Scientific
Research
Publishing

Opportunities to Integrate Primary Health Care Digital Innovations in Maternal and Child Health Care Services in Kenya

Micah Matiang'I[1*], Priscilla Ngunju[1], Aranka Hetyey[2], Lydia Odek[1], Eefje Smet[2], Mieke Arnoldus[2], Yvonne Opanga[3], Colleta Kiilu[3]

[1]School of Medical Sciences, Amref International University (AMIU), Nairobi, Kenya
[2]Venture Programs, Amref Flying Doctors, Laiden, Netherlands
[3]Research Deprtment, Amref Health Africa, Nairobi, Kenya
Email: *miconyiego@gmail.com, *micyiego@yahoo.com, *Micah.Matiangi@amref.ac.ke

Abstract

Background: Adequate and quality Maternal and Child Health (MNCH) care is considered essential in reduction of maternal and child mortality. More than half of the global maternal deaths (66%) are in sub-Saharan Africa with infant mortality of 51/1000 live births in the WHO Africa region [1]. There is potential to improve access and utilization of health services through investing in Primary Health Care (PHC) digital innovations [2] especially in underserved settings [3]. In the last quarter of the year 2021 after lifting of the COVID-19 restrictions, Tekeleza project, aims to integrate digital health innovations into MNCH care within PHC settings in Kenya. The project team undertook a baseline survey in three rural counties (Kisii, Kajiado and Migori) characterized with low social-economic status to identify opportunities to leverage on the use of evidence-based digital innovations to reverse the adverse trends in Maternal and Child Health. **Methods:** A cross-sectional and descriptive study was conducted in 15 Community Health Units (CHUs) in Kenya that were linked to selected Primary Health Care (PHC) facilities from three rural counties. Mixed methods were used to collect data from 404 Households (HHs) selected across the sampled CHUs on Probability Proportionate to Size (PPS). The selected households were assigned unique household or respondent identifiers. The sampling frame for household surveys consisted of all women 18 - 49 years of age, who were either pregnant or in their 18 months post-delivery. From the constructed sampling frame, a simple random sampling procedure was used to select the study sample. An audit was also carried out at the selected PHC facilities and sixty-two (62) Primary Health Workers (PHCWs) including facility managers were interviewed to establish challenges affecting ICT infrastructure and sustainable financing of MNCH

services. **Findings:** The majority of the sampled women (64.9%) were lactating at the time of the study, with 34.4% being pregnant and 0.7% both pregnant and lactating. Despite the high proportions of mothers who received Skilled Birth Attendance, discontinuity in seeking antenatal and postnatal care services was observed in all three counties. The proportion of mothers (n = 404) who reported to have attended at least one ANC was 46.8%. This was attributed to limited access to health facilities, poor staff attitude, and negative cultural practices that got exacerbated by the COVID-19 pandemic. An average of 53.2% of the respondents started attending ANC clinics much later after 12 weeks of gestation to minimize the costs and time they will spend on attending ANC clinics. It also emerged that 68.7% of the respondents had low knowledge levels of selected perinatal and infant care practices. On the making of Sexual and Reproductive Health (SRH) health-seeking decisions, 54.7% of the respondents said, it is their husbands who decide. The PHCWs expressed limited access to Continuing Professional Development (CPDs), a situation that worsened with the COVID-19 Pandemic. Notably, only 54.9% of the PHCWs reported having access to either a Smartphone or desktop at the point of service delivery. Nearly the same proportion (54.8%) has access to the internet at their workstations. Facilities reported delayed reimbursement of National Hospital Insurance Fund (NHIF) and only 54% of the women interviewed had registered in *Linda mama* NHIF package meant to enable them to access free maternity care. Only one county (Migori) had significant utilization of CHVs. **Conclusion:** There is increasing access to Skilled Birth Attendance (SBA) in rural Kenya but discontinuous pregnancy care is still a problem and it got worse during the COVID-19 pandemic. Rural PHC facilities have poor ICT infrastructure and despite the 98% rural access to a phone by women, there is limited bankable usage of handheld technology to improve health information literacy on self and infant care among women of reproductive age. **Recommendations:** Feasibility studies to be conducted on how to sustainably deploy Primary Health Care digital solutions to improve the quality of, access to, and Utilization of Maternal and Child Health (MNCH) services.

1. Introduction

Globally, through the Sustainable Development Goals (SDGs) there is a commitment to reduce Maternal Mortality Rates (MMRs) to less than 70/1000 livebirths and Under-fives Mortality Rates (U5MRs) to 25/1000 livebirths by 2030 [4]. The compromised health infrastructure in Africa's rural settings that affects access and quality of MNCH care is likely to hinder attainment of this dream [5] unless revitalized through innovations. A child below 5 years in Sub-Saharan Africa is 14 times more likely to die than a child in Europe or

America [6]. This is associated with diarrhea, infectious diseases, and nutritional deficiencies which are all preventable through PHC interventions such as health education and vaccination [7].

Despite the efforts from various stakeholders, Kenya's Maternal Mortality Ratio (MMR) and Infant Mortality Rate (IMR) are currently one of the highest in the world; 342/100,000 live births and 31/1000 live births respectively [8]. This has been linked to factors that either affect demand for or supply of the expected MNCH services; this includes demotivated Primary Health Care Workers (PHCWs), long distance to health facilities, limited resources in health facilities, staff shortages in health facilities, low levels of maternal health education in the community, poor linkages between health facilities and households among other health inequalities (Hamal *et al.*, 2020). In addition to zero budgetary allocation for MNCH services in most of the local county governments, only 20% of the general population is able to afford social health insurance premiums in Kenya [9]. This has left most of the population including women with limited access to affordable and reliable health financing for MNCH services [10]. Although the World Health Organization (WHO) recommends leveraging community and PHC based interventions [11] to promote maternal, newborn, and child health in resource-limited settings, there is a need for more evidence on what works best in low resource settings in addition to the traditional local governments led community strategy-based interventions.

