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Postnatal Maternal Outcomes of a Targeted Mobile Phone Intervention Use in Antenatal Care amongst Pregnant Women in a Pastoralist Community in Narok County, Kenya: a Randomized Controlled Trial

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ABSTRACT
Introduction:
Complications occurring in pregnancy, at delivery and in puerperium are the leading causes of mortality and morbidity in Women of Reproductive Age (WRA) globally.Antenatal care (ANC) is a key high impact strategy to improve maternal and child health globally.Using technology in maternal health (mHealth) improves outcomes.
Methods:
The study was conducted in Narok County, Kenya. The study population comprised women of reproductive age who were expectant and attending antenatal care. A Randomized Controlled Trial was conducted to determine the effect of a targeted mobile phone intervention on antenatal care attendance and the subsequent postnatal outcomes. A total of 280 study participants were recruited and followed up to 6 weeks post-delivery. Recruitment began in June 2018 and the study closed in March 2021. 140 participants received the intervention while 140 received the routine care. Randomization was done at individual level.
Results:
262 study participants (93.5%) completed the trial. For the 132 study participants in the intervention arm, 80.3% (n=106) of the mothers had no complication at birth while 19.7% (n=26) reported complications at birth while for 130 the study mothers in the non-intervention arm, 63.08% (n=82) of the mothers had no complication at birth while 36.92% (n=48) of them had complications at birth. The difference in proportions for those with complications was 17.23% (95% CI 6.51-27.94%) which was statistically significant at 95% confidence level (p value = 0.002).
Conclusion:
A targeted mobile phone intervention used in antenatal care in pregnant women in a pastoralist community was associated with fewer complications and improved maternal outcomes at delivery in Narok County, Kenya.
Key Words: Antenatal Care, mHealth, Postnatal Outcomes, Complications at Birth

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I. INTRODUCTION

Background

Women of Reproductive Age (WRA) suffer many complications during pregnancy, at delivery and in puerperium leading tohigh mortality and morbidity globally and more especially in the Lower and Middle Income Countries (LMICs) [1]. It estimated that a woman dies every 90 seconds from the complications of pregnancy and childbirth [2]. The morbidity burden is also huge with high number of women suffering pregnancy-related illnesses or experiencing severe consequences including infertility, obstetric fistulas and incontinence [3].

A World Health Organization (WHO) global analysis of all the maternal mortalities between 2003 and 2009 found that 73% were due to direct obstetric complications and isolated the top three causes as hemorrhage at 27.1%, hypertensive disorders at 14% and sepsis at 10.7% [4]. The majority of these mortalities and morbidity are due to preventable causes and almost all of them (99%) occur in the LMICs [5].

The Kenya Demographic Health Survey (KDHS) 2014 estimated Maternal Mortality Ratio (MMR) for Kenya to be 362 deaths per 100000 live births [6]. World Bank models estimated MMR in Kenya to be 510 deaths per 100000 live births in 2015 [7]. This same ratio was similarly estimated to be 687 deaths per 100000 live births in 1990 in Kenya [7]. The figures indicate that there has been slow progress in tackling the challenge of maternal mortality and morbidity in Kenya since 1990 despite its prioritization in national policies (e.g. Linda

Mama), the United Nations' Millennium Development Goals (MDG's) and Sustainable Development Goals (SDG's).

MMR remains a key and sensitive indicator of the quality of maternal and child healthcare being offered and by proxy also the general quality of health care delivery in a country. It is a measure of the risk of death once a woman has become pregnant and is considered a primary and important indicator of a geographic area's overall health status or quality of life [8] given that pregnancy should, as much as possible, be treated as a normal physiologic process. Women in developing countries face a lifetime risk of maternal death of 1 in 160 compared to 1 in 3700 for those in developed countries [9]. The inequalities are driven by a myriad of causes a major one being limited access to basic preventive services.

Antenatal care (ANC) is a key high impact strategy to improve maternal and child health globally (1). WHO currently recommends at least 8 visits during the woman's pregnancy that should be arranged based on the impact of each visit during the progress of the pregnancy and the overall cost effectiveness. [1] [10-13]. Good quality ANC care can reduce maternal morbidity and mortality and perinatal morbidity [5] [14]. In LMICs, only about half of pregnant women receive the WHO recommended minimum ANC visits [15]. It is also recommended that women should have at least one or more postnatal visits within 28 days of delivery [16-17].

Evidence shows that using technology in maternal health (mHealth) improves outcomes [18] [19]. Studies show that mobile phone technology is effective at changing behaviour to improve antenatal care and postnatal care attendance. The number of mobile subscriptions (SIM Cards) in Kenya was 53.2 million in 2019 compared to the population of 47.5 million Kenyans according to the National Population Census 2019 translating to mobile (SIM) penetration level of 112.0 percent [20]. Leveraging on this high mobile phone penetration within the country to improve health care services and outcomes is critical.

