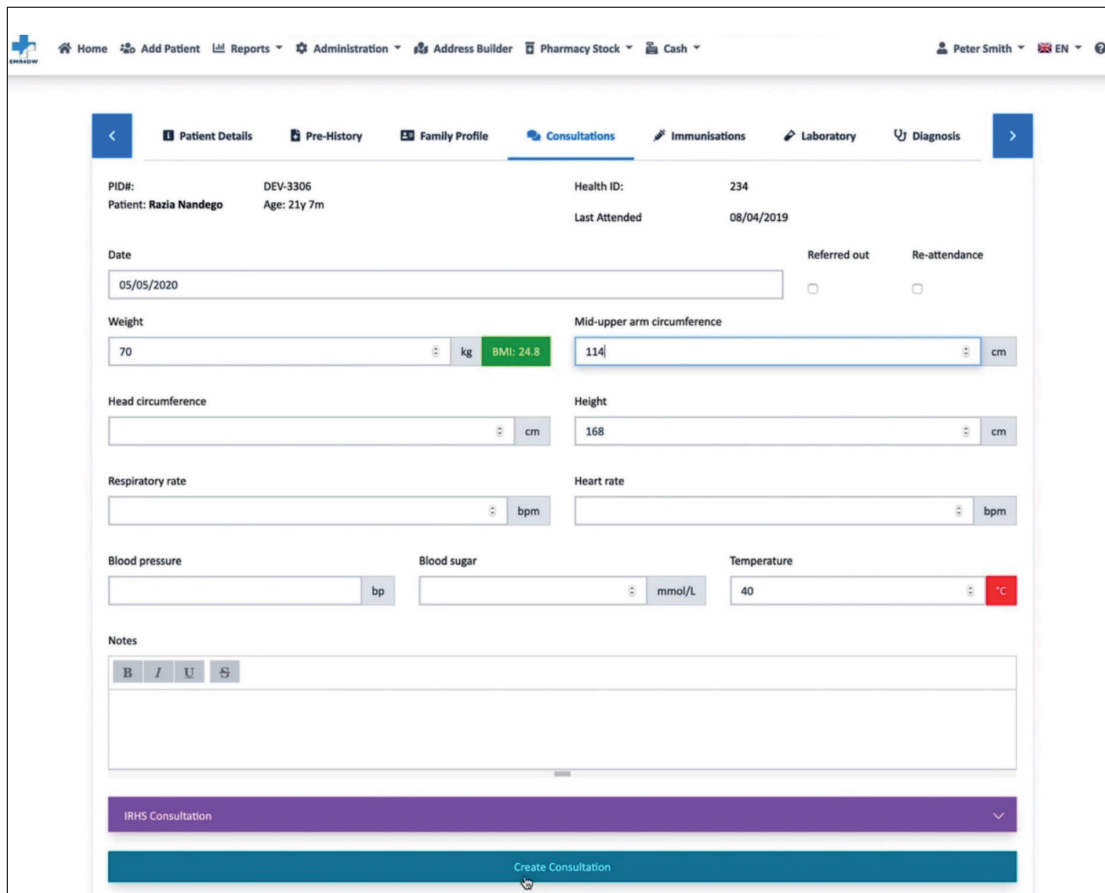


Figure 3. Consultation in the EMR.

Home **Add Patient** **Reports** **Administration** **Address Builder** **Pharmacy Stock** **Cash** Peter Smith EN

Patient Details **Pre-History** **Family Profile** **Consultations** **Immunisations** **Laboratory** **Diagnosis**

PID#: DEV-3306 Health ID: 234
 Patient: Razia Nandego Age: 21y 7m Last Attended: 08/04/2019

Date: 05/05/2020 Hb (g/dl): ESR (1st Hour): Blood Sugar: mmol/L
 Tested When? Fasting Random Post-Prandial

Urine Sugar: -ve tr +1 +2 +3 +4
 Urine Protein: -ve tr +1 +2 +3 +4
 Malarial RDT: Negative
 Have you got a Cold? Option Value

Notes: B I U S

Figure 4. Lab data in the EMR.