To enhance the continuum of care and improve on MNCH indicators, WHO is targeting to enable 65% of the women to make informed decisions regarding their maternal health and that of their children by 2025 [4]. To achieve this there is a need for innovative and affordable innovations that will see women empowered at both the health facility and community level as part of promoting their Universal Health Coverage (UHC). Various PHC digital innovations have been tested to improve the quality of MNCH services but they either target the supply [12] or demand side of service delivery [13]. This unilateral approach has in some contexts involved enrolling women for ANC services at the household level using mobile phones [14]. Although such verticalized interventions have shown some level of success in various pilot projects there is no clear evidence on how simultaneous integration of digital innovations with different capabilities with a focus on both the supply and demand arms (comprehensive or systems approach) affects utilization and quality of care in Primary Health Care settings in a developing country context.

2. Main Objective for the Survey

The MNCH baseline conducted by *Tekeleza* project aimed to assess the feasibility of integrating digital solutions that link the communities to the PHC health facilities to improve utilization and quality of MNCH services at the PHC level.

Specific Objectives for the survey

1) To determine the selected communities' household limitations to accessing the existing MNCH services;

2) To assess the limitations to provision of quality MNCH services within the selected service delivery points at Primary Health Care level;

3) To establish the locally available PHC digital innovations and preparedness of PHCWs to use them.

Method: The baseline survey was cross-sectional and descriptive. Mixed-method research was adopted. The survey's primary sampling units (PSUs) were the 15 Community Health Units (CHUs) linked to the six selected health facilities from the three rural counties with low social-economic status; Kajiado, Kisii, and Migori Counties. The peri-urban sections of the selected counties were not included during the data collection. Households were the secondary sampling units (SSUs) and the sampling frame for household surveys consisted of all women 18 - 49 years of age, who were either pregnant or within 18 months post-delivery from the selected CHUs. From the constructed sampling frame, a simple random sampling procedure was used to select the study sample. The selected households were assigned unique household or respondent identifiers (IDs). The sample size for the three pilot counties was 404 respondents. In addition to this, all frontline health workers in the six selected rural health facilities were targeted for the health facility survey. Qualitative data was collected through KIIs and desk review.

3. Data Collection and Analysis

Quantitative data collection utilized a household questionnaire administered to the sampled mother with a respondent ID. Information collected targeted access to, utilization of ANC services and barriers to ANC and PNC services. Quantitative data was collected electronically using tablets which facilitated efficient and clean data entry and linking of data from each survey tool to the households' demographics. The programming was done using KoBo Collect software. Qualitative data was collected through Key Informant Interviews that targeted members of County Health Management Teams (CHMTs), facility in-charges, Community Health Assistants (CHAs), project officers, and Health financing schemes' representatives. COVID-19 prevention guidelines were observed during the process.

Quantitative data was analyzed using Statistical Package for Social Sciences (SPSS v.26) whereby descriptive statistics and cross-tabulations were the principal data analysis techniques. Qualitative data were thematically analyzed using NVivo 12, where Patterns and associations of the themes were identified, compared, and contrasted within and between the different groups of respondents to enhance the triangulation of data.

4. Results

The study achieved 100% response rate with a total of 404 women aged between 18 - 49 years sampled across 15 CHUs linked to six selected health facilities in *Kajiado*, *Kisii*, and *Migori* counties. A total of 35 (8.7%) of the women were be-

low 20 years of age; 66.6% were in the 20 to 29 years age bracket; 22.8% were aged between 30 and 39 years and 2.0% were aged between 40 - 49 years. The overall mean age was 26.03 years (95% CI = 25.48, 26.58). Cumulatively, about 89.4% of the women interviewed were aged between 20 and 39 years (Table 1).

A significant proportion of the sampled women (64.9%) were lactating at the time of the study; with 34.4% being pregnant. Both pregnant and lactating women were 0.7% of the sample. The majority of the lactating mothers (97.0%) had one child with eight of the mothers (3%) having 2 children aged up to 18 months resulting in a total of 273 children (49.1% female and 50.9% male). Approximately half of the children (49.1%) were aged less than 6 months. The headship type for the sampled households was largely male-dominated across the three counties, with 83.2% and 16.8% being male-headed and female-headed respectively. The sample average for household size was found to be five persons.

On sources of livelihood, the majority of the respondents from Kajiado households (53.3%) depended on casual employment; Kisii County depended on crop farming (63.4%) while in Migori County, the majority (55.6%) depended on fishing business. Most of the sampled households (82.9%) had monthly income levels not exceeding Kenya Shillings 10,000 (Approximately USD 100). It was observed that occupation and wealth do increase the likelihood that women

Table 1. Socio-demographic attributes of the respondents.

