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Mobile phone call reminders to improve oral rehydration salt and zinc adherence for acute diarrhea in children: a single-center, randomized controlled trial

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Abstract

Background Low-osmolarity oral rehydration salt (ORS) and zinc therapy effectively manage diarrhea in children under five years of age, offering both short- and long-term benefits. Despite this, caregivers' adherence to ORS and zinc is often unsatisfactory due to factors such as forgetfulness, resolution of symptoms, and underestimation of the disease's severity. This study assessed the effect of mobile call reminders on ORS and zinc tablet adherence among children with acute diarrhea in a secondary-level health facility in Kwara State, Nigeria.

Methods Using an open-label, randomized controlled trial design, this study compared caregiver-child pairs with acute diarrhea aged 6–59 months who received standard instructions (SI) alone (control group) and an intervention group (IG) who received SI plus phone call reminders on days three and seven of zinc sulfate therapy. All participants used a pictorial diary to track loose/watery stools and ORS and zinc tablet treatments for ten days. The primary outcome measures were independent and combined adherence to ORS and zinc therapy. The secondary outcomes were independent and combined adherence scores, defined as the percentage of times the ORS was given post-diarrhea and the percentage of prescribed zinc tablets administered out of ten.

Results A total of 364/400 mother–child pairs completed the study. The percentage of mothers with full adherence in the intervention group was 82.5% for ORS, 72.1% for zinc, and 58.5% for combined use, compared to 78.8%, 60.8%, and 43.6%, respectively, in the control group. The odds of full adherence to ORS and zinc were 1.6 and 1.7 times higher among intervention mothers [ORS: OR = 1.561, 95% CI = 0.939–2.598, $P = 0.085$; zinc: OR = 1.671, 95% CI = 1.076–2.593, $P = 0.022$], and 1.8 times higher for combined use according to WHO guidelines [OR = 1.818, 95% CI = 1.200–2.754, $P = 0.005$]. The mean adherence scores for the intervention group were higher than those for the control group by 4.1% (95% CI = 0.60–7.60) for ORS, 7.3% (95% CI = 3.74–10.86) for zinc, and 5.7% (95% CI = 3.23–8.17) for the combined treatment.

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Conclusion Phone reminders can effectively improve consistency of home treatment administered by caregivers for children under five years old.

Trial Registration The study was registered retrospectively (17/3/2023) with the Pan African Clinical Trial Registry (PACTR202301560735856).

Keywords Acute diarrhea management, Mobile phone call reminders, Outpatient, Underfives

Introduction

Diarrhea poses a significant threat to children less than five years of age [1]. It is the fourth leading contributor to morbidity and mortality among these age groups [1]. In 2015, diarrhea accounted for 8.6% of overall mortality among children under five years in Nigeria and 10% in the African region [1–4]. Dehydration, although preventable, is the most common cause of diarrhea-related deaths [5].

In 2004, the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) recommended the use of low-osmolarity oral rehydration salts (ORS) and zinc for treating childhood diarrhea [6]. This combination can prevent more than 95% of deaths associated with diarrhea in children [6]. Zinc supplementation improves the outcome of acute diarrhea and reduces the incidence of future diarrhea episodes over the next two to three months; however, these benefits are not observed with poor adherence [7].

Despite the proven effectiveness of this treatment, adherence rates among caregivers to ORS and zinc remain unsatisfactory: According to the 2018 Nigeria Demographic Health Survey, only 31% of children received zinc, 40% received ORS, and 23% received a combination of both for diarrhea treatment at home [8–14]. Earlier studies reported that independent adherence to ORS or zinc ranged between 38% and 76% among children with diarrhea [8–10]. Recently, a higher zinc adherence of 84% was reported in Tanzania. However, this indicates that adherence to home management of diarrhea does not meet the WHO recommendations [11]. Reasons for inadequate adherence were forgetfulness, resolution of symptoms, underestimation of disease severity, vomiting of drugs, and worsened symptoms, among others [8, 9, 11].

Fogg's Behavior Model states that motivation, ability, and a trigger are needed to execute behavior. Mobile phone reminders are a modern trigger [15]. Additionally, mobile phones are widely available, making their use practical [16]. In 2014, 89% of Nigerian adults owned a phone, while approximately half of those who did not have one could access a mobile phone owned by someone else [16]. In the same year, interviews conducted among 4000 Nigerian adults showed that 96.5% of all who owned or had access to a mobile phone had used it to make or receive phone calls in the preceding week [17].