Problem Statement

Across Sub-Saharan Africa ANC attendance varies widely [6]. 74 % of pregnant women attend formal ANC at least once during their pregnancy [6]. However, only 44 % of women attend ANC four or more times [6] [7] [21]. The Kenya Health Demographic survey (KDHS) 2014 reported that 9 in 10 mothers saw a skilled provider at least once for ANC for their most recent birth in the five-year period before the survey [22]. However, only 58 % of women reported 4 or more visits [22]. The proportions vary widely across counties with West Pokot County reporting a proportion of 18.2% while Nairobi County reported 73 % [22]. Narok County reported 46.0 % [22]. It is worthwhile noting that this was self-reported survey data though, and recall bias likely to occur.

The low proportion of attendance of ANC has been correlated with poor prenatal and postnatal outcomes in Africa with maternal and infant morbidities and mortalities remaining high [23] [24]. Those mothers who attend more ANC visits are also more likely to deliver under a skilled healthcare attendant. These challenges coupled with inadequate services being offered in health facilities make the impact of antenatal services less than would be expected, compounded by socio-cultural challenges and lower literacy levels in some parts of Kenya making maternal and child health care delivery more complicated and the health outcomes less than favourable.

Study Justification

The field of mHealth is proposed as a potential solution to the many challenges facing middle and low-income countries in health care delivery [25]. Text messages have been shown to improve health seeking behaviour, treatment adherence, data collection and as a communication tool to improve patient follow up and data reporting [26-28]. Given that mHealth tools have been promising in behaviour change broadly, potential exists to improve essential preventive maternal and child health services as well.

This study was conducted in Narok County in Kenya, a majorly pastoralist community-occupied county. The county was selected because the Kenya Demographic Health Survey listed the counties with mostly pastoralist communities to be among the counties with the lowest 4^{th}ANC attendance [6]. These counties consequently have poor maternal and neonatal health outcomes [17]. The KDHS 2014 reported that in Narok County only 40% of the deliveries were assisted by a skilled healthcare attendant and only 39% of these deliveries were in a health facility, which was much lower than the mean national achievements of 62% and 61% respectively [6].

Study Objective

The main objective of the study was to study the effects of a targeted mobile phone intervention on antenatal care attendance and consequently the postnatal maternal outcomes among pregnant women in a pastoralist community. Its null hypothesis was that this intervention would not be associated with improvement in the postnatal maternal outcomes.

II. Methods

Study Site

The study was conducted in four health facilities in Narok County namely; the Narok County Referral Hospital, a level 5 Hospital; Ololunga Sub-county Hospital, a level 4 health facility; Ntulele Health Centre and Mulot Health Centre, both level 3 health facilities. The study population comprised women of reproductive age who were expectant and attending antenatal care in the Maternal and Child Health Clinics.

Study Design

We conducted a Randomized Controlled Trial (RCT) to determine the effect of a targeted mobile phone intervention on antenatal care attendance and subsequently on the postnatal maternal outcomes. The study was carried out on expectant mothers recruited early in pregnancy who on providing informed consent were enrolled and followed up for up to 42 days after delivery. A targeted mobile phone intervention was developed and administered to the women in the intervention study arm while those in the non-intervention arm received the routine antenatal care.

The intervention consisted of two components; the first a standardized Short-message Service (SMS) designed to include health education on importance of antenatal care attendance and a reminder to attend the ANC clinic regularly, which was sent every two weeks using an individualized messaging system immediately after the mother was recruited. The second component was a phone call reminder made one week before the date the study participant had been booked to attend the ANC clinic. Bookings were done on a monthly basis.

The SMS was translated into Swahili in order to reach all the ethnic groups within the county. Two research assistants were recruited at each participating facility and trained on the study protocol. They were then tasked with implementation of the study which involved recruitment, enrolment, timely sending of the standard text message to each mother in the intervention arm, calling of the study participants at the scheduled times and clinical management of the mothers.

Recruitment began in June 2018 and the study ended in March 2021. After recruitment, the research assistants would immediately call the principal investigator who would allocate the mother to their specific study arm using random numbers developed prior to start of the study. He would then relay the information to the assistants who would then record it in the study registers. They would then begin the intervention immediately depending on the study arm the study participant was allocated to. Randomization was done at individual level.

The postnatal outcomes were measured at birth in the maternity wards and recorded in the study questionnaire upon extraction from the postnatal registers. For those study mothers not found in the registers their data were collected from the government approved antenatal booklets when the mothers visited the postnatal clinics for immunizations. The study mothers who did not deliver in any of the participating health facilities and did not come for the immunizations were called using the phone numbers that they had provided at recruitment and the outcomes of their pregnancies recorded in the questionnaire. Those who delivered at home were advised to bring their babies for immunization.