Socio-demographic Attributes of the Participants in Percentages					
County of Survey		Kajiado	Kisii	Migori	Overall
Total # respondents		135	134	135	404
Percentage distribution		%	%	%	%
Age in years (Mean = 26.03; 95%CI = 25.48, 26.58)	<20 years	3.0	8.2	14.8	8.7
	20 - 29 years	71.9	65.7	62.2	66.6
	30 - 39 years	24.4	24.6	19.3	22.8
	40 - 49 years	0.7	1.5	3.7	2.0
Education level	No formal education	14.8	0.0	0.7	5.2
	Primary level	31.1	36.6	59.3	42.3
	Post-Primary level	1.5	2.2	5.9	3.2
	Secondary	37.0	50.0	29.6	38.9
	College	11.9	8.2	2.2	7.4)
	University level	3.7	3.0	2.2	3.0
Marital status	Single	9.6	9.0	10.4	9.7
	Married	88.9	87.3	85.2	87.1
	Divorced/Separated	0.0	1.5	2.2	1.2
	Widowed	1.5	2.2	2.2	2.0

will seek ANC services from a trained health professional. Across all the counties, household money spending decision-making was predominantly (56.7%) done by the husband/partner. A similar trend was found across all counties where health care matters decision making was predominantly (54.7%) done by the husband/partner.

The survey also revealed that (Table 2), the main source of health advice for pregnant women in the 3 rural counties surveyed was from either a nurse or a doctor (46.8%). Notably, 26.7% of the interviewed women did not seek any health advice during pregnancy. Others got advice from Community health volunteers (21.5%) and relatives (5%). Kajiado County which is in the outskirts of the capital city Nairobi, had the highest proportion of women (48.1%) who did not seek any health advice during pregnancy. This was attributed to low-income levels and indirect costs primarily travel costs incurred while seeking care at a health facility. A Chi-square hypothesis test (0.004 < 0.05 at 95% CI) for Kajiado county revealed that statistically there was a significant association between household average monthly income and the preferred source of health advice. The association was insignificant for Kisii and Migori counties located about 430 km from the capital city Nairobi.

On utilization of ANC services in the three surveyed rural counties, nearly half of the respondents 189 (46.8%) had utilized ANC services at least once during their current/previous pregnancy (Table 3). Kisii County reported the highest proportion (71.6%) of mothers who had attended at least one ANC visit

Table 2. Source of health advice for mothers during their pregnancy.

From who did you seek health advice from during your pregnancy?	County Names			
	Kajiado %	Kisii %	Migori %	Overall %
CHV	5.9	3.0	55.6	21.5
Doctor/Nurse	43.0	71.6	25.9	46.8
Relatives	3.0	9.7	2.2	5.0
Did not seek health advice	48.1	15.7	16.3	26.7
Total	100.0	100.0	100.0	100.0
N	135	134	135	404

Table 3. Proportion of Mothers who had attended at least one ANC Visit.

Attended at least one ANC	County Names			
	Kajiado %	Kisii %	Migori %	Overall %
No	57.0	28.4	74.1	53.2
Yes	43.0	71.6	25.9	46.8
Total	100.0	100.0	100.0	100.0
N	135	134	135	404

during their pregnancy compared to Kajiado and Migori counties at 33.3% and 36.2% respectively. The low proportion of mothers attending ANC visits in Migori County was attributed to high dependence on the CHVs for health advice among the mothers to minimize the chances of contracting coronavirus as well as minimizing transport costs incurred while seeking health advice at the health facilities.

To delineate the effect of the Covid-19 pandemic on the ANC uptake among the respondents, the timing for the first ANC visit among the 139 pregnant and 265 lactating mothers was computed separately in reference to the WHO antenatal care model. Pregnant mothers whose gestation period was more than 12 weeks (3 months) at the time of the survey but had not attended any ANC visit were regarded as "late ANC onset" while those who had attended at least one ANC visit within 12 weeks of gestation were termed as "appropriate ANC onset". The proportion of pregnant mothers who had appropriate first ANC onset in Kajiado was 42.2%, Kisii County 83.3%, and Migori 53.2% (Figure 1). For the lactating respondents, 11.1%, 25.5%, and 3.9% of the sampled mothers from Kajiado, Kisii, and Migori counties respectively (Figure 2) had initiated 1st ANC visit within the first trimester.

Cumulatively, only 30.2% of the 265 lactating mothers that took part in the survey had attended at least 4 ANC visits during their previous pregnancy. Across all the three rural counties, more than 85% of the respondents reported having been attended by a skilled health attendant at the health facility during their delivery. This was attributed to the free maternity care services introduced by the government of Kenya in 2013 that made it easy for women to deliver at the facilities. Among the few cases of unskilled deliveries at home by the traditional
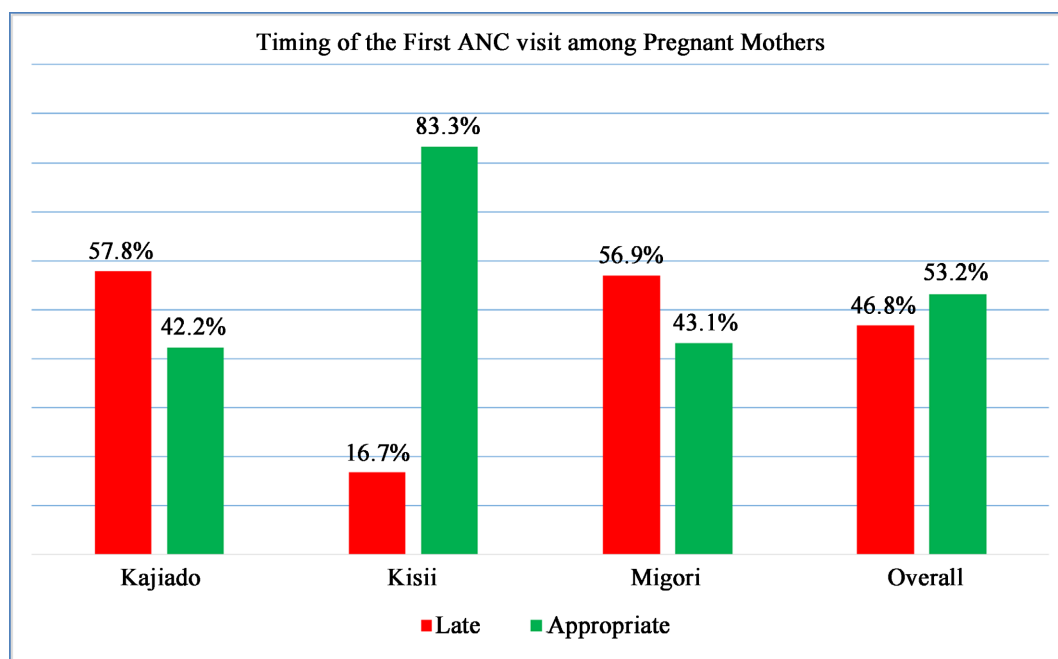