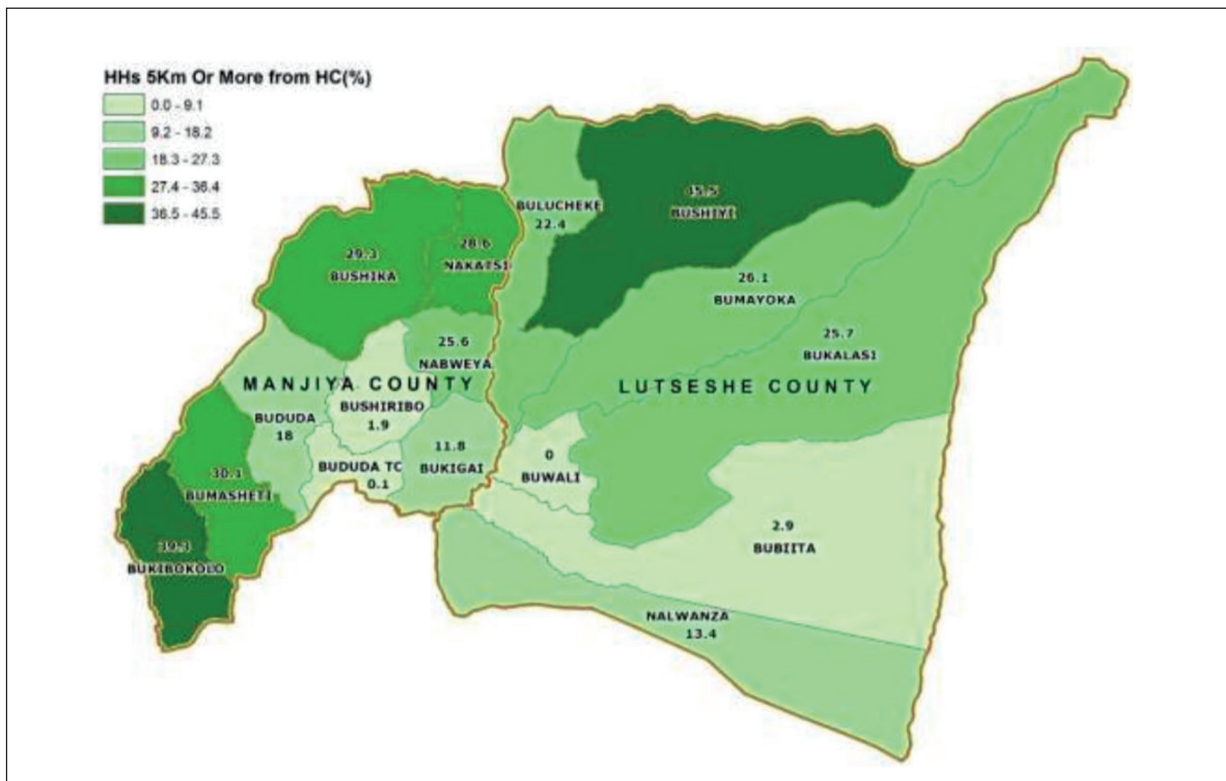


Figure 5. Percentage Distribution of Households 5 km and over to the nearest Public Health Facility; Bududa District, 2014.

Table I. Number of patient visits by month.

	2013	2014	2015	2016	2017	Total
Jan	177	1108	910	739	1927	4861
Feb	1183	1026	806	653	1839	5507
Mar	947	1027	948	1318	2441	6681
Apr	1170	1116	868	2132	2139	7425
May	1208	1108	1001	2620	2424	8361
Jun	1023	971	1080	2436	2203	7713
Jul	1143	1113	1257	2274	2472	8259
Aug	931	923	965	2137	2598	7554
Sep	784	1071	748	1959	1910	6472
Oct	878	1014	731	1916	N/A	4539
Nov	998	864	870	1853	N/A	4585
Dec	780	714	725	1603	N/A	3822
Total	11222	12055	10909	21640	19953	75779

2015 to 2016. In this area, word of mouth is an important method of communication, and the paperless clinic was developing a very good reputation with increased numbers being a sign of high patient satisfaction. The proportion of each disease entity by year and by month is presented in Table II.

The top five disease entities diagnosed are summarized in Table III. Diseases of the respiratory system were at the top regardless of year. Excluding “others” category input by Ugandan health professionals, “certain infectious and parasitic diseases” was the second disease entity diagnosed for all years. Diseases of the digestive system and diseases of the skin and subcutaneous tissue followed.

Figure 6 represents the number of cases of malaria diagnosed by year and by month along with the average amount of rainfall in Mbale. With the exception of the year 2017, there is a clear tendency for number of cases of malaria to rise significantly in April and May after the rainy season. This may be due to an increased number of mosquitos transmitting malaria during the rainy season.

It is not clear why we witness an increased number of malaria diagnoses before the end of the rainy season. Perhaps this is due to the “popularity” of the clinic. An assumption is that people come to the clinic sooner than before as soon as they realize any symptoms such as high fever.

Discussion

In a rural Ugandan village by the mountains, FIMRC has been running a clinic since 2009.

The clinic sits in a remote village called Bududa, which is approximately 260 km east of the capital city. In 2012, Peter Smith, a philanthropic British doctor, visited the clinic and provided medical care as a volunteer. Medical records were written by hand in the clinic just like everywhere else in Uganda. One day Dr. Smith found his medical records in the latrine being used as toilet paper. He immediately thought something had to be done about the situation and took action to make a difference; he founded a non-government organization (NGO) after going back to Britain.

Dr. Smith’s NGO, EMR4DW, was founded in 2012 and a computer programmer Bass Stewart developed a very simple user-friendly EMR that could easily be used with 8 hours of training for anyone with primary education. With the help of many donors in Britain, EMR4DW was able to implement computers with EMRs and a small generator for consistent power supply in Bududa. The benefits of installing an EMR show an improvement in the legibility of clinical notes⁹, enable reminders to prescribe drugs and administer vaccines^{10,11}, and more efficient management of chronic diseases, such as diabetes mellitus, hypertension, and heart failure^{12,13}. With accumulation of WHO coded diseases, the implementation made it possible for statistical analysis by running reports on standardized disease codes. This was analyzed by Dr. Sung Hwi Hong who visited the clinic when he was a student doing his medical elective.

