Project Title: Employing eHealth to Enhance Equity in Access to and Quality of Chronic Care Services in Primary Health Care in Lebanon

IDRC Project Number-Component Number: 106229-008

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Country/Region: Lebanon

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Report Type and #: Final Technical Report

Date: May 23, 2017

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II. Executive summary

In Lebanon, the increasing chronic disease burden, in the general public and among pregnant women, is further aggravated among disadvantaged populations in rural areas and Palestinian refugee camps; a high proportion of residents lack equitable and sustainable access to necessary services for chronic illnesses. This project aimed to enhance the equity in access to quality preventive and curative primary health care (PHC) services in Lebanon through the employment of low-cost eHealth approaches/tools as a cornerstone strategy in an intervention that couples proactive health systems approach with community-based health interventions. The e-Sahha (Arabic word for eHealth) intervention had two components: (1) PHC center-based, in which eHealth targeted the providers and patients (including pregnant women) suffering from diabetes and hypertension treated in these centers, and (2) community-based targeting enhancing access among underserved populations. The intervention was assessed through its effect on: (1) disease detection rates and referrals; (2) patient compliance with treatment regimens (compliance with visits); (3) quality indicators; (4) provider and patient views on the utility of the employed eHealth strategies. A Cost Consequence Analysis (CCA) of applying such eHealth interventions in such a context is currently underway and results will be shared in a scientific paper.

Key conclusions:

- The e-Sahha intervention effectively reached its target population of residents of rural areas and Palestinian refugee camps, engaging both men and women above the age of 40 years. There was genuine acceptability of the intervention across all stakeholders involved.
- The community-based intervention allowed us to identify undiagnosed cases of diabetes and hypertension and those who were not following-up with a regular provider. Hence, remote referrals to PHC centers (PHCCs) were generated in order to facilitate the uptake of Non-Communicable Diseases (NCDs) services in underserved areas.
- All screened pregnant women were following-up regularly with their providers and a minority was suspected to have gestational diabetes. Therefore, the bulk of the intervention was on diabetes and hypertension among men and women above the age of 40 years.
- 63% of the 278 referred individuals responded to a phone survey in which 37.1% reported not showing up to scheduled appointments. This finding on compliance with visits falls within the range of the US no-show rate (5%-55%).
- Our phone surveys enhanced the understanding of the reasons for not showing up for scheduled appointments and reflected the specific arrangements needed to get referred individuals to the PHCCs.
- As for quality indicators, only in the intervention group that received SMS messages, statistically significant improvements were noted in clinical outcomes among diabetic and hypertensive patients in Lebanese rural areas and Palestinian refugee camps.
    - A significant increase in BP control was observed in the intervention group from pre- to post-test periods (58.2% to 63.6%, p= 0.03), which was not replicated in the control group (p=0.37).

- A significant drop in the mean SBP was observed among the intervention group (from 133.7±16.1 mmHg pre-test to 131.8±15.8 mmHg post-test, p=0.02), but not in the control group (p=0.65).
- The proportion of HbA1c poor control decreased significantly in the intervention group from 28.2% at pre-test to 20.3% at post-test (p=0.02), while it remained unchanged in the control group (21.8% vs 22.2%, p=0.93).
- A significant reduction in the mean HbA1c was noted in the intervention group (from 8.00±1.9% to 7.2±2.1%, p<0.01), but not in the control group (p=0.88).

- The regression models revealed that participants living in rural areas reported lower odds of BP control compared to patients living in refugee camps in both study groups (OR=0.31, 95%CI 0.24-0.40 intervention group, OR=0.22 95%CI 0.15-0.30 control group, p<0.01 for both). In contrast, patients living in rural areas had a lower HbA1c score in intervention group (beta=-0.65±0.19%, p<0.01) and were also at higher odds of conforming to HbA1c testing guidelines in both study groups as compared to Palestinian refugee camps participants (OR=4.43 for intervention, and OR=2.22 for control , p<0.01 for both).
- The patient-side eHealth intervention had a positive impact on patients' access to health information and access to care. This was reflected through patients' views on the employed eHealth strategies. Weekly SMSs were viewed by recipients as easy to read and useful (93.9% for both) and 76.9% reported applying SMSs in their daily lives. Reminder SMSs were also found to be useful (93.1%).
- The impact of the e-Sahha SMSs was examined through the last question in the phone survey questionnaire about the perceived improvement in self-management or lifestyle modifications. Although only 29.6% of respondents confirmed perceiving behavior change to a great extent (and 51.5% had somewhat improvement), yet this percentage is realistic as it would have reflected social-desirability bias if it was higher.
- Participants residing in Palestinian refugee camps reported higher levels of SMSs application compared to respondents from Lebanese rural areas (82.3% and 72.9%, respectively; p= 0.004). Similarly, there was a significant difference in behavior change across setting, whereby 32.7% of respondents from refugee camps reported perceived lifestyle modifications/behavior change, compared to 27.4% of respondents from rural areas (p<0.001).
- The impact of SMSs was based on respondents' self-reported reflections on how the e-Sahha SMSs may have changed their behavior. As such, the majority of respondents expressed gratitude for the help they received in making healthy food choices as well as in improving their diabetes and hypertension self-management and treatment compliance.
- All patients participating in five focus group discussions enjoyed the SMS service, shared their satisfaction with its content, easiness, frequency and timing, as well as requested to continue receiving SMSs in the future as they are acceptable and effective in inducing behavior change, in terms of lifestyle modifications.
- The provider-side eHealth intervention also had a positive impact on its beneficiaries. Providers reported that the three types of integrated eHealth tools (online modules, peer-to-peer education platform and questions from practice) were very useful/useful in providing care to patients, and very effective/effective in managing patients' diseases. 80.0% of providers reported practice

change as a result of the eHealth tools and 86.7% reported recommending the program to their peers

- This project represents a key pilot test assessing the relevance of employing eHealth strategies in the context of Lebanon before the actual implementation of the national eHealth policy in Lebanon[1].

The e-Sahha project has a good chance of being sustained and scaled-up as: 1) participating policymakers and research partners from the MOPH and the UNRWA showed great commitment to the project activities and wish to continue; 2) all developed eHealth tools will be provided in-kind to the all MoPH and UNRWA PHCCs across Lebanon; 3) the MOPH showed strong interest and committed to scaling up the system to invest in the implementation of the same intervention in other PHCCs in Lebanon, if the findings of the pilot intervention proved favorable; 4) participating patients were eager to continue the service; 5) providers were satisfied with the eHealth intervention integrated into the existing information system in PHCCs and reported practice change and recommending program to peers.

[1] The MoPH in Lebanon has been working on the national eHealth policy for many years. Yet, no policy has been officially launched and the country still lacks nationally adopted standards for eHealth and Telemedicine. However, the MoPH has established its National E-Health programme, the MOPH Mobile Application, the MOPH Website (Drugs Section), the Interoperability with the Ministry of Education and Higher Education, and Lebanon Health Net. The opportunities for adopting eHealth and mainly mHealth is the large number of cell phone subscribers in Lebanon (>92%), the high usage of internet on cell phones, the high penetration of social networks among internet users, the high levels of smartphones penetration and Mobile internet access across smartphone owners. Sources: http://www.moph.gov.lb/userfiles/files/Programs%26Projects/NationalE-healthProgram/E-Health%20Solutions-2014.pdf and http://www.who.int/goe/publications/atlas/lbn.pdf

III. The research problem

NCDs, principally regarded as diseases of the rich and prevalent in high-income countries, have now become more common in low- and middle-income countries (LMICs) affecting less privileged populations [1, 2]. NCDs are estimated to account for about 80% of the global burden of disease by 2020, unless serious actions are taken [3].

In Lebanon, a LMIC, chronic diseases constitute an important public health burden. This burden is further aggravated among disadvantaged populations in rural areas and in Palestinian refugee camps in Lebanon where a high proportion of residents lack equitable and sustainable access to necessary services for chronic illnesses. The geographic inequity in demand and supply for chronic illnesses services in Lebanon carries another dimension related to gender, common among most LMICs. It relates to diabetes and hypertension screening and treatment among pregnant women. This is of particular concern among disadvantaged population, rural settings and refugee camps, where pregnant women receive lower rates of prenatal care as opposed to urban setting [4].

Vigorous attempts to tackle and ameliorate the expanding burden of NCDs have been taking place [5, 6]; nevertheless, health systems in the region require further reinforcement through innovative models of care that advance cost-effective interventions [7, 8, 9]. eHealth is such an approach that has generated considerable global interest as a transformative factor in health care [10]. Yet, there is still a substantial gap between the postulated and empirically demonstrated evidence benefits of the implementation of eHealth technologies in the resources-poor contexts and rural areas of LMICs, especially employing a primary care approach involving community and PHC centers-focused interventions.

This project aims to enhance the equity in access to quality preventive and curative primary health care services in Lebanon through the employment of low-cost eHealth approaches/tools targeting the supply and demand of primary health care services. Specifically, it targets individuals suffering from chronic diseases, namely diabetes and hypertension, with particular attention to pregnant women.

The specific objectives of the project were to:

- Assess the outcome of community-based interventions employing eHealth strategies on enhancing equity in demand for and access to chronic care services in rural settings and refugee camps
- Evaluate the perceived utility of and satisfaction with eHealth applications integrated in service delivery among primary care providers and service users in rural settings and refugee camps in Lebanon
- Evaluate the impact of eHealth interventions targeting providers and patients in enhancing compliance with care protocols in rural settings and refugee camps
- Determine the effect of eHealth interventions on the quality of diabetes and hypertension care in rural settings and refugee camps in Lebanon among the general public including pregnant women
- Evaluate the effect of a community-based participatory approach (shared governance) on enhancing demand for and access to chronic care services in rural settings and refugee camps
- Estimate the benefits and costs of employing eHealth interventions to enhance the equity in access to quality preventive and curative primary health care services in Lebanon

IV. Progress towards milestones

The project was initiated on July 23, 2013. The following project milestones (as specified in the grant agreement) were completed during the entire reporting period (July 23, 2013-May 23, 2017):

1. **Milestone 1:**
   The first technical progress report and the first financial report covering the first 6 months of the research work (July 2013-January 2014) were submitted in their respective due times. The technical report incorporated suggestions from IDRC and the feedback received, namely from Mrs. Chaitali Sinha. As a result of the submitted reports, the first payment was received from IDRC.

2. **Milestone 2:**
   The 2nd technical progress report and the 2nd financial report covering the 7th to 12th months of the research work (January –July 2014) were submitted in their respective due times. In this technical report, the research team shared with IDRC the final e-Sahha logo, a description of the pilot testing and the changes to be made post this phase, as well as the modified project schedule/timeline from July 2014 until July 2015. As a result of the submitted reports, the 2nd payment was received from IDRC.

3. **Milestone 3:**
   The 3rd technical progress report and the 3rd financial report covering the 13th to 24th months of the research work (July 2014-July 2015) were submitted in their respective due times. In this technical report, the research team shared with IDRC a description of the project activities that took place since the initiation of the intervention phase, the formulated SMS messages to be sent to patients, and the quality indicators that were collected at baseline (pretest). The research team also requested from IDRC to transfer funds from the Year 2 Budget to the Year 3 Budget and transfer funds from specific line items to another
   As a result of the submitted reports, the 3rd payment was received from IDRC.