Figure 1. Proportion of the sampled pregnant women who attended 1st ANC visit within 1st trimester.

birth attendant (TBA), the predominant reasons included: lack of money to pay for transport, long distances to the health facility, poor services at the health facilities, and poor attitude among the healthcare staff. Other reasons mentioned included; that the health facility was closed at the time labor started (often at night), fear of contracting COVID-19 and cultural barriers e.g. mothers believe it's a taboo for young male midwives to attend to them during delivery (Table 4).

The household survey, further revealed that only 67.8 % of the children had been fully vaccinated for age. Kisii County had the highest proportion of children not fully immunized at 51.0%. In Migori and Kajiado counties, 17.7% and 22.3% of the children respectively had not been fully vaccinated. A cross-tabulation of fully immunized children by age category revealed that a higher proportion of children aged up to 6 months were fully immunized compared to those aged 7 - 12 months and 13 - 18 months. This indicates a loss of follow-ups for unimmunized children who are more than 6months old. Among the children, missing two rotavirus doses, second and third doses of polio were the main reason for not being fully immunized (Figure 2). Among the cases of children not fully immunized, the reasons given included; the health facility being too far, lack of money to pay for transport, and lack of vaccines in the health facility.

The survey also assessed the mothers' knowledge of newborn danger signs. They were also requested to mention any symptoms or illnesses that had presented in any of their children (<18 months) within the last two weeks before the survey. All respondents mentioned being informed about newborn danger signs during their pregnancy. Fever, poor sucking or feeding, fast breathing, and difficulty in breathing were the most commonly mentioned danger signs in newborns. Other symptoms mentioned included swollen face and excessive crying of the baby (Table 5). Pneumonia, fever, cough, and diarrhea were the common

Table 4. Reason for non-delivery at health facilities.

Why did you deliver away from the health facility?	County Names		
	Kajiado %**	Kisii %**	Migori %**
Health facility is far	46.2	40.0	0.0
No money to pay for transport	92.3	20.0	0.0
No money to pay for hospital charges	7.7	0.0	0.0
Health services are poor	15.4	40.0	0.0
Don't like the staff attitude	7.7	20.0	0.0
Other reasons as mentioned (*afraid of Covid*-19; *labour pain at night*)	15.4	0.0	100.0
N	24	6	2

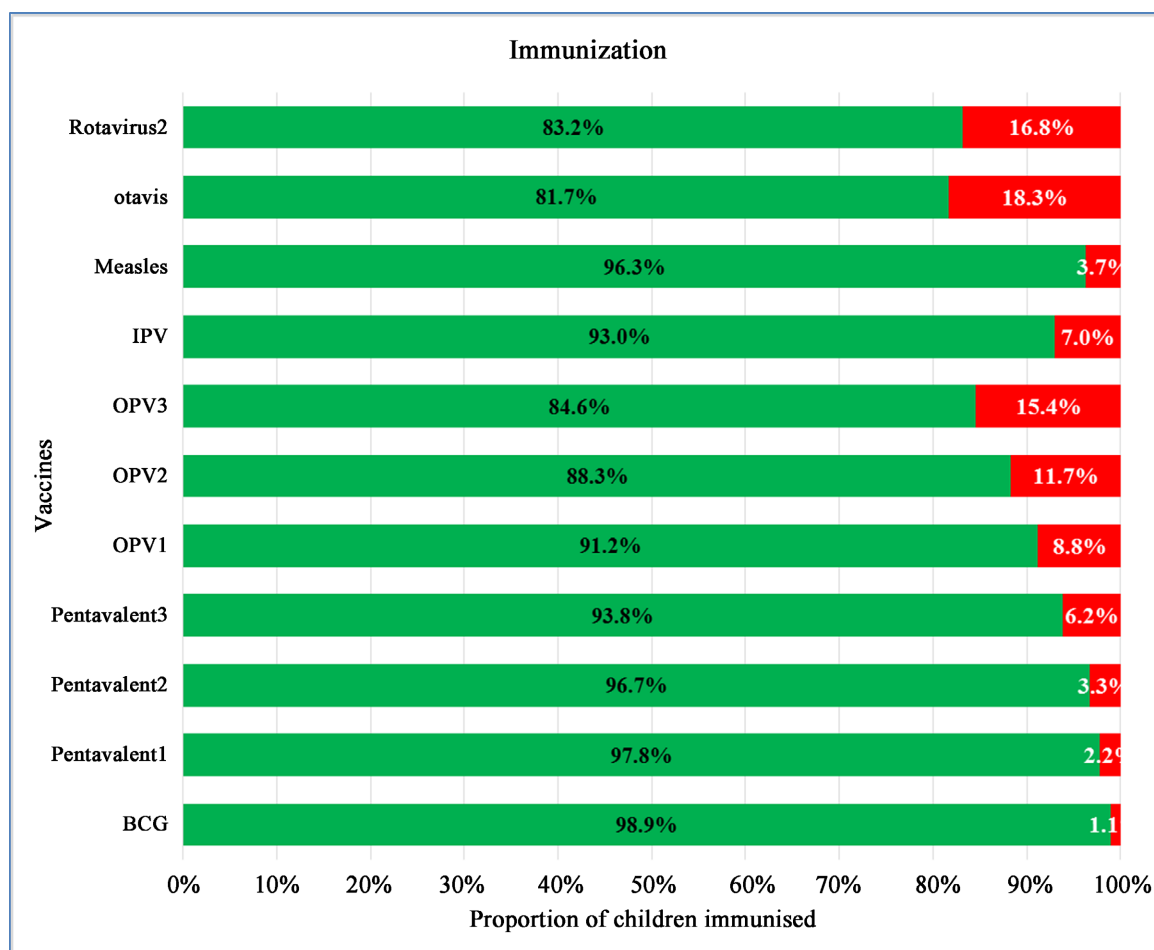**Row values are based on analysis of multiple responses.