Selection Criteria

Study participants were selected on the basis of the mother attending her first ANC within the first or second trimester. They were also required to own a mobile phone or have a contact within the household who owned a phone e.g. a spouse or parent. Additionally, they were to have been resident in the Narok County for at least 5 years prior to recruitment. Minors would be required to have a caregiver who would give informed consent. Mothers who did not give consent and those with co-morbidities were excluded from the study.

Sample Size

This study assumed alpha and power of the study to be 0.05 and 80% respectively. Forty percent of deliveries were skilled healthcare deliveries in Narok in 2014[6]. A20% improvement was assumed to be clinically significant in this study. Using the Fleiss' formula, the sample size calculation gave a sample size of 107 ANC mothers in each study arm. We adjusted the sample size by 10% to account for dropouts and 18% to account for contamination [29] giving each arm 140 study participants.

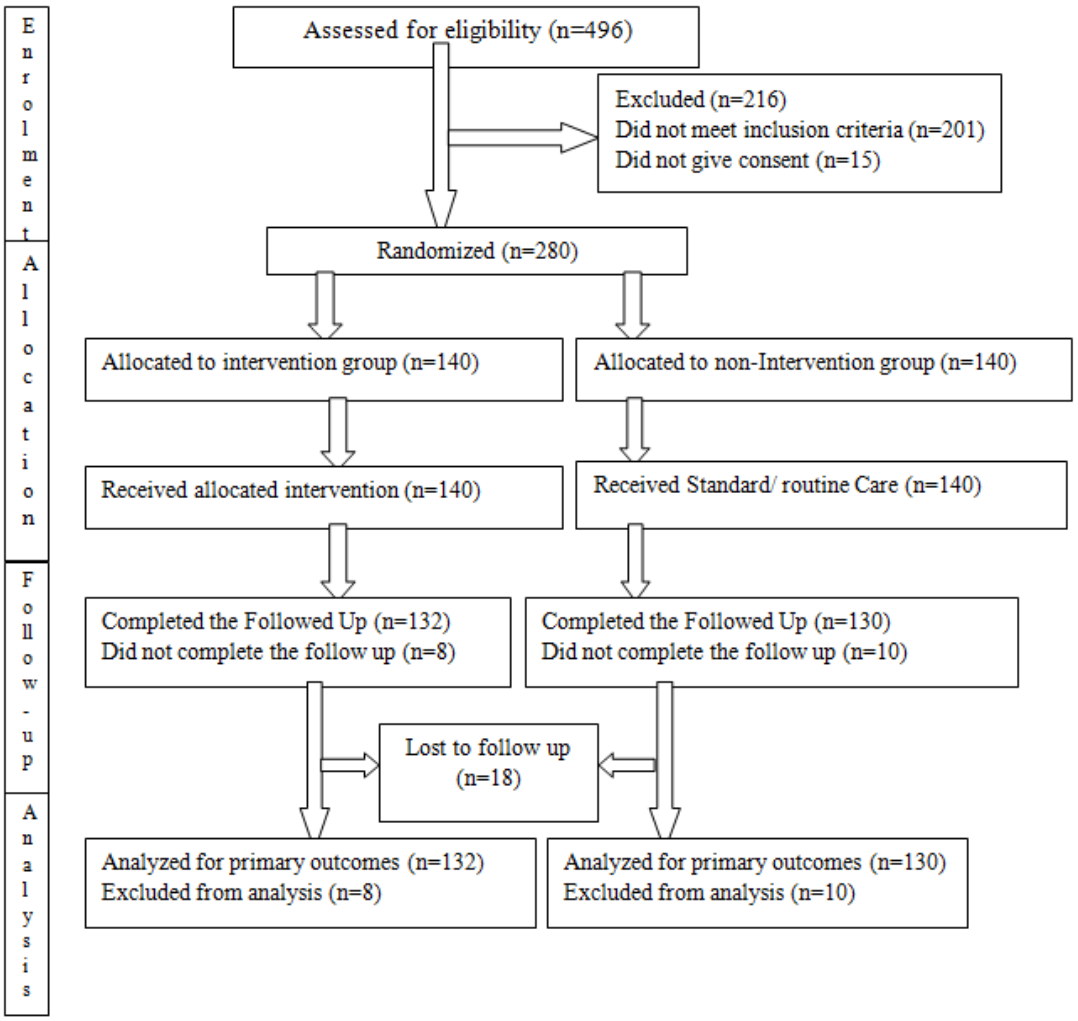
Data analysis was done using Stata statistical Software v14. Ethical approval was obtained from the Kenya Medical Research Institute's Scientific and Ethics Review Unit (SERU).

III. RESULTS

The Organization of the Randomized Control Trial (RCT):

The flowchart (Figure 1) derived from the CONSORT 2010 [30] guidelines on clinical trials, shows the study flow. Two hundred and sixty two (262) of 280 mothers completed the study (93.6% Completion rate).

Figure 1: Flowchart of Phases of Parallel Randomized Trial –Modified from CONSORT 2010



Baseline Characteristics

This is depicted in the table below showing the two groups were comparable at baseline on all variables (Table 1).