Statistics, although they have limitations, can be used to ask questions and seek further answers to problems. Statistical analysis of disease prevalence is crucial in the era of evidence-based medicine/

Table II. Number of diagnosis classified by ICD-10.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVIII	XVIII	XIX	XX	Others	Total
Jan, 2013	30 (17%)	0 (0%)	1 (0.6%)	1 (0.6%)	2 (1.2%)	0 (0%)	5 (2.9%)	8 (4.6%)	7 (4%)	47 (26.6%)	20 (11.3%)	20 (11.3%)	0 (0%)	15 (8.5%)	1 (0.6%)	0 (0%)	0 (0%)	0 (0%)	19 (10.8%)	0 (0%)	1 (0.6%)	177 (100%)
Feb, 2013	201 (17%)	0 (0%)	0 (0%)	5 (0.5%)	3 (0.3%)	11 (1%)	21 (1.8%)	33 (2.8%)	31 (2.7%)	291 (24.6%)	149 (12.6%)	133 (11.3%)	0 (0%)	65 (5.5%)	0 (0%)	2 (0.2%)	0 (0%)	1 (0.1%)	108 (9.2%)	1 (0.1%)	128 (10.9%)	1183 (100%)
Mar, 2013	201 (21.3%)	0 (0%)	3 (0.4%)	4 (0.5%)	2 (0.3%)	2 (0.3%)	25 (2.7%)	25 (2.7%)	29 (3.1%)	233 (24.7%)	119 (12.6%)	90 (9.6%)	0 (0%)	45 (4.8%)	1 (0.2%)	1 (0.2%)	0 (0%)	2 (0.3%)	88 (9.3%)	0 (0%)	77 (8.2%)	947 (100%)
Apr, 2013	196 (16.8%)	0 (0%)	0 (0%)	1 (0.1%)	1 (0.1%)	5 (0.5%)	37 (3.2%)	37 (3.2%)	37 (3.2%)	342 (29.3%)	144 (12.4%)	130 (11.2%)	0 (0%)	65 (5.6%)	0 (0%)	0 (0%)	0 (0%)	1 (0.1%)	76 (6.5%)	1 (0.1%)	97 (8.3%)	1170 (100%)
May, 2013	236 (19.6%)	0 (0%)	2 (0.2%)	3 (0.3%)	2 (0.2%)	4 (0.4%)	19 (1.6%)	27 (2.3%)	39 (3.3%)	313 (26%)	144 (12%)	149 (12.4%)	0 (0%)	72 (6%)	2 (0.2%)	1 (0.1%)	0 (0%)	1 (0.1%)	75 (6.3%)	0 (0%)	119 (9.9%)	1208 (100%)
Jun, 2013	232 (22.7%)	0 (0%)	1 (0.1%)	1 (0.1%)	0 (0%)	4 (0.4%)	12 (1.2%)	29 (2.9%)	30 (3%)	360 (35.2%)	92 (9%)	88 (8.7%)	0 (0%)	49 (4.8%)	1 (0.1%)	0 (0%)	0 (0%)	0 (0%)	41 (4.1%)	0 (0%)	83 (8.2%)	1023 (100%)
Jul, 2013	242 (21.2%)	0 (0%)	2 (0.2%)	4 (0.4%)	1 (0.1%)	4 (0.4%)	20 (1.8%)	27 (2.4%)	46 (4.1%)	414 (36.3%)	118 (10.4%)	98 (8.6%)	0 (0%)	53 (4.7%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	27 (2.4%)	0 (0%)	87 (7.7%)	1143 (100%)
Aug, 2013	141 (15.2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (0.3%)	32 (3.5%)	25 (2.7%)	42 (4.6%)	341 (36.7%)	101 (10.9%)	82 (8.9%)	0 (0%)	53 (5.7%)	1 (0.2%)	0 (0%)	0 (0%)	2 (0.3%)	21 (2.3%)	0 (0%)	88 (9.5%)	931 (100%)
Sep, 2013	124 (15.9%)	0 (0%)	0 (0%)	4 (0.6%)	3 (0.4%)	4 (0.6%)	16 (2.1%)	22 (2.9%)	41 (5.3%)	251 (32.1%)	92 (11.8%)	65 (8.3%)	0 (0%)	50 (6.4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11 (1.5%)	1 (0.2%)	100 (12.8%)	784 (100%)
Oct, 2013	106 (12.1%)	0 (0%)	2 (0.3%)	3 (0.4%)	1 (0.2%)	4 (0.5%)	24 (2.8%)	19 (2.2%)	38 (4.4%)	345 (39.3%)	91 (10.4%)	62 (7.1%)	0 (0%)	38 (4.4%)	1 (0.2%)	0 (0%)	0 (0%)	0 (0%)	15 (1.8%)	0 (0%)	129 (14.7%)	878 (100%)
Nov, 2013	87 (8.8%)	0 (0%)	2 (0.3%)	5 (0.6%)	2 (0.3%)	5 (0.6%)	24 (2.5%)	39 (4%)	32 (3.3%)	337 (33.8%)	115 (11.6%)	128 (12.9%)	0 (0%)	45 (4.6%)	0 (0%)	1 (0.2%)	0 (0%)	2 (0.3%)	43 (4.4%)	0 (0%)	131 (13.2%)	998 (100%)
Dec, 2013	73 (9.4%)	0 (0%)	0 (0%)	3 (0.4%)	2 (0.3%)	6 (0.8%)	22 (2.9%)	32 (4.2%)	40 (5.2%)	217 (27.9%)	88 (11.3%)	107 (13.8%)	0 (0%)	26 (3.4%)	0 (0%)	1 (0.2%)	0 (0%)	0 (0%)	18 (2.4%)	1 (0.2%)	144 (18.5%)	780 (100%)
Jan, 2014	101 (9.2%)	0 (0%)	1 (0.1%)	2 (0.2%)	1 (0.1%)	7 (0.7%)	30 (2.8%)	47 (4.3%)	69 (6.3%)	310 (28%)	113 (10.2%)	141 (12.8%)	0 (0%)	45 (4.1%)	1 (0.1%)	2 (0.2%)	0 (0%)	0 (0%)	21 (1.9%)	0 (0%)	217 (19.6%)	1108 (100%)
Feb, 2014	136 (13.3%)	0 (0%)	1 (0.1%)	5 (0.5%)	1 (0.1%)	4 (0.4%)	24 (2.4%)	24 (2.4%)	58 (5.7%)	221 (21.6%)	108 (10.6%)	123 (12%)	0 (0%)	42 (4.1%)	3 (0.3%)	0 (0%)	0 (0%)	1 (0.1%)	17 (1.7%)	0 (0%)	258 (25.2%)	1026 (100%)
Mar, 2014	139 (13.6%)	0 (0%)	1 (0.1%)	2 (0.2%)	0 (0%)	1 (0.1%)	26 (2.6%)	34 (3.4%)	53 (5.2%)	201 (19.6%)	89 (8.7%)	112 (11%)	5 (0.5%)	40 (3.9%)	1 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)	8 (0.8%)	0 (0%)	314 (30.6%)	1027 (100%)
Apr, 2014	157 (14.1%)	0 (0%)	1 (0.1%)	2 (0.2%)	2 (0.2%)	5 (0.5%)	32 (2.9%)	37 (3.4%)	48 (4.4%)	209 (18.8%)	110 (9.9%)	155 (13.9%)	49 (4.4%)	39 (3.5%)	1 (0.1%)	7 (0.7%)	0 (0%)	0 (0%)	21 (1.9%)	0 (0%)	241 (21.6%)	1116 (100%)
May, 2014	155 (14%)	0 (0%)	3 (0.3%)	3 (0.3%)	1 (0.1%)	6 (0.6%)	25 (2.3%)	39 (3.6%)	52 (4.7%)	181 (16.4%)	104 (9.4%)	176 (15.9%)	99 (9%)	38 (3.5%)	2 (0.2%)	2 (0.2%)	0 (0%)	0 (0%)	15 (1.4%)	0 (0%)	207 (18.7%)	1108 (100%)
Jun, 2014	187 (19.3%)	0 (0%)	1 (0.2%)	0 (0%)	2 (0.3%)	3 (0.4%)	15 (1.6%)	37 (3.9%)	51 (5.3%)	225 (23.2%)	54 (5.6%)	121 (12.5%)	63 (6.5%)	26 (2.7%)	0 (0%)	3 (0.4%)	0 (0%)	0 (0%)	17 (1.8%)	1 (0.2%)	165 (17%)	971 (100%)
Jul, 2014	163 (14.7%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (0.6%)	31 (2.8%)	32 (2.9%)	51 (4.6%)	313 (28.2%)	90 (8.1%)	125 (11.3%)	90 (8.1%)	40 (3.6%)	0 (0%)	7 (0.7%)	0 (0%)	0 (0%)	17 (1.6%)	1 (0.1%)	147 (13.3%)	1113 (100%)