Figure 2. Immunization coverage in the three rural counties.

Table 5. Mothers' knowledge of newborn danger signs.

What illnesses/symptoms if noticed should a child be taken immediately to a health facility?	County Names			
	Kajiado %**	Kisii %**	Migori %**	Overall %**
	135	134	135	404
Child develops fever	97.8	82.8	73.3	84.7
Not able to drink or breastfeed	63.0	56.7	60.0	59.9
Child has fast breathing	36.3	37.3	44.4	39.4
Has difficulty breathing	45.9	26.9	49.6	40.8
Has blood in stool	37.0	6.7	17.0	20.3
Others	23.0	5.2	16.3	14.9

**Row values are based on analysis of multiple responses.

illnesses and symptoms that had presented in most of the respondents' sick children. At least 50% of the mothers whose children developed danger signs responded appropriately and took them to either government or private health

facilities within 24 hours.

Lastly, the women's Dietary Diversity Assessment was based on a 14 days recall period with the conviction that the period would give a clear picture of the dietary diversity, which would level the effect of atypical consumption patterns, for instance, during festivities or social functions. At the data collection, 9 food groups as described in FAO 2010 guidelines were used. The groups were combined at the analysis stage to come up with 3 food groups namely: proteins (meat, milk, beans & peas); carbohydrates (ugali, rice, chapati); and Vitamin A rich fruits & vegetables (green vegetables & fruits).

Food consumption score was used to classify the respondents' consumption into 3 categories namely, poor, borderline, and acceptable. The frequency of consumption of the 3 food groups (maximum 14 days) was multiplied by an assigned weight factor *i.e.* none (0), once (1), twice (2), and thrice or more (3). A food consumption score (FCS) was obtained by summing up the product of each food item after which classification was done as illustrated in Table 6. The findings indicate that more than half of the sampled respondents in Kajiado and Kisii counties were at the acceptable band of the FCS while Kisii County had only 22.4% (Figure 3). This implied that a majority of the sampled women had a borderline intake of all nutrients.

At the PHC facilities (Level III) where the survey was conducted, an audit was conducted on the availability of basic MNCH services delivery equipment and supplies, referral system, digital literacy among PHCWs, and the available innovations that enhanced the delivery of services to either pregnant women or children. All sites surveyed in the 3 counties had weighing scales, Urinalysis kits, syphilis testing kits, thermometers, stethoscopes, and BP machines. However, only 50% of the sites had functional suction machines, oxygen delivery devices, hand washing soap, phototherapy machines, Full Hemogram kits, Hepatitis B testing kits, and disinfectants. Only 60% of the sites had adequate stocks of gloves and Malaria testing kits.

The shortages were attributed to delayed reimbursements of funds to the facilities under the *Linda Mama* (National Hospital Insurance Fund-NHIF) after giving free services to mothers. The delays in claim reimbursements by PHC facilities sometimes took up to a year or more without fruition. More than half of the respondents (54.2%) across all the selected sites from the three counties expressed unwillingness to enroll in health insurance to cater to their health and the health of their children. Cumulatively only 54% of the sampled mothers were

Table 6. Food consumption score bands based on dietary diversity groups.