Table 1: Table showing the Baseline Characteristics of Study Participants

Variable	Intervention Arm(N=132)	Non-Intervention Arm (N=130)
Age (Years)	24.29 ± 5.29	23.44 ± 5.12
Marital Status: n (%)		
Married	115 (87.12)	111 (85.38)
Single	16 (12.12)	19 (14.62)
Separated	1 (0.38)	
Parity (Number of children)	1 ± 1.03	0.88 ± 1.29
Level of Education: n (%)		
Never Attended		7 (5.38)
Primary	47 (35.61)	47 (36.15)
Secondary	53 (40.15)	47 (36.15)
Tertiary	32 (24.24)	29 (22.31)
Level of Educ attained by Spouses: n (%)		
Never Attended	1 (0.76)	4 (3.08)

Primary	30 (22.73)	30 (23.08)
Secondary	47 (35.61)	48 (36.92)
Tertiary	38 (28.79)	29 (22.31)
Distance to a Health Facility: n (%)		
Less than 1 km	24 (18.18)	19 (14.62)
1 to 5 km	74 (56.06)	90 (69.23)
More than 5 km	34 (25.76)	21 (16.15)
Time taken to a Health Facility: n (%)		
Less than 15 minutes	20 (15.15)	12 (9.23)
15 to 30 minutes	38 (28.79)	35 (26.92)
30 to 60 minutes	56 (42.42)	74 (56.92)
More than 60 minutes	18 (13.64)	6 (6.92)
Spouses' Drinking/Smoking status: n (%)		
Didn't Drink or Smoke	95 (83.33)	92 (84.4)
Drank and/or Smoked	19 (16.67)	17 (15.6)
Key Decision Maker at Family Level: n (%)		
Couple together	41 (31.06)	41 (31.54)
Husband	33 (25)	32 (24.62)
Study Mother	53 (40.15)	51 (39.23)
Parent	4 (3.03)	5 (3.85)
Mothers with Previous Scar: n (%)		
With Scar	13 (9.85)	8 (6.15)
Without Scar	119 (90.85)	122 (93.85)
Height (Metres)	1.578 ± 0.066	1.57 ± 0.061
Weight (Kg)	61.35 ± 10.48	60.45 ± 10.79
BMI	24.92 ± 4.52	24.62 ± 4.77
Systolic BP (mmHg)	116.90 ± 13.57	114.90 ± 12.38
Pulse Rate	78.81 ± 6.82	79.73 ± 7.75
Temperature (^{0})	36.63^0±0.37	36.61^0± 0.43
Gestation at Enrolment by Fundal Height (Weeks)	19.43 ± 4.94	20.09 ± 4.39
Gestation at Enrolment by Dates (Weeks)	19.53 ± 6.44	20.13 ± 4.87
Time of Follow (Weeks)	20.59 ± 6.02	19.78 ± 5.04
Hemoglobin (g/dl)	11.75 ± 1.71	11.57 ± 1.46

Values are Means ± SD unless otherwise indicated

[a] Numbers may not add up to 132 or 130 due to missing values

Age at Baseline:

The majority of study participants (119) were aged between 20 and 24 years at 45.42%, followed by the 59 mothers aged between 25 and 29 years at 22.52%. The 50 study mothers aged 19 years and below (teens) were the third highest at 19.08%. The twenty study participants aged between 30 and 34 years formed 7.63 % of the study population while the eleven mothers aged between 35 and 39 years formed 4.198 % of the population. The least proportion of study participants were those aged 40 years and above forming 1.13%. The youngest study mother was 14 years while the oldest was 44 years.