In an immunization clinic in Ilorin, Nigeria (2017), the phone ownership rate was 92.7% [18]. Some studies have demonstrated the efficacy of mobile phones in disease prevention, home monitoring, clinic attendance, self-management of diseases, and improved practices among health workers [12, 19–23]. Thus, mobile phones reminders (call and text messages) may play a role in improving ORS and zinc adherence.

A study conducted in Ilorin, Nigeria demonstrated caregivers' preference for phone calls over text messages [24]. Caregivers who received call reminders could make further clarifications and callback if the initial attempt was missed although high cost and administrative efforts were identified disadvantages [24]. The impact of text and call reminders on zinc adherence was evaluated in Tanzania (11). A study in India employed phone calls to evaluate caregivers' compliance with zinc therapy [13]. In Ghana, researchers assessed the impact of text messages on the rate at which drug sellers recommended ORS and zinc for diarrhea management [20]. Yet, the evidence demonstrating the impact of phone reminders on diarrhea management remains low.

The optimal use of ORS and zinc is crucial for maximizing their proposed benefits [6, 7]. Therefore, interventions that can improve drug treatment for childhood diarrhea are vital. This can be done by utilizing a widely acceptable and accessible tool to address factors that negatively impact adherence [8, 9]. Thus, this study aimed to determine whether mobile phone calls improve the use of ORS and zinc for treating childhood diarrhea.

Methods

The study was an open-label, randomized controlled trial conducted at the outpatient clinic of a secondary health facility that caters to children aged one month to 14 years in Ilorin, an urban city located in North Central Nigeria. The facility is centrally located in Ilorin metropolis and is easily accessible. It provides 24-hour emergency, inpatient, and outpatient care, with an average of 1600 outpatients and 150 cases of diarrhea in children under five per month, peaking between December and February.

The study adhered to the CONSORT guidelines [25]. Eligibility criteria included children aged six to fifty-nine months who presented within the study period (January 1st to May 31st, 2019) with acute diarrhea, defined as at least three abnormally loose or watery stools in the

preceding 24 h) [5]. Inclusion criteria required a caregiver-child pair with acute diarrhea, who could receive drugs on an outpatient basis, owned a mobile phone or had ready access to one, and consented to participate in the study. Exclusion criteria included persistent vomiting, severe dehydration, surgical intervention, prior ORS and zinc use, and inability to return for follow-up visit. Ethical approval was obtained from the University of Ilorin Teaching Hospital (UIH) Ethical Review Committee (ERC) and the State Ministry of Health. There was no external data safety monitoring board involved but the Institutional ERC had a team that provided oversight. Only mothers who provided written consent were included.

The sample size for determining adherence was calculated using the formula for comparing proportions [26].

$$n = \frac{(z_{\alpha} + z_{1-\beta})^2 [p_1(1-p_1) + p_2(1-p_2)]}{(p_1 - p_2)^2}$$

Where n is the minimum sample size in each group, p_1 is the combined ORS and zinc adherence score (72%) from an earlier study [9], and p_2 is the predicted adherence following phone call reminders (86%). Assuming a 5% level of significance ($Z_{\alpha} = 1.96$), a power of 90% ($Z_{1-\beta} = 1.28$), and an attrition rate of 15%, the calculated sample size was 200 per group. Hence, 200 children were recruited for both intervention and control groups.

Enrollment occurred on the day of the clinic visit. Baseline data collected included demographics, anthropometry, clinical features, phone number(s), and home address, along with the preferred time for receiving phone calls. Data collection was performed by the researchers and trained medical officers.

Participants were allocated to one of two groups:

1. The intervention group (IG) received phone call reminders on days 3 and day 7, in addition to standard care.
2. The control group (CG) received only standard care.

Four hundred subjects were recruited and randomly assigned to either the intervention (200) or control (200) group using simple randomization. Four hundred random numbers were electronically generated and pre-labeled as either “A” or “B,” for the intervention and control groups, respectively. Each eligible mother picked a small envelope from a sealed bag containing pre-generated random numbers. The mother called out the number and this was checked against its corresponding label. Mother-child pairs with numbers labeled “A” were assigned to the intervention arm, while those with numbers labeled “B” were assigned to the control arm.