4. **Milestone 4:**
   This milestone was not specified in the grant agreement as the project was expected to end on July 2016. There have been some unintended delays in the community outreach phase leading us to postpone some of the activities that follow. Therefore, two separate no-cost extensions were requested from and approved by IDRC. The first extension was till January 23, 2017 and the second till May 23, 2017.
   As a result, instead of submitting the final technical report in July 2016, the 4th technical progress report and the 4th financial report covering the 25th to 36th months of the research work (July 2015-July 2016) were submitted in their respective due times. In this technical report, the research team shared with IDRC a description of the project activities that took place during the intervention period since the previous reporting period. The team shared the findings/outputs generated from the activities described in the 3rd technical report and highlighted the activities that will take place during the posttest intervention phase (i.e. assessing the satisfactions of both patients and health care providers with the employed eHealth strategies). The team confirmed to proceed with analyzing all data generated from project's activities.

The amount of certain expenditures was forecasted to be slightly divergent for the period July 2016-January 2017 than initially expected in the project Year 3 budget. Consequently, in June 2016, the project team requested to transfer funds from one line item to another.

5. **Milestone 5:**
The final technical report and the final financial report covering the 37th to 46th months of the research work (July 2016-May 2017) are now being submitted according to their deadline. In this final report, the research team will be disseminating the results of all completed project activities. The final financial report will cover all funds expended on the project since its inception.

V. Synthesis of research results and development outcomes

The analysis of outcomes is presented in Table 1 by each project research objective.

Table 1: Synthesis of the main research results by objective

Objective	Project Activity	Main Research Results	Impact
Specific objective 1: *To assess the outcome of community-based interventions employing eHealth strategies on enhancing equity in demand for and access to chronic care services in rural settings and refugee camps*	The eHealth assisted community-based intervention targeted enhancing access among underserved populations. This was achieved through community screening for diabetes and hypertension in the catchment area of eight PHC intervention centers entailing 5 MOPH centers and 3 UNRWA centers. The screening activities were coupled with an online scheduling system for remote referrals to PHCCs.	• Among the 3,481 screened individuals, diabetes, hypertension and comorbidity were detected in 184, 356 and 113 per 1,000 individuals; respectively. • Absence of a regular provider was mostly observed among individuals pre-diagnosed with diabetes (9.6%). • In total, 278 remote referrals were generated based on a diseases suspicion or pre-diagnosis with no regular provider. • 63% of the 278 referred individuals responded to a phone survey in which 37.1% reported not showing up to scheduled appointments. • Reasons for no-show were feeling better/symptoms	Study findings demonstrated the effectiveness of employing low-cost eHealth netbook application in identifying new cases of NCDs and establishing appropriate referrals in underserved communities where pre-diagnosed cases were not adequately followed-up. Implications for future research include the exploration of constraints impeding and enablers facilitating equitable access to NCDs' care through employment of the used eHealth tools. Such studies are key to informing decision makers about the utility of integrating eHealth technology in all PHCCs.

		resolved (36.9 %), and having another obligation (26.1 %). • 15.4% cited transportation and work arrangements as enablers for show-up. • With regards to gestational diabetes (GDB), 45 pregnant women were screened in the 8 intervention areas. Of those, only 1 was pre-diagnosed with and 2 were suspected to have GDB. The three had a regular provider which explains the fact that none was referred to PHCCs. See **Appendix A** for summarized quantitative analy sis.	
Specific objective 2: *To evaluate the perceived utility of and satisfaction with eHealth applications integrated in service delivery among primary care providers and service users in rural settings and refugee camps in Lebanon*	The PHC center-based eHealth intervention consisted of employing eHealth tools targeting: • Patients be suspected to have or suffering from diabetes and hypertension living in the catchment areas of or treated in these centers (sending weekly and reminder SMSs); • Physicians and nurses practicing in these centers (online modules for clinical guidelines and provider-patient communication strategies; and Online forums and FAQs). Patients' and providers' views on the	*Patients' views on the employed eHealth strategies:* • Out of the 1390 participants receiving SMSs, 1000 responded to the questionnaire (response rate= 71.9%). • 93.9% of respondents reading weekly SMSs found them easy to read and useful and 76.9% reported applying SMSs in their daily lives. 93.1% of those reading reminder SMSs found them useful. • In addition, 29.6% and 51.5% reported having some lifestyle modifications to a great extent and somewhat, respectively. Behavior change included reduced salt consumption, improved dietary pattern and physical	Study findings demonstrated the acceptance of people living in rural areas and Palestinian refugee camps to using eHealth in the delivery of NCDs care. Patients' and providers' views reflect that the employed eHealth tools were useful and effective. Findings from this study should be considered by decision makers at the MoPH and the UNRWA, as the employed eHealth strategies, especially SMS messages, could be easily implemented within the PHC context and adapted to suit all diabetic and hypertensive patients across all centers. Given that the proposed eHealth

	employed eHealth strategies were assessed through a posttest surveys.	activity, better compliance with medications, etc. • Patient views on the SMSs were also gathered through Focus Group Discussions held with 8-10 diabetic/hypertensive patients in each of the 5 MoPH intervention centers. Participants found the SMSs easy to understand, frequency and timing were appropriate, and the content was beneficial. • All of them shared their interest to continue receiving the SMSs in the future as they are acceptable and effective See **Appendix B** for summarized quantitative analy sis. *Providers' views on the employed eHealth strategies:* • 15 providers completed the survey at posttest and reported that the three types of eHealth tools (online modules, peer-to-peer education platform and questions from practice) were very useful/useful in providing care to patients and very effective/effective in managing patients' diseases. • 13.3% of providers were completely satisfied with online modules. On the other hand, 53.3%, 66.7% and	interventions stem from the needs of the communities served and that beneficiaries recommended the proposed eHealth tools to peers, decision makers are advised to scale-up and use mHealth as a pillar strategy for improving access to PHC, especially with the new refugee influx in Lebanon.

		53.3% of providers were somewhat satisfied with online modules, peer-to-peer education platform and questions from practice, respectively. • 80.0% of providers reported practice change as a result of the eHealth tools and 86.7% reported recommending the program to their peers See **Appendix C** for summarized quantitative analysis.	
Specific objective 3: *To evaluate the impact of eHealth interventions targeting providers and patients in enhancing compliance with care protocols in rural settings and refugee camps* **AND** **Specific objective 4:** *To determine the effect of eHealth interventions on the quality of diabetes and hypertension care in rural settings and refugee camps in Lebanon among the general public including pregnant women.*	A set of internationally recognized Quality Indicator (QIs) for diabetes and hypertension was employed (i.e. Last result of Blood Pressure (BP), Last date of eye check-up, Last visit for HbA1c testing, Last result of HbA1c, Last date of foot exam, etc.). Data was extracted for all patients meeting the inclusion criteria, who came to the centers during March 2014-2015 (pretest period) and during June 2015-2016 (posttest period). Demographic (gender, age, and telephone number) and medical information (QIs) was used.	Findings indicated that statistically significant improvements in clinical outcomes were noted among diabetic and hypertensive patients in Lebanese rural areas and Palestinian refugee camps, in the intervention group. The most pronounced effect was observed in improved BP control (from 58.2% pre- to 63.6% post-test), mean Systolic BP (133.7±16.1 pre- to 131.8±15.8 post-test), HbA1c poor control (28.2% pre- down to 20.3% post-test) and mean HbA1c (drop by 0.8%), after receiving weekly SMSs for 1 year in the intervention group. See **Appendix D** for summarized quantitative analysis.	Study findings demonstrated that the employment of SMSs can make a difference in NCDs care. The statistically significant improvements in clinical outcomes among diabetic and hypertensive patients in Lebanese rural areas and Palestinian refugee camps may reflect the effect of the eHealth tools on enhancing compliance with care protocols (i.e. annual HbA1c testing, compliance to treatment regimens, etc). The pre-post analytical plan allowed us to assess centers' performance on selected QIs. As statistically significant changes were noted in the intervention group where eHealth strategies were employed, then we can sense the impact of the employed eHealth tools on the quality of diabetes and

			hypertension care in rural settings and refugee camps in Lebanon. Given the potential benefits of mHealth, more specifically SMS-based health interventions for the management and control of chronic conditions, its implementation in the Eastern Mediterranean Region, and specifically Lebanon, is crucial.

Summarized analysis of the similarities and differences across the project's settings

A comparative analysis between rural areas and refugee camps to detect the presence of differential, if any, in the prevalence of each disease across the two target populations. No significant difference in hypertension and comorbidity detection rates when compared between rural areas and refugee camps was detected. Conversely, when diabetes detection rates were compared, a significant difference between the two settings (p= 0.046) was found, with a higher diabetes pre-diagnosis in rural areas. Individuals in refugee camps had a higher hypertension pre-diagnosis rate instead (Appendix A).

In order to test associations between the outcome of referral ("No Show-Up" and "Did Show-Up") and individuals' demographics, a bivariate analysis was performed. There was no significant difference in the latter outcomes in relation to respondents' setting (i.e. rural areas versus Palestinian refugee camps). 58.7% of respondents from rural areas reported showing up to scheduled appointments, with the remaining 41.2% reporting not showing up. As for Palestinian refugee camps, 70.49% reported showing up and 29.5% not showing up to scheduled appointments (Appendix A).

For the barriers to show-up (reasons for no-show), two common themes from both rural areas and Palestinian refugee camps emerged from phone surveys. These are Feeling better/symptoms resolved (self-deception) and having another obligation. Additionally, 15.3% of respondents needed arrangements to get to PHC centers (12.8% from rural areas and 22.2% from Palestinian refugee camps). Only work arrangements (i.e. sick leave) were needed in rural areas compared to mainly transportation arrangements in Palestinian refugee camps with very few mentioning work arrangements (Appendix A). This highlights that there is a difference in the availability of transportation across the two settings, which directly affects the equity in access to care.

When it comes to patients' views on SMSs captured through phone surveys, there were no statistically significant differences (p>0.05) across setting for the easiness and usefulness of SMSs. However, respondents residing in Palestinian refugee camps reported higher levels of SMSs application compared to respondents from Lebanese rural areas (82.3% and 72.9%, respectively; p= 0.004). Similarly, there was a significant difference in behavior change across setting, whereby 32.7% of respondents from refugee camps reported perceived lifestyle modifications/behavior change, compared to 27.4% of

respondents from rural areas ($p<0.001$). It becomes apparent that participants from Palestinian refugee camps reported applying the weekly SMSs more often and having lifestyle modifications or behavior change, as a result (Appendix B).

With regards to the impact of the eHealth tools on providers' care practice, all participating providers (n=6; 100%) from Palestinian refugee camps reported practice change as a result of the integrated eHealth tools, compared to 66.7% of those from rural areas. More so, 100% of providers from Palestinian refugee camps reported commending the program to peers with 77.8% for providers from rural areas (Appendix C). This reflects that the eHealth tools were more welcomed in Palestinian refugee camps and there was more resistance to change in rural areas. This might be due to understaffing as a significant mal-distribution of physicians exists in Lebanese rural areas where less than 10% of physicians are practicing in these settings [11]. This can also be explained by the higher workload in rural areas because of the considerable strain that the Syrian refugee influx in Lebanon is putting on host communities and resources in MoPH PHCCs. Consequently, the demand for chronic diseases' care has increased dramatically leading to long waiting times in PHCCs and causing providers to practice in more than one center, which might hinder their ability to access the eHealth tools while providing care to their patients.