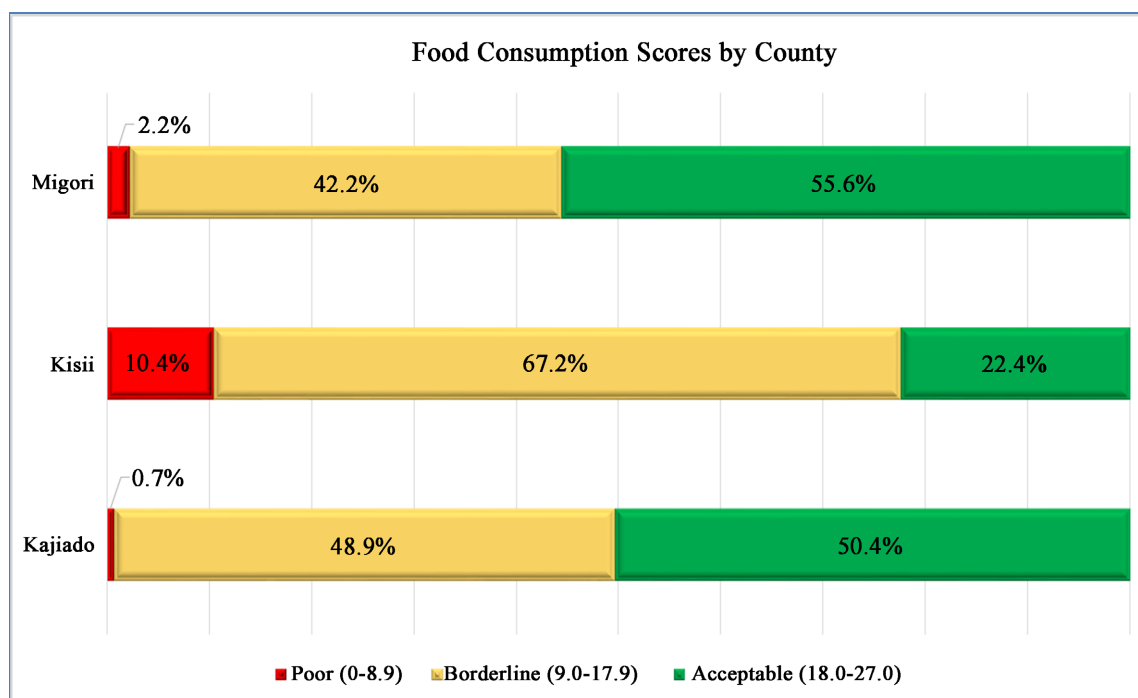| Main Threshold	Nomenclature
Poor (0 - 8.9)	Poor food consumption (Mainly cereals)
Borderline (9.0 - 17.9)	Borderline food consumption (Mainly cereals, milk, and oils)
Acceptable (18.0 - 27.0)	Good food consumption (Mainly cereals, pulses, vegetables, milk, oils, and sugars)

Figure 3. Food consumption scores by county.

enrollec under *Linda mama* insurance package. A significant portion (39.5%) of those willing to pay for the National Hospital Insurance Fund indicated they could only afford premiums worth USD 5.

The referral system was cited to have challenges at the community level because local governments are not paying the Community Health Volunteers any incentives or wages. The CHVs were also demotivated because they lacked the basic supplies to use in the community especially protective equipment (PPEs), disinfectants, reporting tools (MOH 100), gumboots, and First Aid kits. Referral services were also affected by limited access to ground ambulance services and peri-operative theatres.

Other than points of Care Ultrasound services, no other innovative platforms/activities were reported at the survey sites. At the facility level, the survey also targeted 62 PHCWs comprising of nurses, midwives, dental officers, health records officers, clinical officers, pharmacy, dental and lab technicians to assess their levels of digital literacy and preparedness to use technology-enabled innovations. Despite the infrastructure development going on in the surveyed county health facilities, limited ICT infrastructure including poor Internet access was the main barrier to ICT utilization among the healthcare providers. However, 54.9% of the PHCWs indicated that they were only able to access a smartphone when at the workplace. More than half of the PHCWs (54.8%) reported that they had Internet access at their health facilities. Furthermore, most of the health staff used smartphones as a means of access to the Internet (64.7%). On average the 3 counties had only 54% of their facilities accessing internet; a limitation that hampered processing of insurance (linda mama) MNCH claims. Table 7 has a

summary of the PHCWs' access to ICT infrastructure at their service delivery points.

Table 7. Primary Health Care Workers (PHCWs) access to essential ICT infrastructure.

Do you have Internet Access at the facility?	County Names			
	Kajiado %	Kisii %	Migori %	Overall %
No	50.0	38.9	57.1	45.2
Yes	50.0	61.1	42.9	54.8
Total	**100.0**	**100.0**	**100.0**	**100.0**
N	**12**	**36**	**14**	**62**
Type of internet	Kajiado %	Kisii %	Migori %	Overall %
Wifi	83.3	36.4	33.3	44.1
Cable/Ethernet	0.0	45.5	16.7	32.4
Mobile data	16.7	18.2	50.0	23.5
Total	**100.0**	**100.0**	**100.0**	**100.0**
N	**6**	**22**	**6**	**34**
By what means do you access the internet?	Kajiado %	Kisii %	Migori %	Overall %
Smartphone	83.3	59.1	66.7	64.7
Desktop	16.7	40.9	16.7	32.4
Laptop	0.0	0.0	16.7	2.9
Total	**100.0**	**100.0**	**100.0**	**100.0**
N	**6**	**22**	**6**	**34**

5. Discussion

The barriers to utilizing Antenatal and Post-natal care services in the three counties in Kenya are consistent with those documented from related studies. In reference to a systematic review from studies done in eight low income countries [15], accessing maternal care services has been drawn back by cultural beliefs and wrong staff attitudes. In addition to this, demotivated PHC workforce, limited access to continuing professional development, limited family support, transport costs, disrespect and abuse of mothers [16] have aggravated the situation.

Another systematic review [17] also established that limited access to maternal services is a function of both user and service provider characteristics for instance the stage at which a pregnant woman tries to access health services. The other characteristics pointed out includes limited supplies and equipment needed to provide quality care, limited behavior change on seeking of MNCH services and demotivated service providers among others.

Technology driven innovations have been used to address some of the afore-

mentioned barriers to accessing and utilizing maternity services [18]. Testing integrated models that combine evidence based mHealth innovations is yet to be done. The mHealth maternal and newborn care intervention initiated in Guatemala [19] only focused on improving breastfeeding attitudes among lactating mothers. The other verticalized mHealth interventions that have been piloted only aimed to monitor performance of community health workers or pregnant women's knowledge on self care [20]. Most of the mHealth interventions in India [21] only focused on sending text messages to household decision makers and pregnant women hoping to improve their health seeking behaviours. In addition to this, e-MNCH handbooks for mothers have been tested in refugee settings [22] to improve the quality of care but this one too unilaterally addressed the knowledge component leaving out other factors that affect the MNCH ecosystem in a developing country.