Standard care involved brief health talks about diarrhea in either Yoruba (the local language) or English, lasting about five minutes and treatment of diarrhea according to the study treatment protocol based on WHO recommendation [5]. The talks covered prevention and home treatment of diarrhea. Mothers were instructed to prepare and administer ORS after each loose stool until the illness stops, discard ORS 24 h after mixing, administer one zinc tablet daily for 10 days even after the diarrhea stops, and determine when to return to the hospital. Mothers received eight sachets of ORS, a sachet of ten 20 mg zinc sulfate tablets, and a follow-up slip. They were guided to mark a pictorial diary after administering a zinc sulfate tablet, after each instance of bowel movement, and ORS administration.

Live Phone calls were made as follows: Day one was the first day of contact, day ten was the last day of zinc therapy, and follow-up was on day eleven. Mothers in the IG received phone reminders using a prewritten script on the third and seventh days of zinc treatment. On the tenth day, mothers in both groups received phone reminders to confirm availability for the clinic follow-up visit on the eleventh day, with any necessary adjustments noted and made accordingly. A maximum of three phone call attempts were made at the scheduled time to the primary or alternative phone numbers. This process was repeated hourly until contact was made. A successful call indicated that the mother had received the information outlined in the phone script.

During the follow-up on day eleven, the total number of bowel movements and the number of episodes accompanied by ORS were counted and recorded from the diaries. The total number of zinc tablets administered out of ten was also documented.

Outcome measures

Outcome measures were calculated using the medication adherence diaries at the follow-up appointment on day eleven. The primary outcomes were independent and combined adherence to ORS and zinc therapy. The secondary outcomes were independent and combined adherence scores.

The independent ORS adherence score (%) was calculated as the percentage of times ORS was administered after each diarrheal episode. The independent zinc adherence score (%) was calculated as the percentage of zinc tablets administered out of ten. The combined adherence score (%) was calculated as the average of the ORS and zinc adherence scores. The binary full adherence outcomes (ORS, zinc, and combined) were defined as having a corresponding adherence score of 100%.