The logistic regression model revealed that participants living in rural areas reported lower odds of BP control compared to patients living in refugee camps in both study groups. In contrast, patients living in rural areas had a lower HbA1c score in intervention group and were also at higher odds of conforming to HbA1c testing guidelines in both study groups as compared to Palestinian refugee camps participants (Appendix D).

The fact that BP control was better among patients living in refugee camps in both study groups might reflect the role of the UNRWA's NCD program integrated in the intervention and control centers and entailing primary, secondary and tertiary NCDs' prevention [12]. The presence of such a program at UNRWA may have enhanced the effectiveness of the mHealth interventions and facilitated improved access to services. However, as our study reveals, further efforts are needed to improve diabetes prevention and care for Palestinian refugees in regards to improving their glycemic control and treatment compliance [13] (Appendix D).

Furthermore, since conforming to HbA1c testing guidelines was better among patients from rural areas in both study groups; this echoes that the MoPH NCD program was more effective in diabetes management and control as compared to hypertension [14]. The presence of an advanced diabetes control program may have enhanced the effectiveness of the mHealth interventions employed in this study. Despite the best efforts of the research team to ensure comparable service configuration at both rural PHCCs and those at UNRWA refugee camps, it appears that the maturity of the existing programs and the service configurations at each setting played an important role in the care outcomes at the end of the study. This underlines the importance of employing integrative approaches of diseases prevention and control in which existing NCD programs in underserved communities can be coupled with innovative approaches such as mHealth to provide an amplified effect of traditional NCD-targeted care (Appendix D).

Summarized analysis of the associations with demographic characteristics

When it comes to compliance with visits, no significant difference was detected in the outcomes "No Show-Up" and "Did Show-Up" in relation to respondents' age, gender, marital status, education, setting and insurance status. Studies from the literature have noted the relation between gender and show up to appointments [15, 16], whereby men were more likely to miss appointments compared to women. This was not revealed in our study where no significant association between gender and the outcome of referral was detected. However, employment status was found to be associated with not showing-up to the appointment only when controlled for education in the backward selection model of a multivariate logistic regression analysis. This association partly explains the finding of another Lebanese study indicating that unemployed women are the greater users of PHCCs [17]. This reinforces this study's finding that employment is a barrier for showing up to appointments with employed individuals missing an appointment having higher odds than their unemployed counterparts. This calls for modifying the opening hours of PHCCs to better accommodate employed patients.

Differences between participants in their satisfaction with weekly and reminder SMSs were assessed and illustrated in Table 4 of Appendix B. For the five SMSs' satisfaction items, there were no statistically significant differences ($p>0.05$) when comparing participants' gender, marital status, employment status, insurance status and reason for SMS (diagnosis). On the contrary, younger patients aged 40-50 years reported applying SMSs more than older patients (81.6% for 40-50 years, 78.1% for 51-65, 65.5% for 66-75 and 69.8% for 76 years or more; $p= 0.026$). Furthermore, there was a statistically significant difference in the easiness, usefulness and application of SMSs across educational status ($p= 0.001$, $p=0.001$ and $p=0.033$, respectively). Those more often pointing out that SMSs are easy and useful and that they applied them in their daily lives, had a high school or a university degree. This finding confirms those of previous studies indicating that illiteracy and low education levels continue to be barriers to the use of SMSs and to reporting satisfaction with this service. The difference in behavior change across educational status was borderline significant. When comparing participants' answers according to gender, males reported slightly higher percentages than females for the five SMSs' satisfaction items, but in a non-significant manner.

In Tables 5 and 6 in Appendix D, separate regression models were run to gauge the intervention impact on the study groups whilst controlling for baseline characteristics: age, gender, and setting. Table 5 shows the results of the logistic regressions where BP control, HbA1c poor control, and annual HbA1c testing act as the dependent variables (consecutively). When considering BP control, Table 5 indicates that for the intervention group, there was a 28% increase in the odds of BP control in the post-test period as compared to the pretest period (OR = 1.28, 95%CI 1.00-1.64, $p=0.05$), independent of age, gender, and setting. The OR for study period was not statistically significant in the control group ($p=0.11$). A 38% decrease in the odds of HbA1c poor control among the intervention group from the pre-test to the post-test study period was observed (OR=0.62, 95%CI 0.39-0.97, $p=0.04$) independent of age, gender, and setting. The study period OR was not statistically significant among the control group ($p=0.26$). Females were at a lower odds of HbA1c poor control among the intervention group (OR=0.59, 95%CI 0.39-0.89, $p=0.01$), while age ORs were statistically significant for both study groups (OR=0.97 for both, $p<0.01$ and $p=0.03$, respectively). With regard to annual HbA1c testing, the results reveal that both groups had an increase in the odds of doing the test with recommended guideline

period (OR=2.52, 95%CI 1.81-3.49 for intervention, and OR=4.26, 95%CI 2.79-6.49 for control, p<0.01 for both). Age was found to be statistically associated with annual HbA1c testing (OR=0.98, p<0.01) for the intervention group.

Table 6 summarizes the regression models for mean SBP, mean DBP, and mean HbA1c. After controlling for age, gender, and setting, the mean changes in SBP and DBP across study period were not statistically significant (beta=-1.12±0.90 mmHg, p=0.21 for mean SBP intervention group, beta=-1.83±1.18 mmHg, p=0.12 mean SBP control group, beta=-0.49±0.53 mmHg, p=0.36 mean DBP intervention group, and beta=-0.90±0.65 mmHg, p=0.16 mean DBP control group). Only mean HbA1c retained statistical significance in the multivariate analysis. A mean decrease in HbA1c of 0.87% pre-test to post-test period was observed among the intervention group (beta=-0.87±0.19%, p<0.01) but not in the control group (p=0.41). This change was independent of age, gender, and setting. In the current project, it was shown that HbA1c levels and HbA1c poor control differed significantly across gender, with females in the intervention group having a lower HbA1c score (beta=-0.42±0.17%, p=0.01) and lower odds of HbA1c poor control compared with their male counterparts. Age was associated with a decrease in HbA1c, which was seen in the control group only (beta=-0.03±0.01%, p<0.01). Hence, age was not associated with a decrease in HbA1c in our study's intervention group as well, yet the odds of having HbA1c poor control decreased with age for both study groups.

What activities were not completed? Why not? How do they affect the project outputs and outcomes?

One key project activity was not completed; yet, it is currently underway. The last project's specific objective was to estimate the benefits and costs of employing eHealth interventions to enhance the equity in access to quality preventive and curative primary health care services in Lebanon. Therefore, we will be performing the Return on Investment (ROI) analysis with forecasted results for five years (factoring in inflation rates) based on study findings during the project period. This will provide strong evidence for the Ministry of Public Health (MoPH) in Lebanon and UNRWA to invest in the implementation of the same intervention in other PHCCs in Lebanon to widen the compass of health services coverage and reduce inequity. The results will be shared with these stakeholders directly and through scholarly articles sharing the results of different project activities as well.

Changes/amendments during implementation of the project. Reasons? How do they affect the project outputs and outcomes?

A key change to the project activities, made early on during the project's implementation phase after the community outreach activities, was the discontinuation of the intervention targeting pregnant women suspected to have or pre-diagnosed with gestational diabetes. 45 pregnant women were screened in the 8 intervention areas. Of those, only 1 was pre-diagnosed with and 2 were suspected to have GDB. The three had a regular provider which explains the fact that none was referred to PHCCs. As such, the eHealth assisted community-based intervention did not facilitate access of pregnant women to PHCCs. Since no referrals were generated and no beneficiaries were included in the GDB intervention, no SMSs for GDB were sent for this target group. Consequently, as we did not intervene for GDB, we did not analyze the quality indicators for GDB at posttest (this output was withdrawn).

VI. Methodology

Multiple data sources and collection methods were employed. All quantitative statistical analyses were carried out using Statistical Software Package SPSS (version 24.0). Significance levels were set at a p-value ≤0.05.

- **Community screening:**

The community-based intervention was initiated on May 11, 2015 in the 8 intervention areas. Complete screening has been achieved by August 31, 2015, except for one rural MOPH area (screening completed by November 2, 2015). A written informed consent was obtained from each household prior to the initiation of the screening and data collection activities. Using an eHealth assisted netbook application, trained CHWs conducted outreach screenings for diabetes and hypertension in the eight catchment areas of the selected PHCCs. An online appointment system was designed and implemented to allow for remote appointment scheduling. In the event that the individual is identified as highly suspected to have one or more of the screened diseases or pre-diagnosed with no follow-up with a regular provider, the patient was referred to the PHCC of the corresponding area. During community visits, referrals were made remotely through the eHealth assisted netbook application linked to the PHCC of the corresponding area. A screening and referral databases were then created serving as a data source for estimating diseases detection rates and referral rates. These databases also served as a data source for extracting the phone numbers of patients eligible for receiving weekly SMSs.

- **Phone surveys with referred individuals:**

This involved calling patients within one month of being referred from the outreach screening to visit the physician in the respective PHCCs. This survey served as a data source for assessing the rate of no-shows to scheduled appointments (or compliance to visits) and its corresponding underlying causes. The survey was conducted using phone numbers provided during the community screening. In order to increase the response rate, three attempts were established with non-respondents. 110 patients reported showing-up to scheduled appointments at the PHCCs, and the remaining 65 confirmed that they did not show-up, which only then the survey was pursued. The semi-structured questionnaire was developed in reliance on a study by Lacy et al. (2004) [18] and included the following questions: (i) What made it hard to keep the appointment with the doctor/health professional? and (ii) Do you have to make any special arrangements to get to the PHC Center? Prior to addressing the questions of the phone survey, participants' informed consent was secured.
For the analysis of phone surveys, compliance to visits was self-reported (Yes/No question) allowing us to determine the no-show rate. Quantitative data on reasons for no-show and special arrangements needed to get to the PHCCs were entered and analyzed. Showing-up to the scheduled appointment (outcome of

referral) was defined as the dependent variable in the subsequent analysis. Bivariate analysis and multivariate logistic regression using the backward selection technique were also performed to test associations between referred patients' characteristics with outcome of referral (no show-up, vs did show-up). The results will be shared in a scholarly article currently in press.

- **QI extraction:**

Performance on quality indicators (QI) was assessed in March 2015 before launching the intervention, for the period between March 2014 and March 2015. Posttest QI extraction for the same indicators took place 1 year after the implementation of the intervention (in July 2016) in both, the intervention and control sites for the period between June 2015 and June 2016. Trained data collectors were hired to collect the relevant indicators from patients' records at baseline (pretest) and after one-year of the intervention (posttest) in both, intervention and control sites.