Baseline Body Mass Index (BMI) of the Study Participants by Age

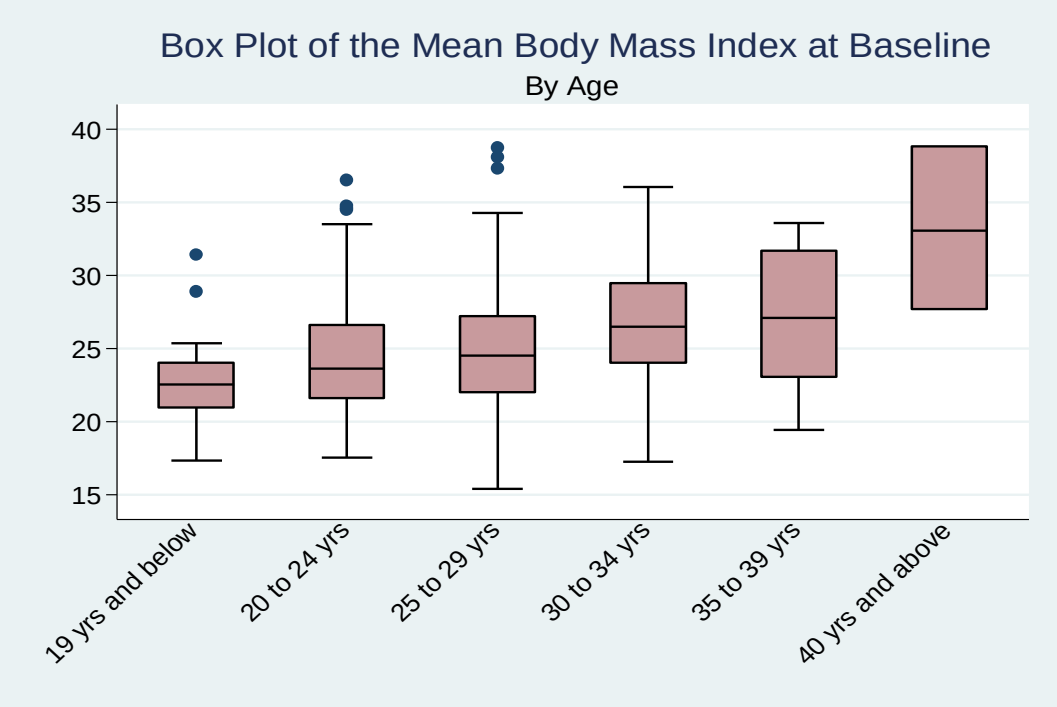
The mean BMI for the 39 study participants aged 19 years and below was 22.61 (SD 2.59, 95% CI 21.77-23.45) while it was 24.44 (SD 4.03, 95% CI 23.61-25.28) for the 92 study participants aged between 20 and 24 years.

The mean BMI for the 47 study participants aged between 25 and 29 years was 25.61(SD 5.87, 95% CI 23.89-27.34) while it was 26.59 (SD 4.46, 95% CI 24.22-28.97) with a median of 26.49 and a range of 18.81 for the 16 study participants aged between 30 and 34 years.

The mean BMI for the 10 study participants aged between 35 and 39 years was 26.80 (SD 4.81, 95% CI 23.36-30.25) while it was 33.18 (SD 5.58, 95% CI 19.33-47.04) for the 3 study participants aged 40 years and above.

This information is summarized in the box plot below showing that the mean BMI at baseline increased with the age of the study participant (Figure 2).

Figure 2: Box Plot showing the Mean Body Mass Index (BMI) of Study Participants by Age



The Intervention:

The mean number of SMS sent to the 132 study mothers in the intervention arm was 11.93 messages (SD 2.50 95% CI 11.50-12.36). The median number of SMS sent was 12 messages with a range of 15 messages (Low4, High 19). The mean number of calls done to the 132 study mothers was 4.68 calls (SD 1.24, 95% CI 4.47-4.89). The median number of calls was 4.5 calls and a range of 6 calls (Low2, High8).

The 131 study mothers in the intervention arm had a mean of 4.10 visits (SD 0.76, 95% CI 3.97-4.23). The 128 study mothers in the non-intervention arm had a mean of 2.84 visits (SD 0.95, 95% CI 2.68-3.01). The difference in means was 1.256 visits (95% CI 1.044-1.467) which was statistically significant at 95% confidence level (p-value<0.0001).

The Place of Delivery by Study Group

For the 130 study participants who were in the intervention study arm, 10% (n=13) delivered at home while 90% (n=117) delivered in a health facility. For the 128 study participants who were in the non-intervention study arm, 30.47% (n=39) had a home delivery while 69.53% (n=89) delivered in a health facility. The proportion of the mothers who delivered at home was three times higher in the non-intervention arm compared to the intervention arm.

Maternal Complications

98.47% (n=258) of the study participants reported on the maternal status at delivery and immediate postnatal period. Of these, 66.67% (n=172) reported having had no maternal complication at delivery while 33.33% (n=86) reported a complication equivalent to prevalence of complications.

Type of Complications at Delivery

The commonest complication at delivery reported was prolonged labour constituting 30.14% (n=22) of all the complications, followed by bleeding constituting 21.92% (n=16) of all the complications. Perineal injuries constituted 6.85% (n=5) of all reported complications while hypertension was at 5.48% (n=4). Miscarriages constituted 6.85% (n=5) while premature labour was at 5.48% (n=4). Infections were reported in two mothers making 2.74% of all complications while three mothers reported having had a previous scar (4.11%). Cephalo-pelvic disproportion was reported in three mothers (4.11%) while one mother had cervical prolapse. There were three maternal mortalities constituting 4.11% of all complications.

Maternal Complications by Study Group

For the study participants in the intervention arm, 80.3% (n=106) of the mothers had no complication at birth while 19.7% (n=26) had complications at birth. For the study mothers in the non-intervention arm, 63.08% (n=82) of the mothers had no complication at birth while 36.92% (n=48) of them had complications at birth. One maternal death occurred amongst those study participants who were in the intervention study arm while two maternal deaths occurred amongst those who were in the non-intervention study arm.