Continued

Table II (Continued). Number of diagnosis classified by ICD-10.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVIII	XVIII	XIX	XX	Others	Total
Aug, 2014	125 (13.6%)	0 (0%)	0 (0%)	2 (0.3%)	2 (0.3%)	3 (0.4%)	17 (1.9%)	14 (1.6%)	55 (6%)	237 (25.7%)	100 (10.9%)	123 (13.4%)	80 (8.7%)	40 (4.4%)	0 (0%)	2 (0.3%)	0 (0%)	0 (0%)	13 (1.5%)	0 (0%)	110 (12%)	923 (100%)
Sep, 2014	143 (13.4%)	0 (0%)	1 (0.1%)	5 (0.5%)	3 (0.3%)	3 (0.3%)	19 (1.8%)	21 (2%)	79 (7.4%)	313 (29.3%)	95 (8.9%)	113 (10.6%)	91 (8.5%)	49 (4.6%)	1 (0.1%)	4 (0.4%)	0 (0%)	0 (0%)	12 (1.2%)	1 (0.1%)	118 (11.1%)	1071 (100%)
Oct, 2014	157 (15.5%)	0 (0%)	1 (0.1%)	0 (0%)	3 (0.3%)	4 (0.4%)	31 (3.1%)	15 (1.5%)	77 (7.6%)	292 (28.8%)	69 (6.9%)	76 (7.5%)	65 (6.5%)	41 (4.1%)	0 (0%)	2 (0.2%)	0 (0%)	0 (0%)	24 (2.4%)	2 (0.2%)	155 (15.3%)	1014 (100%)
Nov, 2014	101 (11.7%)	0 (0%)	1 (0.2%)	4 (0.5%)	2 (0.3%)	8 (1%)	15 (1.8%)	21 (2.5%)	69 (8%)	261 (30.3%)	69 (8%)	89 (10.4%)	77 (9%)	40 (4.7%)	1 (0.2%)	1 (0.2%)	0 (0%)	0 (0%)	12 (1.4%)	0 (0%)	93 (10.8%)	864 (100%)
Dec, 2014	85 (12%)	0 (0%)	1 (0.2%)	3 (0.5%)	1 (0.2%)	3 (0.5%)	18 (2.6%)	21 (3%)	66 (9.3%)	191 (26.8%)	69 (9.7%)	70 (9.9%)	51 (7.2%)	38 (5.4%)	0 (0%)	4 (0.6%)	0 (0%)	3 (0.5%)	6 (0.9%)	2 (0.3%)	82 (11.5%)	714 (100%)
Jan, 2015	110 (12.1%)	0 (0%)	0 (0%)	2 (0.3%)	2 (0.3%)	8 (0.9%)	22 (2.5%)	30 (3.3%)	74 (8.2%)	160 (17.6%)	105 (11.6%)	110 (12.1%)	87 (9.6%)	78 (8.6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	21 (2.4%)	3 (0.4%)	98 (10.8%)	910 (100%)
Feb, 2015	108 (13.4%)	0 (0%)	3 (0.4%)	6 (0.8%)	2 (0.3%)	9 (1.2%)	14 (1.8%)	22 (2.8%)	72 (9%)	141 (17.5%)	100 (12.5%)	94 (11.7%)	73 (9.1%)	56 (7%)	2 (0.3%)	1 (0.2%)	0 (0%)	0 (0%)	15 (1.9%)	2 (0.3%)	86 (10.7%)	806 (100%)
Mar, 2015	116 (12.3%)	0 (0%)	0 (0%)	1 (0.2%)	2 (0.3%)	8 (0.9%)	30 (3.2%)	23 (2.5%)	62 (6.6%)	233 (24.6%)	105 (11.1%)	121 (12.8%)	78 (8.3%)	63 (6.7%)	2 (0.3%)	5 (0.6%)	0 (0%)	1 (0.2%)	11 (1.2%)	2 (0.3%)	85 (9%)	948 (100%)
Apr, 2015	123 (14.2%)	0 (0%)	2 (0.3%)	3 (0.4%)	1 (0.2%)	12 (1.4%)	14 (1.7%)	35 (4.1%)	62 (7.2%)	166 (19.2%)	70 (8.1%)	169 (19.5%)	49 (5.7%)	55 (6.4%)	1 (0.2%)	4 (0.5%)	0 (0%)	0 (0%)	11 (1.3%)	0 (0%)	91 (10.5%)	868 (100%)