The selection criteria required that participants should be Lebanese patients registered at the PHCCs as diabetics or hypertensive individuals and aged 40 years or more. Trained data collectors were hired to collect the relevant indicators from patients' records for all patients meeting the inclusion criteria, who came to the centers during the pretest and posttest periods. Demographic (gender, age, and telephone number) and medical information (QIs) was used (last result of BP, last result of HbA1c, smoking status, and dates of last visit for HbA1c testing and for eye check-up or foot exam).

Pearson's Chi-square test ($\chi 2$) and independent t-test were used to assess the difference in quality indicators before and after the intervention. Logistic regression was used to evaluate the impact of the intervention on HbA1c poor control, BP control, and annual HbA1c testing, while controlling for age, gender, and setting. Similarly, linear regression was used to assess the impact on mean SBP, DBP, and HbA1c while controlling for age, gender, and setting. All analyses were carried at a 0.05 significance level. The results will be shared in a scholarly article currently in press.

Pretest QI extraction was the data source for identifying reminder SMSs that were sent to patients on a monthly basis in their respective due times for follow-up and appointment reminders: reminder of the quarterly hypertension visit, of the annual foot exam for hypertensive patients, of the semi-annual check-ups for the HbA1C levels and of the annual foot exam and eye exam for diabetic patients.

- **Patients' views on the employed eHealth strategies:**

Patients' views on the employed eHealth strategies were collected through a mixed-methods research employing a phone survey based on a semi-structured questionnaire as well as a series of focus groups discussions (FGDs) with patients. The quantitative data collection was carried out between December 2016 and February 2017 after the 1-year SMS intervention, while the qualitative part was carried out during the intervention. Rather than limiting the responses to our fixed hypotheses in the quantitative analysis, the qualitative approach allowed us to formulate a deeper understanding of patients' perceptions of the usefulness of SMSs for diabetes and hypertension care, as well as satisfaction and experiences with SMSs in order to modify any component if needed.

Patients' posttest questionnaires were done through phone survey upon respondents' consent. To optimize participation, at least three attempts were made to contact all those who had still not responded. The questionnaire included 3 Likert-type questions: (1) the perceived clarity or ease of understanding of

the content of the messages (very easy-very difficult); (2) the perceived usefulness of the SMSs (very useful-not useful); (3) the frequency of SMSs' applications in the daily life (never-always). After confirming the receipt of reminder SMSs, experiences with this type of SMSs was explored through assessing their perceived usefulness (very useful-not useful). The last question was about the perceived improvement in self-management or lifestyle modifications (To a great extent-not at all). This was coupled with a free-text option to give respondents an opportunity to describe their lifestyle modifications, if any.
Answers to each individual SMSs' satisfaction item were analyzed using descriptive statistics. In the free-text option comments that captured the main content of the question with regard to the aim of the study were chosen as examples (codes) for behavior change. Bivariate analysis followed to test the association of SMSs' satisfaction items (dependent variables) with participants' characteristics (independent variables), using the chi-squared test. The results will be shared in details in a scholarly article that will be published as part of the SEARCH working group special issue.
For the data collection purpose of the qualitative part of this study, FGDs with 8-10 participants each were conducted in the five rural MoPH intervention centers. Lebanese diabetic/hypertensive patients receiving the SMSs, aged 40 years or more and inhabitants of these areas were given the opportunity to describe their views on other factors of importance that were not covered in the phone survey. A semi-structured question guide was prepared and queried on various aspects of the SMS service including structure, content, frequency and timing, advantages/disadvantages, usefulness and effectiveness, willingness to continue with or recommend the service to family and friends, and suggestions for improvements. The FGDs were transcribed verbatim and then interpreted through qualitative thematic analysis using excel coding with the grounded theory approach. Resulting codes were reviewed by three team members for consistency and analyzed for categories and themes.

- **Providers' views on the employed eHealth strategies:**

PHC center providers (physicians and nurses) from the 8 intervention centers completed two surveys at two different point in times to test their views about eHealth (pretest) and to assess their satisfaction with the employed eHealth tools (posttest):

- Pretest: 17 providers completed the survey in April 2015 during the training sessions on the integrated eHealth tools
- Posttest: 15 providers completed the survey (9 from MOPH centers and 6 from UNRWA centers) in March 2017.

Providers' views were also assessed through a survey based on a questionnaire of four items on a 5-point likert scale: (a) satisfaction with the (i) online modules (ii) and peer-education platforms (very unsatisfied-very satisfied); (b) ease of use/understanding of (i) online modules (ii) and peer-education platforms (very difficult-very easy); (c) perceived effect on quality of care delivered (much worse-much better), (d) perceived impact of provider feedback into modified governance of PHC center and (e) utility of integration of the ehealth interventions into service provision. Answers to each satisfaction item were analyzed using descriptive statistics. We could not perform a more sophisticated analysis such as regression models because of the small sample size.

VII. Project outputs

Table 2 below summarizes the project outputs along with their status (completed, in-process, etc) and their description.

Table 2: Project outputs table

Expected Output	Status	Description
Training sessions delivered to QI collectors, CHWs and providers (physicians and nurses) practicing in intervention PHCs.	Completed	With the aim of knowledge creation, different training sessions were delivered to different target groups before launching the intervention phase. QI collectors were trained on the procedure of data extraction from patients' records and on the needed quality indicators. CHWs were also trained on the process of community screening, including the way of approaching households during visits, the screening process using the purposefully designed screening kit, data entry on the netbook application, criteria for referrals to PHCCs, and all the ethical standards they need to abide to. Additionally, health care providers (physicians and nurses) practicing in intervention PHCCs were trained on the integrated eHealth tools into their health information systems and were encouraged to use them as they help in reducing professional isolation and enhancing access to updated knowledge. All data collectors and online ehealth users provided their feedback at regular intervals and guidance was provided when needed.
Scientific papers to be published from the IDRC-funded e-Sahha project	In process	Two scientific papers were completed and are currently under review. • The first titled "eHealth as a Facilitator of Equitable Access to Primary Health Care: The Case of Caring for Non-Communicable Diseases in Rural and Refugee Settings in Lebanon" is currently under review in the International Journal of Public Health. This paper examines whether the employment of low-cost eHealth tools would enhance the access of undiagnosed and non-health seekers diagnosed individuals to primary health care. The paper has two outcome measures: 1) Disease(s) Detection Rates and Referrals and 2) Compliance with Visits (No Show-Up vs. Show-Up).

		• The second titled "*Enhancing Outcomes of Non-Communicable Diseases Care in Rural Settings and Refugee Camps: Could Low-cost mHealth Interventions Make a Difference?"* is currently under review in the Journal of Medical Internet Research. This paper aims to assess performance on selected quality indicators (QIs) before and after the intervention among the control and intervention sites, and to measure the degree of change occurring as a result of the eHealth intervention, namely SMS messages sent to patients. A third scientific paper titled "Patients' Views on mHealth Use for Non-communicable Diseases Care in Primary Health: Application in Rural Settings and Refugee Camps" is currently in the writing process. This paper will be part of the SEARCH working group special issue. This paper assesses the relevance and effectiveness of mHealth use in PHC to reduce inequity in access to and quality of health care services, especially among hard-to-reach populations. We will be presenting the views and attitudes of patients in Lebanese rural areas and Palestinian refugee camps towards the use of SMSs, in terms of perceptions of satisfaction and usefulness, as well as SMSs' effects on lifestyle modifications. Additional scientific papers are planned to be produced beyond the funding period. One of the proposed papers will be exploring potential role of ehealth in PHC towards universal health coverage. Another one will investigate the cost-benefit of employing ehealth approaches in rural settings and refugee camps as a supplement to traditional primary health care. All papers produced will be freely and openly available to readers and will facilitate access to knowledge among providers, key stakeholders in the MOPH and UNRWA as well as policy-makers in Lebanon and the region.
Blog	Completed	A blog titled "Using Digital Tech To Improve Life For Refugees" was published on Huffington Post. The blog was prepared in collaboration with Mrs. Chaitali Sinha from IDRC, with the aim of showing how digital technologies - such as mobile phones and netbooks - can help to close the access and quality-of-service gaps for Palestinians in refugee

		camps and other vulnerable populations in Lebanon. It highlights that the IDRC-funded e-Sahha project was designed with a clear intention to use mobile technology, embedded in the local context, to improve the continuum of services for high-risk groups and to create the space for them to have a say in the quality of the health services they receive.
Participating in Learning Exchanges Workshops	Completed	The principal investigator (Dr. Shadi Saleh) and the co-PI (Dr. Mohamad Alameddine) participated in October 2014 in the third Global symposium on health systems research, in Cape Town, South Africa, where they presented the research findings generated from the pilot test of the e-Sahha project, which was held in one PHCC before initiating the implementation phase. Both the PI and co-PI also attended a two days of SEARCH meeting and the 4th Global Symposium on health systems research, in Vancouver, Canada in November 2016 During the SEARCH cross-grant learning and sharing workshop, Dr. Saleh facilitated a session on Scaling up e-health, where different IDRC grantees discussed potential approaches for scaling-up eHealth interventions, the role of the government/governmental agencies in scaling-up eHealth interventions and identified the facilitators and barriers to scaling-up. Other discussions were also held and each group shared the experiences stemming from its own IDRC-funded project.
Dissemination of research findings	Completed	A meeting was held with Dr. Walid Ammar, the Director General of the Ministry of Public Health, on March 29, 2017 to present the research findings. Dr. Ammar committed to play a key role in the policy dissemination activities. On April 20, 2017 a knowledge translation workshop (dissemination event) was held with key stakeholders to disseminate the intervention results share key strategic recommendations with MoPH and UNRWA stakeholders. The possible subsequent implementation in other PHCCs was discussed as attendees shared their interest, acceptance, and satisfaction with the eHealth intervention. Additionally, we plan to share the project's findings through seminars, e-conferences, and technical newsletters, if sources of funding are available.

Commitment from stakeholders for potential scale-up	In process	During the project's implementation phase, stakeholders from the MOPH and UNRWA both have formally committed their institutions to potential up-scaling of the selected eHealth interventions depending on the project's findings of effectiveness and utility. During the knowledge translation workshop (dissemination event), stakeholders from both entities were interested in the research findings and providers from intervention PHCCs shared their satisfaction with the integrated eHealth tools as well as the utility of SMS messages sent to patients. Patients living in the catchment areas of PHCCs shared with providers their admiration of the information in the SMSs and their wish to continue receiving them. At the end of the workshop, screening kits were distributed to intervention PHCCs. In order to maximize sustainability, we agreed with stakeholders that the online modules and forums as well as the computer program will be will be provided in-kind to the all MoPH and UNRWA PHCCs across Lebanon. At the national level, the knowledge generated through these meeting as well as the upcoming scientific papers will act as a catalyst to the evidence-based up-scaling of the system to invest in the implementation of the same intervention in other PHCCs in Lebanon.
Cost analysis	In process	This output was planned to be completed during the funding period, yet it still have to materialize. To enhance the uptake and assess the sustainability of this project, the financial Return on Investment (ROI) analysis that will assume the payer perspective will be conducted with forecasted results for five years (factoring in inflation rates) based on study findings during the project period. The payer in this instance is assumed to be the MoPH and UNRWA. As such, some realized benefits that are assumed to have long-term effects (e.g. complications associated with poor control of hypertension or diabetes) can be factored as such payers have a vested interest in maintaining optimal health of such a population. Based on project's findings, the e-Sahha project is anticipated to reflect an efficient intervention through the positive health outcomes and positive ROI in terms of monetary value. This will provide strong evidence for the MOPH and UNRWA to invest in the implementation of the same intervention in other PHCCs in Lebanon to widen the compass of health services coverage and reduce inequity.