Maternal Complications by Place of Delivery

Examining the likelihood of having any complication at birth showed that for the 52 mothers who delivered at home, 38.46% (n=20) had no complication at delivery while 61.54% (n=32) had a complication. For the 206 mothers who delivered in the hospital, 81.55% (n=168) of them had no complication at birth while 18.45% (n=38) had a complication. This indicated that the likelihood of having any complication at delivery was 3.33 times higher in the mothers who delivered at home compared to those who delivered in hospital. All the three maternal deaths occurred amongst those study participants who delivered at home.

Maternal Complications by Body Mass Index (BMI)

For the 8 study mothers who were classified as underweight, 25% (n=2) had no complication at birth and the immediate postnatal period while 75% (n=6) had a complication. For the 114 study mothers who were of normal weight, 68.42% (n=78) had no complication at birth and the immediate postnatal period while 31.58% (n=36) had a complication.

For the 55 study mothers who were classified as overweight, 69.09% (n=38) had no complication at birth and the immediate postnatal period while 30.91% (n=17) had a complication. For the 21 study mothers who were classified as obese class I, 52.38% (n=11) had no complication at birth and the immediate postnatal period while 47.62% (n=9) had a complication. For the 6 study mothers who were obese class II, 33.33% (n=2) had no complication at birth and the immediate postnatal period while 66.67% (n=4) had a complication. The one study mother who was obese class III had a maternal complication at birth.

HYPOTHESES TESTING

Any Maternal Complication at Birth by Study Group

Student t-test of proportions of the null hypothesis that there was no difference in the proportions of study participants who had complications at birth between the two study arms was done.

The difference in proportions was 17.23% (95% CI 6.51-27.94%) between the intervention (19.70%) and the non-intervention (36.92%) study arm. This difference was statistically significant at 95% confidence level (p value = 0.002) and thus the null hypothesis was rejected.

Any Complication at Birth by Place of Delivery

Student t-test of proportions of the null hypothesis that there was no difference in the proportions of study participants who had complications at birth between those who delivered at home and those who delivered in hospital was done. This difference in proportion between the study participants who had a complication at birth was 43.09% (95% CI 28.85-57.34%) between those who delivered at home (61.54%) and those who delivered in a hospital (18.45%). This difference was statistically significant at 95% confidence level (p value <0.0001). Thus the null hypothesis was rejected.

Any Complication at Birth by Parity

The null hypothesis of there being no difference in the likelihood of having any complication at birth for the study participants by parity was tested by use of the Chi Square Goodness of Fit test.

It was found that the difference was statistically significant at 95% confidence level (p value = 0.026 and Pearson Chi^2 statistic = 9.2222). Thus the null hypothesis was rejected meaning the higher the parity the higher the likelihood of a maternal complication.

Any Complication at Birth by Distance to a Health Facility

The null hypothesis of there being no difference in the likelihood of having any complication at birth for the study participant by the distance travelled to a health facility was tested using the Chi Square Goodness of Fit test. The difference was not statistically significant at 95% confidence level (p value = 0.381 and Pearson Chi^2 statistic = 1.9299). Thus the null hypothesis was not rejected; hence distance did not contribute to likelihood of a maternal complication.

LOGISTIC REGRESSION MODEL

Checking for Statistical Significance of Independent Variables

In order to build a logistic regression model, first the dependent variable was bivariately regressed with all the independent variables to check for their statistical significance. Then multivariate logistic regression modeling was done with the statistically significant independent variables forming the basis. The results are shown in the table below (Table 2).

Table 2: Table showing the Bivariate Regression Results of the Dependent Variable and the Independent Variables

Dependent variable	Independent Variable	Odds Ratio	p-value	Confidence Interval (95%)	McFadden's R^2
Complic_birth	None	0.3936	0.000	0.3008-0.5151	0.0000
	Age	0.9990	0.971	0.9487-1.0520	0.0000
	Parity	1.0911	0.446	0.8721-1.3651	0.0018
	BMI	1.0431	0.192	0.9790-1.1114	0.0068
	SBP	0.9864	0.205	0.9658-1.0075	0.0052
	Gestation_FH	1.0225	0.459	0.9640-1.0845	0.0018
	Hemoglobin	0.9016	0.286	0.7455-1.0904	0.0046
	Place_del	0.1414	0.0000	0.0730-0.2736	0.1172
	Assist_Del-2	6.4306	0.0000	2.7635-14.964	0.1177
	Assist_Del-3	7.8596	0.0000	3.2298-19.126	
	NoofANCVisits	0.4352	0.0000	0.3236-0.5853	0.1172
	Mode_del	0.1839	0.0000	0.0871-0.3885	0.0672
	NoofSMSsend	0.8743	0.134	0.7334-1.0422	0.0175
	NoofCallsDone	0.6132	0.018	0.4086-0.9202	0.0485
	Days at Enrol	1.0083	0.036	1.0006-1.0161	0.0169
	DaysofFollowup	0.9946	0.235	0.9858-1.0035	0.0068
	Study Group	2.3865	0.002	1.3665-4.1678	0.0311
	Hosp Level 1	1.7567	0.157	0.8054-3.8313	0.0065
	Level 2	1.1948	0.580	0.6358-2.2451	
	Maritalstatus	0.8574	0.710	0.3811-1.9291	0.0005
	Educ_level2	0.3871	0.232	0.0816-1.8358	0.0187
	level3	0.2368	0.071	0.0495-1.1335	
	level4	0.2234	0.068	0.0446-1.1193	
	Distance_Hosp	0.6527	0.236	0.3223-1.3217	0.0047
	Time_Hosp	1.1396	0.643	0.6559-1.9801	0.0007