May, 2015	181 (18.1%)	0 (0%)	1 (0.1%)	5 (0.5%)	2 (0.2%)	11 (1.1%)	23 (2.3%)	34 (3.4%)	60 (6%)	195 (19.5%)	79 (7.9%)	175 (17.5%)	52 (5.2%)	50 (5%)	1 (0.1%)	2 (0.2%)	0 (0%)	0 (0%)	12 (1.2%)	0 (0%)	118 (11.8%)	1001 (100%)
Jun, 2015	276 (25.6%)	0 (0%)	0 (0%)	4 (0.4%)	2 (0.2%)	12 (1.2%)	16 (1.5%)	27 (2.5%)	59 (5.5%)	231 (21.4%)	88 (8.2%)	136 (12.6%)	70 (6.5%)	32 (3%)	4 (0.4%)	3 (0.3%)	0 (0%)	0 (0%)	13 (1.3%)	0 (0%)	107 (10%)	1080 (100%)
Jul, 2015	287 (22.9%)	0 (0%)	0 (0%)	2 (0.2%)	0 (0%)	11 (0.9%)	23 (1.9%)	30 (2.4%)	70 (5.6%)	396 (31.6%)	86 (6.9%)	118 (9.4%)	76 (6.1%)	40 (3.2%)	5 (0.4%)	2 (0.2%)	0 (0%)	1 (0.1%)	16 (1.3%)	1 (0.1%)	93 (7.4%)	1257 (100%)
Aug, 2015	155 (16.1%)	0 (0%)	1 (0.2%)	1 (0.2%)	1 (0.2%)	9 (1%)	19 (2%)	29 (3.1%)	66 (6.9%)	287 (29.8%)	92 (9.6%)	109 (11.3%)	64 (6.7%)	41 (4.3%)	0 (0%)	7 (0.8%)	0 (0%)	0 (0%)	11 (1.2%)	0 (0%)	73 (7.6%)	965 (100%)
Sep, 2015	98 (13.2%)	0 (0%)	0 (0%)	2 (0.3%)	1 (0.2%)	9 (1.3%)	8 (1.1%)	14 (1.9%)	73 (9.8%)	199 (26.7%)	76 (10.2%)	72 (9.7%)	63 (8.5%)	36 (4.9%)	1 (0.2%)	6 (0.9%)	0 (0%)	0 (0%)	22 (3%)	0 (0%)	68 (9.1%)	748 (100%)
Oct, 2015	101 (13.9%)	0 (0%)	0 (0%)	4 (0.6%)	0 (0%)	11 (1.6%)	15 (2.1%)	16 (2.2%)	69 (9.5%)	213 (29.2%)	52 (7.2%)	90 (12.4%)	47 (6.5%)	42 (5.8%)	0 (0%)	3 (0.5%)	0 (0%)	0 (0%)	3 (0.5%)	0 (0%)	65 (8.9%)	731 (100%)
Nov, 2015	119 (13.7%)	0 (0%)	0 (0%)	1 (0.2%)	0 (0%)	10 (1.2%)	19 (2.2%)	27 (3.2%)	79 (9.1%)	302 (34.8%)	67 (7.8%)	93 (10.7%)	45 (5.2%)	42 (4.9%)	1 (0.2%)	3 (0.4%)	0 (0%)	0 (0%)	11 (1.3%)	1 (0.2%)	50 (5.8%)	870 (100%)
Dec, 2015	95 (13.2%)	0 (0%)	0 (0%)	3 (0.5%)	2 (0.3%)	11 (1.6%)	9 (1.3%)	16 (2.3%)	75 (10.4%)	209 (28.9%)	64 (8.9%)	75 (10.4%)	63 (8.7%)	22 (3.1%)	0 (0%)	1 (0.2%)	0 (0%)	0 (0%)	14 (2%)	3 (0.5%)	63 (8.7%)	725 (100%)
Jan, 2016	101 (13.7%)	0 (0%)	1 (0.2%)	2 (0.3%)	2 (0.3%)	10 (1.4%)	19 (2.6%)	20 (2.8%)	60 (8.2%)	166 (22.5%)	83 (11.3%)	89 (12.1%)	62 (8.4%)	38 (5.2%)	1 (0.2%)	3 (0.5%)	0 (0%)	0 (0%)	14 (1.9%)	0 (0%)	68 (9.3%)	739 (100%)
Feb, 2016	78 (12%)	0 (0%)	0 (0%)	3 (0.5%)	2 (0.4%)	11 (1.7%)	14 (2.2%)	22 (3.4%)	71 (10.9%)	141 (21.6%)	62 (9.5%)	84 (12.9%)	65 (10%)	21 (3.3%)	2 (0.4%)	1 (0.2%)	0 (0%)	0 (0%)	11 (1.7%)	1 (0.2%)	64 (9.9%)	653 (100%)