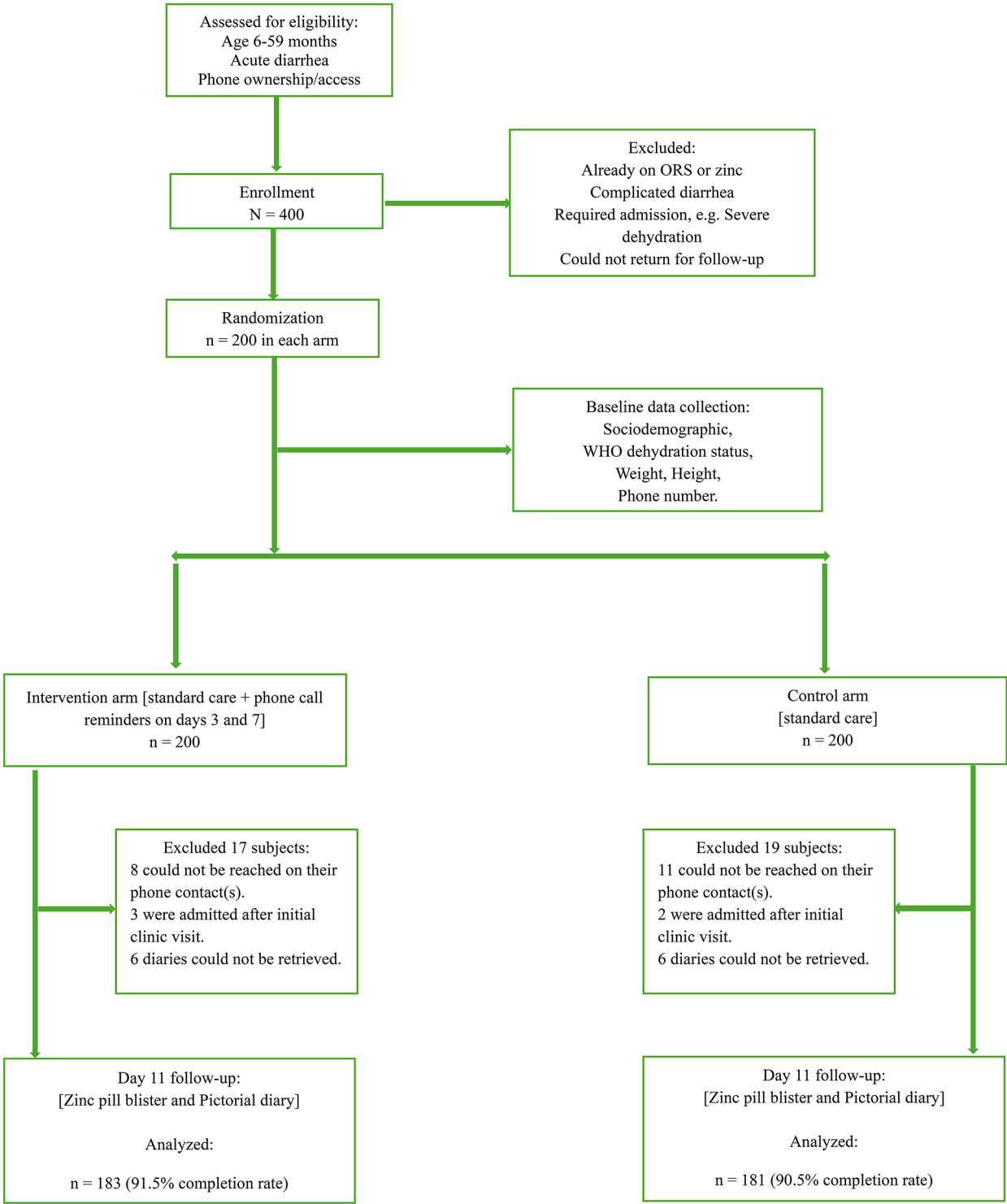


Fig. 1 Study flow diagram

Table 1 Socio-demographic characteristics of the subjects

Variable	Treatment group		
	Total N=364 (%)	Intervention n=183 (%)	Control n=181 (%)
Age (months)			
6 - < 12	164 (45.1)	86 (47.0)	78 (43.1)
12 - < 24	151 (41.5)	72 (39.3)	79 (43.6)
24 - < 60	49 (13.4)	25 (13.7)	24 (13.3)
Sex			
Male	202 (55.5)	97 (53.0)	105 (58.0)
Female	162 (44.5)	86 (47.0)	76 (42.0)
Mothers' age group (years)			
< 25	64 (17.6)	26 (14.2)	38 (21.0)
25–35	265 (72.8)	139 (76.0)	126 (69.6)
> 35	35 (9.6)	18 (9.8)	17 (9.4)
Mother's level of education			
No formal	13 (3.6)	9 (4.9)	4 (2.2)
Primary	16 (4.4)	9 (4.9)	7 (3.9)
Secondary	142 (39.0)	75 (41.0)	67 (37.0)
Postsecondary	193 (53.0)	90 (49.2)	103 (56.9)
Socioeconomic class			
Upper	68 (18.7)	27 (14.8)	41 (22.7)
Middle	174 (47.8)	90 (49.1)	84 (46.4)
Lower	122 (33.5)	66 (36.1)	56 (30.9)
Phone ownership / access			
Owned a phone	326 (89.6)	164 (89.6)	181 (89.5%)
Had access to a phone	38 (10.4)	19 (10.4)	19 (10.5%)

Figures in parentheses are percentages of the total

Statistical analysis

Data were input and analyzed using SPSS 20.0 (IBM Corp., New York, USA). Frequencies and proportions were calculated, and continuous variables are reported as the mean (standard deviation, SD) or median (interquartile range, IQR). The differences in the three binary full adherence outcomes, i.e. full ORS adherence, full zinc adherence and full combined adherence, between the two randomization groups were assessed by odds ratios (OR) with 95% confidence intervals (95%CI) from a simple logistic regression. The differences in the three adherence score outcomes, i.e. ORS adherence score, zinc adherence score, and combined adherence score, between the two randomization groups were assessed by mean differences with 95% CI from independent sample t-tests. A *p* value of < 0.05 was considered statistically significant.

Results

Four hundred subjects were recruited at the beginning of the study, but 364 completed it. Subjects who were admitted after the initial clinic visit, mothers who could not be reached by phone, and those whose diaries could not be retrieved were excluded from the analysis. The completion rate was 91.5% in the intervention group (IG) and 90.5% in the control group (CG) (Fig. 1).