		Upon completion, the results of the cost analysis will be directly shared with stakeholders in the two entities and will be submitted for publication in a scientific paper in order to add evidence to the pre-existing literature about the cost effectiveness of low-cost eHealth tools.

VIII. Problems and challenges

During project's implementation, several challenges emerged.

1. Delays in data collection

There have been some unintended delays in the community outreach phase leading us to postpone some of the activities that follow. CHWs in some areas were facing some challenges during screening activities. After meeting with them and supporting them, suggestions of the CHWs were taken into consideration and the solutions recommended assisted in completing the screening activities in a timely and efficient manner. More so, QI collection in the posttest phase was extended as we observed some problems in data collection, whereby insufficient data was collected from some centers. We were in continuous contact with QI extractors for support and daily follow-up on the progress of their work. We also conducted different field visits for auditing purposes, to make sure about the accuracy of the data collected. As a result, the delays in data collection caused some delays in data analysis and hence in the project's timeline and sharing of results. Another reason for the delays in data collection faced in Palestinian refugee camps only is that some UNRWA PHCCs have tight schedules and open twice a week only. Therefore, it was harder for us to get data from these centers given the tight schedule and the high workload in such centers.

2. Changing data collectors and building their capacities

In one of the intervention rural areas, CHWs faced some challenges during outreach visits mainly caused by some conflict of interests and some political reasons. Two CHWs withdrew from the project and hence, we had to coordinate with the municipality to recruit new individuals while making sure that the process of outreach visits is smooth for both household and CHWs. This took around one month and then we had to train the newly recruiting individuals on community screening. As for the collection of quality indicators, one of the QI collectors from rural areas was on maternity leave in the post-test. Consequently, we recruited a replacement from the same PHCC and we had to train her on the process of extracting the indicators from the system. We were always following with her over the phone on a daily basis and we went for an audit visit to ensure the accuracy of the data collected. Overall, all QI collectors were cooperative and delivered the data in the correct format and within the agreed timeline, except for one QI collector from another rural area, with whom we faced challenges in reaching her as she was not always answering our phone calls/emails. She was also postponing the data collection due to workload problems. Also, when we went for audit visit, we figured out that the data is not collected in the correct format so

we trained her again on the process and we extended the deadline for submitting the data to ensure a good quality.

3. **Phone sharing**

During screening activities and posttest satisfaction surveys, we noticed that a high percentage of women reported sharing a cell phone with their husbands or family members. As a result, not all respondents to the phone survey were beneficiaries themselves and hence not all of them reported reading the SMSs (in both rural areas and Palestinian refugee camps). For instance, 1390 beneficiaries were receiving weekly SMSs. Out of the 1000 respondents, 606 reported receiving and reading SMSs. The remaining either reported that weekly SMSs were received on the phone number of a family member who did not deliver it to the target, or SMSs were not opened due to mobile illiteracy. Yet the feedback of the 606 beneficiaries was valuable and allowed us to draw conclusions about the utility of SMS messages for diabetes and hypertension. We accounted for this by comparing the socio-demographic and clinical characteristics of these 606 cases with those of the 394 respondents reporting that SMSs were not received or not delivered. No statistical differences were generated using the chi-squared test and hence our results are unbiased.
Similarly, in both rural areas and Palestinian refugee camps, another problem faced during posttest surveys with patients was the invalid phone numbers. 390 patients did not respond to the survey after several attempts made. The majority of these had switched off mobile phone (the dialed number cannot be reached) meaning that the phone number was not in use during data collection and hence these beneficiaries were lost to follow-up.

4. **Gender representation**

The study plan has already factored in gender-oriented analysis. Those were discussed by the members of the research team. We aimed to have equal representation from both genders allowing us to draw conclusions about how gender can affect access to services and the uptake of mHealth interventions. However, the gender distribution was not always met. Females made up the majority of screened sample, which might be explained by the fact that males were working during the day. Among the trainers, the project team ensured that most CHWs had males and females among them. That made access to households easier and factored in contextual challenges. In all FGDs, we aimed at having an equal number of male and female participants, yet this was not always met since the time of day that informants were able to participate in the project is affected by their gender.
Several interaction with the different SEARCH grants were performed in order to share experiences, report key findings from each project and foster learning in relation to how to incorporate gender analysis into each project.

5. **Usability of the integrated eHealth tools**

Continuous follow-up with providers practicing in intervention PHCCs in rural areas and Palestinian refugee camps was made in order to increase the usability of the integrated eHealth tools. During the early stages of the project, providers reported low usage of these tools due to workload issues. Yet we encouraged them and supported them in utilizing these tools whenever needed. During the posttest phase, their views were collected reflecting a high satisfaction with the employed eHealth tools. Since

these surveys were self-administered and the data is self-reported we feared from report bias. Therefore, during the dissemination event we made sure that providers were really interested in these tools and want them to be integrated in PHCCs across Lebanon. As a result, they stated that they accessed the guidelines on a daily basis for updating their knowledge, yet they did not ask so many questions in the forums as the available guidelines were sufficient.

IX. Administrative reflections and recommendations

Throughout the project, the project team participated in valuable cross-grant learning activities led by IDRC and the SEARCH project teams. Several exchanges have taken place including face-to-face meetings, skype calls, webinars and emails for continuous feedback. Networking with different project teams was very important as we benefit from each other's' experiences and can reflect them in our own project. All inquiries were addressed separately through a direct exchange with Mrs. Chaitali Sinha and Mrs. Zoe Boutilier and their prompt support was highly appreciated.
More so, the exchange rate fluctuations partly affected our project. In order to address this issue, we requested the transfer of funds from line items to others to cover all our expenses. We also appreciate the support we received from IDRC in handling the issue of exchange rate fluctuations, in receiving the approvals of transferring funds, and in approving the requested no-cost extensions.

This project can be considered as a pilot study assessing the relevance and effectiveness of eHealth use in PHC to reduce inequity in access to and quality of health care services, especially among hard-to-reach populations. The experience from this project is useful in deriving lessons learned for improving future projects. These include the use of voice messaging as a supplement to SMS messaging for a better reach, especially illiterate individuals living in underserved areas. More so, it would have been beneficial if we have conducted a mid-term evaluation before the patients' posttest satisfaction surveys, as we could have detected that SMSs are not being delivered to some beneficiaries since they share mobile phones with their family members. This way we could have increased the response rate and the feedback gathered from patients on the utility of SMSs. However, a key strength was the continuous monitoring throughout the project's implementation and the gathering of beneficiaries' feedback, which is crucial to assessing the relevance of the proposed intervention to the context of Lebanon.

X. Conclusions

Overall, the e-Sahha project achieved its objectives over its 4-year term from July 2013 to May 2017. The eHealth intervention was effective in reaching its target population, diabetic and hypertensive patients living in rural areas and Palestinian refugee camps. These hard-to-reach populations were engaged in their NCD care through increasing their awareness about their health condition as well as treatment compliance. The intervention also provided newly identified chronically-ill patients with the opportunity to benefit from the continued health care provision in intervention PHCCs. There was a positive acceptability and high satisfaction with the eHealth intervention across all beneficiaries, including participants receiving SMS messages and their families, healthcare providers as well as health officials.

Participating patients were eager to continue the service and the integrated eHealth tools helped practicing care providers in centers located in underserved areas to have access to knowledge (modules and forums) to reduce the impact of professional isolation.

Contributions from the e-Sahha project demonstrate how locally driven innovations with strong community engagement can collectively address pressing health challenges by bringing life-saving information to those most in need. The employed eHealth strategies, especially SMS messages, could be easily integrated within the PHC context and adapted to suit all diabetic and hypertensive patients across all centers. Given that the proposed eHealth interventions stem from the needs of the communities served, this project can guide decision makers at the MoPH and the UNRWA in the formulation of the national eHealth policy, the scale-up and the integration of these tools within the Lebanese PHC system. Consequently, this will widen the compass of health services coverage and enhance the equity and quality of chronic care services in PHC at the national level.

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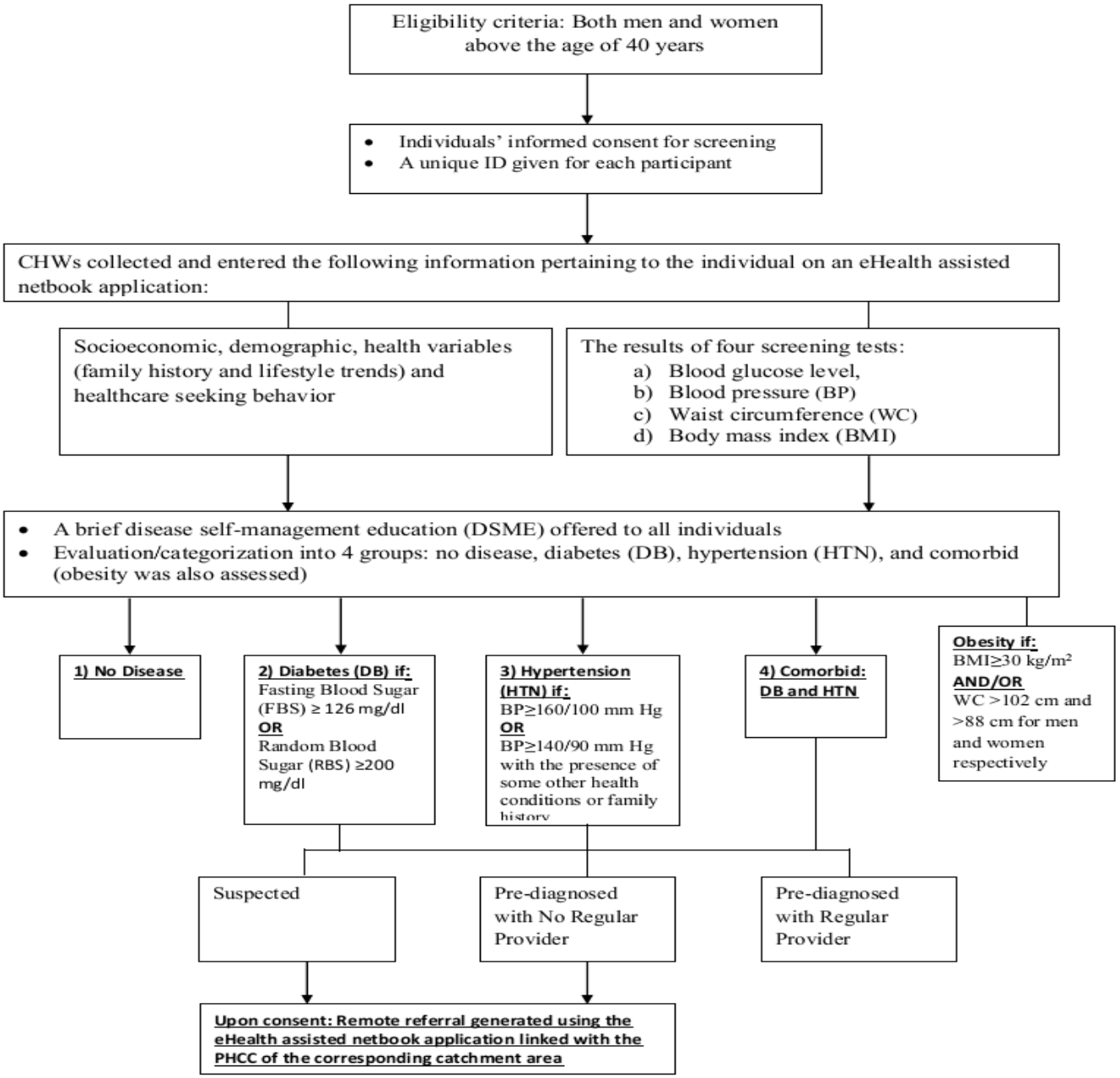
APPENDICES

Appendix A

Results of the community-based intervention employing eHealth strategies

Using an eHealth assisted netbook application, trained CHWs conducted outreach screenings for diabetes and hypertension in the eight catchment areas of the selected PHCCs from May 2015 till November 2015. Details of the screening and referral processes are shown in Figure 1.