Continued

Table II (Continued). Number of diagnosis classified by ICD-10.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVIII	XVIII	XIX	XX	Others	Total
Mar, 2016	279 (21.2%)	0 (0%)	2 (0.2%)	4 (0.4%)	1 (0.1%)	6 (0.5%)	19 (1.5%)	39 (3%)	100 (7.6%)	249 (18.9%)	144 (11%)	127 (9.7%)	156 (11.9%)	81 (6.2%)	2 (0.2%)	1 (0.1%)	0 (0%)	0 (0%)	15 (1.2%)	5 (0.4%)	88 (6.7%)	1318 (100%)
Apr, 2016	487 (22.9%)	0 (0%)	0 (0%)	8 (0.4%)	3 (0.2%)	12 (0.6%)	24 (1.2%)	64 (3.1%)	108 (5.1%)	451 (21.2%)	210 (9.9%)	226 (10.7%)	213 (10%)	132 (6.2%)	2 (0.1%)	10 (0.5%)	0 (0%)	1 (0.1%)	34 (1.6%)	3 (0.2%)	144 (6.8%)	2132 (100%)
May, 2016	632 (24.2%)	0 (0%)	0 (0%)	9 (0.4%)	1 (0.1%)	19 (0.8%)	44 (1.7%)	68 (2.6%)	138 (5.3%)	548 (21%)	235 (9%)	300 (11.5%)	255 (9.8%)	170 (6.5%)	2 (0.1%)	9 (0.4%)	0 (0%)	1 (0.1%)	47 (1.8%)	4 (0.2%)	138 (5.3%)	2620 (100%)
Jun, 2016	780 (32.1%)	0 (0%)	1 (0.1%)	3 (0.2%)	1 (0.1%)	19 (0.8%)	21 (0.9%)	59 (2.5%)	134 (5.6%)	511 (21%)	196 (8.1%)	218 (9%)	202 (8.3%)	141 (5.8%)	6 (0.3%)	11 (0.5%)	0 (0%)	1 (0.1%)	33 (1.4%)	8 (0.4%)	91 (3.8%)	2436 (100%)
Jul, 2016	577 (25.4%)	0 (0%)	1 (0.1%)	4 (0.2%)	5 (0.3%)	25 (1.1%)	32 (1.5%)	61 (2.7%)	130 (5.8%)	578 (25.5%)	178 (7.9%)	209 (9.2%)	211 (9.3%)	148 (6.6%)	4 (0.2%)	6 (0.3%)	0 (0%)	2 (0.1%)	26 (1.2%)	3 (0.2%)	74 (3.3%)	2274 (100%)
Aug, 2016	530 (24.9%)	0 (0%)	1 (0.1%)	8 (0.4%)	4 (0.2%)	26 (1.3%)	51 (2.4%)	54 (2.6%)	119 (5.6%)	559 (26.2%)	161 (7.6%)	189 (8.9%)	207 (9.7%)	97 (4.6%)	5 (0.3%)	1 (0.1%)	0 (0%)	3 (0.2%)	29 (1.4%)	4 (0.2%)	89 (4.2%)	2137 (100%)
Sep, 2016	467 (23.9%)	0 (0%)	1 (0.1%)	4 (0.3%)	0 (0%)	21 (1.1%)	34 (1.8%)	50 (2.6%)	129 (6.6%)	557 (28.5%)	137 (7%)	138 (7.1%)	177 (9.1%)	97 (5%)	4 (0.3%)	3 (0.2%)	0 (0%)	2 (0.2%)	19 (1%)	0 (0%)	119 (6.1%)	1959 (100%)
Oct, 2016	359 (18.8%)	0 (0%)	0 (0%)	3 (0.2%)	1 (0.1%)	27 (1.5%)	26 (1.4%)	39 (2.1%)	128 (6.7%)	626 (32.7%)	162 (8.5%)	183 (9.6%)	132 (6.9%)	92 (4.9%)	2 (0.2%)	1 (0.1%)	0 (0%)	1 (0.1%)	18 (1%)	4 (0.3%)	112 (5.9%)	1916 (100%)
Nov, 2016	354 (19.2%)	0 (0%)	0 (0%)	4 (0.3%)	1 (0.1%)	23 (1.3%)	18 (1%)	46 (2.5%)	132 (7.2%)	613 (33.1%)	157 (8.5%)	148 (8%)	141 (7.7%)	98 (5.3%)	3 (0.2%)	6 (0.4%)	0 (0%)	7 (0.4%)	17 (1%)	3 (0.2%)	82 (4.5%)	1853 (100%)