Table 2 Clinical features present at enrollment

Variable	Treatment group		
	Total N=364 (%)	Intervention n=183 (%)	Control n=181 (%)
Duration of diarrhea before recruitment (hours)			
≤ 24	127 (34.9)	67 (36.6)	60 (33.2)
> 24 – ≤ 48	103 (28.3)	47 (25.7)	56 (30.9)
> 48 – ≤ 72	63 (17.3)	31 (16.9)	32 (17.7)
> 72	71 (19.5)	38 (20.8)	33 (18.2)
Vomiting			
Yes	216 (59.3)	108 (59.0)	108 (59.7)
No	148 (40.7)	75 (41.0)	73 (40.3)
Fever			
Yes	248 (68.1)	119 (65.0)	129 (71.3)
No	116 (31.9)	64 (35.0)	52 (28.7)
Dehydration			
Yes	227 (62.4)	112 (61.2)	115 (63.5)
No	137 (37.6)	71 (38.8)	66 (36.5)
Degree of dehydration			
No dehydration	137 (37.6)	71 (38.8)	66 (36.5)
Mild dehydration	72 (19.8)	39 (21.3)	33 (18.2)
Moderate dehydration	155 (42.6)	73 (39.9)	82 (45.3)

Figures in parentheses are percentages of the total

The socio-demographic characteristics of the children and their caregivers were similar (Table 1). All respondents at enrollment were mothers with a mean (SD) age of 29.1 (5.2) years.

The median (IQR) duration of diarrhea at enrollment was 2.0 (1.0–3.0) days, and this was comparable between the two groups. The clinical features at enrollment were similar between the groups (Table 2).

The odds of full adherence to ORS were 1.6 times greater among mothers who received phone call reminders, with 82.5% of mothers in the IG adhering fully compared to 75.1% in the CG, *P*=0.085 (Table 3).

Phone reminders significantly increased full adherence to zinc therapy by 1.7-fold (*P*=0.022). About 72.1% of mothers who received phone reminders administered the entire course of zinc to their children, compared to 60.8% in the control group (Table 3). On average, intervention group subjects received 9.4 (SD=1.2) zinc tablets, while control subjects received 8.7 (SD=2.1) tablets, (*P*<0.001).

The likelihood of administering ORS after every loose stool and giving all ten zinc sulfate tablets was 1.8 times higher among respondents in the IG (Table 3).

The mean±SD adherence scores for ORS, zinc, and their combined score were significantly higher in the intervention arm than in the control arm, with *p*-values as follows: ORS (*P*=0.020), zinc (*P*<0.001), and combined (*P*<0.001) (Table 4).

Table 3 The ORS and zinc therapy adherence of the caregiver-child pairs

	Treatment arm		Total	OR (95% CI)	χ^2	p value
Variable	Intervention	Control				
	n = 183 (%)	n = 181(%)	N = 364(%)			
ORS adherence						
Full	151 (82.5)	136 (75.1)	287 (78.8)	1.56 (0.94–2.60)	2.968	0.085
Partial	32 (17.5)	45 (24.9)	77 (21.2)			
Zinc adherence						
Full	132 (72.1)	110 (60.8)	242 (66.5)	1.67 (1.08–2.59)	5.268	0.022
Partial	51 (27.9)	71 (39.2)	122 (33.5)			
Combined adherence						
Full	107 (58.5)	79 (43.6)	186 (51.1)	1.82 (1.20–2.75)	8.002	0.005
Partial	76 (41.5)	102 (56.4)	178 (48.9)			

χ^2 : chi-square test; OR: odds ratio; 95% CI: 95% confidence interval

Table 4 Comparison of mean adherence scores in the intervention and control arms

Variable	Treatment arm		MD (95% CI)	p-value
	Intervention Adherence score Mean $\pm$ SD	Control Adherence score Mean $\pm$ SD		
ORS	95.5 $\pm$ 12.7	91.4 $\pm$ 20.4	4.1 (0.60–7.60)	0.020
Zinc	94.3 $\pm$ 11.8	87.0 $\pm$ 21.4	7.3 (3.74–10.86)	<0.001
Combined	94.9 $\pm$ 8.5	89.2 $\pm$ 14.7	5.7 (3.23–8.17)	<0.001

SD: standard deviation; MD: mean difference; CI: 95% confidence interval

Discussion

The mobile phone call reminders in the current study improved mothers' adherence to ORS and zinc treatments for diarrhea by approximately 1.6 and 1.7 times respectively, postintervention. Call reminders may address challenges like forgetfulness, a common reason why caregivers do not give ORS and zinc as expected. Administering ORS after each bowel movement can be cumbersome, especially with frequent loose stools or a child's refusal to drink the solution, which may lead to caregiver fatigue and discontinuation of treatment. Similarly, a caregiver may stop giving zinc tablets once diarrhea episodes end, because "giving medicines are usually associated with the presence of an ongoing illness". However, phone call reminders may prompt caregivers to continue administering ORS and zinc. During a call session, healthcare providers can correct any misconceptions about the treatment's effectiveness, dosage, and duration. Moreover, caregivers might feel a greater sense of responsibility and appreciation for healthcare providers, motivating them to adhere to the treatment regimen.