Figure 1: Flow diagram of the screening and referral processes



Among the 3559 individuals invited to take part in this study, 3481 consented for screening (response rate= 97.8%). The prevalence of both diabetes and hypertension was determined in the sample population of this study. The results are provided in Table 3 in terms of a rate per 1,000 population.

Table 3: Disease detection rate among the 3,481 screened individuals per 1,000 population

	Total	Suspected	Pre-diagnosed
Diabetes Detection Rate (per 1,000 population)	183.56	10.34	173.23
Rural Areas	191.27	11.21	180.06
Refugee Camps	161.25	7.84	153.42
P-value	0.046*	0.391	0.070^^^
Hypertension Detection Rate (per 1,000 population)	355.93	87.33	268.60
Rural Areas	350.46	91.58	258.89
Refugee Camps	371.78	75.03	296.75
P-value	0.233	0.131	0.028*
Diabetes and Hypertension Comorbidity Detection Rate (per 1,000 population)	112.61	2.59	110.03
Rural Areas	117.85	2.70	115.15
Refugee Camps	97.42	2.24	95.19
P-value	0.096	0.813	0.100

* Refers to Statistical Significance at 0.05 CI

^^^ Refers to borderline Significance

- **Lack of a regular provider**

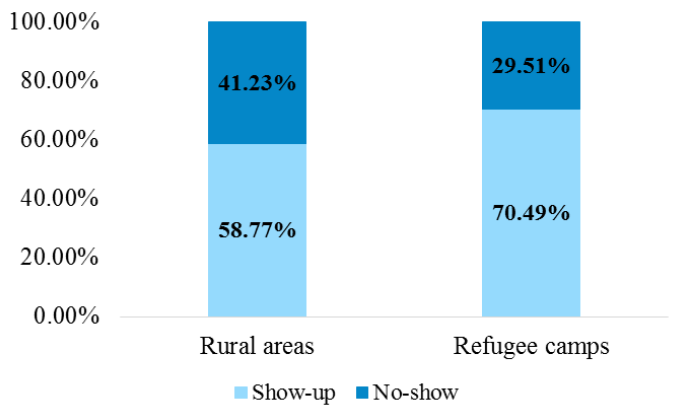
According to the screening results, 603 cases in the eight areas were pre-diagnosed with diabetes. Among those, 58 (9.6%) did not have a regular provider for more than a year. The lack of a regular provider was less observed among the cases pre-diagnosed with hypertension followed by those pre-diagnosed with both diseases (6.9% and 6.2%, respectively).

- **Compliance to visits**

Among the 3481 individuals screened, CHWs generated 278 eHealth assisted referrals on the basis of disease(s) suspicion (n=180) and/or pre-diagnosis with no regular provider for more than a year (n=98). For the purpose of assessing compliance to visits (show-ups/no-shows to scheduled appointments), all 278 beneficiaries referred were subsequently contacted for a phone survey. The surveys' results revealed that compliance to visits among

respondents reached approximately 63%, with 110 respondents reporting showing up to scheduled appointments. Accordingly, the no-show rate in this project was 37.1%.

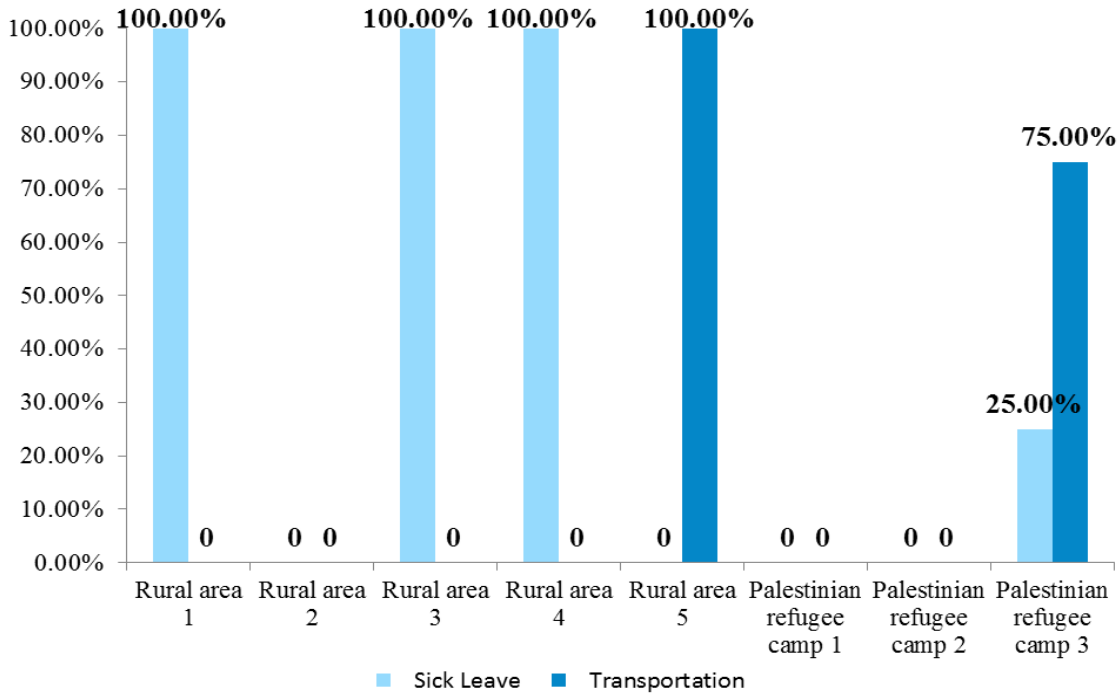
Figure 2: Compliance with visits by setting



- **Barriers to show-up**

In order to explore the barriers to show-up and the corresponding needed arrangements, the research team conducted a short survey with patients who did not show up to scheduled appointments (n=65; 37.1%). Two main reasons for no-show emerged and were feeling better/symptoms resolved (36.9 %), and having another obligation (26.1 %). 15.4% cited transportation and work arrangements as enablers for show-up (12.8% from rural areas and 22.2% from Palestinian refugee camps).

Figure 3: Type of needed arrangement by intervention area



Appendix B

Patients' views on the utility of the employed eHealth strategies

POSTTEST SATISFACTION SURVEY

Upon completion of the 1-year intervention period, all patients receiving SMSs (n= 1390) were contacted for phone survey to determine their feedback and views on usefulness of and satisfaction with the service, as well as self-reported perceptions of lifestyle modifications as a result of the received SMSs.

- **Types of SMSs Sent**

Weekly SMSs only: n=857

Weekly + reminder SMSs: n=533

- **Response Rate**

1000 individuals responded to the phone survey with a response rate (RR) of 71.9%.

- **Patient-reported Confirmation of SMSs Delivery**

Weekly SMSs received and delivered to target: n=606

Reminder SMSs received and delivered to target: n=188

The remaining either received SMSs and did not deliver them to target person or recipient did not open them.