The following variables were statistically significant on bivariate regression; place of delivery (OR 0.1414, 95% CI 0.073-0.274, p value <0.0001); assistant at delivery (OR 6.43, 95% CI 2.763-14.964 for relative, OR 7.860, 95% CI 3.230-19.126 for traditional birth attendant, p value <0.0001); mode of delivery (OR 0.184, 95% CI 0.087-0.388, p value <0.0001); number of ANC visits (OR 0.435, 95% CI 0.327-0.585, p value <0.0001); number of calls done (OR 0.613, 95% CI 0.407-0.920, p value = 0.018); gestation at enrolment in days (OR 1.008, 95% CI 1.0006-1.016, p value = 0.036), and study group (OR 2.387, 95% CI 1.367-4.168, p value = 0.002).

After several iterations of multivariate regression with independent variables, the model with all these statistically significant independent variables, excluding study group due to covariance and adding the age, BMI, parity and education level, was found to be the best (p value = 0.0002 and McFadden's R^2= 0.4154). The AIC and BIC for this model were 70.04 and 97.90 respectively.

This information is summarized in the table below (Table 3).

Table 3: Table showing the Multivariate Logistic Model

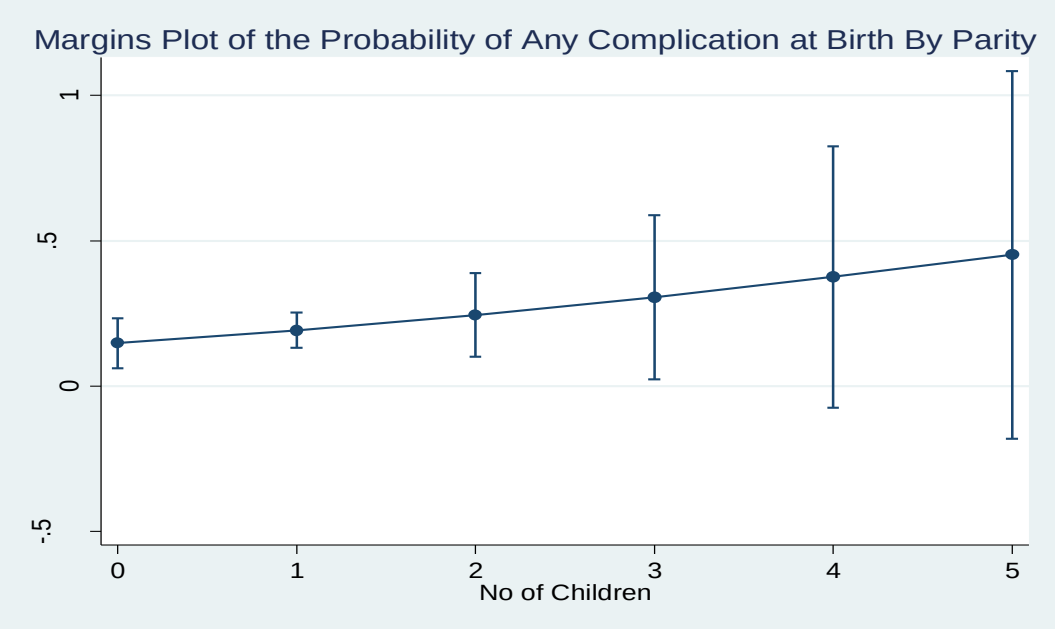
Dependent variable	Covariate	Odds Ratio	p-value	Confidence Interval (95%)	McFadden's R^2	Model p-value	AIC and BIC
Complic_birth	Age	0.8185	0.137	0.6285-1.0659	0.4154	0.0002	70.04
	BMI	1.1184	0.268	0.9174-1.3636			97.90
	No_of_Children	1.0083	0.990	0.2704-3.7591			
	Educ Level 3	0.1345	0.063	0.0162-1.1139			
	Educ Level 4	0.2493	0.285	0.0195-3.1819			
	Place_Del	0.5964	0.741	0.0277-12.832			
	No_of_ANCVisits	0.5260	0.213	0.1914-1.4455			
	Mode_Del	0.0190	0.001	0.0020-0.1813			
	No_of_Calls_Done	0.7138	0.311	0.3718-1.3705			
	Days_at_Enrol	1.0171	0.099	0.9968-1.0378			
	Constant	403.40	0.196	0.0455-3573634			

In the model, mode of delivery remained statistically significant, holding all the other variables constant, showing that for every delivery that was done via spontaneous vertex delivery compared to a Cesarean section, the odds of having any complication at birth decreased by a factor of 0.0190 (95% CI 0.002-0.181, p value = 0.001).The interaction between the independent variables was examined and all the interaction terms were found to be statistically insignificant.