Dec, 2016	266 (16.6%)	2016 (0%)	1 (0.1%)	1 (0.1%)	2 (0.2%)	23 (1.5%)	20 (1.3%)	47 (3%)	135 (8.5%)	504 (31.5%)	157 (9.8%)	153 (9.6%)	118 (7.4%)	83 (5.2%)	4 (0.3%)	0 (0%)	0 (0%)	7 (0.5%)	18 (1.2%)	1 (0.1%)	63 (4%)	1603 (100%)
Jan, 2016	355 (18.5%)	0 (0%)	0 (0%)	57 (3%)	4 (0.3%)	24 (1.3%)	39 (2.1%)	39 (2.1%)	128 (6.7%)	420 (21.8%)	205 (10.7%)	182 (9.5%)	180 (9.4%)	111 (5.8%)	6 (0.4%)	8 (0.5%)	0 (0%)	92 (4.8%)	15 (0.8%)	6 (0.4%)	56 (3%)	1927 (100%)
Feb, 2016	284 (15.5%)	0 (0%)	1 (0.1%)	93 (5.1%)	3 (0.2%)	19 (1.1%)	20 (1.1%)	38 (2.1%)	110 (6%)	310 (16.9%)	164 (9%)	222 (12.1%)	20 (1.1%)	91 (5%)	7 (0.4%)	10 (0.6%)	0 (0%)	247 (13.5%)	18 (1%)	5 (0.3%)	177 (9.7%)	1839 (100%)
Mar, 2016	606 (24.9%)	0 (0%)	1 (0.1%)	191 (7.9%)	2 (0.1%)	22 (1%)	20 (0.9%)	46 (1.9%)	121 (5%)	424 (17.4%)	183 (7.5%)	307 (12.6%)	10 (0.5%)	109 (4.5%)	20 (0.9%)	11 (0.5%)	0 (0%)	180 (7.4%)	19 (0.8%)	2 (0.1%)	167 (6.9%)	2441 (100%)
Apr, 2016	616 (28.8%)	0 (0%)	0 (0%)	160 (7.5%)	0 (0%)	16 (0.8%)	28 (1.4%)	42 (2%)	96 (4.5%)	324 (15.2%)	130 (6.1%)	226 (10.6%)	10 (0.5%)	80 (3.8%)	4 (0.2%)	3 (0.2%)	0 (0%)	234 (11%)	17 (0.8%)	1 (0.1%)	152 (7.2%)	2139 (100%)
May, 2016	520 (21.5%)	0 (0%)	3 (0.2%)	191 (7.9%)	2 (0.1%)	23 (1%)	35 (1.5%)	54 (2.3%)	102 (4.3%)	433 (17.9%)	165 (6.9%)	311 (12.9%)	16 (0.7%)	168 (7%)	12 (0.5%)	3 (0.2%)	0 (0%)	242 (10%)	22 (1%)	2 (0.1%)	120 (5%)	2424 (100%)
Jun, 2016	233 (10.6%)	0 (0%)	1 (0.1%)	172 (7.9%)	1 (0.1%)	21 (1%)	21 (1%)	45 (2.1%)	97 (4.5%)	680 (30.9%)	138 (6.3%)	265 (12.1%)	4 (0.2%)	104 (4.8%)	8 (0.4%)	7 (0.4%)	0 (0%)	201 (9.2%)	21 (1%)	0 (0%)	184 (8.4%)	2203 (100%)
Jul, 2016	231 (9.4%)	1 (0.1%)	0 (0%)	235 (9.6%)	1 (0.1%)	20 (0.9%)	33 (1.4%)	60 (2.5%)	105 (4.3%)	847 (34.3%)	171 (7%)	184 (7.5%)	9 (0.4%)	117 (4.8%)	6 (0.3%)	5 (0.3%)	0 (0%)	190 (7.7%)	23 (1%)	1 (0.1%)	233 (9.5%)	2472 (100%)
Aug, 2016	174 (6.7%)	0 (0%)	0 (0%)	193 (7.5%)	1 (0.1%)	26 (1.1%)	44 (1.7%)	48 (1.9%)	121 (4.7%)	1002 (38.6%)	167 (6.5%)	207 (8%)	10 (0.4%)	122 (4.7%)	5 (0.2%)	5 (0.2%)	0 (0%)	217 (8.4%)	32 (1.3%)	0 (0%)	224 (8.7%)	2598 (100%)
Sep, 2016	170 (9%)	1 (0.1%)	0 (0%)	191 (10%)	0 (0%)	17 (0.9%)	67 (3.6%)	35 (1.9%)	128 (6.8%)	491 (25.8%)	123 (6.5%)	207 (10.9%)	4 (0.3%)	119 (6.3%)	6 (0.4%)	2 (0.2%)	0 (0%)	153 (8.1%)	23 (1.3%)	5 (0.3%)	168 (8.8%)	1910 (100%)

Table III. The top five disease entities by year.