Figure 4: Phone survey results

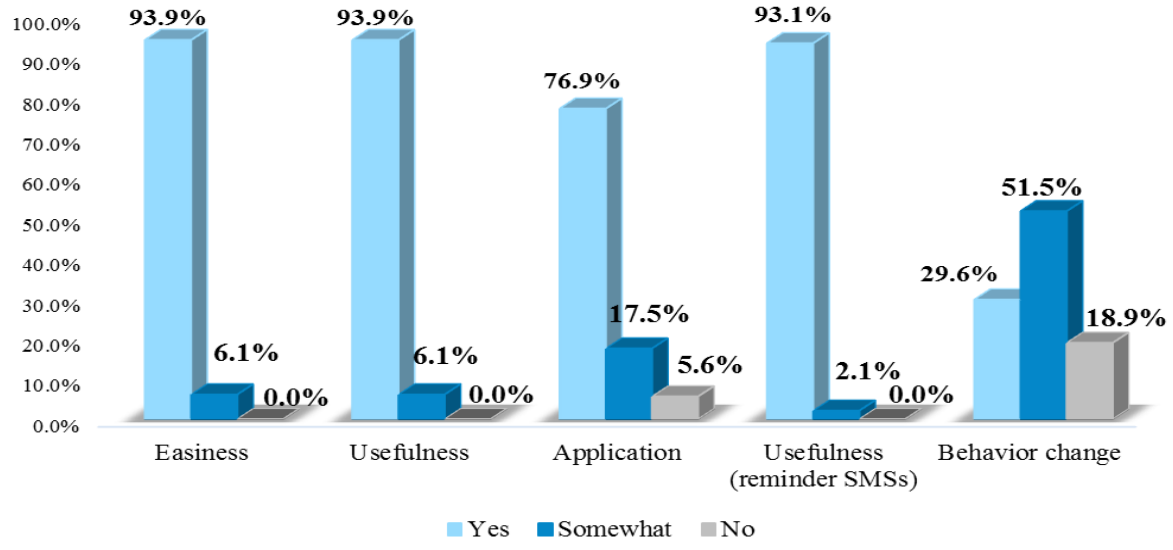


Table 4- Association of SMSs' satisfaction items with independent variables

Variable (N, %)	Items				
	Easiness	Usefulness	Application	Usefulness (reminder SMS)	Behavior change
Gender					
Male	274 (94.1)	273 (94.1)	232 (80.3)	94 (95.9)	88 (30.6)
Female	296 (93.7)	296 (93.7)	233 (73.7)	81 (90.0)	91 (28.8)
P-value	0.810	0.810	0.154	0.110	0.650
Age groups					
40-50	183 (95.8)	183 (95.8)	155 (81.6)	60 (92.3)	63 (33.0)
51-65	270 (93.8)	270 (93.8)	225 (78.1)	77 (96.3)	89 (31.1)
66-75	79 (94.0)	79 (94.0)	55 (65.5)	26 (83.9)	20 (23.8)
76 years or more	37 (86.0)	37 (86.0)	30 (69.8)	12 (100.0)	7 (16.3)
P-value	0.145	0.145	0.026*	0.100	0.247
Marital status					
Single	24 (88.9)	24 (88.9)	20 (74.1)	6 (100.0)	4 (14.8)
Married	442 (94.4)	442 (94.4)	364 (77.9)	136 (94.4)	147 (31.5)
Divorced/Separated	17 (100.0)	17 (100.0)	16 (94.1)	7 (100.0)	7 (41.2)
Widowed	86 (91.5)	86 (91.5)	65 (69.1)	26 (83.9)	22 (22.6)
P-value	0.323	0.323	0.323	0.141	0.240
Educational status					
Illiterate	80 (87.0)	80 (87.0)	61 (66.3)	24 (88.9)	20 (22.0)
Reads and writes	41 (87.2)	41 (87.2)	30 (65.2)	12 (80.0)	10 (21.3)
Elementary	240 (94.1)	240 (94.1)	195 (76.5)	69 (93.2)	71 (28.0)
High school	156 (99.4)	156 (99.4)	131 (83.4)	51 (98.1)	157 (36.3)
University degree	52 (94.5)	52 (94.5)	48 (87.3)	19 (95.0)	20 (38.2)
P-value	0.001*	0.001*	0.033*	0.215	0.068
Employment status					
Unemployed	384 (93.2)	384 (93.2)	306 (74.3)	104 (91.2)	114 (27.7)
Employed	185 (95.4)	185 (95.4)	159 (82.4)	71 (95.9)	65 (33.8)
P-value	0.301	0.301	0.087	0.213	0.076
Insurance status					
Not insured	241 (93.4)	241 (93.4)	195 (75.6)	60 (95.2)	75 (29.2)
Insured (Public/Private Insurance, UNRWA, Others)	328 (94.3)	328 (94.3)	270 (77.8)	115 (92.0)	104 (30.0)
P-value	0.669	0.669	0.274	0.409	0.637
Setting					
Rural area	326 (92.9)	326 (92.9)	256 (72.9)	95 (95.0)	96 (27.4)
Refugee camp	243 (95.3)	243 (95.3)	209 (82.3)	80 (90.9)	83 (32.7)
P-value	0.220	0.220	0.004*	0.270	<0.001*
Reason for SMS					
Diabetes	85 (90.4)	85 (90.4)	76 (81.7)	38 (97.4)	25 (26.6)

Hypertension	320 (94.7)	320 (94.7)	264 (78.1)	88 (94.6)	101 (30.1)
Both	164 (94.3)	164 (94.3)	125 (71.8)	49 (87.5)	53 (30.5)
P-value	0.306	0.306	0.208	0.122	0.672

* Refers to Statistical Significance at 0.05 CI

The application of weekly SMSs and patient-reported behavior change were associated with setting, whereby participants from Palestinian refugee camps reported a higher percentage of SMSs application and behavior change.

Statements in the free-text option giving respondents the opportunity to describe their lifestyle modifications/behavior change were analyzed through thematic analysis. Comments that captured the main content of the question with regard to the aim of the study were chosen as examples (codes) for behavior change. Codes are listed below with their frequencies:

- SMSs are effective in improving compliance in general (124)
- Improving diabetes self-management and treatment adherence (33)
- Dietary modifications (making healthy food choices) (345)
- Feeling physically stronger (2)
- Adherence to recommendations for physical activity (30)
- Taking more precautions to prevent disease progression (15)
- Improving hypertension self-management and treatment adherence (32)
- Medication regimens adherence (36)
- SMSs remind/warn us to perform healthy behaviors (25)
- SMSs provide new information and improve awareness about the importance of making healthy behaviors (24)
- Reduced Smoking (4)
- Weight loss (5)

FOCUS GROUP DISCUSSIONS (FGDS) IN RURAL AREAS

Patient views on the SMSs were also gathered through FGDs held with 8-10 diabetic and/or hypertensive patients in each of the 5 MoPH intervention centers.

Emerging themes regarding patients' views on SMS:

- SMSs are easy to understand
- Frequency and timing of SMSs are appropriate
- The content of SMSs is beneficial

All participants shared their interest to continue receiving the SMSs in the future as they were acceptable and effective.

Appendix C

Providers' views on the utility of the employed eHealth strategies

Physicians and nurses from the 8 intervention centers completed two surveys at 2 different points in times to test their views about eHealth (pretest) and to assess their satisfaction with the employed eHealth tools (posttest).

- Pretest: 17 providers completed the survey
- Posttest: 15 providers completed the survey

- **Ease of Use**

Providers reported that online modules and questions from practice were easier to access than peer-to-peer education platforms (86.7%, 86.7% and 80.0%, respectively).

- **Frequency of Use**

Providers reported that online modules were accessed the most (60.0% were accessing them on a daily basis).

- **Usefulness in Providing Care to Patients**

Providers reported that the three types of eHealth tools (online modules, peer-to-peer education platform and questions from practice) were very useful/useful in providing care to patients (86.7%, 86.7% and 73.3%, respectively).

- **Effectiveness in Managing Patients' Diseases**

Providers equally reported that the three types of eHealth tools (online modules, peer-to-peer education platform and questions from practice) were very effective/effective in managing patients' diseases (86.7% for each of the three types of eHealth tools).

Figure 5 illustrates that providers faced some problems using the eHealth tools yet they were satisfied with the 3 types of tools and they recommended them to their peers (Figure 5).