Marginal Plot:

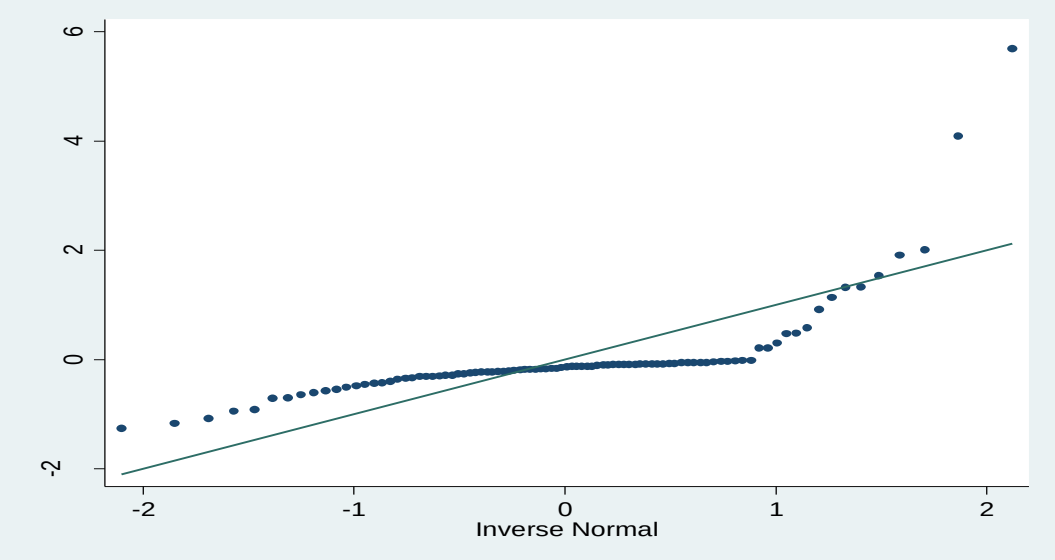
The probability of any maternal complication at birth was calculated by the parity of the study participant and it showed that for every unit increase in the number of children that the study participant had there was an increase in the probability of having any complication after adjusting for all the other variables (Figure 3).

Figure 3: Marginal Plot of the Probability of having Any Complication at Birth by Parity



The predictive plots including the p norm, Kernel density and Q norm plot (Figure 4) showed that the model was a good predictor of the dependent variable.

Figure 4: Q norm Plot



IV. DISCUSSION

Several studies have studied effects of components of mHealth applications/tools on antenatal care. However most of the studies have focused on single components (majorly SMS) and single endpoint - ANC attendance by itself [31-37]. A cluster RCT study done in Zanzibar by Lund S et al was unique because it was bi-component studying SMS and a voucher system to improve ANC attendance and found that this intervention improved ANC attendance (44% vs. 31% for intervention group and nonintervention group respectively (OR 2.39, 95% CI 1.03-5.55) [12]. The current study found an OR 2.387, 95% CI 1.367-4.168, p value = 0.002) which was quite similar to the findings of the Zanzibar Study.

As far as we know no study has recruited mothers early in pregnancy and combined two components of Mhealth (SMS and Calls) then followed up the mothers up to delivery to examine the effects of these mHealth components on postnatal outcomes. In this study, the difference in proportion of the likelihood of a study participant having any complication at birth was 17.23% (95% CI 6.51-27.94%) between the intervention and the non-intervention study arm, which was statistically significant at 95% confidence level (p value = 0.002).On bivariate regression, the number of calls done was statistically significant (p value = 0.018) while the number of SMS done was not (p value = 0.134). Combining these two components of the intervention was useful to improve attendance and by extension the postnatal outcomes.Having attended more ANC visits was associated with lower odds of having any type of complication for study mothers.

Receiving more calls during the antenatal period was associated with lower odds of having any complication at birth. Delivering at home was associated with increased odds of having any type of complication and also neonatal mortality. Using a relative or a traditional birth attendant was associated with having higher odds of having any type of complication and also neonatal mortality.

Multivariate regression model showed that the model was statistically significant, had good McFadden's R^2 of 41.54% and AIC and BIC of 70.04 and 97.90 respectively and was a good predictor of the postnatal outcomes.

V. Conclusion

A targeted mobile phone intervention used in antenatal care in pregnant women in a pastoralist community was associated with fewer complications and improved maternal outcomes at delivery in Narok County, Kenya.

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