	2013	2014	2015	2016	2017
1	X (31.1)	X (24.5)	X (32.8)	X (22.6)	X (31.4)
2	I (16.7)	O (17.5)	I (16.7)	O (15.1)	O (17.0)
3	XI (11.3)	I (13.7)	O (13.6)	I (13.5)	I (15.8)
4	O (10.6)	XII (11.8)	XI (11.8)	XII (11.3)	XII (11.7)
5	XII (10.3)	XI (8.9)	XII (11.3)	XI (8.7)	XI (11.2)

*All disease entities are classified by WHO ICD-10 (I: Certain infectious and parasitic diseases, X: Diseases of the respiratory system, XI: Diseases of the digestive system, XII: Diseases of the skin and subcutaneous tissue and O for others which was input by Ugandan health professionals). *Numbers in parenthesis represent the percentage of each disease entity.

public health. It serves as a firm ground for policy-makers and local health professionals to organize utility-maximizing health projects under given circumstances. Using EMR in limited-resource settings makes it easy to provide valuable statistics in remote areas for different stakeholders to design and evaluate health projects.

Looking at prevalence alone, diseases of the respiratory system (top in Table III) maybe the top priority for aid workers under limited resources. Graph 1 serves as evidence that actions, such as applying insecticides or distributing bed nets before the likely increase sea-

sonal prevalence of malaria could significantly benefit local health.

One important shortcoming of this research is that the data input was done by a local clinical officer and a nurse who are qualified but may have a limited understanding of ICD-10 and making a diagnosis than would doctors. For the given study period, 2013-2017, 10.6-17.0% of diagnoses were classified as “others”. The statistics could have been more accurate with more specific diagnoses.

Another disadvantage of the research is that not all village names were entered accurately. As of now, there were almost 3,000 village names in the system, but some names are highly likely to mean the same village. For example, Juma, Jumaa, Jumma, Zuma, Zumaa, and Zumma may all represent the same village. This is due to the lack of accurate input of village names at the registration desk. Overcoming such limitations will enable us to analyze some important disease incidences by villages. The data can serve government officials and charity organizations to priorities respective villages and diseases at specific times.

Conclusions

On a personal and clinic level, EMRs build trust between patients and clinicians by en-

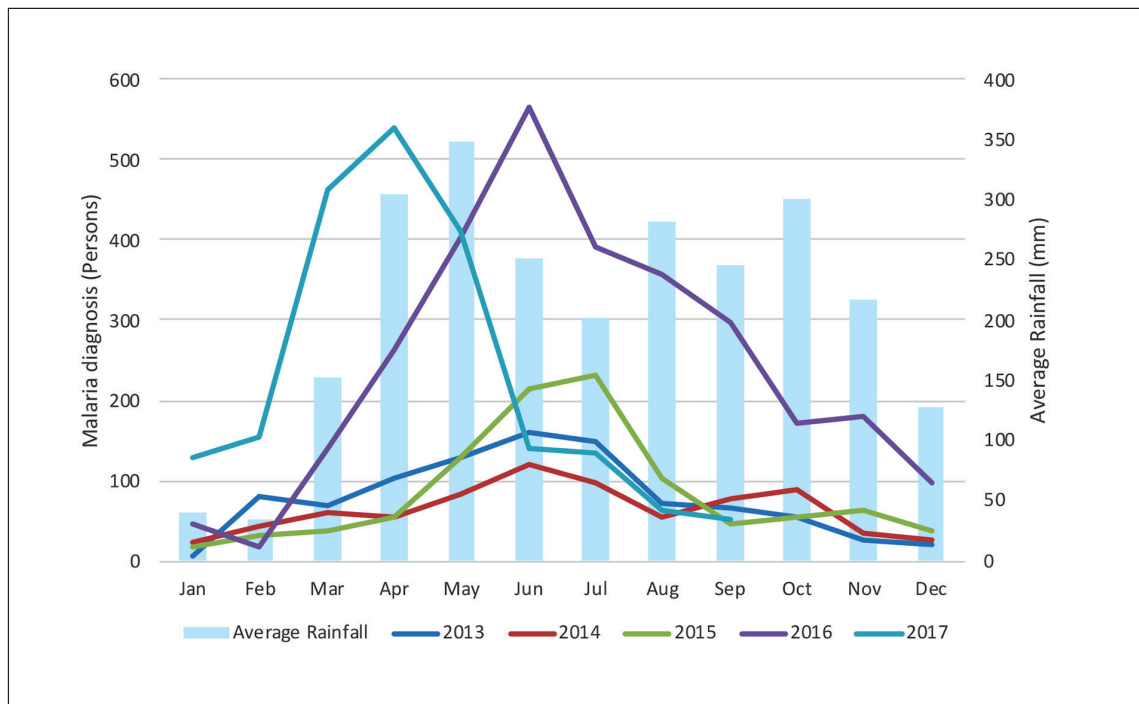


Figure 6. Number of Malaria diagnosed and average rainfall.

sure rapid, accurate, and safe diagnoses and treatment that improves patients' quality of life. At community level, EMRs improve social and economic outcomes by promoting community health, facilitating targeted interventions to minimize the negative impact of disease on community life. Globally, EMRs help countries deliver on Sustainable Development Goals (SDG) 3, 'Ensure healthy lives and promote well-being for all at all ages', SDG 10, 'Reduce inequality within and among countries', and SDG 17, 'Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Authors' Contribution

S.H.H, P.S. and J.I.S. designed the study, coordinated data acquisition, analyzed and interpreted the data, and drafted the manuscript. All authors read and approved the final manuscript.

Compliance with Ethical Standards

The study protocol was approved by the Institutional Review Board of the Yonsei University Health System (IRB No. 4-2017-0728). We were given exemption from getting informed consents by the IRB because the present study is a retrospective study and personal identifiers were completely removed and the data were analyzed anonymously. Our study was conducted according to the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

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