The Maternal Observation and Motivation (MOM) project in India also deployed mHealth intervention to improve self-care practices during pregnancy [23] where the innovation only targeted the demand side of MNCH services delivery. Further evidence also reveals that PHC digital health innovations have been used to enhance the quality of care for pregnant women with chronic morbidities such as hypertension and gestational diabetes [24]. The ReMiND project of India also deployed a verticalized digital innovation that successfully led to increased antenatal visits coverage, iron and folic acid supplementation and adherence to tetanus toxoid vaccination [25].

The digital divide and low literacy levels among women from underserved settings notwithstanding, the effect of digital innovations on utilization and quality of MNCH services will be better understood if a comprehensive approach is taken in deploying of such innovations [26]. Inequalities on accessing quality MNCH services cannot be addressed by innovations that are not contexualised [27] unilateral and adopted along traditional health care models. It has been observed that in the space of PHC digital health innovations, such interventions should be adapted into the routine workflow of the Primary Health Care Workers (PHCWs) to achieve unique value addition [28].

The foregoing *Tekeleza* project base line survey identified plausible opportunitiesfor innovations driven feasibility ystudy to improve the utilization, quality and financial sustainability of MNCH care in Public Primary health care settings in Kenya. The project is in the context of UHC and an increased health worker shortage that necessitates improved community health care, improved linkage between community care and PHC facilities and task sharing across different cadres in health.

6. Conclusion

The MNCH ecosystem in the developing countries have lots of barriers that need comprehensive, sustainable and intergrated PHC digital innovations in order to strengthen the local health system at that level.

7. Recommendations

To improve quality of MNCH services in underserved settings there is a need for further strengthening of linkages between the community and formal health services delivery points. This should target improved data flow between communities and PHC health facilities, upscaling health information literacy among ANC and PNC women and generation of revenue to sustain provision of MNCH services both at the community and facility level. Further bankable models are also needed to motivate and incentivize PHCWs to ensure there is sustainable delivery of quality MNCH services.

Conflicts of Interest

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

References

[1] Musarandega, R., Nyakura, M., Machekano, R., *et al.* (2021) Causes of Maternal Mortality in Sub-Saharan Africa. A Systematic Review of Studies Published from 2015 to 2020. *Journal of Global Health*, **11**, Article No. 04048.
https://doi.org/10.7189/jogh.11.04048

[2] Lund, S., Nielsen, B.B., Hemed, M., *et al.* (2014) Mobile Phones Improve Antenatal Care Attendance in Zanzibar: A Cluster Randomized Controlled Trial. *BMC Pregnancy Childbirth*, **14**, Article No. 29. https://doi.org/10.1186/1471-2393-14-29

[3] Ngwenya, M.W., Muthelo, L., Mbombi, M.O., Bopape, M.A. and Mothiba, T.M. (2022) Utilisation of Digital Health in Early Detection and Treatment of Pre-Eclampsia in Primary Health Care Facilities South Africa: Literature Review. In: Önal, A.E., Ed., *Primary Health Care*, IntechOpen, London, 6-8.

[4] WHO (2021) New Global Targets to Prevent Maternal Deaths: Access to a "Continuum of Care" Needed, before, during and after Pregnancy and Childbirth.
https://www.who.int/news/item/05-10-2021-new-global-targets-to-prevent-maternal-deaths

[5] Dahab, R. and Sakellariou, D. (2020) Barriers to Accessing Maternal Care in Low Income Countries in Africa: A Systematic Review. *International Journal of Environmental Research and Public Health*, **17**, Article 4292.
https://doi.org/10.3390/ijerph17124292

[6] WHO Report (2022) Child Mortality (under Five Years).
https://www.who.int/news-room/fact-sheets/detail/levels-and-trends-in-child-under-5-mortality-in-2020

[7] De Vita, M., Scolfaro, C., Santini, B., *et al.* (2019) Malnutrition, Morbidity and Infection in the Informal Settlements of Nairobi, Kenya: An Epidemiological Study. *Italian Journal of Pediatrics*, **45**, Article No. 12.
https://doi.org/10.1186/s13052-019-0607-0

[8] Maldonado, L.Y., Bone, J., Scanlon, M.L., Anusu, G., Chelagat, S., Jumah, A., Ikemeri, J.E., Songok, J.J., Christoffersen-Deb, A. and Ruhl, L.J. (2020) Improving Maternal, Newborn and Child Health Outcomes through a Community-Based Women's Health Education Program: A Cluster Randomised Controlled Trial in Western Kenya. *BMJ Global Health*, **5**, e003370. https://doi.org/10.1136/bmjgh-2020-003370

[9] Hamal, M., Dieleman, M., De Brouwere, V., *et al.* (2020) Social Determinants of

Maternal Health: A Scoping Review of Factors Influencing Maternal Mortality and Maternal Health Service Use in India. *Public Health Reviews*, **41**, Article No. 13. https://doi.org/10.1186/s40985-020-00125-6

[10] Kenya County Purchasing Report (2019) Purchasing at the County Level in Kenya. https://thinkwell.global/wp-content/uploads/2019/11/Kenya-county-purchasing-report-2019_11_01-Final.pdf

[11] Schleiff, M.J., Aitken, I., Alam, M.A., *et al* (2021) Community Health Workers at the Dawn of a New Era: 6. Recruitment, Training, and Continuing Education. *Health Research Policy and Systems*, **19**, Article No. 113. https://doi.org/10.1186/s12961-021-00757-3