Figure 5: Problems using and overall satisfaction with the ehealth tools

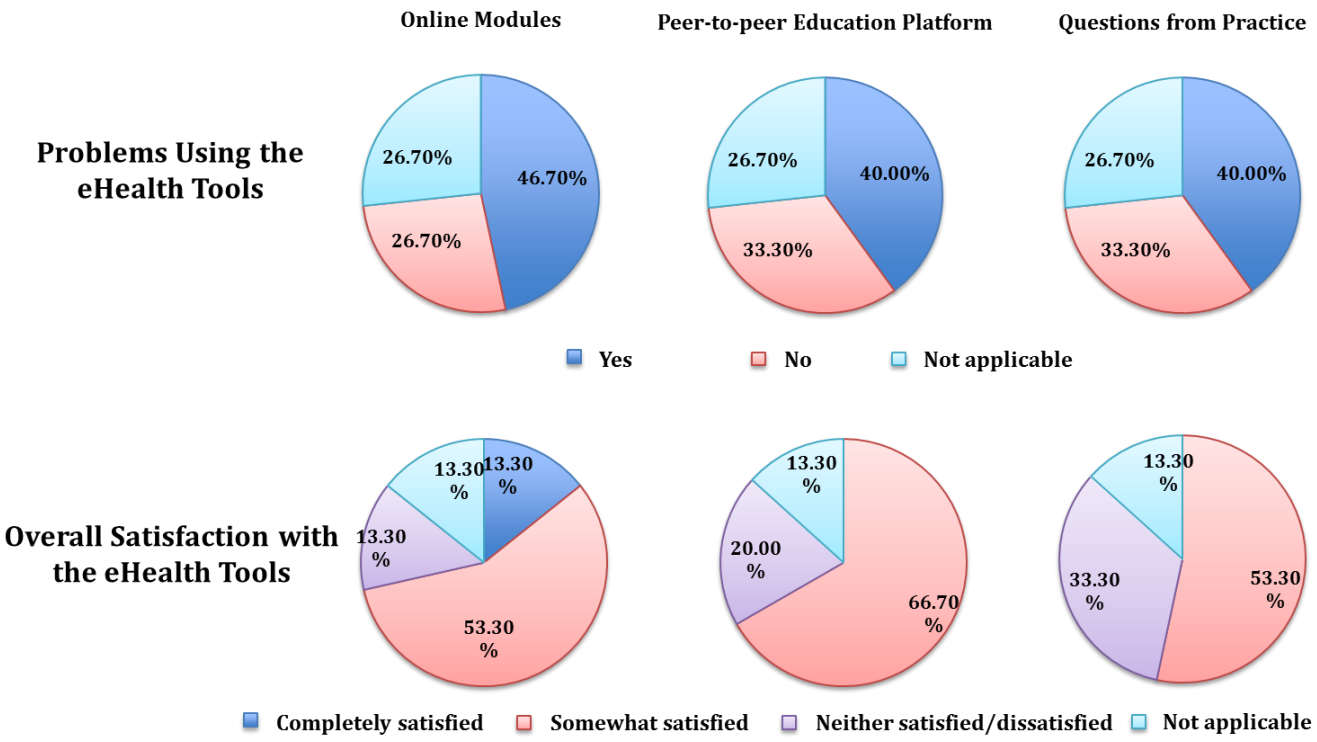


Figure 6: Practice change and recommending program to peers

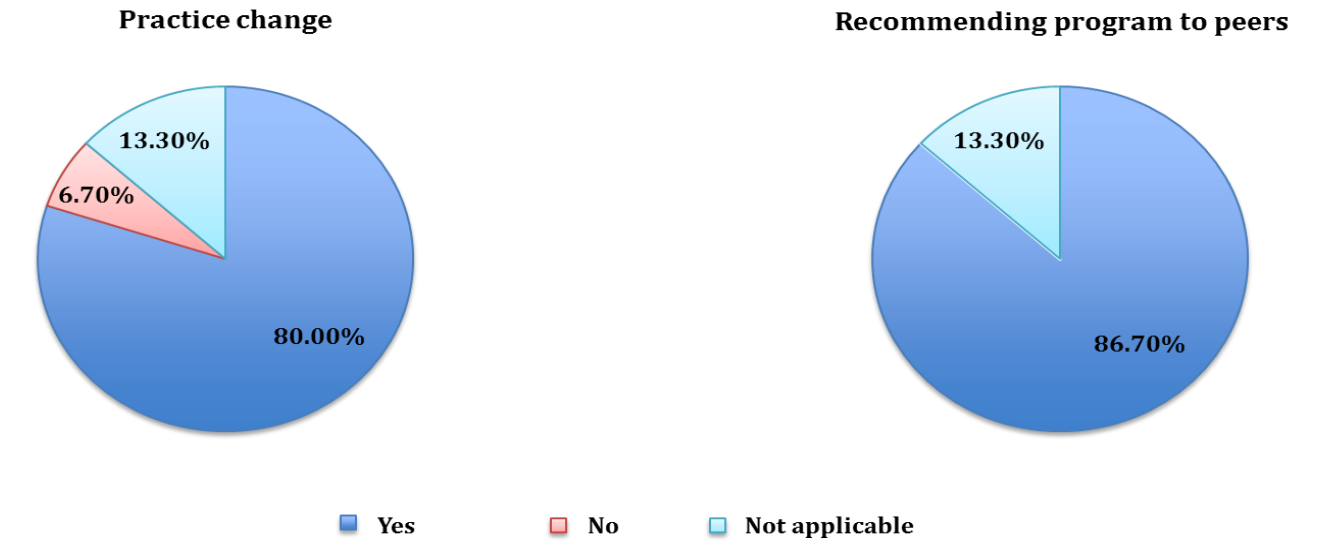


Figure 7: Providers' reported practice change by setting

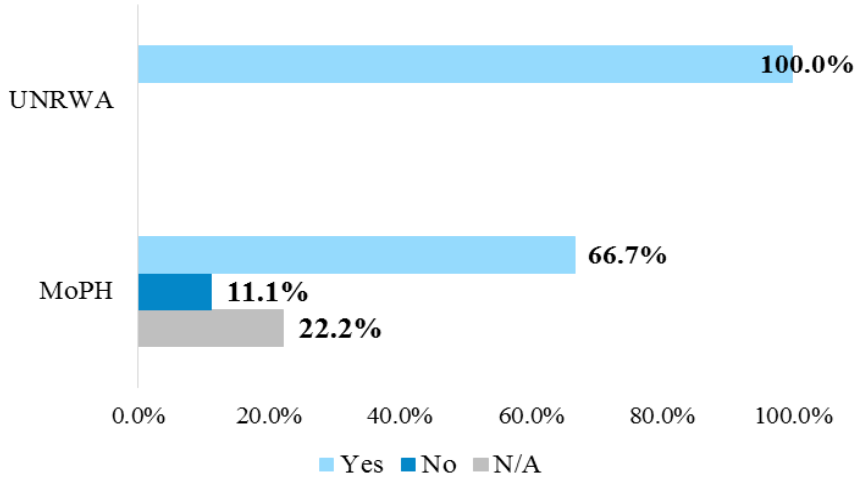
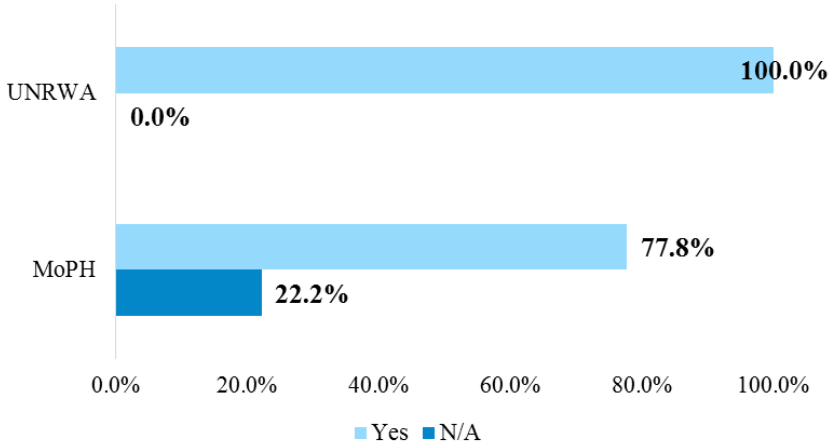


Figure 8: Providers' reported recommending program to peers by setting



Appendix D

Effect of eHealth interventions on the quality of diabetes and hypertension care

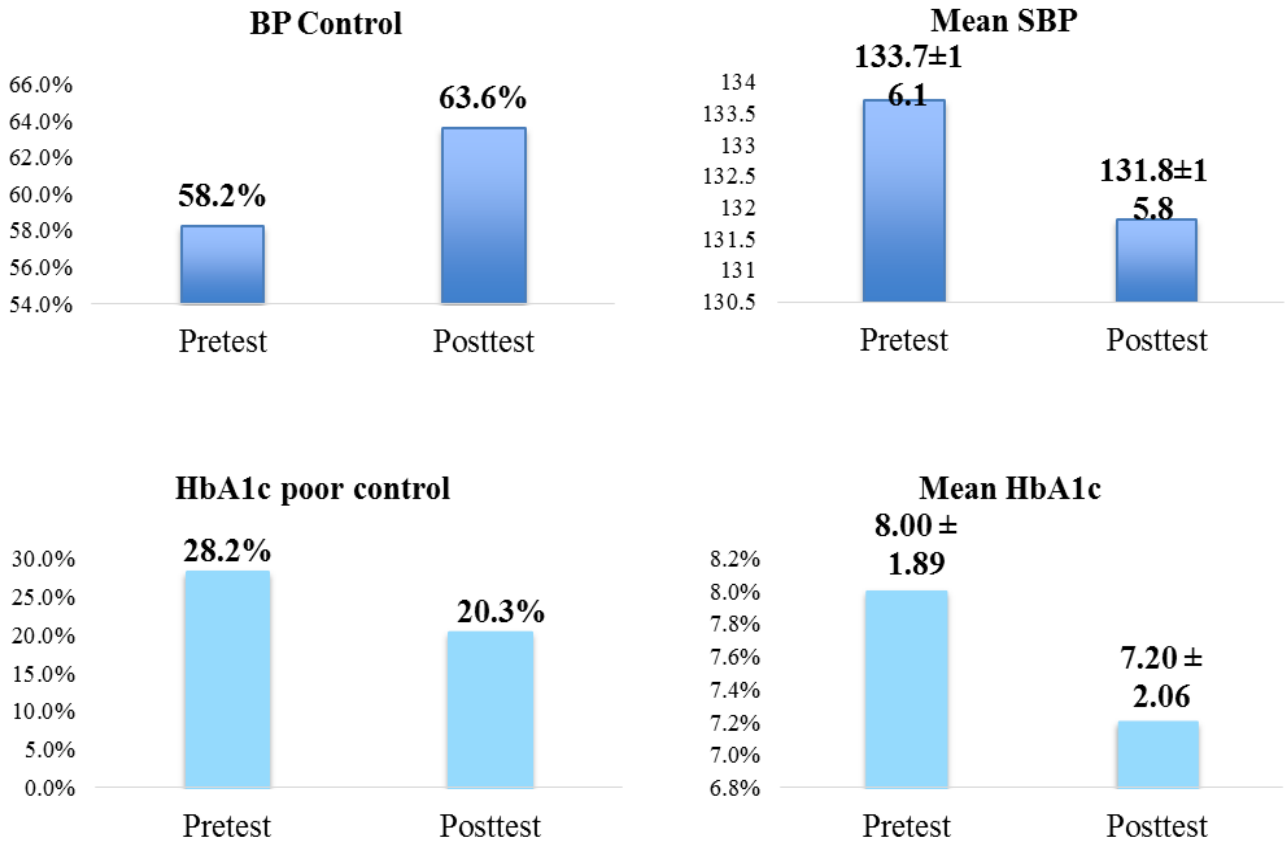
A pre-post analytical plan was used to assess centers' performance on quality indicators (QI) in both, the intervention and control sites.

- Pretest: Data collected between March 2014-March 2015
- Posttest: Data collected between June 2015-June 2016

A set of internationally recognized quality indicators for diabetes, hypertension and Gestational Diabetes were employed (i.e. date of last visit for diabetes/hypertension, date of last Blood Pressure (BP) or Hba1c, date of last eye/foot checkup, and many others).

After 1-year of SMS-based intervention, the most pronounced effect in intervention group (only) were the below:

Figure 9: Significant improvements in clinical outcomes in the intervention group



- **Regression models**

Separate regression models were run to gauge the intervention impact on the study groups whilst controlling for baseline characteristics: age, gender, and setting. The results of the logistic regressions where BP control, HbA1c poor control, and annual HbA1c testing act as the dependent variables will be shared in a scientific paper. Similarly, the results of the linear regression models for mean SBP, mean DBP, and mean HbA1c after controlling for age, gender, and setting and more in-depth analysis will be shared in the same paper.

Table 5- Logistic regression model of BP control, HbA1c poor control and annual HbA1c testing by study group

	Intervention			Control		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
BP control						
Study Period						
Posttest	1.28	(1.00, 1.64)	0.05*	1.28	(0.95, 1.72)	0.11
Pretest		ref			ref	
Gender						
Females	1.12	(0.88, 1.44)	0.36	0.97	(0.74, 1.29)	0.85
Males		ref			ref	
Age (continuous)	0.99	0.98, 1.00)	0.06	0.99	(0.98, 1.00)	0.03*
Setting						
Rural areas	0.31	(0.24, 0.40)	<0.01*	0.22	(0.15, 0.30)	<0.01*
Palestinian Refugee Camps		ref			ref	
HbA1c poor control						
Study Period						
Posttest	0.62	(0.39, 0.97)	0.04*	0.68	(0.35, 1.33)	0.26
Pretest		ref			ref	
Gender						
Females	0.59	(0.39, 0.89)	0.01*	0.84	(0.47, 1.49)	0.56
Males		ref			ref	
Age (continuous)	0.97	(0.96, 0.99)	<0.01*	0.97	(0.95, 1.00)	0.03*
Setting						
Rural areas	0.71	(0.45, 1.11)	0.13	0.81	(0.43, 1.51)	0.51
Palestinian Refugee Camps		ref			ref	
Annual HbA1c testing						
Study Period						
Posttest	2.52	(1.82, 3.49)	<0.01*	4.26	(2.79, 6.49)	<0.01*

Pretest		ref			ref	
Gender						
Females	1.17	(0.85, 1.61)	0.34	1.04	(0.69, 1.56)	0.87
Males		ref			ref	
Age (continuous)	0.98	(0.97, 0.99)	<0.01*	1.01	(0.99, 1.03)	0.37
Setting						
Rural areas	4.43	(3.20, 6.13)	<0.01*	2.22	(1.46, 3.39)	<0.01*
Palestinian Refugee Camps		ref			ref	

BP: Blood Pressure; HbA1c: Glycosylated hemoglobin
Annual HbA1c testing within recommended guideline: dates are considered acceptable if done within the recommended guideline period, whilst a 30-days grace period was allowed (refer to Figure 1)
* Refers to Statistical Significance at 0.05 CI

Table 6- Linear regression model of the means SBP, DBP and HbA1c by study group

	Intervention			Control		
	Beta	**SE**	**p-value**	**Beta**	**SE**	**p-value**
Mean SBP						
Study Period						
Posttest	-1.12	0.90	0.21	-1.83	1.18	0.12
Pretest		ref			ref	
Gender						
Females	-0.59	0.90	0.51	0.30	1.11	0.79
Males		ref			ref	
Age (continuous)	0.08	0.04	0.03*	0.12	0.04	0.01*
Setting						
Rural areas	7.98	0.92	<0.01*	9.07	1.21	<0.01*
Palestinian Refugee Camps		ref			ref	
Mean DBP						
Study Period						
Posttest	-0.49	0.53	0.36	-0.90	0.65	0.16
Pretest		ref			ref	
Gender						
Females	-1.89	0.53	<0.01*	-0.73	0.61	0.23
Males		ref			ref	
Age (continuous)	-0.02	0.02	0.26	-0.07	0.02	<0.01*
Setting						
Rural areas	1.66	0.54	<0.01*	2.17	0.67	<0.01*
Palestinian Refugee Camps		ref			ref	

Mean HbA1c						
Study Period						
Posttest	-0.87	0.19	<0.01*	-0.22	0.27	0.41
Pretest		ref			ref	
Gender						
Females	-0.42	0.17	0.01*	-0.21	0.22	0.35
Males		ref			ref	
Age (continuous)	-0.01	0.01	0.12	-0.03	0.01	<0.01*
Setting						
Rural areas	-0.65	0.19	<0.01*	0.07	0.25	0.76
Palestinian Refugee Camps		ref			ref	

SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure

* Refers to Statistical Significance at 0.05 CI