In this study, adherence was notably high, with around 75% and 61% of mothers in the control arm achieving full adherence to ORS and zinc, respectively. This is higher compared to 64% for ORS and 34% for zinc in the status quo arm of an Ethiopian study [9]. Similarly, zinc adherence was low in Kenya at 38% [12] and 47% in Benin [27]. The higher adherence observed in this study could be

due to increased awareness of the efficacy of these treatments and detailed counseling provided during enrollment. The use of pictorial medication diaries may have also heightened caregivers' awareness of the importance of administering the drugs. However, a previous study in Nigeria reported 76% adherence to zinc tablets [10]. The comparatively lower figure in the current study might be attributed to the mothers' educational status. The higher a mother's educational status is, the greater the likelihood that she will engage in jobs or roles that may not allow sufficient time for caring for her children, and vice versa [10].

The improved adherence with phone reminders aligns with findings from previous studies [27–30], although those studies were not specific to diarrhea. This study's use of medication diaries provided an objective measure of caregiver adherence, a key strength. However, potential limitations include the risk of caregivers not administering sufficient volume of ORS after bowel movement which could result in an underestimation of the true adherence to ORS therapy. Future research should include measures to verify adequate ORS administration. Additionally, the requirement for phone ownership or access may limit the generalizability of the findings. This may affect the intervention's applicability to diarrhea treatment in homes lacking mobile phones or good network services.

Conclusion

Phone call reminders effectively improve adherence to ORS and zinc treatment for managing diarrhea in children under five at home. Integrating these reminders into standard outpatient care could significantly reduce morbidity and mortality rates. However, the related administrative and organizational efforts might incur significant costs. Further research is recommended to assess the universal applicability and cost effectiveness of this intervention.

What is already known on this topic?

- In low-income countries, children have an average of three diarrhea episodes annually, accounting for 10% of global underfive morbidity and mortality.
- Combined, ORS and zinc can prevent up to 95% of diarrhea-related deaths. However, factors such as forgetfulness, underestimation of the severity of the illness, early resolution of symptoms, and vomiting of medications lead to 24–62% of caregivers forgetting to administer these treatments.

What this study adds?

- Our study suggests that mobile phone reminders improve adherence to ORS and zinc use in the home management of childhood diarrhea.
- Our study suggests that integrating mobile phone reminders into pediatric outpatient clinics could help manage acute illnesses and reduce morbidity.

Abbreviations

CG	Control Group
CI	Confidence Interval
ERC	Ethical Review Committee
IBM	International Business Machines
IG	Intervention Group
IQR	Interquartile Range
MD	Mean Difference
OR	Odds Ratio
ORS	Oral Rehydration Salt
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
SI	Standard Instruction
UIH	University of Ilorin Teaching Hospital
UNICEF	United Nations Children's Fund
USA	United States of America
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12913-024-11507-w>.

Supplementary Material 1
Supplementary Material 2

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Author contributions

TFK-A was involved in study conception, protocol development, data collection, analysis and interpretation, including the initial manuscript draft. RMI was involved in study conception, protocol development, data analysis and interpretation, and initial draft writing. KOA was involved in protocol development, data collection and analysis, and initial draft writing. SKE and AOB were involved in study conception, protocol development, analysis and

data interpretation. The manuscript was revised and received final approval for submission by all authors. TK-A is the guarantor of the study.

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Data availability

The dataset generated and analyzed during the current study is not publicly available because it is part of a larger data collection but is available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from the University of Ilorin Teaching Hospital (UIH) Ethical Review Committee (NHREC/02/05/2010) and Kwara State Ministry of Health. Before commencing the fieldwork, permission was obtained from the Medical Director of the Children Specialist Hospital, Ilorin. Informed consent to participate was obtained from all mothers included in the study. The study was registered retrospectively with the Pan African Clinical Trial Registry (PACTR202301560735856).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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