[12] Martínez-Fernández, A., Lobos-Medina, I., Díaz-Molina, C.A., Chen-Cruz, M.F. and Prieto-Egido, I. (2015) TulaSalud: An m-Health System for Maternal and Infant Mortality Reduction in Guatemala. *Journal of Telemedicine and Telecare*, **21**, 283-291. https://doi.org/10.1177/1357633X15575830

[13] Oduro-Mensah, E., Agyepong, I.A., Frimpong, E., *et al.* (2021) Implementation of a Referral and Expert Advice Call Centre for Maternal and Newborn Care in the Resource Constrained Health System Context of the Greater Accra Region of Ghana. *BMC Pregnancy Childbirth*, **21**, Article No. 56. https://doi.org/10.1186/s12884-020-03534-2

[14] Esamai, F., Nangami, M., Tabu, J., *et al.* (2017) A System Approach to Improving Maternal and Child Health Care Delivery in Kenya: Innovations at the Community and Primary Care Facilities (a Protocol). *Reproductive Health*, **14**, Article No. 105. https://doi.org/10.1186/s12978-017-0358-6

[15] Nuamah, G.B., Agyei-Baffour, P., Mensah, K.A., *et al.* (2019) Access and Utilization of Maternal Healthcare in a Rural District in the Forest Belt of Ghana. *BMC Pregnancy Childbirth*, **19**, Article No. 6. https://doi.org/10.1186/s12884-018-2159-5

[16] Tuyisenge, G., Hategeka, C., Luginaah, I., *et al.* (2018) Continuing Professional Development in Maternal Health Care: Barriers to Applying New Knowledge and Skills in the Hospitals of Rwanda. *Maternal and Child Health Journal*, **22**, 1200-1207. https://doi.org/10.1007/s10995-018-2505-2

[17] Higginbottom, G.M.A., Evans, C., Morgan, M., *et al* (2020) Access to and Interventions to Improve Maternity Care Services for Immigrant Women: A Narrative Synthesis Systematic Review. *Health Services and Delivery Research*, **8**, 70-71. https://doi.org/10.3310/hsdr08140

[18] Lunze, K., Higgins-Steele, A., Simen-Kapeu, A., *et al.* (2015) Innovative Approaches for Improving Maternal and Newborn Health—A Landscape Analysis. *BMC Pregnancy Childbirth*, **15**, Article No. 337. https://doi.org/10.1186/s12884-015-0784-9

[19] José, T.P., Clara, Z. and Jorge, T.R. (2017) Modeling and Testing Maternal and Newborn Care mHealth Interventions: A Pilot Impact Evaluation and Follow-Up Qualitative Study in Guatemala. *Journal of the American Medical Informatics Association*, **24**, 352-360. https://doi.org/10.1093/jamia/ocw102

[20] Lee, S.H., Nurmatov, U.B., Nwaru, B.I., *et al.* (2016) Effectiveness of mHealth Interventions for Maternal, Newborn and Child Health in Low- and Middle-Income Countries: Systematic Review and Meta-Analysis. *Journal of Global Health*, **6**, Article ID: 010401. https://doi.org/10.7189/jogh.06.010401

[21] Hazra, A. and Mondal, S.K. (2018) Mobile Phone Messaging to Husbands to Improve Maternal and Child Health Behavior in India. *Journal of Health Communication*, **23**, 542-549. https://doi.org/10.1080/10810730.2018.1483444

[22] Nasir, S., Goto, R., Kitamura, A., Alafeef, S., Ballout, G., Hababeh, M., Kiriya, J.,

Seita, A. and Jimba, M. (2020) Dissemination and Implementation of the e-MCH Handbook, UNRWA's Newly Released Maternal and Child Health Mobile Application: A Cross-Sectional Study. *BMJ Open*, **10**, e034885.
https://doi.org/10.1136/bmjopen-2019-034885

[23] Paulsamy, P., Easwaran, V., Ashraf, R., Alshahrani, S.H., Venkatesan, K., Qureshi, A.A. and Manoharan, V. (2021) Association of Maternal Observation and Motivation (MOM) Program with m-Health Support on Maternal and Newborn Health. *Healthcare*, **9**, Article 1629. https://doi.org/10.3390/healthcare9121629

[24] Shankar, P., Ruby, N., Aditi, G., Pankaj, B., Madhu, G. and Jarnail, S.T. (2017) Impact of m-Health Application used by Community Health Volunteers on Improving Utilisation of Maternal, Newborn and Child Health Care Services in a Rural Area of Uttar Pradesh, India.

[25] Abir, T., *et al.* (2017) The Impact of Antenatal Care, Iron-Folic Acid Supplementation and Tetanus Toxoid Vaccination during Pregnancy on Child Mortality in Bangladesh. *PLOS ONE*, **12**, e0187090. https://doi.org/10.1371/journal.pone.0187090

[26] Merck (2021) Maternal Health Innovations and Digital Divide.
https://www.merckformothers.com/docs/MfM_Report_How_maternal_health_innovations_are_closing_the_digital_divide.pdf

[27] Owoyemi, A., Osuchukwu, J.I., Azubuike, C., *et al.* (2022) Digital Solutions for Community and Primary Health Workers: Lessons from Implementations in Africa. *Frontiers in Digital Health*, **4**, Article ID: 876957.
https://doi.org/10.3389/fdgth.2022.876957

[28] Vasudevan, L., Ostermann, J., Moses, S.M., Ngadaya, E. and Mfinanga, S.G. (2020) Patterns of Mobile Phone Ownership and Use among Pregnant Women in Southern Tanzania: Cross-Sectional Survey. *JMIR mHealth and uHealth*, **8**, e17122.
https://doi.org/10.2196/17122